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Conventional versus green investments: advancing innovation for better financial and environmental prospects

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ABSTRACT
Recently, the level of climate change has substantially been rising; relatively not much is known on 'how' companies alter the association between their environmental performance and financial performance within the context of specific elements of innovation: conventional innovation and green innovation. Drawing upon the stakeholder theory and the natural resource-based view of the firm, this research uses firm-level Environmental, Social, and Governance (ESG) data of 462 companies across 7 Asian countries for the period 2015–2019 and employs time fixed-effects panel regression with country and industry dummies. We find that measures of innovation (i.e. conventional innovation and green innovation) are beneficial to the firm value. However, the positive effect of conventional innovation on the firm valuation builds at the expense of the environment since it poses a significant threat to environmental quality by positively contributing to carbon emission. Whilst firms' investments in green innovation are advantageous to either type of firm performance. Further analysis shows that firms that focus on environmental practices generate significant outcomes, e.g. improved financial performance, suggesting that firms should prioritize their green investments to enhance the innovation outcomes so as to achieve superior financial value and to attract potential environmentally proactive stakeholders.

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Investment management; environmental disclosure; innovation; ESG; carbon emission; corporate social responsibility

1. Introduction

It has been recognized by the investors that the indicators of environmental, social, and governance (ESG) are the key factors involved in risk management, valuation, and even regulatory compliance for companies. Managers nowadays are rapidly incorporating ESG into the asset allocation procedure by adopting a more holistic approach along with more thematic and emerging investment vehicles that appeal investors with certain investment objectives (Fatemi, Glaum, and Kaiser 2018). As such, social and environmental consciousness is being spread over most facets of everyday life, and several companies are concerted to align with given environmental principles. Such efforts have likely influenced to the steady upsurge in the global coverage provided to

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'sustainable' labels over the past few years. Evidence indicates a similar rise in demand for what is regarded as *socially responsible* or *sustainable* investments. The proportion of global institutional and retail investors that incorporate ESG principles to minimum a quarter of their investment portfolios leaped from 49 percent in late 2017 to 76 percent in 2019 (Collins and Sullivan 2020). For decades, managing investments directed on one's value has been in place, discussions between clients and investment advisors have become commonplace considering investing in ESG (Collins and Sullivan 2020; Wong et al. 2021). Despite significant adoption among investment communities, the differing approaches to the incorporation of ESG by investors, regulators, and investment management firms indicate the potential advantages of considering ESG metrics have yet to be recognized.

The necessity of being competitive and the globalization of the economies have pushed the companies to invest in innovation and knowledge in order to search for potential solutions that can offer a competitive advantage in dynamically changing business conditions (Schreiber, Zeni, and Feevale 2016). However, environmental aspects of making such investments have remained faded and not prioritized by the companies, which as a result, poses a significant threat to the environmental quality. There are two broader approaches to innovation: (i) *conventional innovation* – also known as traditional innovation, and (ii) *green innovation* – also refers to as eco-innovation. Conventional innovation is the straightforward implementation of new ideas/knowledge to improve existing or generating new products, processes, and services with the aim to enhance business performance without taking into account its possible consequences on the environment and the society (Cui and Mak 2002; Lev and Sougiannis 1996). The notion of green innovation has started to be documented as a means to prevent further environmental degradation since the 1990s, as green innovation is likely to decrease the level of pollution, waste, and usage of other material resources (Yurdakul and Kazan 2020).

According to the sustainable development goals defined by the United Nations, the use of sustainable innovation in developing and consuming green products supports achieving development strategies, reduces potential economic, environmental, and social costs, and reinforces competitiveness (Clark and Wu 2016). Employing green innovation emerges as one of the possible actions in this regard. In general, an innovation that is sensitive towards enhancing environmental impact can substantially contribute to the betterment of society (Pons, Bikfalvi, and Llach 2018). For instance, improved environmental impacts may include the reduction in health-related risks when in use, increases the lifetime of the product/service, allow for reduced consumption of energy, reduced environmental pollution, easier to retrofit or maintain, and characterized by improved recycling, reuse, redemption, and disposal.

According to McKinsey, more than 84% of executives of S&P 500 companies believe that their business' success is endowed on innovation. Theoretically, innovation in any form, i.e. conventional innovation or green innovation, can improve efficiency, increase productivity, and reduce cost, translating into better firm performance. In particular, innovation can increase the competitiveness of technological resources by enhancing the production processes' efficiency or lowering the capital costs incurred to acquire required raw materials. However, some conventional innovations may lead to the higher consumption of non-renewable resources, increase pollution, and significantly contribute to global warming, which may not be appreciated by environmental stakeholders (Paramati et al. 2020; Yang, Hong, and Modi 2011). Business leaders, traditionally, consider that an added financial distress and additional costs for companies are constraints in their efforts to reduce environmental degradation, and this thought appears to dominate in several business industries (Lee and Wu 2014). Nevertheless, some leading companies such as Accenture, Apple, and even Google, have started to maintain sustainable business practices. They believe that a decrease in carbon emission and energy consumption is no more an option and progressively determines how much profits their businesses can generate by being sustainable and environmentally proactive (Paramati et al. 2020). The rationale is that businesses can reduce carbon risks (Hsu and Wang 2013), explore new potential opportunities, and increase the current level of long-term investments (Guenther and Hoppe 2014), which eventually translate into better financial and environmental performance (Lee, Min, and Yook 2015).

In recent years, the level of climate change seems to have increased noticeably; relatively not much is known concerning how companies alter the link between corporate environmental performance and financial performance. Previous studies have documented this relationship between environmental performance and financial performance offers a range of contextual and firm-specific elements which can develop a more robust relationship (Clarkson et al. 2011; Lee, Min, and Yook 2015; Ong et al. 2019). Lee, Min, and Yook (2015) argue that carbon emission significantly decreases the firm value. According to Lee, Min, and Yook (2015), there is a strong positive impact of environmental-related initiatives on firms' financial performance. In contrast, a negative relationship between green performance and financial performance has been found in numerous studies (Rassier and Earnhart 2010; Wagner et al. 2002). Moreover, some empirical studies do not found any relationship between green performance and financial performance (Iwata and Okada 2011). However, the impact of both conventional and green innovation on the relationship between financial performance and environmental performance has gained minimal focus from researchers. Very few studies analyzed the link between these two involving the conventional innovation and green innovation in the relationship simultaneously (Awaysheh et al. 2020; Iwata and Okada 2011; Lee and Byung 2015). Thus, the purpose of this study is not only to explore the relationship between firms' environmental performance and financial performance but also shed light on the impact of conventional innovation-intensity (CII) and green innovation (GI) on both financial performance and environmental performance of those Asian firms that simultaneously invest in CII and GI. While firms spending on R&D is the conventional view of innovation, and green innovation concentrates on the practices of following improved environmental innovation. Integrating these two innovation perspectives on which firms invest concurrently and identifying environmental innovation scores (green innovation) as a key firms' environmental commitment to follow a firm environmental strategy allows us to examine the relationship between CO_2 emissions and financial performance. In particular, we develop an empirical model to investigate the impact of both CII and GI on firms' financial performance and environmental performance, using the novel set of firm-level ESG data for the seven Asian countries (Japan, Singapore, Taiwan, Hong Kong, Malaysia, India, and Indonesia) over the period 2015–2019. The nature of the data allowed us to differentiate between conventional and eco-innovation and offer a robust measure of firms' ESG performance where biases concerning the firm size and transparency are minimal.

The findings of this research show that environmental performance (reduction in carbon emission CO_2) is positively related to firms' financial performance; and that both measures of innovation (i.e. conventional innovation-intensity and green innovation) are positively associated with the firms' financial performance. However, conventional innovation-intensity has a deleterious impact on environmental performance, whilst investments in green innovation are advantageous for either type of firm performance. The contributions of this research to the stream of investment management, innovation, and environmental management literature are fourfold. First, firm-level studies on environmental performance have been scant, mainly due to the unavailability of the data. Those who studied this phenomenon primarily relied upon the data collected through survey questionnaires on a specific group of firms within a particular sector and country (i.e. Lee and Byung 2015; Ong et al. 2019; Yurdakul and Kazan 2020; Zhang et al. 2017). Since the growing Asian economies are being successful when evaluated basis on their swift growth, however less effective in preservation of environmental damage compared to other regions (Howes and Wyrwoll 2012). Thus, to our knowledge, this is the first regional study conducted in Asia that uses firm-level ESG performance data, which allows us to uncover this existing challenge in cross-sectoral across different countries. Second, previous studies solely emphasize the broader aspects of R&D-augmented innovation and its outcomes on a specific performance measure (i.e. Churchill et al. 2019; Paramati et al. 2020; Schreiber, Zeni, and Feevale 2016), instead; in this study, we filled this gap by decomposing innovation into two types in which firms invest simultaneously and investigate their joint impact on various performance measures – financial and environmental. Third, our findings offer insights on the importance of complying with the environmental policies by investing in green innovation with an awareness that bringing an essential change in redesigning products for environmental sustainability via employing non-toxic materials in the production processes, using eco-packaging, eco-friendly labeling, lower energy consumption, and improved recycling and decomposition designs would enable firms to achieve productivity. Productivity improvement in the resources would allow these firms to obtain higher financial and environmental performance. Lastly, our findings contribute to the investment management literature by signifying the investments in green innovation, since green innovation serves as the vital component through which firms could obtain market related benefits from their environmental investments, introducing systematically the steady chains of sustainable products and services with improved functionality and layout i.e. better recycling design, reduced energy consumption level, lowered exploitation of natural resources and materials, and improved product/service's functionality with the better lifecycle. These eco-friendly products/services are shown to be advantageous to the companies in terms of gaining green products' market share, formation of green branding, and the likelihood of setting premium prices. These benefits are specifically crucial to those firms who longing to be competitive in the green industry and to enhance their revenues and returns on investment. Similarly, firms should focus more on their environmental management practices towards the implementation of improved production processes and activities that support improved recycling, reproduction, pollution prevention, and waste reduction. Production activities with these green features are demonstrated to be critical in enduring competitive capabilities to achieve better financial and environmental prospects.

The remaining sections of this paper are arranged as follows. The theoretical background and hypotheses development are reported in section 2. Section 3 explains the details on methodology, data collection procedures, and variables' description. Subsequently, results are presented with a detailed discussion in section 4. Lastly, section 5 consists of the concluding remarks, implications for the management and the policymakers, and providing the direction for potential future research.

2. Theoretical background

The environment has become challenging for the companies to manage since the regulatory requirements of making environmental investments are considered as costly by the businesses (Hojnik and Ruzzier 2016). However, it is not difficult to convert these costs into a competitive advantage and a great performance source with green innovations (Munodawafa and Johl 2019). Accordingly, green innovation brings solutions to improve the productivity of resources and help significant cost reduction incurred by firms to environmental investments, which influences both market performance and environmental performance (Pujari 2006). Environmental quality is often overlooked in the process of carrying out production activities (Udemba 2021a). Emissions that arise from the production include all carbon footprints from either producing goods and services domestically or overseas (Adebayo et al. 2021). Green technology is being encouraged since innovation is often not guided towards cleaner technologies and it does not help to reduce emissions (Udemba 2021b). Despite inferences on the Environmental Kuznets Curve (EKC) model (Bekun et al. 2021) from the technological effect side, little is known on the relationship between innovation, environmental, and financial performance across firms, countries, and regions. Friedman (2007) in the theoretical debate on the stakeholder theory argues that investments in environmental practices that advantageous to the external stakeholders at the cost of shareholders will often lead to decreased firm value and its revenues. Improved environmental performance that is accompanied with effective relationship management of stakeholders confers better financial performance, but if the extent and scope of firm environmental responsiveness waifs beyond the management of stakeholders to address environmental concerns that reflect little or no association to the firms' relationship with stakeholders, then environmental performance come to be related with reduced financial benefits (Brammer and Millington 2008). The natural-resource based view (NRBV) (Barney 1991; Hart 1995) of the firm suggest that environmental investments are facilitative in developing competitive advantage, and such competitive advantages according to the stakeholder theory (Freeman 1984; Jones 1995) can translate into the improved financial performance if effective relationship management with key stakeholders is in place, thus firms' environmental proactiveness may have greater external visibility and perhaps play an important role in reshaping the companies' perception in the eyes of key stakeholders i.e. employees, investors, customers, suppliers, etc. (Porter and Kramer 2002; Brammer and Millington 2008).

There are two strands of literature, the advocates of first-strand employed integrated assessment approach such as R&DICE (William 2002), ENTICE (Grimaud, Lafforgue, and Magné 2011), WITCH (Marangoni and Tavoni 2014), and CIECIA (Wang and Gu 2018) to investigate the effect of R&D-augmented innovation on environmental quality. In general, these studies have reported that the CO_2 emission would improve through R&D investments. Though investing solely in R&D would not be sufficient, it depends considerably on improving existing technologies' performance. Since integrated assessment approaches seen to be effective in environmental policy (Gyamfi, Bein, and Bekun 2020; Weyant 2017), one of the potential limitations associated with integrated assessment approaches is that the results strictly rely upon and highly sensitive to the particular model assumptions (Carraro et al. 2010; Gyamfi et al. 2021). Weyant (2017) argues that the mitigation expense estimation in integrated assessment approaches is highly sensitive in response to the assumptions made on the particular strategies used to attain desired reductions in emission and how such strategies are executed. The integrated assessment approaches get criticized on several other issues as well, concerning the problems linked to the choices of model design caused either by limitations on the data or limited understanding of the potential socioeconomic and physical relationships applicable in assessing the effects of emission mitigation and climate change policies (i.e. Ackerman and Stanton 2012; Pindyck 2013, 2017; Tol and Fankhauser 1998).

The second strand of literature, on the other hand, investigated the link between innovation and environmental performance typically using the survey method across firms and industries. For example, Schreiber, Zeni, and Feevale (2016) examine the impact of innovation on the environment in a sample of chemical firms in Brazil. Lee and Byung (2015) analyze the effect of green innovation on CO_2 emission using a sample of manufacturing companies in Japan. Asiedu, Gyamfi, and Oteng (2021) studied the relationship between economic performance and environmental performance in Belgium, the USA, and Canada. Ong et al. (2019) investigate the relationship between green innovation, environmental performance, and financial performance of Malaysian manufacturing firms. Yurdakul and Kazan (2020) examine the effect of eco-innovation on environmental and financial performance by implementing a survey on Turkey's manufacturing companies. Udemba et al. (2021) explored the relationship between economic performance and CO_2 emission amid environmental performance in India. Zhang et al. (2017) studied the impact of R&D on CO_2 emission by collecting a sample from 30 provinces of China. Shahbaz, Nasir, and Roubaud (2018) explore the effects of R&D investments on environmental performance in France. In general, these studies tend to document the negative relationship between R&D-augmented innovation and CO_2 emission – representing the environmental performance. However, most of these studies based on the survey collection across a specific group of firms in a particular industry and country. There are very few studies (e.g. Churchill et al. 2019; Paramati et al. 2020; Shahbaz, Nasir, and Roubaud 2018) that attempts to quantify the impact of either conventional or green innovation on environmental and financial performance at the national level using publicly available information with limited focus and inconsistent findings. To date, there are almost no studies in our chosen firms of Asian economies that mainly focus on micro-level publicly available data from a range of sectors to quantify the impact of both conventional R&D-augmented innovation and environmental innovation on firms' financial and environmental performance. Thus, this study seeks to fill this gap by developing an empirical model to examine the impact of both conventional innovation and green innovation on firms' financial and environmental performance, and how environmental performance alters the financial landscape of those Asian firms that simultaneously invest in both conventional and green innovation.

2.1. Hypothesis development

2.1.1. Firms' environmental performance and financial performance

It is asserted by the natural-resource-based view (NRBV) (Barney 1991; Hart 1995) that the firms' resources and capabilities are the major drivers of performance. Firms that implement strategies for developing capabilities tend to report better firm performance (Hart and Dowell 2011). Therefore, the NRBV advocates the substantial role of environmental policies on companies' competitive landscape and emphasizes the key influence in generating capabilities that support economic activities on the grounds of a sustainable environment. The theory of NRBV (Hart 1995; Hart and Dowell 2011; Teece 2007) underpinned that the environmental-friendly policies can facilitate in lowering the cost of operations and enhance productivity because of efficient innovations used to protect the environment, which as a result produces better financial performance (Ong et al. 2019). A positive relationship between corporate green performance and firms' performance have documented in several empirical studies (i.e. Clarkson et al. 2011; Eltayeb, Zailani, and Ramayah 2011; Long et al. 2017; Yurdakul and Kazan 2020). Likewise, a positive link between firms' green performance and financial performance was observed in some studies using longitudinal design (Delmas, Lim, and Nairn-Birch 2016; Ritala et al. 2018). Lee, Min, and Yook (2015) argue that carbon emission significantly decreases the firm value. According to Lee, Min, and Yook (2015), there is a strong positive impact on environmental-related initiatives and firms' financial performance. In contrast, a negative relationship between green performance and financial performance has been found in numerous studies (Rassier and Earnhart 2010; Wagner et al. 2002). Moreover, some empirical studies do not found any relationship between green performance and financial performance (Iwata and Okada 2011). Therefore, given fewer studies that have documented the contrary findings, a positive association between firm green performance and financial performance has been established in various empirical studies. Accordingly, this study hypothesizes that the measures of firm green performance, i.e. ESG score, CSR score, and reduction in carbon emission (CO_2) are positively associated with the firm's financial performance. We argue that a firm's strategy of developing capability for sustainable use of natural resources that enhance its environmental performance (reduced carbon emission CO_2) is likely to improve financial performance. Thus, we hypothesized that;

H1: Environmental performance (reduction in CO_2) is positively related to the financial performance of firms in Asian countries.

2.1.2. Conventional innovation and financial performance

Several studies have attempted to discover whether R&D expenditures – conventional innovation-intensity (CII), serve as a driver for inducing firm value. The findings regarding this relationship are offering mixed evidence. According to the real options theory, investments in innovation are perceived as firm growth option value (Chintakananda and McIntyre 2019; Kraft, Schwartz, and Weiss 2018). In particular, firms' growth option value is positively impacted by R&D investments (Tong and Reuer 2004), since higher uncertainty (volatility) to the expected returns in making R&D investments is associated with higher market value (Oriani and Sobrero 2008). From the perspective of the resource-based view, firms develop a competitive advantage from their distinct resources (Peteraf 1993; Khalil, Khalil, and Khalil 2021); according to this argument, R&D expenditures might be positively related to the firm value. Some other studies find a positive association of CII with the financial performance of firms (Churchill et al. 2019; Denicolai, Zucchella, and Strange 2014; Paramati et al. 2020). Eberhart, Maxwell, and Siddique (2004) explain that following the sudden increase in R&D investments, the performance of U.S firms significantly improved. Firms' investments in R&D increase profitability and positively impact overall financial performance (Lev and Sougiannis 1996). Alternatively, in estimating the long-term persistence of firm value, Rao, Yu, and Cao (2013) reported that firms spending on R&D positively associated with financial performance; however, the positive effect turns out to be weaker and disappears with the passage of time. Some other studies show that the issue of information asymmetry is severe between managers and investors in firms with higher level of innovation-intensity, thereby negatively impact their financial performance (Cui and Mak 2002; Honoré, Munari, and de La Potterie 2015).

Given the evidence mentioned above, it can be summarized that the positive effect of CII is more visibly documented than the negative impact on firms' financial performance. Thus, we assume that CII positively contribute to the financial performance and, therefore, hypothesized that;

H2: Conventional innovation is positively related to the financial performance of firms in Asian countries.

2.1.3. Green innovation and firms' financial performance

The findings of most of the empirical studies on innovation have postulated spending on green innovation as a key antecedent of financial performance (Cheng, Yang, and Sheu 2014; Cheng and Shiu 2012; Doran & Ryan, 2012; Setiawan and Aryanto 2019; Zhang, Rong, and Ji 2019). According to the stakeholder theory, environmental investments implying stakeholder transparency and engagement lead firms to have greater access to capital, particularly during the times when there is limited access to capital or in the period of crisis where trust and social capital are essential antecedents that thereby translate into improved financial benefits (Awaysheh et al. 2020; Lins, Servaes, and Tamayo 2017). Green innovation helps to improve financial performance in two main ways. First, companies equipped with greater intensity of green innovation tend to recognize its competitive benefits in the shape of improved operational and production processes, more innovative products/services, and reduction in the cost of operations (Ambec and Lanoie 2008; Ong et al. 2019). Second, these companies can create reputation and legitimacy by differentiating themselves from potential competitors, thereby improve their value and revenues (Ambec and Lanoie 2008; Darnall, Ponting, and Vazquez-Brust 2012; Porter and Linde 1999). Various empirical studies documented a link between green innovation and several financial performance indicators. D. Zhang, Rong, and Ji (2019) reported a positive relationship between green innovation and listed manufacturing companies' financial performance in China. A positive relationship is also found between eco-innovation and SMEs' market performance in Indonesia by Setiawan and Aryanto (2019). Doran and Ryan (2012) argue that green innovation has a more stronger impact on firm performance than conventional innovation. Managers can better contribute to firms' financial and non-financial performance through green innovation (Aboelmaged 2018). Firms can reduce costs, generate greater sales, and improve profits by investing in green innovations, where cooperation from all the participants in an organization is the key to enhance performance in developing and using eco-innovations (Rabadán, González-Moreno, and Sáez-Martínez 2019). Green innovation of any kind improves environmental quality and positively contribute to the firms' financial performance (Cheng, Yang, and Sheu 2014; Cheng and Shiu 2012). Despite the findings of all these studies, Ghisetti and Rennings (2014) indicated that green innovation has no impact on the financial performance of German-based firms. Given these evidence with mixed findings, this study hypothesizes that the green innovation reported by firms as 'environmental innovation scores' is positively related to financial performance. Thus, we hypothesized that:

H3: Green innovation is positively related to the financial performance of firms in Asian countries.

2.1.4. Conventional innovation and firms' environmental performance

Romer (1990) posits that investments in research and development (R&D) translate into innovation, leading to improved production efficiency and effective use of energy and natural resources. As revenues increase, firms can allocate the proportion of their income to invest in R&D; therefore, more efficient technologies can be adopted and implemented by such firms. On one hand, more efficient innovations tend to ease the drain on natural resources and helps to reduce the level of waste and emission as by-products (Li and Wang 2017), which as a result, leads to a cleaner environment (Shahbaz, Nasir, and Roubaud 2018). For instance, Churchill et al. (2019) argue that environmental quality is likely to improve by spending on R&D, only if there are appropriate environmental management measures to ensure adequate management of emission and waste. On the other hand, the effect of conventional R&D-augmented innovation on environmental quality, i.e. carbon emission, is a priori unclear. Given the significant positive impact of innovation on profits and firm value (Blundell, Griffith, and Reenen 1999; Chemmanur, Loutskina, and Tian 2014; Guo, Pérez-Castrillo, and Toldrà-Simats 2019; Hall and Oriani 2006), conventional innovation, which is sensitive to the environment may adversely affect environmental quality by the scale influence of greater production activities linked with improved profits and business expansion (Churchill et al. 2019; Paramati et al. 2020). Although innovation is likely to enhance efficiency and financial performance, the growing output resulting from more extensive production activities may still need more natural resources-related inputs, which in turn, can increase the level of CO_2 emission. Consequently, environmental performance may reinforce to have diminishing returns over time by innovation. Since an increase occurs in the stock of current knowledge, it becomes more challenging to develop new inventions over time, leading to a lower induced level of R&D (Newell 2009). Though, contemporaneously, firms' growth mechanism continues to require more deployment of natural resources as an input. Accordingly, we hypothesize that conventional innovation-intensity (CII) poorly upset the environmental quality – by positively contribute to the CO_2 emission. Thus, we hypothesized that:

> **H4:** Conventional innovation adversely affects the environmental performance of firms in Asian countries.

2.1.5. Green innovation and firms' environmental performance

Environmental policies guided by the concept of eco-innovation explain environmental initiatives that pay off in the form of better environmental quality, thus linking green innovation to firms' environmental performance (Figge and Hahn 2012; Orsato 2006). Following the eco-efficiency and eco-innovation concept, businesses looking to obtain economic benefits have to implement environmental strategies at an optimal level; and must operate at a most efficient level of environmental performance, thereby attaining eco-efficiency at a minimal possible cost (Schaltegger and Synnestvedt 2002; Wagner and Schaltegger 2004). The green innovation offers a greater eco-efficiency level since its existence reflects companies' focus on product development and market demand according to their environmental management practices that tend to produce economic benefits (Figge and Hahn 2012; Schaltegger and Synnestvedt 2002). Firms with greater green innovation levels tend to bring about market differentiation by supplying environmental-friendly innovative products, which translate into higher revenues with improved environmental outcomes (Ambec and Lanoie 2008; Lee, Min, and Yook 2015; Ong et al. 2019). Similarly, green innovation may also contribute to reducing waste and emissions from production activities. As a result, firms might need to enhance their base of capabilities developed from environmental activities and procedures into green innovation to let themselves and society enjoy the better environmental performance. Hence, firms can achieve superior environmental performance by developing and implementing eco-products design and processes through making investments in green innovation. Thus, we hypothesized that:

> **H5:** Green innovation is positively related to the firms' environmental performance in Asian countries.

3. Data and research methods

3.1. Data

This research employs data from listed companies of 7 Asian economies, including Japan, Taiwan, Hong Kong, Malaysia, Singapore, Indonesia, and India, since these economies are encountered critical environmental problems that likely to undermine future economic growth, security of natural resources, and regional stability. The sample consists of annual firm-level data obtained from Thomson Reuters' Datastream for the period of five years from 2015–2019. In particular, the data on the set of Environmental, Social, and Governance (ESG) is explicitly provided by Thomson Reuter, which is of our specific interest. The ESG scores reflected in the Thomson Reuter's Datastream are designed to objectively and transparently estimate a firm's ESG performance based on firm reported information on and across ten broader themes, including emissions, innovation, CSR strategy, resource use, human rights, etc. We first obtained the cross-economies data of 6023 firms, we then excluded companies from various idiosyncratic industries such as financial services, equity investments, retailers, insurance, tobacco, and real estate. Based on the given data on our desired available variables, we left with the sample of 462 firms that we included in our final panel of analysis over the period of 2015–2019. Table 1 shows firms' inclusion from each sector and country; the 'others' group consists of companies from beverages, electricity, telecommunication, gas, oil & water, household goods, support services, and personal goods.

3.2. Models

We estimated the following models to test our hypotheses (omitting sectoral and country's dummies):

$$\mathrm{Q_{it}} = \beta_1 + \beta_2\mathrm{CO_{2it}} + \beta_3\mathrm{CII_{it}} + \beta_4\mathrm{GI_{it}} + \beta_5\mathrm{ESG_{it}} + \beta_6\mathrm{CG_{it}} + \beta_7\mathrm{SZ}_{it} + \beta_8\mathrm{AG_{it}} + \beta_9 TAT_{it} + \varepsilon_{it} \quad (1)$$

$$\mathrm{CO_{2i_t}} = \beta_1 + \beta_2\mathrm{CII_{it}} + \beta_3\mathrm{GI_{it}} + \beta_4\mathrm{ESG_{it}} + \beta_5\mathrm{CG_{it}} + \beta_6\mathrm{SZ}_{it} + \beta_7\mathrm{AG_{it}} + \beta_8 TAT_{it} + \varepsilon_{i_t} \quad (2)$$

We decompose firm performance into two aspects: financial performance and environmental performance. First, we consider Tobin's q as a measure of financial performance. Besides, we employed profit margin (PM) as an alternative to financial performance to ensure its robustness. As indicated by Peters and Taylor (2017), Tobin's q (Q) is determined by summing the market value of equity and book value of debt minus current assets divided by the total capital. Second, we estimate the environmental performance by a reduction in the amount of CO_2 emission; however, we also employed CSR scores reported in firms' ESG database as another indicator of social and environmental performance for a robustness check. CO_2 emissions were reported in tons, as guided by the Lee, Min, and Yook (2015), we scaled CO_2 by total assets to avoid scaling differences in the analysis and to ensure consistency in units. The element of the primary concern of this study was innovation as an explanatory variable; we again decompose innovation into two parts: conventional innovation intensity (CII) and green innovation (GI). Firms explicitly report their investments on both R&D (Datastream Code: WC01201) and Environmental R&D (Datastream code: TRESGENPIS) in their ESG metrics. However, due to the large number of missing observations concerning firms' investments

Table 1. Sample composition according to each sector and country.

Sector	Country							Total
	Japan	Taiwan	Hong Kong	India	Malaysia	Indonesia	Singapore	
Technology	51	24	13	13	01	00	00	102
Industrial goods & services	57	14	10	11	01	01	00	94
Health care	38	10	16	13	01	01	01	80
Chemicals	43	17	09	08	01	00	01	79
Food producers	25	14	11	07	04	01	00	62
Travel & leisure	10	08	04	03	01	00	00	26
Others	07	03	04	02	01	01	01	19
Total	231	90	67	57	10	04	03	462

in Environmental R&D, we use a more consistent proxy for Green Innovation which is 'environmental innovation scores' that firms report in their ESG metrics and we termed it as 'green innovation (GI)'. As directed by Denicolai, Zucchella, and Strange (2014), firms' spending on R&D activities is what we referred to as 'conventional innovation'. We scaled these R&D expenditures by total assets and termed them as 'conventional innovation intensity (CII)' in our analysis. Moreover, we controlled for several firm-specific factors such as firm age (AG), firm size (SZ), total asset turnover (TAT), management scores related to the firm's best adoption of corporate governance principles (CG), and overall firm's ESG performance scores (ESG). Keeping in view that the larger firms tend to display ceteris paribus higher performance, thereby we controlled for several sectoral dummies such as for industrial goods and services (IG&S), technology (TEC), chemicals (CHM), health care (H.C), travel and leisure (T&L), food producers (FDP), and companies in 'others' category (control group). Finally, given the skewed data distribution, we incorporate dummies related to each country included in our sample, i.e. Japan (JP), Taiwan (TW), Singapore (SG), Indonesia (ID), Hong Kong (HC), India (IN). We reserved Malaysia as a controlled group in our analysis. Table 2 briefly demonstrates the details of variables, definitions, units, and Datastream symbols used to extract the relevant data for each variable.

The summary statistics and pairwise-correlation matrix are reported in Tables 3 and 4, respectively. The average (median) Tobin's q (Q) for our selected sample firms is 4.38 (0.84). The average (median) profit margin (PM) is 6.66 (5.94). The average (median) ratio of carbon emission (CO_2) to total assets is 0.04 (0.001). The ratio of firms' R&D expenditures to total assets, which we refer to as conventional innovation intensity (CII) is reported to have an average (median) value of 0.04 (0.02). Some other variables related to environmental concerns such as GI, ESG, CSR, and CG are presented as the performance scores that firms report, ranging from 0 to 100. Higher scores mean firms' greater achievement toward following sustainable practices. The average (median) score of green innovations (GI) is 36 (34.89).

Table 4 consists of pairwise correlations between variables. Tobin's q is positively correlated with the profit margin (PM), CSR, ESG, green innovation (GI), and conventional innovation intensity (CII), but negatively correlated with carbon emission (CO_2), firm size (SZ), firm age (AG), asset turnover (TAT) and corporate governance (CG). Whereas carbon emission (CO_2) is negatively correlated with the PM, CSR, ESG, CG, GI, firm size, firm age, and asset turnover. However, CO_2 is positively correlated with the CII. Most of the correlation coefficients are statistically significant; however, the magnitude is reasonably small enough among all the explanatory variables, which demonstrates that our regression results are free from the biases caused by the multicollinearity problem.

4. Results

4.1. Models' estimation

To estimate our models, we need to select between random effects and fixed effects panel regression. Built on the Haussmann test results, we employ periods fixed effects panel regression with country and industry dummies to test the equation (1) and equation

Table 2. Description of variables.

Variable	Variable name	Definition	Datastream code	Unit
Tobin's q	Tobin's q	Market value of equity + book value of debt – current assets / total capital stock (Peters and Taylor 2017)	WC08001 + WC03255 – WC02201 / WC02999	Ratio
PM	Net profit margin	Net income / sales	DWNM	Ratio
CO_2	CO_2 equivalent emissions total	Total carbon dioxide (CO_2) and CO_2 equivalents emission in tonnes / total assets (Lee, Min, and Yook 2015).	ENERDP023 / WC02999	Ratio
CSR	CSR strategy score	CSR strategy category score reflects a company's practices to communicate that it integrates the economic (financial), social and environmental dimensions into its day-to-day decision-making processes.	TRESGCGVSS	Percentage
CII	Conventional innovation intensity	R&D expenditures / total assets (Nemlioglu and Mallick 2017)	WC01201 / WC01001	Ratio
GI	Environmental innovation score	Green innovation category score reflects a company's capacity to reduce the environmental costs and burdens for its customers, and thereby creating new market opportunities through new environmental technologies and processes or eco-designed products.	TRESGENPIS	Number
ESG	ESG score	ESG Score is an overall company score based on the self-reported information in the environmental, social and corporate governance pillars.	TRESGS	Number
CG	Management score	Management category score measures a company's commitment and effectiveness towards following best practice corporate governance principles.	TRESGCGBDS	Number
SZ	Firm size	ln (number of employees)	WC07011	Number
TAT	Asset turnover	Net sales / average total assets	WC08401	Ratio
AG	Firm age	ln (number of years in operation)	–	Number
JP	Japan	= 1 if company is listed in Japan; 0 otherwise	–	Binary
HK	Hong Kong	= 1 if company is listed in Hong Kong; 0 otherwise	–	Binary
TW	Taiwan	= 1 if company is listed in Taiwan; 0 otherwise	–	Binary
SG	Singapore	= 1 if company is listed in Singapore; 0 otherwise	–	Binary
ID	Indonesia	= 1 if company is listed in Indonesia; 0 otherwise	–	Binary
IN	India	= 1 if company is listed in India; 0 otherwise	–	Binary
IG&S	Industrial goods & services	= 1 if company is categorized in industrial goods and services sector; 0 otherwise	–	Binary
CHM	Chemical	= 1 if company is categorized in chemical sector; 0 otherwise	–	Binary
TEC	Technology	= 1 if company is categorized in technological sector; 0 otherwise	–	Binary
H.C	Health care	= 1 if company is categorized in health care sector; 0 otherwise	–	Binary
FDP	Food producers	= 1 if company is categorized in food producer sector; 0 otherwise	–	Binary
T&L	Travel and leisure	= 1 if company is categorized in travel & leisure sector; 0 otherwise	–	Binary

(2). Table 5 demonstrates the regression results on the estimated coefficients reflecting both firms' financial and environmental performance. We start with modeling the measure of financial performance (Tobin's q) by adding only control variables (firm

Table 3. Descriptive statistics.

Variable	Mean	St. Dev	Median	Minimum	Maximum
Tobin's q	4.38	4.58	0.84	0.93	48.64
PM	6.66	11.35	5.94	1.69	73.70
CO_2	0.04	0.12	0.00	0.00	1.04
CSR	46.01	30.85	45.55	0.00	99.64
CII	0.04	0.14	0.02	0.00	3.14
GI	36.00	32.69	34.89	0.00	99.61
ESG	46.75	19.78	47.31	0.00	92.34
CG	47.93	28.16	47.31	0.00	99.89
SZ	9.08	1.77	9.32	2.39	13.04
AG	3.67	1.65	3.58	0.00	7.60
TAT	0.81	0.42	0.79	0.00	3.04

Table 4. Matrix of pairwise-correlations.

Variable	Q	PM	CO_2	CSR	CII	GI	ESG	CG	SZ	AG	TAT
Q	1										
PM	0.17*	1									
CO_2	−0.23*	−0.02	1								
CSR	0.06*	0.05*	−0.10*	1							
CII	0.20*	0.19*	0.17*	−0.07*	1						
GI	0.07*	−0.10*	−0.10*	0.36*	−0.09*	1					
ESG	0.06*	0.00	−0.12*	0.30*	−0.02	0.47*	1				
CG	−0.01	0.03	−0.06*	0.26*	−0.00	0.07*	0.46*	1			
SZ	−0.13*	0.00	−0.12*	0.33*	−0.14*	0.26*	0.34*	0.14*	1		
AG	−0.19*	−0.13*	−0.01	−0.04*	−0.07*	0.07*	0.01	0.01	−0.37*	1	
TAT	−0.12*	−0.14*	−0.05*	−0.01	−0.19*	0.02	−0.01	0.01	0.17*	0.06*	1

(* p-value < 0.05)

age, size, asset turnover, ESG, and CG) together with country and industry dummies – Model 1 (Table 5). Model 1 was reported to have a fairly good explanatory power ($R^2 = 0.27$). As anticipated, all the country dummies are statistically significant except for Japan (JP), therefore, it is necessary to keep all these dummies in the subsequent models' estimations to capture country-related variations: it appears that the only country that exhibits lower Tobin's q on average is India (IN) than the control group 'Malaysia' country. This contradicts the findings of Al-Ahdal et al. (2020), who argue that the financial performance of Indian firms is better than other countries in their sample. Notably, most industry-related dummies are statistically significant except for industrial goods and services (IG&S) and chemical (CHM) sectors. The five firm-specific control measures are also estimated, including firm age (AG), firm size (SZ), asset turnover (TAT), firms' adoption of overall environmental, social, and governance practices' score (ESG), and corporate governance effectiveness scores (CG). Except for the total assets turnover (TAT), the rest of the control variables' estimated coefficients are statistically significant. However, only ESG scores are positively associated with Tobin's q; this is consistent with the mainstream literature suggesting that the firms' efforts towards following ESG practices significantly and positively contribute to their financial performance (Fatemi, Glaum, and Kaiser 2018; Nemlioglu and Mallick 2017; Wong et al. 2021). All other control variables negatively related to Tobin's q. Though a positive impact of firm age and firm size on firm performance is reported by some studies (i.e. Ahn 1999; Hatzikian 2015), but our findings confirm the negative impact documented by several authors (Dang, Li, and Yang 2018; Majumdar 1997; Raja and

Table 5. The estimated results of financial performance and environmental performance.

	Financial Performance			Environmental Performance	
Variables	Model 1 Tobin's q	Model 2 Tobin's q	Model 3 Tobin's q	Model 4 CO_2	Model 5 CO_2
JP	0.579	1.414**	0.865	−0.163***	−0.185***
	(0.602)	(0.607)	(0.616)	(0.018)	(0.018)
TW	4.072***	4.504***	4.414***	−0.084***	−0.082***
	(0.984)	(0.974)	(0.968)	(0.030)	(0.029)
HK	2.843***	3.191***	2.666***	−0.068***	−0.092***
	(0.632)	(0.626)	(0.629)	(0.019)	(0.019)
SG	3.627***	4.146***	3.991***	−0.101***	−0.109***
	(1.191)	(1.180)	(1.182)	(0.036)	(0.036)
IN	−2.895***	−2.099***	−2.311***	−0.156***	−0.160***
	(0.638)	(0.640)	(0.636)	(0.019)	(0.019)
ID	1.998*	2.946***	2.703***	−0.185***	−0.191***
	(1.052)	(1.048)	(1.041)	(0.032)	(0.031)
IG&S	0.035	0.023	0.064	0.002	0.005
	(0.279)	(0.276)	(0.274)	(0.008)	(0.008)
TEC	0.751***	0.919***	0.660**	−0.033***	−0.044***
	(0.266)	(0.264)	(0.270)	(0.008)	(0.008)
CHM	0.342	0.246	0.156	0.019**	3.621***
	(0.316)	(0.312)	(0.310)	(0.010)	(1.189)
H.C	2.506***	2.347***	1.675***	0.031***	0.002
	(0.295)	(0.293)	(0.332)	(0.009)	(0.010)
T&L	1.243**	1.368***	1.043**	−0.024*	−0.038***
	(0.488)	(0.483)	(0.484)	(0.015)	(0.015)
FDP	1.111***	1.065***	1.229***	0.009	0.018
	(0.369)	(0.365)	(0.364)	(0.011)	(0.011)
ESG	0.020***	0.021***	0.014**	−0.000	−0.001***
	(0.006)	(0.006)	(0.007)	(0.000)	(0.000)
CG	−0.012***	−0.011***	−0.009**	0.000	0.000
	(0.004)	(0.004	(0.004)	(0.000)	(0.000)
SZ	−0.343***	−0.322***	−0.335***	−0.004**	−0.004**
	(0.065)	(0.064)	(0.064)	(0.002)	(0.002)
AG	−1.119***	−1.101***	−1.201***	−0.004	−0.009*
	(0.149)	(0.147)	(0.147)	(0.004)	(0.004)
TAT	−0.185	−0.238	−0.388	0.010	0.002
	(0.221)	(0.219)	(0.219)	(0.007)	(0.007)
CO_2		−5.118***	−4.302***		
		(0.713)	(0.723)		
CII			17.541***		0.836***
			(3.101)		(0.092)
GI			0.622**		−0.0003***
			(0.290)		(0.0001)
Constant	7.310***	6.124***	6.971***	0.232***	0.265***
	(0.931)	(0.935)	(0.940)	(0.028)	(0.028)
Obs.	2115	2115	2112	2118	2115
R-squared	0.273	0.290	0.302	0.154	0.190
Adjusted R^2	0.265	0.283	0.294	0.145	0.181

This table show the estimation results of time fixed effects panel regression with country and sectoral dummies from 2015–2019. The dependent variable is Tobin's q to measure financial performance (Model 1 – Model 3), and CO_2 to measure environmental performance (Model 4 – Model 5). Standard errors are reported in parentheses. ***, **, * indicates that the estimated coefficient is significant at 1%, 5%, and 10% level, respectively.

Kumar 2005). The likelihood of growth opportunities are often associated with the smaller companies; this may occur beyond a certain threshold since the actual relationship between firm age, firm size, and firm performance tends to have curvilinearity (Dang, Li, and Yang 2018), that entails a functional form in a quadratic shape. Thus, as we include squared term to the firm age and size, the coefficients' signs turned from negative to positive and statistically significant – the estimation did not present for the brevity purpose. Similarly, the measure of corporate governance (CG) is also negatively related to Tobin's q, which is consistent with the previous studies (Koji, Adhikary, and Tram 2020; Naushad and Malik 2015), thereby indicating that some measures of CG such as board size, board independence, or board diversity may affect firm performance adversely (Koji, Adhikary, and Tram 2020). However, we consider that it may depend on the various factors such as companies' nature of business, the complexity of structure, and economic objectives.

Next, we added carbon emission (CO_2) in the list of explanatory variables to analyze the effect of firms' environmental performance on financial performance – Model 2 (Table 5). As a response, the model's explanatory power significantly improved (R^2 = 0.29). All the country dummies continue to retain their statistical significance, including Japan (JP) which was previously insignificant in Model 1. The Indonesia dummy strengthens its position by improving the significance level from 10% to 1%. Likewise, the industry dummies and the set of control variables hold as does in Model 1 with the same signs and strength. As anticipated, the coefficient of CO_2 is very statistically significant (< 0.00) with a negative value (−5.118). This confirms that a higher level of CO_2 negatively impacts the firm performance (Tobin's q); alternatively, a lower level of CO_2 (better environmental performance) is positively related to the firm value (Tobin's q) – *which leads to a strong confirmation of hypothesis 1.* Some previous studies (i.e. Link and Naveh 2006; Muhammad et al. 2015; Sarumpaet 2005) reported that environmental performance does not have any impact on firms' financial performance. But the findings of this research confirm a strong positive effect of environmental performance on financial performance. Our results are consistent with the extant literature (Albrizio, Kozluk, and Zipperer 2017; Ong et al. 2019; Yurdakul and Kazan 2020), suggesting that environmental policies regarding the exploitation of natural resources and measures taken to reduce the level of CO_2 are advantageous to the financial performance of the firms. Therefore, environmental performance certainly a major factor in improving the financial performance of environmentally proactive companies. These firms tend to generate financial benefits directly from improving environmental quality by reducing carbon emissions, hazardous materials, and better implementation of the waste management system. According to the value-based eco-management view (Figge and Hahn 2012; Iwata and Okada 2011; Schaltegger and Figge 2000; Wagner and Schaltegger 2004), firms with environmental practices are more likely to get benefited financially when they have the ability to assimilate their environmental and financial performance, where a continuous increase in environmental performance translate into economic benefits. Firms' investments in environmental practices can help to lower operational expenses through enhanced efficiency. Given that performance relies upon firms' ability to develop eco-efficiency through which economic and environmental value can be derived simultaneously.

Next, we further extend our model by incorporating another two terms related to innovation to test the impact of conventional innovation-intensity (CII) and green innovation (GI) on firms' financial performance – Model 3 (Table 5). Again, there is an improvement in the explanatory power of the model relatively (R^2 = 0.30). The estimated coefficients of all the country and industry dummies, control variables, and CO_2 are robust on adding two innovation-related terms and hold their significance, but the dummy for Japan (JP) becomes insignificant again. The dummies for industrial goods and services (IG&S) and chemical sectors continued to stay insignificant like in the previous Models. It appears that the coefficient of both CII and GI are positive (+17.541, +0.622) and very significant, implying that both measures of innovation positively impact the financial performance (Tobin's q) of the firms. *Thus, hypotheses 2 and 3 are strongly supported*. Our results are consistent with the previous studies (Long et al. 2017; Munodawafa and Johl 2019; Schaltegger and Synnestvedt 2002), suggesting that the CII and GI positively contribute to the firm value. The fact that the R&D augmented innovation-intensity plays a significant role in improving firms' financial performance has been extensively documented in the literature (Coad and Rao 2008; Gu 2016; Wellalage and Fernandez 2019). Firms tend to have better financial performance when they invest in R&D to develop new or modify the existing setup to ensure the efficiency and capability of their operational activities. Similarly, when it comes to green innovation, firms are likely to obtain financial benefits when they incorporate changes to redesign or restructure their processes for better environmental outcomes (Ong et al. 2019). The improved processes may help to reduce the costs and achieve higher financial gains. Besides, environmentally conscious customers are willing to pay more, and investors are likely to invest greater funds (Lee, Min, and Yook 2015), therefore, may lead firms to generate more revenues and other benefits such as a good reputation that may eventually contribute to the market value of the firm. Moreover, when all the firms adopt a green policy, the benefits might disappear. Therefore, this relationship must be interpreted carefully as it may not continue to give an advantage over competitors. But those who do not invest in green innovation would be disadvantaged.

We then use CO_2 as a dependent variable to estimate the firms' environmental performance in Model 4, present in Table 5, by including only control variables together with country and industry dummies. The estimation shows a fairly good explanatory power of the model ($R^2 = 0.15$). Interestingly, the estimated coefficients for all the country dummies were reported to impact CO_2 negatively. This reflects that carbon emission in all these countries is relatively lower than the control 'Malaysia' group. Most of the sectoral dummies are also statistically significant except for industrial goods and services (IG&S) and food producers. In particular, the effect of dummies for the chemical sector (CHM) and health care (H.C) sector is significantly positive, implying that both sectors significantly contribute to the level of CO_2 than positive, which demonstrate that both of these sectors positively contribute to the CO_2 than the control 'other' group. The only control variable with a significant result was firm size (SZ) that is negatively related to the CO_2. We next include the conventional innovation-intensity (CII) and green innovation (GI) in the model to analyze their impact on the environmental performance of firms – Model 5 (Table 5). The outcome is the significant improvement in the model's explanatory power ($R^2 = 0.19$). All the country and industry dummies continue to maintain their statistical significance, as does in model 4. Concerning the control variables, besides firm size (SZ), ESG and firm age (AG) are statistically significant and were previously insignificant in Model 4, AG albeit is significant only at 10% level. All these three control variables are reported to have a negative impact on CO_2. As anticipated, the coefficient of conventional innovation-intensity (CII) is positive (+0.836) and strongly significant ($p < 0.00$). Whilst the coefficient of green innovation (GI) is negative, albeit with a smaller magnitude (−0.0003), but very statistically significant ($p < 0.00$). It is clearly apparent that CII positively contributes to CO_2, whereas GI helps to improve environmental performance by reducing the level of CO_2. *Thus, hypotheses 4 and 5 are strongly supported.* The evidence of a positive relationship between CII and CO_2 contradicts with some studies (Fernández, López, and Blanco 2018; Paramati et al. 2020), but consistent with various other studies (i.e. Churchill et al. 2019; Petrović and Lobanov 2020; Shaari et al. 2016), suggesting that the conventional R&D can increase CO_2 and have a deleterious impact on the environment. Regarding the negative relationship between GI and CO_2, our findings are consistent with the earlier studies (Anton, Deltas, and Khanna 2004; Carrión-Flores and Innes 2010; Ong et al. 2019; Yurdakul and Kazan 2020), indicating that green innovation is the most suggestive measure to reduce CO_2 and much advantageous to the firms' environmental performance. Green innovation may provide the broadest scope in developing a competitive advantage by redesigning the processes such that with the minimal possible emission, water and solid waste, materials and energy, and allow recycling and reuse of parts are most likely to bring underlying change necessary to achieve higher environmental performance.

4.2. Robustness check

The empirical results reported in Table 6 are concerning the alternative measures of estimating firms' financial performance and environmental performance to ensure the consistency of our earlier estimation. As suggested by several studies (i.e. Coad and Rao 2008; Nemlioglu and Mallick 2017; Seo and Kim 2020), we employ the profit margin (PM) of firms as an alternative measure of financial performance. Similarly, regarding the firms' environmental performance, guided by the various authors (i.e. Ehsan et al. 2018; Escrig-Olmedo et al. 2017; Nazari, Hrazdil, and Mahmoudian 2017), we use CSR score reported by the firms in their ESG performance index as another measure of environmental performance. We once again start by estimating the impact of environmental performance (reduction in CO_2) on financial performance (PM) in Model 6 presented in Table 6. The explanatory power of the model is reported to have the value of $R^2 = 0.10$. The estimated coefficients for most of the country and industry dummies are statistically significant except for the Indonesia dummy and sectoral dummies related to the industrial goods and services (IG&S) and technology (TEC). For the control variables, the effect of firm age (AG) and firm size (SZ) is significantly positive to the PM. Notably, total asset turnover (TAT), which was insignificant in all the estimations reported in Table 5, becomes strongly significant and negatively related to the PM. The impact of ESG and CG on PM is positive but statistically insignificant. As anticipated, the coefficient of CO_2 is negative (−7.631) and highly significant ($p < 0.00$), suggesting that higher CO_2 level negatively impact the financial performance of firms; alternatively, lower CO_2 level (better environmental performance) is positively related to firms' financial performance. Thus, confirming our proposition that environmental performance has a significant positive impact on financial performance. When we add CII and GI in our estimation of Model 7 in Table 6, we observed a significant improvement in the model's explanatory power (R2 = 0.17). The control variable ESG becomes significant upon inclusion of these two innovation-related terms; however, firm age (AG) loses its statistical significance. As expected, the estimated coefficient of CII is positive (+22.484) and highly significant ($p < 0.00$) with the PM, however, the coefficient of GI turns out to have an

Table 6. Robustness check.

	Financial Performance		Environmental Performance	
Variables	Model 6 PM	Model 7 PM	Model 8 CSR	Model 9 CSR
JP	−5.255***	−2.978*	−12.766***	−14.761***
	(1.641)	(1.604)	(3.199)	(3.265)
TW	−5.486**	−7.202***	−14.089***	−15.137***
	(2.560)	(2.531)	(5.147)	(5.150)
HK	5.745***	2.322**	−2.476***	−3.378
	(1.224)	(1.051)	(0.461)	(3.325)
SG	8.640***	5.010**	−3.140	−4.477
	(2.911)	(2.001)	(6.282)	(6.288)
IN	4.173***	3.051***	−9.189***	−10.965***
	(1.333)	(1.660)	(3.330)	(3.379)
IND	−2.491	−1.208	−0.669	−2.804
	(2.834)	(2.719)	(5.494)	(5.533)
IG&S	−0.231	−0.302	−1.464	−1.429
	(0.745)	(0.714)	(1.455)	(1.452)
TEC	0.305	0.769	−5.200***	−5.560***
	(0.713)	(0.690)	(1.401)	(1.404)
CHM	2.398***	2.573***	−5.092***	−5.275***
	(0.845)	(0.810)	(1.649)	(1.648)
H.C	4.011***	6.169***	−8.999***	−8.733***
	(0.792	(0.815)	(1.659)	(1.658)
T&L	2.217*	2.409**	0.125	−0.166
	(1.305)	(1.254)	(2.555)	(2.552)
FDP	−2.066**	−2.184**	−7.726***	−7.602***
	(0.987)	(0.949)	(1.939)	(1.936)
ESG	0.002	0.035***	1.280***	1.273***
	(0.016)	(0.017)	(0.035)	(0.035)
CG	0.008	−0.004	−0.206***	−0.206***
	(0.010)	(0.010)	(0.021)	(0.021)
SZ	0.316**	0.359**	1.127***	1.093***
	(0.143)	(0.167)	(0.339)	(0.339)
AG	1.078***	0.372	0.800	0.762
	(0.367)	(0.381)	(0.776)	(0.775)
TAT	−2.179***	−3.161***	0.071	0.252
	(0.592)	(0.572)	(1.164)	(1.163)
CO_2	−7.631***	−3.457**		−11.128***
	(1.930)	(1.873)		(3.811)
CII		22.484***	−6.975**	−5.530**
		(1.620)	(3.265)	(2.297)
GI		−0.019**	0.034*	0.030*
		(0.009)	(0.019)	(0.019)
Constant	11.740***	12.871***	−2.598	−0.100
	(2.529)	(2.434)	(4.889)	(4.955)
Obs.	2118	2115	2114	2114
R-squared	0.106	0.174	0.562	0.574
Adjusted R^2	0.097	0.164	0.557	0.569

This table show the estimation results of time fixed effects panel regression with country and sectoral dummies from 2015–2019. The dependent variable is profit margin (PM) to measure financial performance (Model 6 – Model 7), and CSR to measure environmental performance (Model 8 – Model 9). Standard errors are reported in parentheses. ***, **, * indicates that the estimated coefficient is significant at 1%, 5%, and 10% level, respectively.

unexpected significant negative (−0.019) relationship with PM. This might be because firms may encounter costly investments on GI, which may take time for the firms to yield returns from such investments and contribute to their profits (Lee and Byung 2015; Lee, Min, and Yook 2015).

The robustness for the firms' environmental performance (CSR) is checked in Model 8 and Model 9 (Table 6). The explanatory power of both Model 8 and Model 9 is remarkably very higher than those estimated in all previously estimated Models with the value of $R^2 = 0.56$ and 0.57, respectively. In Model 8, the country and industry dummies' coefficients retain their statistical significance with even more stronger magnitudes. The effect of ESG and firm size is very significant and positive to CSR. As anticipated, the estimated coefficient of CII is negative (−6.975) and very statistically significant ($p < 0.00$). Whilst the coefficient of GI is positive (0.034), albeit at the 10% level of significance. Therefore, leading to the confirmation of our hypotheses that CII has a deleterious impact on environmental performance, whereas GI plays an advantageous role in improving environmental performance. We performed an additional check by including CO_2 as an independent variable into the regression of CSR to confirm our understanding of the destructive role CO_2 can play in impacting the environmental performance – Model 9. As anticipated, the coefficient of CO_2 captured most of the variation in explaining CSR; the estimated effect is negative (−11.128) and strongly significant ($p < 0.00$). Whilst the coefficients of both CII and GI remain robust by retaining their statistical significance. Thus, we confirm that both CO_2 and CII deleteriously impact firms' environmental performance, whereas GI has a built-in capability to improve financial performance and environmental performance. By altering such capabilities in attaining greater environmental performance, firms might set marginally higher prices (Khalil, Asad, and Khan 2018; Ong et al. 2019) by introducing products and services with more green features, which may translate into higher revenues. Likewise, green innovation through improved operational and production processes perhaps helps lower operating costs (Ambec and Lanoie 2008; Khalil, Khalil, and Khan 2019), thus enhancing firms' financial performance. Accordingly, the companies need to invest in green innovation since it facilitates transforming capabilities integrated into firm environmental performance towards financial performance. Overall, our findings related to all the hypotheses remain insensitive to different model specifications and empirical settings and robustly supported.

5. Conclusion

This research focuses on analyzing the impact of innovation on firms' financial performance and environmental performance. While firms spending on R&D is the conventional view of innovation, and green innovation concentrates on the practices of following improved environmental innovation. Integrating these two innovation perspectives on which firms invest concurrently and identifying environmental innovation scores (green innovation) as a key firms' environmental commitment to follow a firm environmental strategy allows us to examine the relationship between CO_2 emissions and financial performance. In particular, we further develop an empirical model to investigate the impact of both conventional innovation and green innovation on firms' financial performance and environmental performance, using the novel set of firm-level ESG data for the seven Asian countries (Japan, Singapore, Taiwan, Hong Kong, Malaysia, India, and Indonesia) over the period 2015–2019. By applying period fixed-effects panel regression with country and industry dummies, our analysis shows that both conventional innovation and green innovation are enablers for better financial performance; however, conventional innovation is solely less effective in environmental performance than green innovation. Our findings endorse green innovation as a key driver, which indeed has a tremendous impact on both firm financial and environmental performance.

Some intriguing managerial implications can be drawn from the findings of this research. Undertaking challenges of climate change by the firms entails technology development, capability, and financial investments. Though integrating decision of environmental sustainability often imposes constraints on firms in terms of bearing additional costs, however, such integrations if properly administrate and execute, can enlighten up with potential business opportunities, which may translate into better environmental prospect and financial performance. As we find in this research, investing in green innovation reduces carbon emission (CO_2) and improved financial performance. The realized benefits from green innovation and superior environmental performance, however, might be unobvious due to the unavailability of related measurement tools, or corporate managers might have limited information and often miss potential profits and business opportunities. To visibly obtain realized benefits from better financial and environmental performance, the decision-makers should ensure that the cost and benefit are quantifiable and reportable. Necessary tools are required to practically quantify and report financial and environmental outcomes to help management make decisions and define their priorities for the sustainability of environmental and financial performance. Moreover, corporate managers often get pushed by investors and stakeholders to make short-term investments, particularly in green innovation and eco-technology. Achieving financial and environmental success from short-term investment decisions is unlikely since gaining visible environmental and financial performance outcomes may require a longer time than expected; thus, short-term decisions should be avoided to attain successful performance outcomes.

The crucial role of green innovation in improving both the financial value and environmental performance of firms, suggesting policymakers that they should prioritize sustainable investments to enhance the innovation outcomes so as to achieve superior financial performance and to attract potential environmentally proactive stakeholders. Governments are already making significant developments in promoting environmental innovation at national or regional levels; however, their intervention is extremely essential to develop policies on the advancement of green innovation at the firm level such as policies for the adoption and implementation of green innovation and related tax incentives are necessary to encourage companies to instigate the structure of green innovations. Additional policy measures might also include somewhat extra tax rebates on income realized from selling green and further capital allowances on radical innovations' implementation. Some special rewards from the government can be associated with those firms who perform extraordinarily in their ESG pillars, in particular, in the environmental innovation, to encourage the management that is involved in crafting strategies for environmental issues. Climate change mitigation and adaptation responses should also be considered by government policymakers addressing national policy on carbon emission in their environmental planning and protection plans. The policies on climate change mitigation and adaptation entail developing and deploying innovative technological solutions, and both need funds. Policymakers require to design schemes and incorporate appropriate guidance with financial incentives from their budget to effectively execute the government's climate change policies. For example, the Japanese government's introduction of a regulatory obligation for accounting and reporting greenhouse gas emission (GHG) has enabled Japanese firms to manage, quantify, and disclose carbon emissions in their financial statements (Lee, Min, and Yook 2015). Likewise, the Korean government implemented a similar requirement of reporting GHG for Korean companies, aiming to facilitate companies' management of climate change by establishing a collaborative norm between the stakeholders, leading industries, and the government. Well-defined institutional policies to quantify and report climate change effects can help firms better equip themselves with capabilities and required technologies related to climate change.

Like other research, this research also has some limitations that future work may likely address. Firstly, our study has mainly focused on only two aspects of firm environmental performance: carbon emission and CSR performance. Given the rich nature of firms' environmental sustainability and multidimensionality of the construct that integrates an extensive range of corporate behavior concerning relationships with customers, suppliers, communities, and wider sustainability responsibility (i.e. biodiversity), thus, it is essential to extend the analysis to investigate other important dimensions of sustainable environmental performance. Secondly, our sample and analysis have mainly covered only the selected Asian countries. Carbon emission, of course, is represented as one imperative domain of environmental performance since the actual and possible harm that is apparent as being associated with them. Therefore, enhanced data on emissions would certainly contribute to improved environmental management measurement and environmental performance. We can also take advantage of gaining insights on environmental management once researchers perform a regional comparative analysis, build on different geographical coverage and various data sources. The issue of regional comparison in firms' environmental management is worthy enough for significant additional work.

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