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Environmental management practices and financial performance using data envelopment analysis in Japan: The mediating role of environmental performance

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Abstract

This study investigates the relationship between environmental management practices (EMPs) and financial performance (FP), and consequently ascertain whether environmental performance (EP) can mediate the EMPs–FP nexus. Distinctly using data envelopment analysis and generalised method of moments techniques to analyse a comprehensive dataset of Nikkei 225 listed firms from 2007 to 2018 (1,920 firm-year observations), our findings first suggest that EMPs have a positive effect on FP. Second, the desired EP can be achieved through the adoption of comprehensive EMPs. Third, improved EP has a substantial impact on shaping the EMPs’ effect on FP. These findings are consistent with the predictions of resource-based view and institutional theories. The results are robust to controlling for different types of alternative measures and endogeneities. The findings have important implications for academics, investors, managers, policy-makers, and regulators.

Keywords: Environmental management practices, environmental performance, financial performance, data envelopment analysis, institutional theory, and resource-based view

1 INTRODUCTION

Unprecedented global environmental threats have increased the strategic importance of environmental management practices into the operations of any business unit (Haque & Ntim, 2018, 2020). The predominant role of industrial units in the destruction of the ecological system has become the subject of ongoing debate among business, management and strategic researchers. Prior studies (Bhattacharyya & Cumming, 2015; Dang, Nguyen, Bu, & Wang, 2019; Elmagrhi, Ntim, Elamer, & Zhang, 2019; Shahab, Ntim, Chengang, Ullah, & Fosu, 2018; Shahab, Ntim, & Ullah, 2019; Shahab et al., 2020) suggest that, in the current complex global business environment, it has become too difficult to gain and retain competitive advantages and survive without fulfilling environmental legitimacy by addressing multiple stakeholders' concerns, including those relating to environmental challenges. Accordingly, it is argued that proactive environmental management practices can enhance corporate environmental performance (Anton, Deltas, & Khanna, 2004; Chen, Nginedema, & Li, 2018; Dahlmann, Branicki, & Brammer, 2019; Haque & Ntim, 2018, 2020; Melnyk, Sroufe, & Calantone, 2003; Xue, Zhang & Li, 2020). Environmental management practices are "*part of the overall management system that includes organizational structures, planning activities, responsibilities, practices, procedures, processes, and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy*" (ISO 14001). Theoretically, corporations may voluntarily commit to good environmental activities due to two main reasons: (i) to obtain competitive advantages, including gaining access to crucial resources (Allegrini & Greco, 2013; De Villiers, Naiker, & Van Staden, 2011); and/or (ii) to legitimize their operations by obtaining the approval of the wider community (Al-Shaer & Zaman, 2016; Cong & Freedman, 2011). Specifically, resource dependence theory focuses on the financial benefits and competitive advantages that can be obtained from committing to good environmental management practices, whereas legitimacy and stakeholder theories are predominantly concerned with improving corporate reputation and image by adopting strong environmental management practices. Specifically, resource dependence (Feng & Wang, 2016; Hart, 1995) and institutional (DiMaggio & Powell, 1983) theories indicate that committing to good environmental management practices can improve corporate financial performance by increasing pressure on managers to engage in good environmental activities, and this, in turn, can help in developing and maintaining good business connections with influential stakeholders in order to gain access to critical resources.

Empirically, prior studies examining the associations among environmental management practices, environmental performance, and financial performance suffer from several weaknesses due to the following reasons. First, corporate environmentalism is recognised as a multilayer construct, which has two different concepts (i.e., environmental management practices and environmental performance) that are difficult to easily link together (Dragomir, 2018; Henri & Journeault, 2008; Trumpp, Endrikat, Zopf, & Guenther 2015; Xie & Hayase, 2007). Second, corporate environmentalism phenomenon has mostly been examined by prior studies via the lens of economic benefits with a specific focus on ascertaining whether being green is profitable or not (Christmann, 2000; Clarkson, Li, Richardson, & Vasvari, 2011a; Jiang, Xue, & Xue, 2018; Li, Nginedema, & Chen, 2017). Third, prior studies have largely measured corporate environmental initiatives indirectly using

environmental disclosure proxies, but such measures may not accurately capture companies' actual environmental performance (Albertini, 2013; Deegan, 2013; 2017; Deegan & Gordon, 1996). Arguably, this raises doubt about the generalizability of the findings of these studies.

Fourth, prior studies have used various scales to measure environmental management practices (Al-Tuwaijri, Christensen, & Hughes, 2004; Clarkson, Li, Richardson, & Vasvari, 2008; Ilinitich, Soderstrom, & Thomas, 1998; Montabon, Sroufe, & Narasimhan, 2007; Xie & Hayase, 2007). However, very few studies have addressed the construct validity of these scales (Trumpp et al., 2015). To address this limitation, the current study uses a comprehensive five sub-dimensional environmental management practices scale suggested by Xie and Hayase (2007), and a statistically confirmed construct validity by Trumpp et al. (2015), to measure corporate environmental management practices. Fifth, there is still no agreement in the extant literature about what environmental performance is and how it should be measured (Nawrocka & Parker, 2009; Song, Fisher, Wang, & Cui, 2018). Hassan and Romilly (2018) and Tadros and Magnan (2019) argue that new informational resource discovery is the real contribution towards improvement in the quality of environmental performance measurement. Therefore, the current study also measures environmental performance through environmental efficiency by using Data Envelopment Analysis (DEA). Observably, prior studies have widely used DEA to examine environmental performance/efficiency at the macro-level of analysis (Jin, Zhou, & Zhou, 2014; Wojcik, Dyckhoff, & Clermont, 2019; Zhou, Ang, & Poh, 2006; Zhou, Poh, & Ang, 2007). By contrast, DEA has rarely been used to examine environmental efficiency/performance at the corporate-level of analysis (Wang, Li, & Zhao, 2018), and this, arguably, can also limit the generalisability of their findings. According to Song et al. (2018), DEA is considered as an appropriate method for measuring relative efficiency, particularly for corporate environmental outcomes compared to traditional multivariate linear regression techniques, such as ordinary least squares regression.

Meanwhile, Japan provides an appropriate avenue for this study due to the following reasons. First, Japan is known as a more environmentally responsible nation over the last few decades (Weidner, 2020). Specifically, Japan has experienced a high level of corporate environmental reporting regulations (Endo, 2020; Lee, Park, Song, & Yook, 2017; Yagi & Managi, 2018). Second, in Japan, industrial units are not only at the transition phase in dealing with corporate environmental issues, but also there is a rudimentary emphasis on environmental management practices (Yagi & Managi, 2018). Third, in Japan, 19,131 firms have ISO 14001 certification and ranked top among G7 countries (Endo, 2020). Fourth, Japan is characterised by advanced technological development and strong corporate environmental regulations (Oshitani, 2013). For example, greenhouse gas (GHG) accounting and reporting have been mandatory in Japan since 2006. Moreover, regulations concerning the promotion of business activities with environmental considerations have focused on the reliability of the environmental reporting framework, specifically for large corporations since 2004 (Lee et al., 2017). All of these characteristics, arguably, make Japan an interesting context to conduct this study.

Given the noticeable limitations of past studies and appropriateness of the Japanese context, our research seeks to broaden the current knowledge and contribute to the existing literature in a number of ways. First, and to the best of our knowledge, prior studies have not examined the interrelationship among environmental management practices, environmental

performance and financial performance (e.g., Chen et al., 2018; Feng et al., 2018; Li et al., 2017). Therefore, our research seeks to contribute to the literature by examining the association between corporate environmental management practices and financial performance, and consequently ascertain whether corporate environmental performance can mediate this association. Second, and unlike past studies that examined environmental performance either using carbon emissions (CO₂) or energy, waste and water separately (Arena, Mastellone, & Perugini, 2003; Clarkson, Overell, & Chapple 2011b; Feng et al., 2018), the current study examines environmental performance using major inputs and outputs of environmental performance. Specifically, the current study focuses on major components (energy as an input and sales as a good output and carbon emissions as an bad output) as environmental performance proxy. Third, we provide a methodological contribution by being among the first group of researchers to pioneer the DEA technique within the context of environmental management and performance study. Finally, our study distinctively uses five proxies for environmental performance and examine their mediating impact on environmental management practices and financial performance nexus. These five proxies are: (i) total carbon emissions produced; (ii) carbon emissions intensity; (iii) carbon emission productivity; (iv) carbon emission per unit size; and (v) DEA.

The rest of the paper is structured as follows. The second section presents the theoretical framework. The following sections review the empirical literature and hypotheses development, outline the research design, and report the findings and discussion. The final section concludes the paper.

2 THEORETICAL BACKGROUND

A number of traditional theories (e.g., legitimacy, resource dependence, stakeholder, and signalling theories) have been applied by past studies in interpreting the links between environmental performance and financial performance (e.g., Ntim & Soobaroyen, 2013a, b). A major issue with the application of such traditional theories in addressing environmental issues is that they fail to recognise the importance of natural resources within a firm's broader social and environmental strategies (Ntim, 2016; Oliver, 1997; Wagner, 2015). By contrast, institutional theory and resource-based views (RBV) can address such limitations (Tran et al., 2020), and therefore, in this study, we have elected to apply these theories in explaining the relationship among environmental management practices, environmental performance, and financial performance.

In this case and on the one hand, RBV indicates the need to develop internal capabilities in order to gain a competitive advantage over competitors (Barney, 1991). Specifically, RBV is based on the premise of unique internal resources and capabilities. The firm's competitive advantage is contingent on the use of its tangible and intangible resources, which are not easily imitated (Arda, Bayraktar, & Tatoglu, 2019). More precisely, being less pollution oriented is likely to be a burden on a firm's resources (Porter & Van der Linde, 1995). However, such continuous improvements in environmental policies can lead firms towards sustainable development (Al-Tuwaijri et al., 2004; Trumpp & Guenther, 2017). Therefore, an RBV framework suggests that adopting innovative environmental strategies, in the form of good environmental management practices, can improve corporate sustainable strategic growth, and

this in turn can promote corporate financial benefits by obtaining access to the crucial resources (Christmann, 2000).

On the other hand, the institutional theory suggests that a firm's environmental actions convey its external environmental stance (Berrone, Fosfuri, & Gelabert, 2017). Specifically, the institutional theory proposes that firms' practices and operations are highly influenced by the changes in social expectation, cultural norms, and values (Feng & Wang, 2016). DiMaggio and Powell (1983) categorized institutional isomorphism into three categories: (i) coercive/regulatory; (ii) cognitive/mimetic; and (iii) normative isomorphism. Coercive institutional isomorphism is emanated from indirect and direct forces. Direct forces include government rules and regulation, while indirect forces are the cultural expectation of the broader society that influences the firm's structure and procedures for meeting the environmental legitimacy (Haque & Ntim, 2018). These political influences have emerged from the most powerful stakeholders through the power of environmental fines, compulsory shutdowns, and boycott the product (DiMaggio & Powell, 1983). Whereas, mimetic isomorphism stems from strategic organisational actions to become more competitive and environmentally friendly in the market (DiMaggio & Powell, 1983). Normative isomorphism is originated from collective societal values exerted by media, institutional associations and networks, suppliers, specialised staff, and customers (Haque & Ntim, 2018; Soobaroyen & Ntim, 2013). Therefore normative isomorphism is not built in any environmental standards but pushes the corporation policy towards resource allocation to prevailing and implementing environmental management practices (Wang et al., 2018). Therefore, the institutional theory indicates that committing to good environmental management practices can enhance corporate environmental performance (i.e., reducing carbon emissions/pollution), which in turn can improve corporate financial performance by maintaining good relations with the powerful stakeholders and winning their support.

Therefore, and due to the dynamic and complex nature of environmental management practices that cannot be fully explained by relying on an individual theoretical perspective (Haque & Ntim, 2018; Nawrocka & Parker, 2009), and consistent with the recent calls to integrate socio-political environmental prospects with economic incentives to explain corporate environmental phenomena (Aerts, Cormier, & Magnan, 2008; Feng & Wang, 2016; Moussa, Allam, Elbanna, & Bani-Mustafa, 2020), this study employs both institutional and RBV to explain the associations among environmental management practices, environmental performance, and financial performance.

3 EMPIRICAL LITERATURE AND HYPOTHESES DEVELOPMENT

3.1 Environmental Management Practices and Environmental Performance

RBV postulates that target of desired environmental performance can only be achieved by allocating resources and capabilities towards environmentally friendly activities (Alam, Atif, Chien-Chi, & Soytaş, 2019). Advancement in the environmental management processes and structures may stimulate business performance with minimum environmental hazards. First, the allocation of resources towards clean technology is not only the demand of today's business world, but also helps to secure the target of eco-efficiency. Second, the adoption of proper environmental management practices transforms the organization policies towards clean

efficient energy. Thus, to reduce the carbon emission intensity, there is a need to embrace the continuous environmental management practices programme.

In this case, firms are restructuring their strategies in order to secure desired environmental performance by embracing the concept of environmental management practices (Florida, 1996; Theyel, 2002). Melnyk et al. (2003) argue, for example, that further investigation is required to confirm the direct and indirect relationship among environmental management practices, environmental performance, and corporate financial performance. According to Anton et al. (2004), regulatory and market-based pressures do not impact on environmental performance directly, but can encourage organisations to change their environmental strategy by increasing commitment to good environmental responsible practices, which can improve their financial performance. Nawrocka and Parker (2009) conducted a meta-study by analysing twenty-three studies examining the association between environmental management practices and environmental performance and find unclear relationships between these two variables due to two main reasons. First, there is no agreement among the existing literature on the best measurement of environmental performance. Second, there is neither clarity nor a strong argument on how and why environmental management practices can influence environmental performance.

Prior empirical studies have reported mixed results when examining the association between environmental management practices and corporate environmental performance. For example, and using a sample of 15 US chemical firms, Delmas and Blass (2010) and Delmas and Toffel (2004) report that firms with strong environmental management practices tend to have lower levels of compliance with environmental practices, as well as higher levels of toxic releases. In contrast, and consistent with the findings of prior studies (Chen et al., 2018; Famiyeh, Adaku, Amoako-Gyampah, Asante-Darko, & Amoatey, 2018; Hartmann & Vachon, 2018), the findings of Li et al. (2017) suggest that the higher the level of green initiatives, the higher the levels of green performance for a sample of 500 largest US-listed firms. Similarly, the findings of Wang et al. (2018) suggest that implementing good environmental practices can help in minimizing the harmful effects of Chinese corporations on the ecological systems. Moussa et al. (2020) also report that US firms tend to implement proactive environmental strategies (i.e., carbon reduction strategies) geared towards achieving desired environmental performance in order to improve their social legitimacy and acceptance. However, and using a sample of 167 EMAS-certified hotels from Italy, Spain and Portugal, Heras-Saizarbitoria, Boiral, García, and Allur, (2020) report that the adoption of best environmental practices is not significantly related to environmental performance. We investigate our arguments in the Japanese context, where the government is the third-largest contributor of funds to support the climate risk emergency programme of the United Nation 2030 Sustainable Development Goals. Moreover, Japan's progress remains unsatisfactory, even in the presence of carbon tax and several environmental policies (Schumacher, Chenet, & Volz, 2020). In contrast, Endo (2020) argued that Japanese firms have shown greater commitment towards their environmental performance by adopting voluntary and mandatory environmental practices. In Japan, listed firms are required to publish the status of their environmental initiatives in their environmental reports (Japanese Ministry of the Environment, 2016). Therefore, and based on the above arguments and predictions of resource-based and institutional theories, we expect

that environmental management practices can impact positively on firm environmental performance. Hence our first hypothesis is that:

H1. *Adoption of good environmental management practices leads to better environmental performance.*

3.2 Environmental Management Practices and Financial Performance

Theoretically, institutional theory (Alhossini et al., 2020; Famiyeh et al., 2018; Ntim & Soobaroyen, 2013a, b) indicates that committing to strong environmental management practices can enhance firms' operational efficiency by reducing their operational costs and optimising their consumption of energy and resources, which can impact positively on their financial performance. Similarly, a resource-based theoretical perspective (Russo & Fouts, 1997) suggests that the implementation of good environmental management practices can improve firms' competitive advantage and growth opportunities by enhancing their reputation/image and providing better connections with key stakeholders, and that, consequently, can improve their financial performance.

Empirically, few quantitative studies have reported that environmental management practices can influence the eco-efficiency of firms (Laari, Töyli & Ojala, 2018; Florida, 1996; Hertin, Berkhout, Wagner, & Tyteca, 2008; Jiang et al., 2018; Montabon et al., 2007). For example, Florida (1996) known among the first scholars, empirically investigated the relationship between environmental management practices and financial performance and demonstrated that environmental management practices lead to substantial environmental and financial performance. Similarly, the findings of Theyel (2000) suggest that implementing good environmental management practices can improve corporate efficiency and profitability by lowering operational costs, including reducing waste arising in manufacturing processes. Dahlmann et al. (2019) also reveal that, in the long term, corporate aspiration for achieving reductions in carbon emission can enhance its performance by improving networking with influential stakeholders and gaining competitive advantages (i.e., access the crucial resources). Similarly, the findings of Li et al. (2017) suggest that the impact of environmental management practices on financial performance is not immediate and firms should incorporate green initiatives and policies in their long-term strategies to achieve competitive advantages and survive. However, Xie et al. (2019) find a negative association between committing to high levels of environmental activities and financial performance for a sample of 6,631 firms from 74 countries. Nevertheless, Japan is viewed as a global energy transition economy and trying to align its economy towards zero-emissions and sustainable economy (Schumacher et al., 2020). Thus, Japanese listed firms are expected to engage in good environmental management practices in order to meet the expectations of powerful stakeholders and survive. We, therefore, hypothesise that:

H2. *Adoption of good environmental management practices leads to better financial performance.*

3.3 Environmental Performance and Financial Performance

Theoretically, resource-based view theory (Hart, 1995; Yadav, Han, & Kim, 2017) suggests that environmental efficiency is a key factor to gain competitive advantages and improve firms' financial performance by meeting the expectations of powerful stakeholders regarding the sustainability and environmental protection, and thus obtaining their support. Resource-based view perspective also suggests that firms often engage in environmentally friendly activities in order to demonstrate accountability to powerful stakeholders and improve their reputation/image in the marketplace, and this, in turn, can have a positive impact on their financial performance (Shen, Ma, Wang, Pan, & Meng, 2019; Russo & Fouts, 1997). Similarly, institutional theory (Zeng, Meng, Yin, Tam, & Sun, 2010; Nguyen et al., 2020) proposes that committing to environmentally friendly activities can help not only in maintaining good relations with the key stakeholders, but also in improving the production processes and reducing production costs (e.g., labour and material requirements), and this can positively influence firms' financial performance.

The empirical evidence on the association between environmental performance and financial performance is generally mixed. For example, and in line with the findings of prior studies (Al-Tuwaijri et al., 2004; Ambec & Lanoie, 2008; Christmann, 2000; Konar & Cohen, 2001; Manrique & Martí-Ballester, 2017; Prado-Lorenzo & Garcia-Sanchez, 2010; Russo & Fouts, 1997; Wagner, 2015), Yadav et al. (2017) report a positive relationship between environmental and financial performance for a sample of 382 US-listed firms. However, other studies have also found either a negative (Cormier & Magnan, 1997; Stanwick & Stanwick, 1998) or no (Earnhart & Lizal, 2007; Wagner, 2005; Walls, Berrone, & Phan, 2012; Qiu, Shaukat, & Tharyan, 2016) relationship between environmental performance and financial performance. The inconclusive empirical results of prior studies seem to be mainly due to two reasons. First, prior studies have largely measured corporate environmental performance subjectively using environmental disclosure proxies. However, such measures may not accurately capture companies' actual environmental performance (Albertini, 2013; Deegan, 2013; 2017; Yagi & Managi, 2018). Second, and despite increasing suggestions that committing to environmentally friendly activities is more beneficial in achieving long term financial goals (Busch & Lewandowski, 2017), most of the past studies examining the relationship between environmental performance and financial performance in Japan have been conducted over a short time period (Iwata & Okada, 2011; Nakao, Amano, Matsumura, Genba, & Nakano, 2007; Sueyoshi & Goto, 2010). Tokyo Stock Exchange (TSE) is known as an early supporter of Task Force on Climate-related Financial Disclosures (TCFD), as Nikkei 225 firms are supporting and expressing their environmental disclosures in considering the TCFD recommendations (Schumacher et al., 2020). In September 2018, Japan has launched a public/private group of green finance, now it is not difficult to say that sustainable investment became the mainstream of the Japanese financial market. Therefore, and based on the above arguments, we expect a positive association between environmental performance and financial performance among Japanese listed firm. Hence, our third hypothesis is that:

H3. *Better environmental performance leads to better financial performance.*

3.4 The Mediating Effect of Environmental Performance on the Environmental Management Practices–Financial Performance Nexus

As explained above, prior studies have largely examined the direct impact of environmental management practices on firms' financial performance and provided mixed results (Florida, 1996; Hertin et al., 2008; Jiang et al., 2018; Li et al., 2017; Miroshnychenko et al., 2017; Montabon et al., 2007; Xie et al., 2019). A major limitation of these studies is that they failed to account for the mediating role of environmental performance in this relationship. Theoretically, institutional theory predicts that committing to strong environmental management practices can increase opportunities to improve environmental performance by promoting investment in environmentally friendly activities, and that can have a positive impact on firms' financial performance by reducing the negative environmental effects and improving product/service value (Lin et al., 2013; Porter & Van der Linde, 1995). Similarly, the resource-based view perspective suggests that implementing good environmental management practices can improve corporate financial performance by reducing production costs and increasing productivity through better utilisation of corporate resources (Bernauer et al., 2007). This theory also proposes that implementing strong environmental management practices does not only reduce firms' negative environmental effects, but also provide them with competitive advantages through improving their reputation/image by fulfilling the expectations of powerful stakeholders (Chang, 2011), and this, in turn, can improve firms' financial performance. Empirically, and to the best of our knowledge, none of the existing environmental studies have quantitatively examined the mediating effect of environmental performance on the environmental management practices and financial performance nexus. This offers an opportunity to contribute to the extant literature in this area of research. Therefore, and given that environmental management practices are not primarily implemented to increase financial profits, but rather to reduce environmental damages and improve the utilisation of corporate resources (Feng et al., 2018). Japanese firms are often criticised for their stakeholder-oriented practices (Endo, 2020), and hence Japanese firms tend to adopt the reactive approach and are more likely to disclose selective environmental information when failed to achieve desire environmental performance (Nishitani, & Kokubu, 2020). However, reporting of GHG emissions and energy consumption is mandatory for large Japanese manufacturing firms (Fujii et al., 2013). Moreover, and according to Lee et al. (2017), about forty-two percent of the Japanese firms are involved in third-party assurance of their environmental performance. Therefore, we argue that improving environmental performance, which is often associated with implementing good environmental management practices, can result in improving financial performance. Specifically, in the context of Japan, we argue that environmental management practices indirectly impact firms' financial performance through strengthen environmental performance. From the above discussion, this study predicts that environmental performance is a missing link between environmental management practices and firm's financial performance (Figure 1). Therefore, our final hypothesis is that:

H4. *Environmental performance mediates the association between environmental management practices and financial performance with the relationship being stronger in firms with better environmental performance.*

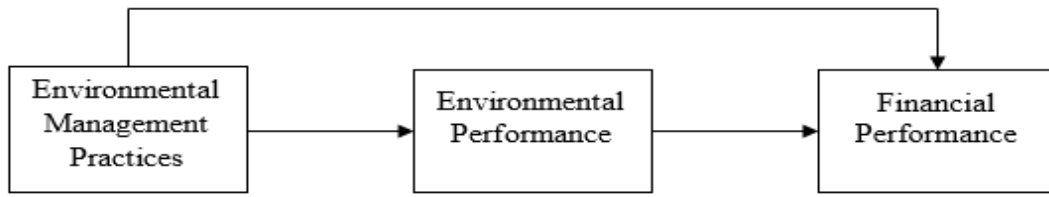


Figure 1 Conceptual and empirical framework

4 RESEARCH METHODOLOGY

4.1 Data and Sample

The initial sample consists of the 2,580 firm-year observations from Nikkei 225 listed firms on the Tokyo Stock Exchange (TSE), Japan from 11 different industries over the period 2007-2018. The study started in 2007 due to that: Japan has made corporate environmental GHG reporting mandatory since 2006 (Fujii et al, 2013). We ended our analysis in 2018 since it was the last year with available data when data collection started. To ensure the comparability of the results, we exclude 348 financial sector firms from the initial sample due to their specific reporting and regulatory pattern (Ntim & Soobaroyen, 2013a, b). The financial sector firms include commercial banks, insurance companies, securities, other financial services, and real estate. Moreover, all these financial sector firms are not highly participated in industrial pollution and energy consumptions. We further removed 26 non-financial firms (312 firm-year observations) due to missing carbon emissions and environmental management practices information throughout the study period. The final unbalanced panel dataset consists of 1,920 firm-year observations from 9 different industries from 2007-2018. Table 1 depicts the study's sample by industry type. All the environmental performance and environmental management practices data were extracted from the Thomson Reuters Asset4 database, while all financial data were collected from the Worldscope database. Thomson Reuters Asset4 environmental, social, and governance (ESG) database is known as a comprehensive global ESG database among the others (Dragomir, 2018; Trumpp et al., 2015). The industrials sector with 612 observations (31.88%) is the most represented industry, followed by the material sector with 348 observations (18.13%) and consumer discretionary with 264 observations (13.75%).

Insert Table 1 about here

4.2 Research variables

Table 2 depicts the measurement of the study's variables. To test our hypotheses (H1 – H4), we use four main variables. First, we employ environmental management practices as our main explanatory variable. We applied a comprehensive five sub-dimensional scale of environmental management practices proposed by Xie and Hayase (2007) and Trumpp et al., (2015). This environmental management practices scale consist on 31 items, which cover the following five main areas: (i) environmental policy – 9 items; (ii) environmental objectives – 5 items; (iii) environmental processes – 7 items; (iv) organisational structure – 4 items; and (v)

environmental monitoring – 6 items. Environmental management practices index is calculated by adding 31 initiatives and score of 1 is awarded if a firm is engaged in environmental initiatives in a given year, otherwise 0. Following this approach, a firm environmental management practices absolute score can range between 31 (implying good quality of environmental management practices) and 0 (implying poor quality of environmental management practices). To best of our knowledge, the above scale of environmental management practices covers all aspects of a firm's environmental initiatives with respect to ISO 14001 definition (see the Appendix for further details about our environmental management practices index). In order to address the concern of the validity of the environmental management practices construct, Cronbach's alpha is calculated. The alpha value of 0.917 indicates that the internal consistency of environmental management practices items is relatively high and the instrument is valid.

Second, our main response variable is financial performance. It is measured using Tobin's Q and this is mainly due to the following three reasons: (i) Tobin's Q has largely been used by prior environmental studies to measure corporate financial performance (Busch & Lewandowski, 2017; Horváthová, 2010; Manrique & Martí-Ballester, 2017; Shen et al., 2019; Surroca, Tribó, & Waddock, 2010; Yagi & Managi, 2018); (ii) Tobin's q adequately capture the value of long-term investments (i.e., investments in environmentally friendly activities) (Dowell, Hart, & Yeung, 2000; Surroca et al., 2010); and (iii) Tobin's q is less sensitive to management manipulation compared with other accounting-based measures (i.e., *ROA* and *ROE*) (Hassan & Romilly, 2018).

Insert Table 2 about here

Third, environmental performance is used as our response, explanatory and mediating variable in *H1*, *H3*, and *H4*, respectively. This study uses five distinct proxies to measure environmental performance. The first proxy of environmental performance is environmental efficiency (*EP_DEA*) measured by total energy consumption as input and sales as a good output, while total carbon emissions as bad output with the help of Data Envelopment Analysis (DEA) (Chen, Xu, & Chen, 2017; Song et al., 2018). DEA is a non-parametric mathematical technique that is a comparatively novel data-oriented technique, which measures environmental efficiencies using several inputs into the number of different desirable and undesirable outputs without taking any prior assumptions about the relationship between inputs and outputs (Chen et al., 2017). To estimate corporate environmental efficiency, we applied constant return to scale input-oriented DEA efficiency. The sample is divided into environmental sensitive and non-sensitive industries and estimated the efficiency separately each year. The second proxy of environmental performance carbon emission productivity (*EP_EE*) measured by the net sales/ total carbon emissions (Chen et al., 2018; Fujii et al, 2013). The third proxy of environmental performance is measured by total carbon emission per unit size of total assets (*EP_PUS*) (Hartmann & Vachon, 2018; Hawn & Ioannou, 2016). The fourth proxy of environmental performance is measured by the natural log of total carbon emissions produced (*EP_Emi*) (Haque & Ntim, 2018; Moussa et al., 2020). The fifth proxy of environmental performance is carbon emissions intensity (*EP_Int*) measured by carbon emissions to sales (Trumpp & Guenther, 2017). *EP_DEA*, *EP_EE*, and *EP_PUS* measurements

proposed the positive association with environmental management practices and financial performance that means better environmental performance as the measurement level of these proxies is proposed. Whilst, EP_Emi, and EP_Int proposed a negative association with environmental management practices and financial performance that means better environmental performance.

Finally, and following well established environmental literature (Fujii et al., 2013; Gangi et al., 2020; Haque & Ntim, 2018; Hartmann & Vachon, 2018; Hassan & Romilly, 2018; Moussa et al., 2020), we controlled for five firm-specific characteristics, which are firm size, clean technology, leverage, research and development (R&D) and sensitive/polluting industries. First, and in terms of firm size, prior studies suggest that large firms are more likely to engage in environmental friendly activities because they tend to have greater financial capacity to use clean energy and produce less carbon emissions (Fujii et al., 2013; Moussa et al., 2020; Trumpp & Guenther, 2017). In contrast, Halkos and Tzeremes (2007) argue that small firms tend to have flexible and non-hierarchical structures, and this can impact positively on promoting environmental friendly activities. Following prior studies (Hartmann & Vachon, 2018), firm size is measured as the the natural log of a firm's total assets. Second, and in terms of clean technology, prior studies suggest that the usage of clean green technologies, such as renewable energy can help in reducing carbon emissions, and this can in turn impact positively on firm's environmental performance/practices (Blackman & Bannister, 1998; Clarkson et al., 2011a). Data relating to the usage of clean technology was collected from Thomson Reuters Asset4 database and value of 1 is given to firms using clean technology, 0 otherwise. Third, prior studies (Gangi et al., 2020; Hassan & Romilly, 2018; Moussa et al., 2020) suggest that high leveraged firms tend to commit to good environmental practices in order to meet the expectations of powerful stakeholders, and this can impact positively on their environmental and financial performance (Haque & Ntim, 2020). Following past studies (Shahab et al., 2020), we measure leverage as total debt divided by total assets. Fourth, investing in research and development (R&D) can positively influence firm's environmental and financial performance by improving resources management and reducing carbon emissions (Alam et al., 2019; Fujii et al., 2013). Research and development is measured as the natural log of total research and development expenditure. Finally, Industry context does matter in linking the environmental management practices with environmental performance (Hartmann & Vachon, 2018; Moussa et al., 2020). It is argued that polluting environmental sensitive industries tend to disclose more information about their environmental and social performance than their less sensitive counterparts (Qureshi et al., 2020). Therefore, and consistent with Qureshi et al. (2020), a value of 1 is given to environmental sensitive/polluting industries¹ and 0 otherwise.

4.3 Econometric models

Endogeneity is a potential problem that may occur when examining the association among environmental management practices, environmental performance, and financial performance,

¹Sensitive/polluting industries are identified based on the criteria of the North American Industry Classification System. Based on this classification, sensitive/polluting industries include automobile & parts, chemical, constructions, transportation, energy, chemical and mining, food, beverage & tobacco, technology hardware, paper & pulps, rubber, other manufacturing, waste management, and utility firms.

and that can increase concerns about the reliability and validity of the obtained results. System Generalised Method of Moments (GMM) estimator is considered as one of the best statistical tools for resolving heterogeneity, endogeneity and estimation bias issues (Ullah et al., 2018, 2020). The system GMM estimation technique deals with these endogeneity problems by including internal instruments derived from the lagged-values of the dependent variables (Arellano & Bond 1991; Blundell & Bond 1998; Ullah et al., 2018). Moreover, the two-step GMM model helps to prevent unnecessary data loss (Ullah et al., 2018). Therefore, and following well-established environmental literature (Al-Tuwaijri et al., 2004; Anton et al., 2004; Haque & Ntim, 2018), we employed the dynamic two-step system GMM model to address any potential endogeneity and reverse causality problems to estimate our five models. To examine the impact of environmental management practices on environmental performance (*H1*), we estimate our first GMM regression model as below:

$$EP_{it} = \beta_0 + \beta_1 EP_{it-1} + \beta_2 EMPS_{it} + \beta_3 C_{it} + \mu_{it} + \varepsilon_{it}. \quad (1)$$

Where *EP* denotes the environmental performance measured using five proxies, which are Data Envelopment Analysis (*EP_DEA*), carbon emission productivity (*EP_EE*), carbon emission per unit size (*EP_PUS*), total carbon emissions produced (*EP_Emi*), and carbon emissions intensity (*EP_Int*), and as alternative response variables. *EP_{it-1}* is the first lagged of the dependent variable. *EMPS* is our main explanatory variable refers to the environmental management practices. *C* represents 5 firm-specific control variables, which are firm Size (*F_Size*), complex industries (*Polluters*), leverage (*Lev*), clean technology (*C_Tech*), and research & Development (*R&D*). Further, *i* and *t* refer to each firm and year, respectively, whereas μ_i is the time fixed effects, and ε_{it} is the error term.

To test our second hypothesis (i.e., the impact of environmental management practices on corporate financial performance), we estimate the following equation model:

$$FP_{it} = \beta_0 + \beta_1 FP_{it-1} + \beta_2 EMPS_{it} + \beta_3 C_{it} + \mu_{it} + \varepsilon_{it}. \quad (2)$$

Where *FP* represents the financial performance and *FP_{it-1}* is the first lagged of the dependent variable. *EMPS* refers to environmental management practices and *C* presents the same five firm-specific control variables used in equation 1.

Further, we estimated the following regression model to examine the impact of environmental performance on financial performance (*H3*):

$$FP_{it} = \beta_0 + \beta_1 FP_{it-1} + \beta_2 EP_{it} + \beta_3 C_{it} + \mu_{it} + \varepsilon_{it}. \quad (3)$$

In equation 3, *FP* denotes the financial performance and *FP_{it-1}* is the first lagged of the outcome variable. Whereas, *EP* denotes the environmental performance measured used five proxies as explained in equation 1. We also control for the same five firm-specific characteristics employed in equations 1 and 2.

Finally, to examine the mediating effect of environmental performance on the environmental management practices–financial performance nexus, we estimate the following empirical model:

$$FP_{it} = \beta_0 + \beta_1 FP_{it-1} + \beta_2 EP_{it} + \beta_3 EMPS_{it} + \beta_4 C_{it} + \mu_{it} + \varepsilon_{it}. \quad (4)$$

Where *FP* refers to financial performance and FP_{it-1} is the first lagged of the dependent variable. *EP* refers to our mediating variable, which is environmental performance, and is measured by five different proxies used in equations 1 and 3. *EMPS* denotes environmental management practices. We also controlled for the effect of the five firm-specific characteristics. Finally, and to control the potential effects of outliers and extreme values, we winsorized all the continuous variables at the 5th and 95th percentile levels. Table 2 describes the measurement of all study variables used in the above empirical models.

5 RESULTS AND DISCUSSION

5.1 Descriptive statistics and univariate analysis

Table 3 depicts the descriptive statistics of all examined variables. *FP* is widespread, ranging from 0.37 to 6.70, with a mean value of 1.45 and a standard deviation of 0.42. Whereas, *EP* mean values from all five proxies (*EP_DEA*, *EP_EE*, *EP_Emi*, *EP_Int* and *EP_PUS*) is 0.78, 7.26, -0.01, 13.66, 0.14 respectively with a standard deviation of 0.26, 1.51, 0.22, 1.74, 0.20, indicating that *EP* data tend to be less spread (more clustered) around the mean. The mean value of our main independent variable *EMPS* is 15.74 with standard deviation of 6.04 shows that most of the firms are adopted environmental practices in Japan. The findings provide support for past evidence (Endo, 2020; Lee et al., 2017; Yagi & Managi, 2018) that Japanese firms are more environmentally conscious than others.

Insert Table 3 about here

Table 4 presents the correlation among all examined variables. It is evident that environmental management practices have a significant positive relationship with *EP_EE*, and *EP_Pus* and negative significant relationship with *EP_Int* as expected in *H1*. Moreover, *EP_DEA* and *EP_Emi* are not significantly related to environmental management practices. Overall, these correlation coefficients are broadly consistent with *H1*. Further, Table 4 shows that environmental management practices have a significant positive relationship with financial performance as expected in *H2*. Similarly, the reported results in Table 4 indicate that *EP_DEA*, *EP_EE*, *EP_Int* and *EP_Emi* have significant relationship with financial performance, while *EP_PUS* have insignificant relationship with financial performance. Overall, these correlations are not broadly contrary to our research hypotheses. Furthermore, the correlation coefficients among independent and control variables of the study are reasonably low, so multicollinearity is unlikely to be a concern in our examined models.

Insert Table 4 about here

5.2 Results

we employ the two-step system GMM regression analysis to control for dynamic, simultaneous and omitted variables endogeneities (Stock & Watson, 2011; Ullah et al., 2018, 2020). Generally, and as shown in Table 5, $AR(1)$ p -values are significant, whereas $AR(2)$ p -values are insignificant, implying that there is no serious serial autocorrelation problems in our models. Further, models 1-16 in Table 5 pass the Hansen J test for the over-identifying restrictions. Table 5 shows the GMM estimation results. Five substantive measures of environmental performance variables are used. In models 1-16 of Table 5, environmental performance is measured as : (i) environmental performance by efficiency (EP_DEA); (ii) emission productivity (EP_EE); (iii) carbon emission per unit size (EP_PUS); (iv) total carbon emissions produced (EP_Emi); and (v) carbon emissions intensity (EP_Int), respectively. EP_DEA , EP_EE , and EP_Pus measurement proposed a positive relationship with environmental management practices and financial performance. While EP_Emi and EP_Int measurement proposed the negative relationship with environmental management practices and financial performance.

Insert Table 5 about here

Hypothesis 1 predicts that the adoption of environmental management practices leads to better environmental performance. Model 1, 5 and 8 of Table 5 evident that environmental management practices have statistically significant and positive impact on environmental performance together with all control variables as expected ($\beta=0.003$, $p < 0.01$; $\beta=0.024$ $p < 0.01$; $\beta=0.002$; $p < 0.01$). Environmental performance measurement, EP_DEA , EP_EE and EP_PUS are directly related to the energy efficiency carbon emissions productivity and carbon emission improvement over a year methods. Whilst, environmental performance proxies, EP_Emi and EP_Int are directly related to the carbon emission outputs level (lower the carbon emissions level and carbon emission intensity means the positive environmental performance and vice versa). We also find that corporate environmental practices is significant and negatively related to the environmental performance in model 11 and 14 of Table 5 , these negative coefficients actually signifies the positive nexus between environmental practices and environmental performance ($\beta= -0.007$, $p < 0.01$; $\beta= -0.001$ $p < 0.01$). The observed sign is consistent with the measurement of environmental performance proxies and results of prior studies (Clarkson et al., 2008; Hassan & Romilly, 2018; Moussa et al., 2020). Further, the results support the fundamental argument of resource based-view and institutional theories that the adoption of environmental management practices helps in reducing corporate environmental hazards. The findings offer support for the effectiveness of environmental management practices towards achieving the desired environmental performance and are in line with the previous studies (Arda et al., 2019; Aslam, Rehman, & Asad, 2020; Famiyeh et al., 2018; Hartmann & Vachon, 2018; Moussa et al., 2020). The results do not support the argument of Heras-Saizarbitoria et al. (2020) and Testa, Iraldo, & Daddi. (2018) that despite the worldwide use of environmental management practices the effectiveness of this tool is still challenging.

Hypothesis 2 predicts that the adoption of environmental management practices leads to better financial performance. Model 2 of Table 5 evident that environmental management

practices have a statistically significant and positive impact on financial performance together with all control variables as expected ($\beta=0.003$, $p < 0.01$). The finding highlighted that firms can achieve superior financial performance by implementing strategic environmental initiatives. The results are compatible with the resource based-view concept that resources induction towards environmental friendly activities amplified at a higher level of sustainable growth. (Hart, 1995). Similarly, the result is consistent with the findings of previous studies (Gangi et al., 2020; Jiang et al., 2018; Xie et al., 2019) assertion that the adoption of environmental friendly activities is the surety of firm competitiveness. While the result is contested with (Miroshnychenko et al., 2017; Yang, Hong, & Modi, 2011).

Hypothesis 3 predicts that better environmental performance leads to better financial performance. Model 3 and 6 of Table 5 evident that environmental performance has a statistically significant and positive impact on financial performance together with all control variables as expected ($\beta=0.029$, $p < 0.01$; $\beta=0.079$ $p < 0.01$). We also observed the negative significant coefficient in model 12 and 15 of Table 5 ($\beta= -0.033$ $p < 0.01$; $\beta= -0.167$ $p < 0.01$). The negative coefficients represent that lower carbon emissions intensity and lower level of carbon emissions is positively influence the financial performance and vice versa. The observed sign is consistent with the measurement of environmental performance proxies and the findings of past studies (Hassan & Romilly, 2018; Li, & Ramanathan, 2018). Whereas, model 9 predicts a significant inverse relationship between environmental performance and financial performance ($\beta= -0.199$, $p < 0.01$). The results of model 9 are not matched with the proxy measurement of environmental performance by *EP_PUS* that stated improvement in the level of carbon emission per unit size over a year leads to better financial performance (Hartmann & Vachon, 2018). Thus, the overall findings confirm hypothesis 3 and consistent with the resource-based view and institutional context. The results support the findings of Fujii et al., (2013), although they used the old data set of Japanese listed firms (covering 2001-2008). The results also corroborate several recent studies (Busch & Lewandowski, 2017; Hassan & Romilly, 2018; Li et al., 2017; Shahab et al., 2020). However, the results contradict the findings of Shen et al. (2019) and Trumpp and Guenther (2017).

Hypothesis 4 predicts that environmental performance mediates the association between environmental management practices and financial performance with the relation being stronger in firms with better environmental performance. We test the mediation by following Baron and Kenny's (1986) mediation technique rules with hierarchical regression analysis. The mediation conditions are: (i) the independent variable environmental management practices significantly influence the dependent variable financial performance; (ii) the independent variable environmental management practices significantly influence the mediating variable environmental performance; and (iii) the mediating variable environmental performance significantly influence the dependent variable financial performance; after fulfilling the above three mediation condition we run the combined effect of independent variable environmental management practices and environmental performance mediating variable on dependent variable financial performance.

Insert Table 6 about here

All the mediation conditions for direct relationships are fulfilled as shown in Table 5. However, model 4, 7, 10, 13, and 16 of Table 5 show combined regression results relating to the impact of both independent and mediating variables (i.e., environmental management practices and environmental performance) on our dependent variable (i.e., financial performance). The influence of environmental management practices on financial performance remain statistically significant in all models (positive, negative) depends upon the measurement of environmental performance proxy) as expected ($\beta=0.001$, $p < 0.05$; $\beta=0.001$, $p < 0.05$; $\beta=0.005$, $p < 0.01$; $\beta=0.002$, $p < 0.01$; $\beta=0.001$, $p < 0.10$). While environmental performance as a mediator impact on financial performance remain statistically significant (positive, negative) depends upon the measurement of environmental performance proxy ($\beta=0.117$, $p < 0.01$; $\beta=0.072$, $p < 0.01$; $\beta=-0.028$, $p < 0.01$; $\beta=-0.0135$, $p < 0.01$) in model 4, 7, 13 and 16 respectively, as expected, except with *EP_PUS* in model 10, where the relationship was found inverse ($\beta=-0.187$, $p > 0.01$). Further to test the mediation effect of environmental performance between environmental management practices and financial performance, we conduct the Sobel test as proposed by Baron and Kenny (1986). Table 6 results show that environmental performance mediates the relationship between environmental management practices and financial performance ($\beta=0.0012$, $p < 0.01$; $\beta=0.0040$, $p < 0.01$; $\beta=0.0007$, $p < 0.05$; $\beta=0.0027$, $p < 0.01$) as expected with environmental performance measured using *EP_DEA*, *EP_EE*, *EP_Emi* and *EP_Int*, respectively, except the case where the environmental performance is measured using *EP_PUS* ($\beta=0.0000$, $p > 0.10$ n.s). Hence, these results endorsed the argument of past studies (Chen et al., 2018; Feng et al., 2018; Yang et al., 2011) that the effectiveness of environmental management practices on financial performance needs to measure through environmental performance. However, the results contrast with the argument of Chen et al. (2018) that firms should take reactive environmental initiatives rather than proactive to consider the cost and benefit analysis. Altogether, the estimated results support the RBV and institutional theoretical aspects that investment of resources in environmental management practices, tends to aim towards achieving environmental legitimacy (Feng & Wang, 2016; Haque & Ntim, 2018) that can easily be communicated to customers, regulators and investors (Al-Tuwaijri et al., 2004; Christmann, 2000; Trumpp & Guenther, 2017). Moreover, the results are also consistent with institutional theory that coercive, regulatory and mimetic pressures may originate significant positive impact on environmental performance (Chithambo, Tingbani, Agyapong, Gyapong, & Damoah, 2020). Green practices are adopted with the aim to reduce corporate environmental impacts, and gain sustainable growth (Miroshnychenko et al., 2017). Thus, achieve a better environmental performance goal will lead towards better financial performance directly or indirectly through the adoption of proper environmental management practices. Overall, the findings of this study confirmed the mediating effect of environmental performance. Thus hypothesis 4 is supported.

6. CONCLUSIONS, IMPLICATIONS AND LIMITATIONS

This study makes a number of new contributions to the business strategy and the environmental literature by examining the mediating role of environmental performance in the relationship between environmental management practice and financial performance. Using Japanese data consisting of Nikkei 225 firms for the period of 2007 to 2018, our findings indicate that

environmental management practices have a positive effect on financial performance. We find further that environmental performance has a mediating effect on the environmental management practices–financial performance nexus. Our findings are in line with predictions of our theoretical framework that draws insights from the resource-based view and institutional theory perspectives. The findings of this study have some implications for managers, investors, and policymakers.

First, the results of the study indicate that Japanese firms have embraced the concept of environmental legitimacy by adopting voluntary and mandatory corporate environmental management practices. The results of this study also suggest that the integration of continuous improvement in environmental programmes is a useful tool to meet current environmental challenges. Second, the findings of this study demonstrated that implementing proper environmental programmes not only improved the firm's image but also helps to reduce the ecological effect. Third, managers always pondered that investment in environmental practices is a non-productive expenditure because they are expecting a direct link between environmental management practices and financial performance. The result indicates that it is better to identify the indirect link between environmental management practices and financial performance through environmental performance. Thus, managers can build strong customer loyalty by pursuing a green agenda. Fourth, this study also has an implication for investors that investing in green and environmental issues can impact positively on financial returns in the longer term.

The result also provides several implications for policymakers. Globally, the industrial 'zero-emission target' has become a major issue for global media and press. Japan as a case study demonstrates to other industrial economies that stringent corporate environmental regulations can lead to the adoption of voluntary comprehensive environmental practices. It would, therefore, be a positive step for other economies to formulate corporate environmental guidelines similar to Japan that are most likely to help meet existing climate challenges.

Certainly, this study has some limitations that should be acknowledged. First, this study's sample is drawn from a single country – Japan, and therefore, the findings should be interpreted and generalised with great care. Future studies can improve upon this study by drawing their sample from other countries that may uncover cultural and regional factors. Furthermore, Albertini, (2013) argued that environmental and financial performance relationship is significantly influenced by the regional and sectorial differences. Hence, future research can compare the polluting and non-polluting sectors differences with inclusion of civil and common law countries. Second, although, we have endeavoured to address potential endogenities problems, our magnitude and directions of our coefficients may still suffer such problems, and other techniques, such as difference-in-difference, generalised, two- and three-stage least squares regression techniques can be applied to address any potential endogeneities. Also, we have used energy and carbon emission as proxies of environmental performance that may not be reflective of the finer picture of actual environmental performance. However, the use of other environmental performance related variables, material, waste and water may offer new insight and make the findings more robust. Third, the measurement of environmental performance can be improved further with consideration of the latest DEA techniques. Future research may extend the study by using three-stage DEA to evaluate the environmental efficiency. Fourth, GHG reporting was mandatory in Japan since 2006 (Li et al., 2017) for larger carbon emitter corporations (Fujii et al., 2013). Future research can examine the focal

relationship in the sample of large carbon emissions Emitters Corporation, in order to reduce the self-reported sample bias. Finally, future studies can examine the moderating role of clean technology along with the casual link of environmental performance between environmental management practices and financial performance.

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Table 1 Industry distribution of sample

Industry	Freq.	Percent
Consumer Discretionary	264	13.75
Consumer Staples	180	9.38
Energy	36	1.88
Health Care	132	6.88
Industrials	612	31.88
Information Technology	240	12.5
Materials	348	18.13
Telecommunication Services	48	2.5
Utilities	60	3.13
Total	1,920	100

Table 2 Variables measurements

Variables	Symbols	Exp. Sig	Source	Description
Dependent variable				
Financial Performance	FP	+ / -	Worldscope	The market value of total shares outstanding + total liabilities divided by total assets. (Clarkson et al., 2011a)
Independent variables				
Environmental Management Practices	EMPs	+ / -	Asset4	Environmental management practices is calculated by adding 31 dummy variables that measure a firm's engagement in environmental practices. Therefore the minimum score of 0 to a maximum of 31. <i>See the Appendix for further details.</i> (Trumpp et al., 2015; Xie & Hayase, 2007)
Mediating variables				
Environmental Performance	EP			Authors' elaboration on Asset4 & Worldscope data for calculating environmental performance by five different ways Inputs: Total Energy Consumptions in gigajoules (GJ) Desirable Outputs: Sales (million) Undesirable Outputs: Total emission CO ² (tons) (Chen, Xu, & Chen, 2017; Song et al., 2018)
Environmental performance by DEA	EP_DEA	+	Asset4 & Worldscope	
Environmental performance by productivity	EP_EE	+	Asset4 & Worldscope	Sales/CO ² emissions natural log (Chen, Nginiatedema, & Li, 2018; Fujii et al., 2013)
Environmental performance by Carbon emission per unit size	EP_PUS	+	Asset4 & Worldscope	$EP_{it} = -1 \left[\frac{\frac{EMI_{it} - EMI_{it-1}}{A_{it} - A_{it-1}}}{\frac{EMI_{it}}{A_{it}}} \right]$

<p>Where EP it denotes the environmental performance of firm i in time t, EMIit denotes its carbon emissions and Ait denotes its assets. The independent variable, environmental management, denotes the activities a firm adopts in order to improve its environmental performance. (Hartmann & Vachon, 2018; Hawn & Ioannou, 2016)</p>				
Environmental performance by Total Emission	EP_Emi	-	Asset4 & Worldscope	Natural log of total carbon emission (Haque & Ntim, 2018; Moussa et al., 2020)
Environmental performance by Emission Intensity	EP_Int	-	Asset4 & Worldscope	Total carbon emission divided by total sales (Trumpp & Guenther, 2017)
Control variables	Controls			
Firm Size	F_Size	+ / -	Worldscope	The natural log of total assets of the firm (Hartmann & Vachon, 2018)
Complex Industries	Polluters	+ / -		1 for the sensitive industries, 0 otherwise (Qureshi et al., 2020).
Leverage	Lev	+ / -	Worldscope	Total debt divided by total assets (Shahab et al., 2020)
Clean Technology	C_Tech	+ / -	Asset4	1 for the firm using clean technology, 0 otherwise
Research & Development	R&D	+ / -	Worldscope	Log of total research and development expenditure.

Table 3 Descriptive statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max
Dependent variable					
FP	1,851	1.45	0.42	0.37	6.70
Mediating variables					
EP_DEA	1568	0.78	0.26	0.45	1.00
EP_EE	1709	7.26	1.51	3.14	13.71
EP_PUS	1521	-0.01	0.22	-0.90	0.97
EP_Emi	1717	13.66	1.74	7.92	18.77
EP_Int	1898	0.14	0.20	0.01	4.29
Independent variable					
EMPs	1915	15.74	6.04	0.00	31.00
Control variables					
F_Size	1851	21.03	1.01	18.96	24.63
Polluters	1872	0.76	0.43	0.00	1.00
C_Tech	1873	0.39	0.49	0.00	1.00
Lev	1851	0.25	0.15	0.01	0.71
R&D	1691	17.00	1.49	10.60	20.79

Note: Please see Table 2 for variable definitions.

Table 4 Correlation matrix

	FP	EP_DEA	EP_EE	EP_PUS	EP_Emi	EP_Int	EMPs	F_Size	Pollluters	C_Tech	Lev	R&D
FP	1.00											
EP_DEA	0.08*	1.00										
EP_EE	0.12*	0.42*	1.00									
EP_PUS	-0.04	-0.04	0.03	1.00								
EP_Emi	0.06*	-0.16*	-0.81*	-0.00	1.00							
EP_Int	-0.07*	-0.18*	-0.78*	-0.03	0.69*	1.00						
EMPs	0.06*	-0.03	0.15*	0.11*	-0.04	-0.15*	1.00					
F_Size	0.04	0.07*	-0.02	0.06*	0.55*	0.13*	0.17*	1.00				
Pollluters	0.13*	-0.18*	-0.28*	-0.03	0.34*	0.22*	0.06*	0.18*	1.00			
C_Tech	0.04	-0.12*	-0.13*	-0.04	0.18*	0.07*	0.13*	0.13*	0.41*	1.00		
Lev	0.32*	-0.14*	-0.41*	-0.03	0.47*	0.43*	-0.02	0.28*	0.31*	0.11*	1.00	
R&D	-0.02	0.24*	0.26*	0.07*	0.06*	-0.22*	0.41*	0.43*	-0.09*	0.01	-0.19*	1.00

Note: Please see Table 2 for variable definitions.

* indicate statistical significant at 5 % level.

Table 5 GMM regression results

Variables	Dependent variables									
	EP_DEA (1)	FP (2)	FP (3)	FP (4)	EP_EE (5)	FP (6)	FP (7)	EP_PUS (8)	FP (9)	FP (10)
Lagged of dependent variables	0.069*** (0.001)	0.411*** (0.005)	0.388*** (0.007)	0.461*** (0.011)	0.844*** (0.003)	0.348*** (0.010)	0.397*** (0.0114)	-0.058*** (0.006)	0.343*** (0.005)	0.370*** (0.008)
EMPS	0.003*** (0.000)	0.003*** (0.000)		0.001** (0.000)	0.024*** (0.001)		0.001** (0.000)	0.002*** (0.000)		0.005*** (0.000)
EP_DEA			0.029*** (0.010)	0.117*** (0.012)						
EP_EE						0.079*** (0.003)	0.072*** (0.004)			
EP_PUS									-0.199*** (0.010)	-0.187*** (0.011)
F_Size	0.036*** (0.003)	-0.038*** (0.004)	-0.076*** (0.004)	-0.056*** (0.005)	0.074*** (0.007)	-0.056*** (0.006)	-0.055*** (0.005)	0.050*** (0.004)	-0.0231*** (0.005)	-0.018*** (0.004)
Pollutter	-0.197*** (0.004)	0.001 (0.013)	0.017*** (0.006)	0.041*** (0.012)	-0.115*** (0.014)	0.083*** (0.013)	0.176*** (0.017)	0.008 (0.010)	0.051*** (0.007)	0.075*** (0.020)
C_Tech	0.023*** (0.003)	0.106*** (0.005)	0.044*** (0.006)	0.017*** (0.005)	-0.033*** (0.011)	0.070*** (0.006)	0.019*** (0.005)	-0.025*** (0.005)	0.046*** (0.006)	0.046*** (0.005)
Leverage	-0.088*** (0.008)	0.561*** (0.015)	0.567*** (0.012)	0.482*** (0.010)	-0.799*** (0.035)	1.023*** (0.027)	0.900*** (0.029)	0.0156 (0.0155)	0.664*** (0.025)	0.640*** (0.026)
R&D	0.012*** (0.001)	0.026*** (0.003)	0.061*** (0.002)	0.044*** (0.003)	0.002 (0.005)	0.053*** (0.004)	0.041*** (0.003)	-0.012*** (0.003)	0.055*** (0.003)	0.047*** (0.003)
Constant	-0.184*** (0.048)	0.935*** (0.082)	1.139*** (0.072)	0.915*** (0.100)	-0.393*** (0.149)	0.278** (0.127)	0.397*** (0.133)	-0.847*** (0.082)	0.183* (0.100)	0.245*** (0.073)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
AR(1) (p-value)	-1.05(0.29)	-3.63(0.00)	-3.08(0.00)	-3.15(0.00)	-1.97(0.04)	-3.42(0.00)	-3.37(0.00)	-6.89(0.00)	-3.20(0.00)	-3.20(0.00)
AR(2) (p-value)	-1.42(0.16)	0.53(0.59)	0.63(0.53)	0.81(0.42)	0.48(0.63)	0.30(0.76)	0.55(0.58)	-1.06(0.29)	0.12(0.90)	0.26(0.79)
Hansen's J - p-value	0.32	(0.49)	0.48	0.83	0.44	0.49	0.89	0.21	0.44	0.87
Observations	1,289	1,520	1,346	1,346	1,391	1,427	1,427	1,243	1,411	1,411
Number of firms	142	143	143	143	143	143	143	143	143	143

Note: Please see Table 2 for variable definitions ***, ** and * indicate statistical significance at 1, 5 and 10% levels, respectively. The figures in parentheses are the standard errors.

Table 5 (Continued) Regression results

Variables	Dependent variables					
	EP_Emi (11)	FP (12)	FP (13)	EP_Int (14)	FP (15)	FP (16)
Lagged of dependent variables	0.938*** (0.004)	0.385*** (0.007)	0.393*** (0.009)	0.808*** (0.003)	0.355*** (0.007)	0.365*** (0.009)
EMPS	-0.007*** (0.000)		0.002*** (0.000)	-0.001*** (0.000)		0.001* (0.000)
EP_Emi		-0.033*** (0.003)	-0.028*** (0.005)			
EP_Int					-0.167*** (0.006)	-0.135*** (0.009)
F_Size	0.057*** (0.005)	-0.000 (0.006)	-0.011 (0.009)	0.042*** (0.002)	-0.015*** (0.005)	-0.026*** (0.009)
Pollutter	0.109*** (0.009)	0.008 (0.014)	0.031* (0.017)	0.0462*** (0.003)	0.039*** (0.014)	0.069*** (0.014)
C_Tech	-0.027*** (0.005)	0.082*** (0.005)	0.0730*** (0.006)	0.037*** (0.002)	0.064*** (0.005)	0.052*** (0.008)
Leverage	0.128*** (0.034)	0.801*** (0.015)	0.729*** (0.029)	0.323*** (0.008)	0.931*** (0.019)	0.876*** (0.024)
R&D	-0.003 (0.003)	0.058*** (0.003)	0.046*** (0.003)	-0.015*** (0.001)	0.045*** (0.003)	0.039*** (0.005)
Constant	-0.247** (0.110)	0.088 (0.111)	0.413*** (0.150)	-0.684*** (0.031)	0.201* (0.102)	0.523*** (0.158)
Year effects	Yes	Yes	Yes	Yes	Yes	Yes
AR(1) (p-value)	-4.17(0.00)	-3.42(0.00)	-3.42(0.00)	-1.44(0.15)	-3.46(0.00)	-3.44(0.00)
AR(2) (p-value)	-1.22(0.22)	0.39(0.70)	0.47(0.66)	1.11(0.27)	0.32(0.75)	0.38(0.71)
Hansen's J (p-value)	0.57	0.44	0.88	0.45	0.38	0.89
Observations	1,394	1,427	1,427	1,391	1,427	1,427
Number of firms	143	143	143	143	143	143

Note: Please see Table 2 for variable definitions ***, ** and * indicate statistical significance at 1, 5 and 10% levels, respectively. The figures in parentheses are the standard errors. Hansen test of over-identifying restrictions.

Table 6 Mediation results

Description of Path	Coefficients	Std. Error	T-statistic
EMPS→EP_DEA→FP	0.0012***	0.0003	3.6108
EMPS→EP_EE→FP	0.0040***	0.0006	6.9698
EMPS→EP_PUS→FP	0.0000	0.0003	-0.1972
EMPS→EP_Emi→FP	0.0007**	0.0003	2.8895
EMPS→EP_Int→FP	0.0027***	0.0004	6.0785

Note: Please see Table 1 for variable definitions ***, ** and * indicate statistical significance at 1, 5 and 10% levels, respectively.

Annexure 1: Environmental Management Practices Scale

Environmental Policy

1. Does the company have a policy to improve its energy efficiency?
2. Does the company have a general, all-purpose policy regarding resource efficiency?
3. Does the company have a policy to improve its use of sustainable packaging?
4. Does the company have a policy to improve its water efficiency?
5. Does the company have a policy to lessen the environmental impact of its supply chain?
6. Does the company have a dematerialization policy?
7. Does the company have an eco-design policy?
8. Does the company have a product life-cycle assessment policy?
9. Does the company have a general, all-purpose policy regarding environmental product innovation?

Environmental Objectives

1. Has the company set targets or objectives to be achieved on energy efficiency?
2. Has the company set targets or objectives to be achieved on general resource efficiency?
3. Has the company set targets or objectives to be achieved on its use of sustainable packaging?
4. Has the company set targets or objectives to be achieved on water efficiency?
5. Has the company set targets or objectives to be achieved on the environmental impact of its supply chain?

Environmental Processes

1. Does the company use environmental criteria (ISO 14000, energy consumption, etc.) in the selection process of its suppliers or sourcing partners?
2. Does the company describe, claim to have or mention processes in place to include its supply chain in the company's efforts to lessen its overall environmental impact?
3. Does the company claim to use environmental criteria (e.g., life-cycle assessment) to source or eliminate materials?
4. Does the company describe, claim to have or mention processes in place to improve its energy efficiency?
5. Does the company describe, claim to have or mention processes in place to improve its resource efficiency in general?
6. Does the company describe, claim to have or mention processes in place to improve its use of sustainable packaging?
7. Does the company describe, claim to have or mention processes in place to improve its water efficiency?

Environmental Structure

1. Does the company train its employees on environmental issues?
2. Does the company have an environmental management team?
3. Does the company claim to have an EMAS certification?
4. Does the company describe, claim to have or mention processes in place to maintain an environmental management system?

Environmental Monitoring

1. Does the company claim to use key performance indicators (KPI) or the balanced scorecard to monitor energy efficiency?

2. Does the company claim to use key performance indicators (KPI) or the balanced scorecard to monitor resource efficiency in general?
3. Does the company claim to use key performance indicators (KPI) or the balanced scorecard to monitor its use of sustainable packaging?
4. Does the company claim to use key performance indicators (KPI) or the balanced scorecard to monitor water efficiency?
5. Does the company claim to use key performance indicators (KPI) or a balanced scorecard to monitor the environmental impact of its supply chain?
6. Does the company conduct surveys of the environmental performance of its suppliers?

Adapted from (Trump et al., 2015), score 1 if the information is available otherwise 0.