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The Effect of Environmental Corporate Social Responsibility on Environmental Performance and Business Competitiveness: The Mediation of Green Information Technology Capital

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Abstract With the emergence of environmental sustainability and green business management, increasing demands have been made on businesses in the areas of environmental corporate social responsibility (ECSR). Furthermore, the influence of ECSR on green capital investment, environmental performance, and business competitiveness has also been the subject of attention from enterprises. However, in previous studies, the mediating role of green information technology (IT) capital in the relationship between ECSR, environmental performance, and business competitiveness, has not been investigated by researchers. In order to bridge this gap in the ECSR literature, this study aims to examine the influence of ECSR on green IT capital, and the consequent effect of green IT capital on environmental performance and business competitiveness. Data were collected from 358 companies from the top 1000 manufacturers in Taiwan. The results confirmed that ECSR has significant positive effects on green IT human capital, green IT structural capital, and green IT relational capital. Green IT structural capital and green IT relational capital have positive effects on environmental performance and business competitiveness, and environmental performance has a positive effect on business competitiveness. In addition, green IT structural capital and green IT relational capital have partial mediating effects on ECSR, environmental performance, and business competitiveness. The implications and suggestions for future research are discussed.

Keywords Business competitiveness · Environmental corporate social responsibility (ECSR) · Environmental performance · Green IT capital · Green IT human capital · Green IT structural capital · Green IT relational capital

Introduction

With the rise of environmental awareness since the 1960s, enterprises have increasingly been required to comply with international treaties and regulations, such as the Montreal Protocol (1987), the Framework Convention on Climate Change (1992), European Union environmental directives (WEEE, RoHS, and EuP) (2003), and the Kyoto Protocol (2005). As a result, the norms associated with environmental treaties are of growing international importance, and implementation has become increasingly strict, producing an enormous impact on the business environment (Shrivastava 1995; Porter and Van der Linde 1999; Chen 2008; Chuang and Huang 2015).

In addition to international environmental treaties, businesses have also begun to recognize environmental protection as part of corporate social responsibility (CSR) in response to international environmental thinking and greater expectations for CSR from the community. Businesses have therefore started to incorporate environmental protection into CSR, enabling businesses to maximize their productivity while also reducing waste and emission volumes to lessen the impact on future generations (Mazurkiewicz 2004). As a result, environmental protection has had an increasing influence on corporate thinking. The increasing emphasis on environmental protection emerging

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from governments and environmental organizations and its associated norms means that enterprises are under increasing pressure for environmental protection (Hart 1995; Berry and Rondinelli 1998).

The traditional view is that while complying with relevant environmental regulations, the investment of limited resources in nonproductive antipollution equipment combined with lower investment in productive equipment reduces productivity (Christainsen et al. 1980; Conrad and Morrison 1989). Some studies have even shown that environmental performance has no significant effect on business performance (Rockness et al. 1986). However, the current view is that good corporate environmental performance can effectively reduce energy use and waste generation, enabling businesses to achieve cost savings (Shrivastava 1995; Porter and Van der Linde 1999; Chen and Chang 2013; Sánchez-Medina et al. 2015).

Research has also shown that while compliance with environmental norms generates additional costs, it can also produce corresponding cost reductions in other areas. These include: (1) initial investment costs and return on investments, such as energy investment, saving paper, and recycling, (2) long-term recovery of costs, such as increased logistics efficiency, (3) direct costs, such as waste treatment technology (Ravindra and Pradeep 2012). Erdmann et al. (2004) and Hilty et al. (2006) find that information and communication technologies (ICTs) have enormous potential to support business-sustainable operation, and produce both positive and negative effects on the environment. These effects occur on three levels. (1) First level (direct influence): the direct environmental influence of ICT on production, use, and recycling and disposal. (2) Second level (indirect influence): the indirect influence of ICT on the environment, for example in the transportation process. May increase or decrease the impact on the environment. (3) Third level (system influence): medium–long-term change in user behavior or economic structures, producing changes in patterns of consumption (Erdmann et al. 2004; Hilty et al. 2006).

Aside from the influence of information technology (IT) on the environment, many scholars believe that aside from reducing costs and increasing differentiation, IT also influences business competitiveness, and can even expand the scope of market competition. Therefore, IT plays a key role in maintaining a competitive advantage (Porter and Millar 1985; Chen et al. 2006; Seng and Tsai 2007). Therefore, the benefits of IT have gradually evolved from cost reduction in the early period (for instance reduced paper use and electricity costs) to help enterprises generate more value and benefits. At the same time, the trend toward green IT is not just about cost savings, but also about companies fulfilling their CSR and even strengthening their brand value.

From the perspective of energy saving in enterprises, Corbett (2010) believes that the use of green IT systems—for example, putting computers into power saving mode after a specific period of time or using server virtualization—enables enterprises to continue to deliver greater energy efficiency, which has a profound effect on the structure of enterprises. Therefore, it may enable enterprises to develop a competitive advantage. Orsato (2006) claims that the use of green IT can be viewed as a way to reduce emissions volume and save energy, and that consistency between the green IT policy and the overall strategic framework of enterprises will lead to integration of the green IT and enterprise strategies. As such, practices related to green IT strategy will give enterprises a competitive edge.

Dedrick (2010) believes that when enterprises start implementing green IT, they must consider the applicability of the technology, and the influence of the organizational characteristics and environmental factors. In addition, there must be a consensus within the organization, while also bringing in the concept of organizational management in order to produce substantive benefits from the investment. In addition, green IT capital investment is a continuous process, which in addition to enhancing business competitiveness, can also strengthen the green image of businesses, ensuring the sustainability of the business. Thus, it is necessary to put a long-term focus on the influence of green activities on business competitiveness (Chuang and Huang 2015).

Most previous studies on environmental issues focused on how businesses have responded to increasingly strict environmental regulations, as well as on how stakeholders (such as corporate executives, law enforcers, green consumers, and community residents) have approached environmental issues (Huang and Kao 2003; Kao et al. 2010; Post et al. 2011). However, Sarkis (1995) believes that in the process of economic development, the manufacturing industry has a significant impact on ecology and the natural environment. Although international environmental regulations have become increasingly strict, and can have some level of effectiveness on environmental protection, the key is for businesses to reduce their impact on the environment. As a result, in recent years, issues related to environmental CSR (ECSR) and green management have received increasing attention in academia and in the industry (Rahman and Post 2012). At the same time, Rahman and Post (2012) believe that ECSR is a potential source of business competitiveness. If ECSR can be effectively measured and financed, businesses will be able to sustain their competitiveness.

From the abovementioned literature, we find that a number of preliminary studies have explored ECSR, green IT capital, environmental performance, and business

competitiveness (Rahman and Post 2012; Post et al. 2011; Chuang and Huang 2015; Kao et al. 2010; Chen et al. 2006). However, existing studies have failed to explore the relationship between these variables. In addition, although some scholars have examined the relationship between environmental performance and business competitiveness (Kao et al. 2010), a comprehensive study has yet to investigate this topic. Therefore, the present study explores the relationship between these four variables, using a comprehensive empirical framework to discuss how ECSR and green IT capital increase environmental performance and business competitiveness, and we explore the mediating effect of green IT capital.

The present study attempts to cover three gaps in the current research. The first gap is the finding of Kao et al. (2010) that although environmental performance has a significant positive influence on business competitiveness, whether environmental performance influences business competitiveness or business competitiveness influences environmental performance needs to be confirmed by further research. The second gap in the research is that from a perspective of enterprise-sustainable development, Post et al. (2011) believe that ECSR should be considered as a priority issue for business operations, and the ECSR scale constructed by Rahman and Post (2012) proposes that future research should increase the number of variables strongly correlated with ECSR. The third gap in research is the concept of green IT capital proposed by Chuang and Huang (2015). Although this research finds that corporate greening has a strong positive influence on green IT capital, they also recommend continuing to identify which research variables can accumulate green IT capital, for example, variables related to corporate greening or environmental management in order to help enterprises increase their competitiveness.

In view of ECSR in the research of corporate environmental issues, and to enrich the discourse on green IT capital, this study examines the relationship between ECSR, green IT capital, environmental performance, and business competitiveness, in the hope of increasing our understanding of the effect of ECSR on business competitiveness. Therefore, the aims of the study are as follows:

(1) Exploring the relationships between ECSR, green IT capital, environmental performance, and business competitiveness; and
(2) Exploring the mediating effect of green IT capital in the relationships between ECSR and environmental performance, and between ECSR and business competitiveness.

Literature Review and Research Hypotheses

Environmental Corporate Social Responsibility (ECSR)

The concept of ECSR first emerged from the concepts of environmental management and CSR. ECSR is a crucial and distinct aspect of CSR (Rahman and Post 2012). Research by Baughn et al. (2007) has shown that the US businesses have higher levels of CSR than businesses from other countries, as well as greater access to resources. However, the US businesses have lower levels of ECSR compared to other countries. In other words, higher levels of CSR do not always produce high ECSR.

Some scholars argue that ECSR covers the impact of a business's products, operations, and facilities on the environment. By reducing energy waste and carbon dioxide emissions, productivity is maximized, while also reducing the use of resources to lessen the impact on future generations (Mazurkiewicz 2004). ECSR is also viewed as environmentally friendly activities, which, apart from exceeding the requirements of environmental regulations, take responsibility also for the negative external effects of their operations (Lyon and Maxwell 2008; Portney 2008).

From the perspective of corporate ecological responsiveness, these are a series of measures that reduce the harm caused by enterprises to the natural environment. These measures include product flows, reducing energy consumption, and the use of resources, thereby reducing the company's ecological footprint (Bansal and Roth 2000). From a government policy perspective, ECSR involves the methods that enterprises use to control pollution, including market mechanisms such as carbon emissions trading, disclosure mechanisms for market information, toxic emission inventories, and voluntary plans developed by enterprises, such as green energy-saving plans (Leon and Moon 2007).

From a broader perspective, ECSR is focused on the eco activities of certain companies, and the prevention or limitation of negative environmental impacts created by enterprises, covering the areas of corporate governance, credibility, and environmental performance. Rahman and Post (2012) believe that ECSR should include the indicators of disclosed governance, disclosed credibility, and disclosed environmental performance. From an individual perspective, ECSR includes environmental information on waste disposal, including valuable environmental information on waste water and emissions (Guenther et al. 2007).

From a product perspective, this includes both the newly developed green product and reducing the impact of existing products on the environment (Gilley et al. 2000). From a business policy perspective, businesses must develop new, shared values that incorporate the three pillars—people, planet, and profit—into the company strategy (Cramer 2005). From the perspective of business operating performance, ECSR reflects the willingness of businesses to incorporate environmental consciousness into business operations, enabling businesses to develop in a sustainable manner and reduce their environmental impact, while at the same time not affecting their operational performance (Williamson et al. 2006).

Based on the literature above, ECSR is mostly focused on corporate governance (Mazurkiewicz 2004; Williamson et al. 2006), credibility (Bansal and Roth 2000; Guenther et al. 2007), environmental performance (Bansal and Roth 2000; Williamson et al. 2006; Leon and Moon 2007), environmental vision and strategy (Cramer 2005), environmental spending (Guenther et al. 2007), and internal environmental initiatives (Gilley et al. 2000). As a result, the current study proposes that ECSR should include the influence of business operating philosophy, products, activities, and equipment on the environment. While not affecting business performance, this can minimize the use of resources, including reducing energy waste and carbon dioxide emissions, to maximize production efficiency.

Green IT Capital

From a green IT perspective, Molla et al. (2011) believes that green IT is the use of IT-enabled products or services through the design, production, operation, and disposal stages. These IT-enabled products or services should not cause harm to humans and make an overall contribution to environmental protection. Thibodeau (2007) believes that green IT is an optimization process that applies ICT to minimize overall resource consumption and waste production. Watson et al. (2010) start from the perspective of energy, arguing that green information system (IS) is "energy + information < energy", rather than just limiting the definition of green IS to IT—understanding it as the integration of individuals, processes, software, and IT to support individuals, organizations, and society to achieve sustainable development goals. On the basis of the literature above, the present study argues that "green IT" is a type of process that uses ICT to reduce IT carbon omissions (minimizing), increase the efficiency of energy use (maximizing), and use environmentally friendly IT products or services in the product design, manufacturing, distribution, and recycling process to reduce the impact on the environment, thereby helping the firm to become an environmentally friendly organization.

Chuang and Huang (2015) believe that the use of IT requires the consumption of a large amount of energy, and results in increased carbon emissions and negatively effects environmental industries. Therefore, IT must also incorporate concepts such as environmental protection, energy conservation, and carbon reduction, for instance, green energy-saving systems such as server virtualization, in order to improve work processes and the environment. This will not only reduce the impact on the environment, but also allow companies to comply with international environmental regulations.

Green IT capital is a capability or resource in organizations that applies green concepts to IT infrastructure, IT personnel, and IT management, and partnerships. Green IT capital is able to satisfy the increasing environmental awareness among consumers, while also creating competitive advantage (Chuang and Huang 2015). As a result, businesses that emphasize green IT capital can also develop ECSR initiatives to create products or services that meet the needs of society.

Chuang and Huang (2015) identified three dimensions that should be a part of green IT capital:

(1) *Green IT human capital* refers to the capability and experience of green IT employees, meaning the professional knowledge, as well as energy-saving technology, capability, and experience possessed by green IT employees. Businesses use training and education to develop employees with green IT capabilities;
(2) *Green IT structural capital* refers to basic green IT infrastructure, meaning that IT infrastructure has hardware, software, networks, and IT systems based on green concepts; and
(3) *Green IT relational capital* refers to green IT management and relationships, meaning partners or users that adhere to environmental concepts such as green products or services, and maintaining good cooperative relations to increase value and customer loyalty through the period of cooperation.

The realization of CSR refers to an ongoing corporate commitment to abide by ethical norms, contributing to economic development, while also improving the quality of life for its employees and their families, and the wider community and society (WBCSD 2008). In other words, it emphasizes the responsibilities of businesses toward stakeholders, including internal shareholders, board members, managers, and employees, as well as external consumers, suppliers, channel partners, business partners, communities, and interest groups (Ferrell et al. 2010). Relatively speaking, businesses that attach importance to external stakeholders (such as green consumers) will invest more in green activities such as green technology and

management innovation (Huang and Kao 2003). Furthermore, the higher the level of corporate greening, the more these companies will invest in green IT structural capital, green IT human capital, and green IT relational capital (Chuang and Huang 2015).

In summary, the promotion of ECSR means that businesses hope to use the realization of environmental consciousness to enhance corporate image, and that corporate governance and management is assessed from the interests of stakeholders. Therefore, ECSR involves the active implementation of strategies and action plans, including employee training and innovative products to ensure a sustainable business. However, green IT capital not only satisfies the demands of stakeholders regarding environmental consciousness, it also generates a competitive advantage for the organization. In other words, green IT capital provides the resources and capabilities for sustainable business operations. As a result, businesses that place more emphasis on ECSR are more likely to make long-term investments in green IT capital. On this basis, we propose our research hypotheses:

H1a ECSR is positively associated with green IT human capital.

H1b ECSR is positively associated with green IT structural capital.

H1c ECSR is positively associated with green IT relational capital.

The Relationship Between Green IT Capital and Environmental Performance

Environmental performance is used to measure the outcomes of business's environmental protection and environmental management policy. In the ISO 14001:2004 (2004) standard for environmental management systems, the International Organization for Standardization (ISO) established a definition of environmental performance. By controlling environmental factors through environmental policy, targets, and indicators, a business can achieve measurable environmental management system outcomes. In addition, Callan and Thomas (1996) believe that many companies have begun to pay attention to and apply the environmental performance assessment criteria established by the Coalition for Environmental Responsible Economics in the US.

From a business investment perspective, Verrecchia (1983) believes that good environmental performance will reduce a company's future environmental costs, which is good news for investors. In addition, Porter and Van der Linde (1999) believe that strict environmental regulations strengthen the environmental performance of businesses, enabling businesses to actively seek appropriate environmental solutions, achieving efficient production or innovative capabilities, and thus enhancing the market value of the business. From the natural resource-based perspective, businesses are increasingly restrained by the natural environment, proactive prevention can deliver improved environmental performance over ex post facto control (Berry and Rondinelli 1998; Hart 1995; Porter and Van der Linde 1999; Shrivastava 1995). On the basis of the above literature, this study uses ISO 14001 (2004) as a basis to define environmental performance as external measures of the improved community relations and corporate image obtained by businesses in the process of environmental management and related activities, and internal measures of reduced production costs, strengthened internal management and communication of information, and awareness and understanding of regulations.

From the perspective of the intellectual capital of businesses, investment in and use of IT is a source of intangible value for organizations. IT can bring to the organization considerable tangible and intangible benefits (Ross et al. 1996). Green IT capital refers to the application of environmental protection in IT, using a series of green management strategies such as investment of green IT capital to produce software and hardware equipment, networks, and IT systems that reflect green concepts. In addition, green IT capital helps develop employees with green IT capabilities, and maintaining good cooperative relations with partners and users who are supportive of environmental protection, to develop products or services that meet the environmental protection needs of society creating unique business value and market competitiveness (Chuang and Huang 2015).

Therefore, if investment in green IT capital by a business can strengthen cooperative relations with partners, customers, or community residents who emphasize environmental protection, it can enhance the image and reputation of the business. Internally, green IT capital can reduce environmental costs, and strengthen employee's professional knowledge of green concepts and energy-saving technologies. At the same time, businesses can quickly understand the norms and expectations of government environmental regulations. In short, when a business promotes strategies related to green business management, it can achieve better environmental performance (Kao et al. 2010). Therefore, increasing green IT capital investment can help businesses strengthen their environmental performance. On this basis, we propose the following hypotheses:

H2a Green IT human capital is positively associated with environmental performance.

H2b Green IT structural capital is positively associated with environmental performance.

H2c Green IT relational capital is positively associated with environmental performance.

The Relationship Between Green IT Capital and Business Competitiveness

Business competitiveness or competitive advantage are frequently put forward in the field of management. In other words, business competitiveness means that a business implements strategies that competitors will find difficult to substitute, or that competitors are unable to obtain the existing benefits, ensuring that the business maintains a stable level of profitability (Porter and Millar 1985; Coyne 1986; Chen 2008). Melville et al. (2004) take a perspective from the resource-based theory, arguing that if enterprise investment in IT is combined with complementary organizational resources, this can improve business processes, thereby increasing organizational performance and producing an IT business value model.

In addition, many businesses use IT to facilitate customer relationship management, manufacturing, procurement, and supply chain activities. IT also strengthens businesses competitiveness (Sambamurthy et al. 2003). These perspectives are also consistent with the resource-based theory, which regards IT as a critical resource that is associated with competitive advantage (Powell and Dent-Micallef 1997; Bharadwaj 2000; Melville et al. 2004; Pike et al. 2005). Therefore, it is clear that when businesses have IT resources and capabilities, these create value for the business. Many studies have shown that aside from reducing costs and increasing differentiation, IT can also influence business competitiveness, and even expand the scope of market competition. Furthermore, IT is also a source of business capability and values. Therefore, IT plays a key role in maintaining competitive advantage (Porter and Millar 1985; Chen et al. 2006; Seng and Tsai 2007).

In terms of the effectiveness of business investment, Dedrick (2010) states that two main benefits of green IT investment exist: first, reducing IT costs, and second, helping enterprises implement management strategies. In addition, green IT has four main areas of significance for enterprise management: cost savings, fulfillment of CSR, compliance with environmental laws and regulations, and waste recycling. Ryan (2008) also believes that green IT is an approach for dealing with environmental problems in IT that can open new market opportunities. Businesses with this technology and vision can provide products and services for resolving environmental issues, thereby lowering energy costs and achieving a sustainable competitive advantage. Vykoukal et al. (2009) point out that green IT has economic and ecological benefits, and can increase the competitiveness of enterprises. Past studies have shown that, aside from enhanced work efficiency and cost savings, integrating investment in green IT and corporate strategy can enhance the competitiveness of enterprises.

Chen et al. (2006) believe that green innovation performance such as energy-saving technologies, green IT, waste recycling, green product design, and green management have a positive impact on businesses competitiveness. In addition, Chuang and Huang (2015) examined the influence of green IT capital on business competitiveness for top 1000 manufacturers in Taiwan. Their results showed that green IT capital and its three dimensions—green IT human capital, green IT structural capital, and green IT relational capital—have a significant influence on business competitiveness. In summary, if businesses are able to incorporate green thinking in the process of accumulating IT capital, they can create green IT capital, which can contribute to corporate environmental management and increase business competitiveness. In other words, businesses that invest in more green IT structural capital, green IT human capital, and green IT relational capital have higher market competitiveness. On this basis, we propose the following hypotheses:

H3a Green IT human capital is positively associated with business competitiveness.

H3b Green IT structural capital is positively associated with business competitiveness.

H3c Green IT relational capital is positively associated with business competitiveness.

The Relationship Between Environmental Performance and Business Competitiveness

From the perspectives of environmental performance and business strategy, when businesses take spontaneous actions on environmental issues, they can obtain potential benefits. These potential benefits include enhanced corporate image, attracting consumers who care about the environment, achieving positive investment reviews, saving money through energy conservation, strengthening relations with residents in nearby communities, and producing high-value green products (Hutchinson 1992). Some scholars also believe that that positive and sustained action by businesses to improve environmental performance can increase the level of satisfaction among stakeholders, and thus improve the competitiveness of businesses (Stock et al. 1997).

Porter and Van der Linde (1999) believe that businesses should regard pollution as an inefficient or wasteful practice. Appropriate green product design can help businesses create competitiveness. In other words, firms that are leaders in the investment in environmental protection have

greater market competitiveness, meaning that they can charge higher prices for products, enhance their corporate image, and even sell their green technologies and services, which can develop new markets and gain a competitive advantage as a result. At the same time, businesses that adopt a proactive environmental management strategy combine environmental goals and the functions of corporate departments. Using innovative environmental technologies to solve environmental problems not only avoids environmental protests or fines, but also enhances corporate image, and even develops new market opportunities, which in turn enhances business competitiveness (Berry and Rondinelli 1998; Kao et al. 2010).

In addition, Goodman and Veritas (1998) claim that businesses use environmental management methods to increase environmental performance, which not only brings business opportunities, but also generates a range of benefits for enterprises that directly impact business competitiveness, including reducing pollution, environmental conflicts, business risks, and manufacturing costs; improving product quality and production efficiency; making effective use of corporate resources, and enhancing corporate image. Boström and Pöysti (1992) also believe that good corporate environmental performance can bring many economic benefits to enterprises such as more efficient use of raw materials, cost reductions, and improving company image, thus gaining market share. From the above findings, aside from more efficient use of raw materials and energy, reduction in waste, and lower costs, improved corporate environmental performance can also enhance corporate image, help businesses to obtain greater value, and improve competitive advantage in the marketplace.

In summary, businesses should not passively try to avoid their ECSR (Porter and Van der Linde 1999; Ravindra and Pradeep 2012). Instead, they should respond to government environmental protection initiatives and actively promote environmental activities, as well as transform the pressure of environmental protection into a force to improve organizational efficiency and product quality, which enables them to achieve performance goals and enhance market competitiveness. In addition, an empirical study by Kao et al. (2010) found that environmental performance has a positive influence on business competitiveness. In other words, environmental performance is not an obstacle to business operations. On the contrary, it provides a boost to business competitiveness. Enhanced environmental performance brings greater market competitiveness. On this basis, we propose the following hypothesis:

H4 Environmental performance is positively associated with business competitiveness.

The Mediating Effect of Green IT Capital

To summarize the above, when business investment in green energy-saving activities based on the fulfillment of CSR, the government can make effective use of technologies and expertise specific to each type of industry, producing a certain degree of social benefit. Davern and Kauffman (2000) indicated that the intangible benefits of IT are more important than the tangible benefits, and IT is combined with different organizational resources, forming new capabilities, and producing a unique competitive advantage.

However, in order to combine environmental goals and IT as part of a proactive environmental management strategy, and innovative environmental technologies to solve environmental problems, businesses must invest a greater amount in green IT capital to develop products and services that meet green demands from society (Chuang and Huang 2015). In addition, when businesses organize more environmental protection activities such as environmental protection technology and green IT, they can achieve greater market competitiveness (Chen 2008). At the same time, if businesses adopt a proactive environmental management strategy, they can achieve better environmental performance (Kao et al. 2010).

Therefore, in order to fulfill CSR for environmental protection, businesses will invest a greater amount in green IT capital, strengthening innovative environmental technologies to solve environmental problems. In addition, when a business makes larger investments in green IT capital, they can enhance their innovation capabilities, helping the business create a unique competitive advantage, while also improving its environmental performance. As a result, this study infers that green IT capital may have a mediating effect in the relationship between ECSR and environmental performance, as well as in the relationship between ECSR and business competitiveness. In other words, businesses need to invest in green IT structural capital, green IT human capital, and green IT relational capital in order to increase environmental performance and business competitiveness. On this basis, we propose the following hypotheses:

H5a Green IT human capital mediates the relationship between ECSR and environmental performance.

H5b Green IT structural capital mediates the relationship between ECSR and environmental performance.

H5c Green IT relational capital mediates the relationship between ECSR and environmental performance.

H6a Green IT human capital mediates the relationship between ECSR and business competitiveness.

H6b Green IT structural capital mediates the relationship between ECSR and business competitiveness.

H6c Green IT relational capital mediates the relationship between ECSR and business competitiveness.

From the perspective of resource-based theory (Wernerfelt 1984; Barney 1991), the accumulation of intellectual capital is the key to maintain the competitiveness of businesses. However, many scholars believe that in the process of accumulating different types of investment capital, the investment and use of IT are a source of organizational competitiveness. Furthermore, IT can bring considerable tangible and intangible benefits to organizations (Ross et al. 1996; Laudon and Laudon 2000; Porter and Millar 1985; Chen et al. 2006; Seng and Tsai 2007; Chuang and Huang 2015). At the same time, many scholars believe that ECSR is a potential source of business competitiveness. Positive action by businesses to improve environmental performance can both increase the level of satisfaction among stakeholders, as well as enable businesses to remain competitive and ensure the long-term sustainability of their operations (Stock et al. 1997; Kao et al. 2010; Rahman and Post 2012).

In addition, Kao et al. (2010) suggest that future research can further confirm the relationship between environmental performance and business competitiveness. Post et al. (2011), and Rahman and Post (2012) believe that ECSR is a priority consideration for business operations, and suggest that future research should increase the number of variables strongly correlated with ECSR. Chuang and Huang (2015) also suggest that ongoing research can accumulate green IT capital variables, such as corporate greening and environmental management in order to help enterprises increase their competitiveness. Therefore, we explore the relationship between ECSR, green IT capital, environmental performance, and business competitiveness based on the literature discussed above. We present the following conceptual model (see Fig. 1).

Research Methods

Research Subjects and Procedures

The manufacturing industry has always been one of the main drivers of Taiwan's economy. Sarkis (1995) indicates that manufacturing industry has a significant impact on ecology and the natural environment. However, the manufacturing sector includes polluting and energy-intensive industries such as petrochemicals, steel, cement, electronics, paper, and textiles. As resources become increasingly scarce and green barriers to international trade become increasingly strict, the use of green manufacturing to increase competitiveness is a key element for the sustainable operation of the manufacturing industry.

In addition, according to the index on "the value of output of energy-intensive industries as a ratio of the value of all manufacturing output" which is an indicator for sustainable development in Taiwan, at the end of 2012, energy-intensive industries still accounted for 25.16 % of manufacturing output. This shows that polluting energy-intensive industries still account for a large part of manufacturing industry, and that within energy-intensive industries, the steel industry and petrochemical industry account for a large share of the total. Therefore, it is clear that Taiwan needs to accelerate the greening of its manufacturing industry, in order to reduce resource consumption and polluting emissions, changing energy-intensive industries, and reducing their share of manufacturing as the same time as increasing product competitiveness.

This study uses the top 1000 manufacturing firms in Taiwan in 2014 as its research subjects. Questionnaires were administered by telephone and email. Our questionnaires have been designed design based on existing instruments from past literature. Prior to mailing to the respondents though the email, we conducted the first pretest with five experts and scholars, to solicit their feedback and modify the questionnaire. Subsequently, the questionnaires were randomly mailed to 30 managers of IT departments, environmental protection departments, or business departments of business greening in the top 1000 companies in Taiwan's manufacturing industry. They were asked to fill in the questionnaire and identify the ambiguities in terms, meanings, and issues in the second pretest. High content validity is a necessary requisition for the questionnaire in this study.

Electronic questionnaires were mailed directly to 2014 top 1000 in Taiwan's manufacturing industry. The respondents received a cover letter attached to each electronic questionnaire described the objectives of the survey in general terms and assured respondents of confidentiality as well as the voluntary nature of participation in the survey.

However, when we use a self-reported scale and rely on a single source of respondents, common method variance (CMV) may occur. In other words, CMV will cause inflation in the relationships between concepts, and in some cases, this may lead to deflation in the relationship between concepts. Although the results of our survey were derived from the subjective perception of respondents, as Miller and Cardinal (1994) have pointed out, when questionnaires are anonymous, respondents are willing to reflect the actual situation. In addition, objective test data is to some extent affected by external factors, creating noise in the data. Therefore, subjective data is preferable to objective test data. In addition, we asked for managers in information,

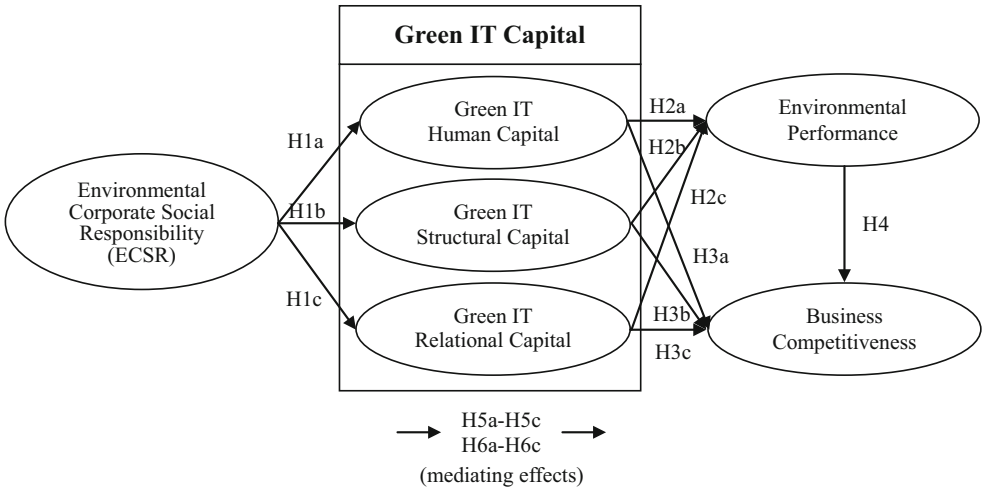

Fig. 1 Research framework

environmental protection, and operations departments to complete our questionnaire. Because the respondents have a high level of professionalism and involvement in the operations and decision making within business departments, their responses to the questionnaire are able to accurately reflect the actual situation in the company. At the same time, according to Jap and Ganesan (2000), as long as the questionnaire design process is followed, and arrangement of questionnaire items does not cause respondents to produce associations between different dimensions, the occurrence of this type of bias can be reduced.

In order to avoid the possible interference of CMV on the results, the present study pays attention to the design of the measuring tools and layout of the questionnaire to avoid unnecessary psychological interference on respondents. In the present study, data is collected through anonymous questionnaires to ensure that respondents are more relieved. At the same time, the questionnaire does not reveal the titles of the variables in order to avoid suspicion or fear when completing the questionnaire, which would produce self-preservation or social desirability phenomena. Finally, the questionnaire also use reversed items in order to reduce carelessness or the tendency to produce identical responses.

Participants in this study are managers of IT departments, environmental protection departments, or business departments from 358 companies ranked in 2014 top 1000 in Taiwan's manufacturing industry. Of these 358 questionnaires were returned, producing a response rate of 35.8 %. Of the study sample, 72.9 % of the companies had been established for more than 20 years, and capitalization of between NT$100 million and NT$5 billion (75.2 %) and the number of employees between 101 and 1000 (62.3 %) comprised the largest groups (see Table 1).

Table 1 Descriptive statistics for 358 companies

	Number of samples	%
Firm age		
≤5 years	1	0.3
6–10 years	15	4.2
11–20 years	81	22.6
21–30 years	92	25.7
>30 years	169	47.2
Capital (NT$)		
<50 million	25	7.0
50 million–100 million	64	17.9
100 million–3 billion	128	35.8
3 billion–5 billion	59	16.5
>5 billion	82	22.9
Employees size		
≤50 persons	6	1.7
51–100 persons	16	4.5
101–1000 persons	223	62.3
1001–2000 persons	57	15.9
2001–5000 persons	29	8.1
>5000 persons	27	7.5

Definitions and Measurements of Variables

To follow Brislin's (1986) recommendation of ensuring accuracy and conceptual equivalence in both Chinese and English versions, all questionnaire items were translated and back-translated by bilingual native speakers of both languages. Participants rated items on a seven-point Likert-type scale ranging from 1 (strongly disagree) to 7 (strongly agree). The questionnaire comprised five parts with a total of 45 questions: (a) the descriptive data of companies,

(b) ECSR, (c) green IT capital, (d) environmental performance, and (e) business competitiveness.

Environmental Corporate Social Responsibility (ECSR)

We refer to Rahman and Post (2012) to define ECSR as the duty manifested in three concepts, i.e., disclosed governance, disclosed credibility, and disclosed environmental performance. That is, ECSR is the duty to cover the environmental implications of the company's operations, products and facilities; eliminate waste and emissions; maximize the efficiency and productivity of its resources; and minimize practices that might adversely affect the enjoyment of the country's resources by future generations. Moreover, we refer to Rahman and Post (2012) to measure ECSR using their 12 items ($\alpha = 0.94$): (1) are terms of conditions for suppliers, regarding environmental practices, reported? (2) is the stakeholder involved in setting corporate environmental policies? (3) does a department of pollution and/or senior management position for environment exist? (4) has ISO 14001 been implemented at the plant and/or firm level? (5) does the company have an environmental report, a CSR report, or a CSR with a section on environmental responsibility? (6) does company provide information about environmental audits? (7) does the company participate in an industry-specific association to improve environmental practices (Electronic Industry Citizenship Coalition or American Chemistry Council)? (8) does the company participate in government initiative to improve environmental practices? (9) does the company disclose its energy use (in reduction or absolute numbers)? (10) does the company disclose its water use (in reduction or absolute numbers)? (11) does the company disclose its greenhouse gas emissions (in reduction or absolute numbers)? (12) does the company disclose its electricity use (in reduction or absolute numbers) (Post et al. 2011; Rahman and Post 2012).

Green IT Capital

We refer to Chuang and Huang (2015) to define green IT capital as an organizational competence and asset that applies green concepts to IT infrastructure, IT staff, IT management, and relationships. We also adopt the green IT capital scale developed by Chuang and Huang (2015). The 10-item scale was loaded on three dimensions: (a) the three items on green IT human capital ($\alpha = 0.93$) include: (1) the company currently has allocated budgets to train green IT staff, (2) the employees of this company diligently use IT for conservation, (3) the IT staff of this company have professional knowledge of green ITs. (b) The three items on green IT structural capital ($\alpha = 0.88$) include: (4) the company currently has allocated budgets and resources for green IT, (5) the company has continued to invest in IT infrastructure (such as storage, servers, and networks) aimed at improving efficiency in the use of energy, (6) the company has considered an energy-management system for desk computers and notebooks. (c) The four items on green IT relational capital ($\alpha = 0.85$) include: (7) the top manager of the company has listed green IT management as a priority issue, (8) the company has adopted green IT-related systems (such as server virtualization and an energy-recycling system), (9) the company is concerned about issues relating to the carbon footprint of its IT suppliers, and (10) the company is concerned about issues relating to the recycling of IT materials (Chuang and Huang 2015).

Environmental Performance

Environmental performance is based on the scales developed by Kao et al. (2010). The questionnaire contains a total of eight items on environmental performance ($\alpha = 0.96$), as follows: (1) company satisfaction with current performance in reducing pollution and production costs, (2) company satisfaction with current performance in reducing environmental fines, (3) company satisfaction with current performance in improving relations with the community, (4) company satisfaction with reduction in workplace accidents, (5) company satisfaction with current performance increasing image in environmental protection, (6) company satisfaction regarding current increases in products with environmentally friendly design, (7) company satisfaction with current performance strengthening internal environmental management and communication, (8) company satisfaction with performance in awareness and understanding of current trends in environmental regulations (Kao et al. 2010).

Business Competitiveness

We define business competitiveness as a strategy that makes a business difficult to be replaced by competitors and can help maintain its profit margins (Porter and Millar 1985; Coyne 1986; Chen 2008; Chuang and Huang 2015). In brevity, the reason why a business can maintain its competitive edge is that it is rich in resources with market value and not easily duplicable or surpassable (Barney 1991). Besides, we refer to Chen (2008) to measure business competitiveness using its 10-item measurement ($\alpha = 0.94$): (1) in comparison with your competitors, you have an advantage in lower costs, (2) compared with your competitors, you can offer better products and services, (3) in comparison with your competitors, you have a greater ability in R/D and innovation, (4) compared with your competitors, you are better in management, (5) you gain

more profit margins than your competitors do, (6) your growth in revenue surpasses that of your competitors, (7) your industrial position is difficult for your competitors to surpass, (8) you have a better business image than your competitors, (9) in comparison with your competitors, you can offer more products and services, (10) your innovative ideas are not easily imitated by your competitors (Chen 2008).

Analysis

This study conducts the two-step procedure involving confirmatory factor analysis (CFA) and structural equation modeling (Anderson and Gerbing 1988). Data with list wise deletion of missing values used for the LISREL analysis results in a final sample size of 358. Overall measurement of model fit is assessed with four indices: the χ^2 statistics, the comparative fit index (Bentler 1990), the goodness-of-fit index (GFI; Jöreskog and Sörbom 1988), adjusted GFI (AGFI; Bagozzi and Yi 1988), normed fit index (NFI; Bentler and Bonett 1980) and root mean square error of approximation (RMSEA; Brown and Cudeck 1993). In addition, to test the hypothesized mediating role of green IT capital, this study first assesses the following conditions for mediation: (a) the independent variable relates to the mediator variable, (b) the independent variable relates to the dependent variable, (c) the mediator relates to the dependent variable, and (d) the independent variable must have no effect on the dependent variable when the mediator is held constant (full mediation) or become significantly smaller (partial mediation) (Baron and Kenny 1986).

Results

Reliability and Validity

The means, standard deviations, correlations, and reliabilities of measures of all the variables are presented in Table 2. In this study, the Cronbach's α is the reliability measure. The Cronbach's α coefficients of six constructs are greater than 0.7, meeting the criteria (Hair et al. 1998). Besides, the other measure of the reliability is to examine the loadings of each constructs' individual items. The loadings (λ) of all items of the six constructs are significant and are all higher than 0.5 (Hair et al. 1998) (Table 4).

In addition, we conducted CFA to assess the discriminant validity of each construct (Jöreskog and Sörbom 1988). Pertaining to the measurement model, the results of the CFA provided support for the six-factor model indicating the distinctiveness of the six constructs used in this study. The χ^2 value for the six-factor model ($\chi^2 = 598.82$, df = 155, $p < 0.01$) was significantly lower than that for the four-factor model ($\chi^2 = 747.69$, df = 164, $p < 0.01$) and the one-factor model ($\chi^2 = 1343.67$, df = 170, $p < 0.01$). Additionally, all fit indices showed a better fit for the six-factor model (CFI = 0.96, GFI = 0.90, AGFI = 0.89, NFI = 0.91, RMSEA = 0.06) relative to the four-factor model (CFI = 0.94, GFI = 0.85, AGFI = 0.83, NFI = 0.87, RMSEA = 0.09) and the one-factor model (CFI = 0.69, GFI = 0.57, AGFI = 0.52, NFI = 0.58, RMSEA = 0.20). All the items in the CFA had acceptable loadings (>0.40). Therefore, the results indicated the six variables were distinct constructs (see Table 3).

Moreover, we apply Fornell and Larcker's (1981) measure of average variance extracted (AVE) to evaluate the discriminant validity of the measurement. The AVE measures the amount of variance captured by the construct through its items relative to the amount of variance due to the measurement error. To satisfy the requirement of the discriminant validity, the square root of a construct's AVE must be greater than the correlations between the construct and the other ones in the model. The square roots of all constructs' AVEs in Table 4 of this study are all more than the correlations among all constructs in Table 2. Therefore, the discriminant validity of the measurement in this study is acceptable. In addition, if the AVE of a construct is higher than 0.5, it means that the convergent validity of the construct is acceptable. In Table 4, the AVEs of the six constructs are 0.71, 0.73, 0.54, 0.61, 0.76 and 0.75, that are all higher than 0.5. It indicates that the convergent validity of the measurement is acceptable. Based on the above results, the reliability and validity of the measurement in this study are acceptable.

However, in order to establish whether there is a potential danger of CMV. We conducted Harman's one-factor test to assess the CMV (Podsakoff and Organ 1986). The factor analysis of the six constructs is shown in Table 5. According to the factor analysis, every construct in this study can be classified into only one factor. Besides, the CFA results also indicates that six variables were distinct constructs. Based on the above results, the CMV is not significant.

The Results of the Structural Model

Due to the possible endogeneity problem in green IT capital, we use the Durbin–Wu–Hausman test to examine whether green IT human capital, green IT structural capital, and green IT relational capital are endogenous variables (Davidson and MacKinnon 1993). First, when business competitiveness is the dependent variable. The χ^2 values are 0.10, 0.55, 1.37, $p > 0.05$. Second, when environmental performance is the dependent variable, the χ^2 values are 0.53, 0.90, 0.77, $p > 0.05$. Therefore, the null hypothesis

Table 2 Descriptive statistics and correlations analysis

Variables	Mean	SD	1	2	3	4	5	6
(1) Environmental corporate social responsibility (ECSR)	4.8	1.1	[0.94]					
(2) Green IT human capital	3.3	1.2	0.55**	[0.93]				
(3) Green IT structural capital	4.4	1.1	0.61**	0.72**	[0.88]			
(4) Green IT relational capital	4.1	1.1	0.58**	0.63**	0.68**	[0.85]		
(5) Environmental performance	5.0	1.0	0.60**	0.28**	0.49**	0.51**	[0.96]	
(6) Business competitiveness	4.9	0.9	0.43**	0.23**	0.36**	0.41**	0.49**	[0.94]

$N = 358$. Figures in parentheses are α reliabilities

** $p < 0.01$

Table 3 Comparison of measurement models

Models	Factors	χ^2	df	$\Delta\chi^2$	CFI	GFI	AGFI	NFI	RMSEA
Baseline model	Six factors	598.82	155	–	0.96	0.90	0.89	0.91	0.06
Model 1	Four factors: green IT human, structural, and relational capital were combined into one factor	747.69	164	148.87**	0.94	0.85	0.83	0.87	0.09
Model 2	One factor: all variables were combined into one factor	1343.67	170	744.85**	0.69	0.57	0.52	0.58	0.20

For χ^2, $N = 358$

CFI comparative fit index, *GFI* goodness of fit index, *AGFI* adjusted goodness of fit index, *NFI* normed fit index, *RMSEA* root mean square error of approximation

** $p < 0.01$

that three green IT capitals are exogenous variables in accepted. Based on the endogeneity tests, we regard green IT capital as an exogenous variable, and input this variable into the structural equation model estimates.

Figure 2 presents the path coefficient estimates for the hypothesized model. The results show that ECSR significantly positively affects green IT human capital ($\beta = 0.66$, $p < 0.01$), green IT structural capital ($\beta = 0.70$, $p < 0.01$), and green IT relational capital ($\beta = 0.69$, $p < 0.01$), thus supporting H1a–c, which proposed that enterprises dedicated to a higher ECSR will raise more investment on green IT human capital, green IT structural capital, and green IT relational capital. In addition, to test H2a–c and H3a–c, the results show that green IT structural capital ($\beta = 0.70$, $p < 0.01$) and green IT relational capital ($\beta = 0.70$, $p < 0.01$) had significantly positive effects on environmental performance, thus H2b and H2c were supported. However, the green IT human capital were not significant for environmental performance ($\beta = 0.04$, $p > 0.05$), H2a was, therefore, not supported. Further, green IT structural capital ($\beta = 0.11$, $p < 0.1$) and green IT relational capital ($\beta = 0.24$, $p < 0.01$) had significantly positive effects on business competitiveness, but the green IT human capital were also not significant for business competitiveness ($\beta = -0.08$, $p > 0.05$), thus only supporting H3b and H3c, which proposed that enterprises with more investment on green IT structural and relational capital will raise the environmental performance and business competitiveness. To test H4, results indicated that enterprises' environmental performance was found to be significantly positive related to business competitiveness ($\beta = 0.37$, $p < 0.01$), which proposed that enterprises with better environmental performance will raise the business competitiveness. Therefore, the H4 was supported.

The conditions of mediation are assessed by the hypothesized model (Prussia and Kinicki 1996; Aryee and Chen 2006). First, the ECSR was significantly correlated with all three mediators of green IT human capital, green IT structural capital, and green IT relational capital (see Table 2). Second, correlation coefficients indicate that ECSR relate significantly to both of outcome variables (see Table 2). The third condition was also satisfied as the results showed that the mediators of green IT human capital, green IT structural capital, and green IT relational capital all significantly influenced the outcome variables of environmental performance and business competitiveness (see Table 2). To evaluate the fourth condition of mediation, the fit of the fully mediated model (hypothesized) is compared to the partially mediated models that depict two direct paths from ECSR to the outcome variables. The partially mediated model ($\chi^2 = 632.11$, df = 158, $p < 0.01$; CFI = 0.95, GFI = 0.89, AGFI = 0.88, NFI = 0.92, RMSEA = 0.068) fit better than the fully mediated model

Table 4 The factor loadings (λ), AVEs and the square root of AVE

Factors	Items	λ	AVE	The square root of AVE
Environmental corporate social responsibility (ECSR)	ECSR1	0.73**	0.73	0.85
	ECSR2	0.76**		
	ECSR3	0.86**		
	ECSR4	0.83**		
	ECSR5	0.86**		
	ECSR6	0.84**		
	ECSR7	0.86**		
	ECSR8	0.90**		
	ECSR9	0.84**		
	ECSR10	0.81**		
	ECSR11	0.91**		
	ECSR12	0.86**		
Green IT human capital	GITHC1	0.80**	0.71	0.84
	GITHC2	0.71**		
	GITHC3	0.80**		
Green IT structural capital	GITSC1	0.53**	0.54	0.73
	GITSC2	0.58**		
	GITSC3	0.61**		
Green IT relational capital	GITRC1	0.58**	0.61	0.78
	GITRC2	0.64**		
	GITRC3	0.60**		
	GITRC4	0.55**		
Environmental performance	EP1	0.85**	0.76	0.87
	EP2	0.73**		
	EP3	0.82**		
	EP4	0.85**		
	EP5	0.82**		
	EP6	0.73**		
	EP7	0.84**		
	EP8	0.75**		
Business competitiveness	BC1	0.75**	0.75	0.87
	BC2	0.80**		
	BC3	0.76**		
	BC4	0.72**		
	BC5	0.68**		
	BC6	0.85**		
	BC7	0.79**		
	BC8	0.85**		
	BC9	0.74**		
	BC10	0.63**		
	BC11	0.87**		

** $p < 0.01$

($\chi^2 = 691.82$, df = 160, $p < 0.01$; CFI = 0.94, GFI = 0.88, AGFI = 0.87, NFI = 0.90, RMSEA = 0.075), and the χ^2 change value ($\Delta\chi^2 = 59.71$; $p < 0.01$) was significant, which revealed that the partially mediated model was the best fitting model.

As shown in Fig. 2, the green IT human capital was not significant for both outcome variables. It is indicated that green IT human capital had no mediating effect on the relationship between ECSR and environmental performance as well as business competitiveness. H5a and H6a

Table 5 Harman's one-factor test

Constructs	Number of items	Number of factors	Accumulation percentage of explained variance
(1) Environmental corporate social responsibility (ECSR)	12	1	61.3
(2) Green IT human capital	3	1	59.1
(3) Green IT structural capital	3	1	55.4
(4) Green IT relational capital	4	1	66.2
(5) Environmental performance	8	1	51.7
(6) Business competitiveness	10	1	66.4

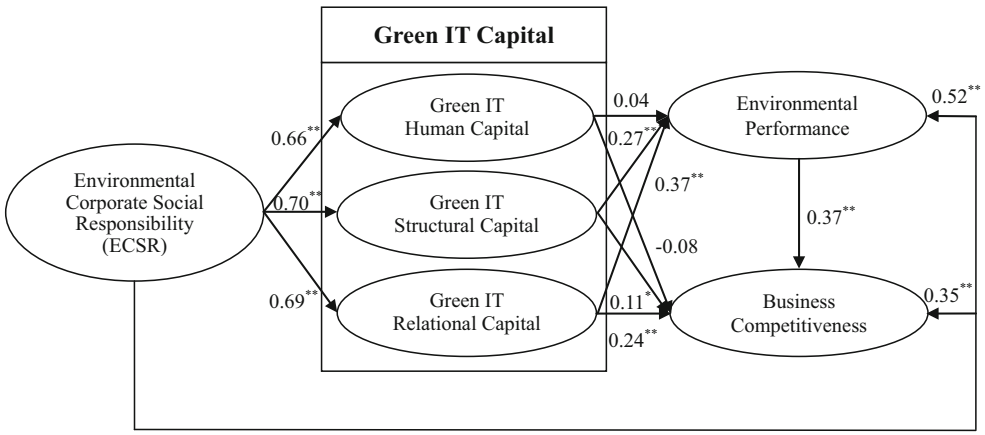

Fig. 2 Estimated path coefficients of the hypothesized model

were, therefore, not supported. However, green IT structural capital partially mediates the relationships between ECSR and both of outcome variables, thus partially supported H5b and H6b. Likewise, green IT relational capital partially mediates the relationship between ECSR and environmental performance as well as business competitiveness. The results, therefore, partially supported H5c and H6c.

Conclusion and Implications

Conclusion

In previous studies on enterprise green management issues, ECSR, environmental performance, and business competitiveness have not been applied to research on green IT capital. Thus, we provide an approach about ECSR to increase the investment of green IT capital and the subsequent enhancement of environmental performance and business competitiveness. Furthermore, we develop a research framework of environmental performance and business competitiveness to discuss their relationships with ECSR and green IT capital. This conclusion has been proved in this research. A summary of the results is shown in Table 6.

Empirical results have shown that ECSR has a significant positive relationship with green IT capital (green IT human capital, green IT structural capital, and green IT relational capital). This demonstrates that when a business has higher ECSR, it will also invest more in green IT human capital, green IT structural capital, and green IT relational capital. As pointed out by Buysse and Verbeke (2003), businesses that place more emphasis on environmental issues will invest more resources in green management activities.

In addition, in terms of the influence of green IT capital on environmental performance and business competitiveness, this study found that green IT structural capital and green IT relational capital have significant influences on environmental performance and business competitiveness. However, green IT human capital does not have a significant influence on environmental performance or business competitiveness. Grantham and Nichols (1997) contend that businesses emphasize on the investment of green IT structural capital and green IT relational capital, since structural capital is the organizational capacity to meet market demands, which means the capacity of businesses

Table 6 Summary of results

Hypothesis numbers	Propose hypotheses	Results
H1a	Environmental corporate social responsibility (ECSR) is positively associated with green IT human capital	Yes
H1b	Environmental corporate social responsibility (ECSR) is positively associated with green IT structural capital	Yes
H1c	Environmental corporate social responsibility (ECSR) is positively associated with green IT relational capital	Yes
H2a	Green IT human capital is positively associated with environmental performance	No
H2b	Green IT structural capital is positively associated with environmental performance	Yes
H2c	Green IT relational capital is positively associated with environmental performance	Yes
H3a	Green IT human capital is positively associated with business competitiveness	No
H3b	Green IT structural capital is positively associated with business competitiveness	Yes
H3c	Green IT relational capital is positively associated with business competitiveness	Yes
H4	Environmental performance is positively associated with business competitiveness	Yes
H5a	Green IT human capital mediates the relationship between environmental corporate social responsibility (ECSR) and environmental performance	No
H5b	Green IT structural capital mediates the relationship between environmental corporate social responsibility (ECSR) and environmental performance	Yes
H5c	Green IT relational capital mediates the relationship between environmental corporate social responsibility (ECSR) and environmental performance	Yes
H6a	Green IT human capital mediates the relationship between environmental corporate social responsibility (ECSR) and business competitiveness	No
H6b	Green IT structural capital mediates the relationship between environmental corporate social responsibility (ECSR) and business competitiveness	Yes
H6c	Green IT relational capital mediates the relationship between environmental corporate social responsibility (ECSR) and business competitiveness	Yes

to adapt to environmental change. Furthermore, the characteristics of structural capital are related to the internal operational procedures of organizations (Bontis 1999).

Chen (2008) also demonstrates that compared to green human capital, Taiwan's manufacturing industry puts more emphasis on the investment in green relational capital, meaning that manufacturing firms in Taiwan are more concerned about the maintenance of green relationships with upstream and downstream suppliers, customers, and strategic partners to ensure that all parties benefit in the market. Therefore, environmental performance and business competitiveness are increased as the result of the investment of green IT structural capital and green IT relational capital.

In terms of the influence of environmental performance on business competitiveness, this study found that environmental performance has a significant influence on business competitiveness, meaning that a stronger environmental performance has a greater influence on market competitiveness. In other words, for businesses, environmental performance is not a cost or an obstacle. In contrast, it provides a boost to business competitiveness. From the natural resource-based view, when faced with environmental challenges and resource use, the question of how to develop strategies to prevent pollution, manage products, and achieve business-sustainable operation is the key to maintain competitive advantage (Hart 1995). Therefore, good environmental performance not only can promote environmentally sustainable development, it is also the source of competitive advantage for businesses.

Besides, the mediating effect in the relationship between green IT capital and ECSR, and between environmental performance and business competitiveness, the study found that green IT human capital did not have a mediating effect in the relationship between ECSR and environmental performance, or between ECSR and business competitiveness. A possible reason might be that in order to comply with environmental standards, businesses engage in environmental protection activities which can directly deliver an improved environmental performance for businesses, helping them to achieve better public relations and enhanced financial performance, as well as create competitive advantage (Klassen and McLaughlin 1996; Chuang and Huang 2015). In other words, in the implementation of ECSR, businesses may be investing relatively little in green IT human capital, thereby weakening the mediating effect of green IT human capital on environmental performance.

Finally, green IT structural capital and green IT relational capital had a partial mediating effect on the relationship between ECSR and environmental performance, and between ECSR and business competitiveness. Chen (2008) confirmed that Taiwan's IT industry devotes much

closer attention to the maintenance of interaction on green relationships between suppliers, clients, and strategic partners, aiming to create a three win situation in the marketplace. In addition, Chuang and Huang (2015) also pointed out that Taiwan's manufacturers place importance not only on the visible investment in green IT infrastructure including hardware, software, network, and IT established under the concept of greening but on the cooperative and interactive relationship between enterprise, clients and strategic partners, thereby heightening the value and loyalty of business partners. Accordingly, Taiwan's manufacturing industry need to expand and harness the power of cooperation with their green partners. It also needs to continually invest in IT infrastructure to improve efficiency in energy use to secure a competitive advantage in the marketplace. Thus, in order to carry out the aim of ECSR, Taiwan's manufacturers will invest a greater amount in green IT structural capital and relationship capital. Only through this means that they can enhance their unique competitive advantage and environmental performance, achieving business-sustainable operation subsequently.

Practical Implications

The manufacturing industry plays an important role in Taiwan's development process, and was the main force driving Taiwan's economic development and growth, making a contribution to Taiwan's economic development that cannot be ignored. As CSR and environmental protection have become operating goals for businesses, they have started to move in the direction of environmental protection and CSR, and hope for joint effort from their employees. This study found that firms which are more concerned about ECSR, green IT structural capital, and green IT relational capital have higher environmental performance and business competitiveness. Therefore, this study describes the management implications for the ECSR, green IT structural capital, and green IT relational capital.

For businesses, environmental thinking should be incorporated into corporate philosophy and commitments, in order to establish an image of CSR. Therefore, at the same time as providing products or services, businesses must also consider whether every aspect of their operation is compliant with environmental regulations, and ensure the concept of sustainable development is deeply rooted in the corporate culture. When managers are investing time and cost, they must also carefully consider which environmental measures can bring the most effective outcomes for the business. The shared values and beliefs of a business can help employees understand how the organization functions, helping them develop a greater sense of identity with the organization's environmental policies, and promoting more pro-environmental attitudes and behavior among employees at both the individual and company levels.

For the manufacturing sector, when ECSR is regarded as part of a company's competitive strategy, companies should focus on how to obtain sustainable benefits from these challenges. This means that aside from investment in tangible assets such as green IT equipment, Taiwan's manufacturing industry should also focus on cooperative relations with other firms and customers that adhere to green thinking, and maintaining good cooperative relations to increase value and loyalty through the period of cooperation (Chen 2008). In addition, businesses are biased toward investment in structural capital and relational capital, since structural capital is an organizational capacity for businesses to meet market demands (Grantham and Nichols 1997).

As Taiwan's manufacturing industry has relatively high structural capital and relational capital, comparably speaking, the manufacturing industry in Taiwan tends to focus on environmental improvements in its internal operations, directly responding to demands and changes in market conditions. Apart from strengthening its investment in green structural capital, the manufacturing industry in Taiwan should expand its relations with green partners in the marketplace, combining forces to enhance competitive advantage. In addition, firms should also focus on environmental protection, enabling the industry to move toward reducing pollution.

Contributions and Recommendations

This study has four contributions. First, in previous studies on corporate environmental issues, environmental performance and ECSR have not been applied to research on green IT capital. However, as environmental performance is a frequently used indictor of firms' environmental protection and environmental management performance results (Hart 1995), obtaining environmental performance results has implications for whether firms can achieve business-sustainable operation, and is therefore very important for firms. Second, previous research simply considers the internal corporate greening, and ignores the responsibility for negative externalities that is also a requirement of ECSR. ECSR includes the dimensions of disclosed governance, disclosed credibility, and disclosed environmental performance indicators, and also includes environmental performance as a factor when firms are choosing suppliers. Therefore, rather than just considering the internal corporate greening of firms, ECSR means that firms must also take responsibility for all negative externalities, and is therefore more macro in orientation. Third,

this study addresses the lack of research on green IT capital in the investigation of corporate environmental issues, and enriches the discourse on green IT capital. Fourth, this study develops a comprehensive empirical framework that can be used by researchers working on relevant green topics in the future.

There are four directions of future research. First, in this study, the results showed that although investment of green IT capital has a positive influence on business competitiveness, its mediating effect on the relationship between ECSR and business competitiveness was not fully supported, showing that other key dimensions influence the industry's views on green IT capital. Therefore, this study suggested that related variables could be organized in future research to gain a more detailed understanding of different theories of environmental sustainability and business capital management, in order to fully understand the relationship between the relevant variables, enriching our theoretical framework. Second, we suggested that future studies could examine other industries. Since this study focused survey work on the manufacturing industry, future research could explore different industries to verify the applicability of the theory in different industries, and enhance the generalizability of the research findings.

Third, data on environmental performance in the present study were collected using self-reported performance from a single source of respondents. However, the respondent's subjective perception, which results from relying on a single source of respondents, combined with the problem of CMV, might lead to bias in the performance data (Avolio et al. 1991). The present study dealt with this problem with both advance prevention and post-detection. From the post-detection statistical controls, we can conclude that the effect of CMV is quite low, but we cannot entirely rule out single source bias. Therefore, we recommend that when measuring environmental performance, future research can use objective indicators of environmental performance by, for example, obtaining more indicators on the generation of waste and pollution, and energy consumption, with the consent of government agencies or survey enterprises.

In addition, if future research uses self-reporting to collect environmental performance data, we suggest using the dyadic data approach for data collection. This can be performed by dividing questionnaires into two types, one for top executives and the other for managers in environmental protection or corporate greening departments. Executives can be invited to respond to items on environmental performance, while managers in environmental protection or corporate greening departments can be invited to respond to items on the other dimensions. By collecting data from two different sources—top executives and department managers—the research outcomes will be more objective.

Finally, although the present study finds that environmental performance has a significant positive effect on business competitiveness, in the relationship between environmental performance and business competitiveness, there is still no significantly academic evidence to clarify whether environmental performance influences business competitiveness or whether business competitiveness influences environmental performance. Therefore, we suggest carrying out longitudinal studies to further understand the relationship between environmental performance and business competitiveness.

Limitations

This study has two limitations. First, it adopts a cross-sectional design, making the causal interpretation impossible. These findings therefore should be further confirmed by longitudinal studies. Second, the constructs of ECSR, green IT capital, environmental performance, and business competitiveness are measured with data collected from a single source of self-reported questionnaires. Even though the factor analysis confirms that constructs are distinctive from each other, the problem of CMV still needs to be considered when interpreting the results.

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