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Reassessing the Puzzle of Environmental Management Systems and Their Impact on Firm Performance: A Panel Data Analysis

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Abstract

Companies have increasingly adopted environmental management systems (EMSs) in response to the need for improving their environmental sustainability and accountability. EMSs enable companies managing their environmental activities, supposedly leading to improved environmental performance and cost savings. However, research findings regarding the effectiveness of EMSs on key environmental and financial performance measures are inconclusive. To address this puzzle, we collected data from various sources to analyze the relationships between EMS certification, environmental performance, and financial performance for the STOXX 600 using panel data regression covering six years. With this comprehensive, large-scale approach, we account for largely neglected indirect effects and widespread validity issues of prior research, such as cross-sectional designs, perception-based performance measures, and small sample sizes. Our results show that EMS certification has a significant positive effect on environmental performance, particularly on emission reduction. We did not find a significant effect of EMS certification and environmental performance on financial performance.

Keywords: Sustainability, green IS, environmental management system, firm performance, panel data analysis, regression

Introduction

The Intergovernmental Panel on Climate Change (IPCC) report from 2023 warns that without radical and rapid reductions in CO_2 and other greenhouse gas (GHG) emissions, global warming of 1.5°C will be exceeded by the end of the 21st century (IPCC, 2023). Underscoring the role of companies in combating climate change, the Carbon Disclosure Project found only 100 companies responsible for 71% of global GHG emissions since 1988 (Griffin, 2017). As organizations have increasingly recognized the need for improving environmental sustainability (Loeser et al., 2017; Winston, 2019), a significant number of organizations have adopted environmental management systems (EMSs) and obtained certification (Darnall & Edwards, 2006; European Commission, 2022; Steger, 2000).

The implementation and certification of EMSs represent two of various information systems (IS) initiatives for organizations to enable more environmentally sustainable products and processes (Kranz et al., 2021; Loeser et al., 2017). An EMS is a "formal system and database which integrates procedures and processes for the training of personnel, monitoring, summarizing, and reporting of specialized environmental performance information to internal and external stakeholders" (Melnyk et al., 2003, p. 332). Therefore, EMSs enable and support companies in developing, implementing, managing, coordinating, measuring, and monitoring corporate environmental activities (Melnyk et al., 2003; Sroufe, 2003) expectedly improving environmental performance. This in turn can have a positive impact on financial performance through cost reductions, for instance through lower energy and resource consumption and efficiency improvements (Lo et al., 2012; Voinea et al., 2020). Moreover, EMSs and environmental performance can also enhance a company's reputation which can increase customer loyalty and satisfaction and consequently, indirectly, financial performance (Feng & Wang, 2016; Voinea et al., 2020). Thus, EMSs provide an opportunity for organizations to integrate environmental sustainability into their overall business strategy, leading to potential benefits for both the natural environment and the bottom line.

Although several empirical studies have investigated the outcomes of EMS certification, the empirical evidence on its effectiveness is inconclusive (Boiral et al., 2018). While many researchers found a positive relation between EMS certification and environmental performance (i.e., organizational impact on the natural environment), also the opposite has been reported (Boiral et al., 2018). Similarly, while several papers demonstrate increased financial performance of certification (e.g., Darnall et al., 2008; Tan, 2005), others show the opposite effect (e.g., Miroshnychenko et al., 2017; Paulraj & De Jong, 2011) or no effect at all (e.g., Heras-Saizarbitoria et al., 2011). In addition, there is an ongoing debate about whether and how environmental performance and financial performance are related. Reflecting the theoretical disagreement on seeing environmental and financial performance as a dualism or duality, empirical studies reported mixed findings on the impact of environmental performance on financial performance (Earnhart, 2018; Horváthová, 2010). The inconclusive findings in existing research can be attributed to several factors such as the lack of consensus on measuring environmental and financial performance and largely neglecting any indirect effects. We therefore propose a research model that incorporates multiple linkages of the relationships between EMS certification, environmental performance, and financial performance. We base our study on the resource-based view (RBV) and natural resource-based view (NRBV) that provide theoretical lenses on the relation between environmental and financial performance (Hart & Dowell, 2011). From an RBV and NRBV perspective, resources such as EMSs can provide both competitive advantage and positive outcomes for the natural environment. It is our objective to reassess the puzzle and provide a better and nuanced understanding of the contribution of EMS certification to organizations' environmental and financial performance considering direct, moderation, and mediation effects and the multidimensionality of the environmental performance construct. By exploring the mediation effect, we aim to uncover the underlying mechanisms through which EMS certification may impact financial outcomes via improved environmental performance. Simultaneously, our investigation of the moderation effect allows us to assess how EMS certification influences the relationship between environmental and financial performance, acknowledging the potential contextual variations. This dual-pathway approach aligns with the intricacies of real-word organizational dynamics and offers a more nuanced understanding of the interactions among these factors. Overall, our study was guided by the research question: *How does EMS certification contribute to organizations' performance*?

To answer this question, we collected annual panel data of the 600 largest European companies from 2013 to 2018 and employed a series of panel data regressions. While our empirical results suggest that the presence of EMS certification improves environmental performance, primarily through a reduction of emissions, the results do not provide evidence of a significant relation between EMS certification and financial performance or between environmental performance and financial performance. Moreover, our study neither confirms the existence of a mediating role of environmental performance between EMS certification and financial performance, nor does this study find significant evidence for the moderating role of EMS certification on the environmental-financial performance nexus.

Our study's theoretical contribution lies in its conceptual distinction between the direct and indirect effects and its consideration of the multidimensional nature of environmental performance (Melnyk et al. 2003). Moreover, we address methodological issues of prior research such as social desirability bias and the limitations of cross-sectional studies by relying on secondary data and a longitudinal design. Although our study cannot establish the direction of causality, our findings shed light on the crucial role of emission reduction in the relationship between EMS certification and environmental performance.

Theoretical Background

Environmental Management Systems and Their Performance Implications

Research on Green IS has shown that IS are a key enabler of organizational sustainability affording behavioral opportunities to mitigate negative environmental impacts (Dedrick, 2010; Kranz et al., 2015; Seidel et al., 2013). IS are a key ingredient of an EMS which is defined as a "formal system and database which integrates procedures and processes for the training of personnel, monitoring, summarizing, and reporting of specialized environmental performance information to internal and external stakeholders of the firm" (Melnyk et al., 2003, p. 322). The IS potential to EMSs lies in the capability to systematically gather, process, and make available information on corporate environmental performance in order to promote change toward sustainability (El-Gayar & Fritz, 2006). In this way, EMSs enable and support companies in the development, implementation, management, coordination, measurement, and monitoring of corporate environmental activities enabling more environmentally sustainable products and processes and a continual reduction of their environmental impact (e.g., Melnyk et al., 2003; Sroufe, 2003).

EMSs are considered one of the various Green IS initiatives that help reduce human impact on the natural environment (Dedrick, 2010; Loeser, 2013; Loeser et al., 2017). Several studies have examined the enabling effects of EMSs and find IS to enable more eco-efficient business processes with reduced energy and resource consumption and waste (Kranz et al., 2015; Loeser, 2015; Watson & Kranz, 2021). In addition to environmental performance implications, studies have found that IS also enable improved economic performance by reducing operational costs due to increased resource efficiency of IT and business processes (Loeser et al., 2017; Melville, 2010).

Previous research analyzing EMS certifications' *environmental performance* implications has yielded inconclusive results. While some studies have found a positive relationship between EMS certification and environmental performance (Ann et al., 2006; Link & Naveh, 2006; Melnyk et al., 2003; Morrow & Rondinelli, 2002; Poksinska et al., 2003; Potoski & Prakash, 2005; Prajogo et al., 2014; Pun & Hui, 2001; Turk, 2009; Zhang et al., 2014), there is also contrary empirical evidence that EMS certification has not improved corporate environmental performance (Barla, 2007; Boiral, 2007; Boiral & Henri, 2012; Hertin et al., 2008; King et al., 2005; Zobel, 2013). In a majority of studies, EMSs have been found to positively affect waste reduction and waste management, air pollution, emission reduction, and energy and resources consumption (Boiral et al., 2018).

Regarding the effect of EMS certification on *financial performance*, previous research has also reported mixed findings. Some researchers have identified a positive impact (Ann et al., 2006; Lo et al., 2012; Ong et al., 2016; Tan, 2005). Others, however, found a negative effect (e.g., Miroshnychenko et al., 2017; Paulraj & De Jong, 2011), or no effect at all (e.g., Heras-Saizarbitoria et al., 2011; Muda & Wahyuni, 2019). In addition, there is an ongoing debate about whether and how environmental performance and financial performance are related. Reflecting the theoretical disagreement on seeing environmental and financial performance as a dualism or duality, empirical studies reported mixed findings on the impact of environmental performance on financial performance (Earnhart, 2018; Horváthová, 2010).

Inconclusive findings in existing research can be attributed to numerous factors. First, there is a lack of consensus on measuring environmental and financial performance (Albertini, 2013; Nawrocka & Parker, 2009). The type of environmental and financial performance measure can substantially influence the results for the investigated relationships (Earnhart, 2018). In existing studies, researchers have applied a variety of different measures such as single measures (e.g., GHG emissions), multiple measures in separate analyses, and aggregate measures (e.g., measures established via factor analysis) (Albertini, 2013; Trumpp et al., 2015), which may not be comparable and, if based on perceptions such as opinions of managers, may be subject to social desirability bias (Boiral et al., 2018). The same applies to financial performance, for which researchers have used accounting-based (e.g., return on assets) or market-based indicators (variation of the stock price) (Albertini, 2013). Concerning EMSs, King et al. (2005) pointed out that the crucial distinction between adoption and certification has often not been made. A second reason is that studies were conducted in very heterogeneous contexts with regard to geographic region, industry, and company size (Boiral et al., 2018). Third, existing studies have applied different research and analysis methods (Nawrocka & Parker, 2009), which has been found to influence the results (Horváthová, 2010). Additionally, prior research has largely neglected any indirect effects such as the potential indirect effect of improved environmental performance resulting from EMS certification, which can lead to cost savings and subsequently enhance a company's financial performance.

For organizations to design and implement an effective EMS, EMS standards provide a practical basis, requirements, and guidelines (Darnall & Edwards, 2006; El-Gayar & Fritz, 2006; ISO, 2022; Melnyk et al., 2003). Organizations can either self-declare compliance with the EMS standards or get certification in order to prove and communicate compliance with the standards (Bansal, 2002; King et al., 2005). The two most important standards and thus subject to most research are the *ISO 14001* and the European standard *European Eco-Management and Audit Scheme* (*EMAS)* (Morrow & Rondinelli, 2002; Steger, 2000).

Resource-Based View and Natural Resource-Based View

We ground our study on the RBV and NRBV that provide a theoretical lens to the relation between corporate environmental and financial performance (Hart & Dowell, 2011). We do so for three major reasons: Firstly, RBV and NRBV strongly focus on performance as the key outcome variable and, secondly, the RBV explicitly recognizes the importance of intangible resources (Russo & Fouts, 1997), such as EMSs. Thirdly, the NRBV provides an appropriate theoretical background for the outcomes of the adoption of Green IS initiatives (e.g., Loeser, 2015; Wade & Hulland, 2004), as it constitutes a valuable way to think about how IS link to business strategy and environmental and financial performance.

The RBV emphasizes the crucial role of firm-specific factors, i.e., resources, as a basis for achieving competitive advantage (Barney, 1991; Grant, 1991; Wernerfelt, 1984). According to the RBV, resources are classified as tangible, intangible, and personnel-based (Grant, 1991; Russo & Fouts, 1997). While tangible resources include financial and physical resources such as equipment, intangible resources include reputation and technological resources such as EMSs. Personnel-based resources include organizational culture, knowledge, as well as employees' commitment and loyalty. While resources are not considered productive in and of themselves (Grant, 1991), resources in the form of inputs to processes are the source of a corporate capabilities, and in turn the primary source of competitive advantage.

Hart (1995) expanded the RBV of the firm to the NRBV— a theory of competitive advantage that builds upon the interaction between organizations and the natural environment. It is argued that the biophysical environment could seriously constrain corporate efforts to create a sustainable competitive advantage. Hence, the NRBV examines how resources can result in both competitive advantages and positive outcomes for the natural environment. Hart (1995) suggested three interrelated strategic capabilities that companies can build on, namely pollution prevention, product stewardship, and sustainable development. These three capabilities and the key resources' continuous improvement, stakeholder integration, and shared vision affect the ability to sustain a competitive advantage (Hart, 1995). Each capability has a different environmental driving force, is associated with one of the above-mentioned key resources, and with a certain source of competitive advantage (Hart, 1995; Hart & Dowell, 2011): *Pollution prevention capability* minimizes and avoids waste and emissions through continuous improvement resulting in a competitive advantage of lower costs (Hart, 1995; Hart & Dowell, 2011). By extending the scope of pollution prevention over the entire value chain, *product stewardship capability* minimizes product life-cycle costs through stakeholder integration into product design and development. This leads to the potential for competitive advantage through strategically preempting competitors—for instance, through establishing standards (Hart, 1995; Hart & Dowell, 2011). *Sustainable development capability* minimizes environmental burdens related to firm growth and development through long-term commitment to sustainable development strategies. This leads to the potential for competitive advantage through raising a firm's future performance in relation to its competitors (Hart, 1995; Hart & Dowell, 2011). From an RBV and NRBV perspective, resources such as EMSs can thus provide both competitive advantage and positive outcomes for the natural environment (Grant, 1991; Hart, 1995).

Hypotheses Development

Previous research has provided support that the relations between EMS certification, environmental performance, and financial performance are complex. We thus develop a research model that accounts for multiple relations between the constructs (see Figure 1).

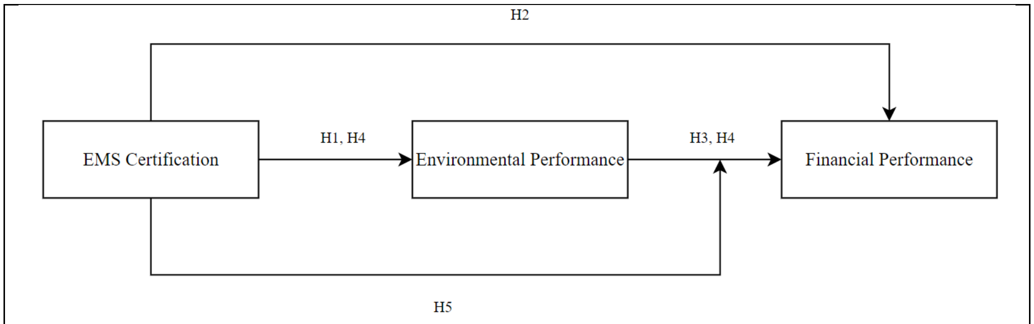

Figure 1. Graphical Representation of the Model

EMS standards have often been criticized for simplistically assuming that companies with EMS certification effectively address their environmental impacts and thus increase their environmental performance (Rondinelli & Vastag, 2000). Nevertheless, based on the evidence currently available, it seems indeed fair to assume that EMSs are promising in supporting organizations to manage environmental information across the entire organization in order to evaluate how corporate decisions affect the environment (Chen et al., 2008; El-Gayar & Fritz, 2006). Thereby, organizations can identify, manage, and monitor activities that might harm the environment, set environmental objectives, and develop better environmental practices such as waste reduction, reduction of the use of raw materials, and product and process redesigns (Boiral & Henri, 2012; He & Shen, 2019; Melnyk et al., 2003). On the contrary, studies that have found a negative effect on environmental performance might be prone to selection bias, i.e., companies with poor environmental performance opt for EMS certification in order to improve their image without committing to a meaningful improvement (Heras-Saizarbitoria et al., 2020; Voinea et al., 2020). It is thus reasonable to expect that environmental activities lead to better environmental performance (Boiral & Henri, 2012):

H1: *EMS certification is positively related to environmental performance*.

Furthermore, we investigate the effects of and on three dimensions of environmental performance to differentiate the various impacts: emission reduction, resource use, and environmental innovation. Although environmental performance is considered a multidimensional construct, most studies have not considered its multidimensional nature (Trumpp et al., 2015) which may explain the mixed picture. Yet, according to NRBV, the mechanisms behind dimensions of environmental improvement differ (Albertini, 2013). For instance, the mechanism for pollution prevention is very different from that for product stewardship (Albertini, 2013; Hart, 1995). Therefore, we include the three dimensions in our analysis to uncover the different mechanisms.

Previous research has reported mixed findings on the effect of EMS certification on financial performance. From the theoretical perspective of RBV and NRBV, resources and capabilities affect the ability to sustain a competitive advantage and are the primary sources of profitability (Grant, 1991; Hart, 1995). According to NRBV, in addition to enhancing environmental performance, EMS certification can provide organizations with unique resources and capabilities that can lead to competitive advantage (Hart, 1995; Sroufe, 2003). The underlying explanation is described by Delmas (2001), who pointed out how EMS certification, notably the ISO 14001 standard, can transform into a valuable resource. Delmas (2001) stated that EMS certification can be considered an intangible resource that improves management quality and provides internal operational efficiencies that could ultimately create opportunities to gain a competitive advantage. Although EMS certification itself is not rare, it is argued that it is useful in creating unique internal operational capabilities and improving performance outcomes (Prajogo et al., 2012). Furthermore, regarding inimitability, it is argued that the activities related to EMSs rely on knowledge-based skills that are difficult for competitors to replicate (Darnall & Edwards, 2006). Although we will hypothesize in H4 that environmental performance mediates the relationship between EMS certification and financial performance, we expect a direct effect of EMS certification on financial performance. The underlying argument is that EMS certification may not always positively impact both environmental and financial performance. For instance, a less costly option for waste disposal identified by the certified EMS would positively affect financial performance without affecting environmental performance (Voinea et al., 2020). Therefore, in this study, we assume that the effects of EMS certification on financial performance are realized through two mechanisms (H2 and H4). First, we hypothesize:

H2: *EMS certification is positively related to financial performance.*

The literature provides two perspectives on the environmental-financial performance nexus (Iraldo et al., 2009; Schaltegger & Synnestvedt, 2002; Wagner & Schaltegger, 2003). According to the *traditionalist view*, there is a conflict between a firm's environmental performance and its competitiveness and economic success (Iraldo et al., 2009; Schaltegger & Synnestvedt, 2002; Walley & Whitehead, 1994). Companies complying with environmental regulations and setting ambitious environmental goals need to increase environmental expenditures that might hurt firms' competitiveness and economic success (Iraldo et al., 2009; Schaltegger & Synnestvedt, 2002; Walley & Whitehead, 1994). In contrast, according to the *revisionist view*, improved environmental performance can be a source of competitive advantage (Iraldo et al., 2009) and benefit a firm's economic success (Schaltegger & Synnestvedt, 2002). In line with theoretical disagreement on the environmental impact on financial performance, empirical studies have provided inconclusive empirical evidence. The meta-analysis conducted by Horváthová (2010) found that about 55% of studies reported a positive relationship between environmental and financial performance, while 16% of studies reported a negative, and 30% an insignificant relationship. We base our argumentation on NRBV (Hart, 1995), according to which improved environmental performance leads to better financial performance. On the one hand, NRBV emphasizes that minimizing emissions and waste contributes to cost reductions and market gains and thus increases profitability (Hart, 1995; Klassen & McLaughlin, 1996; Prajogo et al., 2012). On the other hand, NRBV suggests that good environmental management practices can improve firms' competitive advantage and growth opportunities by enhancing their reputation, which then can improve financial performance (Aslam et al., 2021; Russo & Fouts, 1997). Therefore, we hypothesize:

H3: *Environmental performance is positively related to financial performance.*

In order to investigate the relationship between EMS certification and financial performance in more detail and determine the source of the effect, we also analyze the indirect effect through environmental performance. Previous research has demonstrated the mediating role of environmental performance on financial outcomes (Feng et al., 2018; Ong et al., 2016). We expect the relationships hypothesized in H1, H2, and H3 to be positive and significant and thus assume to detect mediation:

H4: *Environmental performance mediates the relationship between EMS certification and financial performance.*

To further analyze the relationship between environmental and financial performance, we investigate a potential moderating effect of EMS certification on the relationship between environmental performance and financial performance. Schaltegger and Synnestvedt (2002) argued that not only the level of environmental performance but primarily the kind of environmental management affects the economic outcome. As a consequence, "to understand and measure the links between environmental protection and economic success it is crucial to analyze the quality of environmental management with respect to the range of possibilities for improving the environmental performance in the most economic manner" (Schaltegger & Synnestvedt, 2002, p. 343). Accordingly, we assume that companies with EMS certification have an information advantage that can be exploited to improve their environmental performance in an economic way. Furthermore, according to RBV and NRBV, EMSs provide specialized information for critical functions (Melnyk et al., 2003). Hence, we assume EMS certification to alter the effect of environmental performance on financial performance. In particular, we hypothesize that the positive relationship between environmental performance and financial performance will be strengthened by EMS certification:

H5: *EMS certification moderates the relationship between environmental performance and financial performance.*

Methods

Data Collection

To test our research model, we collected annual data of the Stoxx Europe 600 index constituents from 2013 to 2018 which was the most recent data available for our analysis in early 2022. Our focus on publicly listed companies is due to the contribution of publicly listed companies to GHG emissions. In 2015, publicly listed investments accounted for one-fifth of global industrial GHG emissions (Griffin, 2017). Moreover, we focused on panel data in this study for the following reasons. First, panel data allows us to analyze changes at the firm level (Andreß et al., 2013). Second, the problem of omitted variable bias is less severe with panel data because part of the unobserved heterogeneity can be controlled for (Andreß et al., 2013).

We collected the data using Refinitiv Eikon, which contains the databases Refinitiv Datastream, Refinitv Worldscope Fundamentals, and ESG. As Cheng et al. (2014) emphasize, a sufficient level of reliability of these databases can be assumed for research purposes (Garcia et al., 2017). We deleted observations with missing values to create a balanced panel data set that increases the reliability, validity, and robustness of the analysis. Further, we conducted outlier analysis to identify extreme observations. To this end, we converted the data into standard scores (z-scores) (Hair et al., 2014). As these scores have a mean of zero and a standard deviation of one, we were able to identify truly distinctive observations (Hair et al., 2014). Following Hair et al.'s (2014) recommendation for larger sample sizes, we used a threshold value of absolute standard scores of four. Observations with standard scores greater than or equal to four were declared as outliers and excluded from the sample. Ultimately, we obtained a balanced sample of 232 companies constituting 1,392 firm-year observations.

The most represented countries in the sample were the United Kingdom (24.56%), France (15.52%), and Germany (12.93%), whereas companies from Cyprus (0.43%), Poland (0.43%) and Portugal (0.86%) were the least represented. With regard to the industry based on the Industry Classification Benchmark, most companies classify as industrials (28.88%), followed by consumer discretionary (18.10%), and basic materials (12.07%). In contrast, utilities (3.02%) and financials (1.29%) were the least represented.

Research Variables

We used three main variables EMSC, TQ, and EPS to test the relationships between EMS certification (EMSC), financial performance (TQ), and environmental performance (EPS) (see Table 1). In addition, we used three variables as dimensions of environmental performance to cover emission (ES), environmental innovation (EIS), and resource use (RUS). We controlled for firm size, financial leverage, company growth, industry, and ISO certification. Table 1 provides an overview of the variables and their operationalization.

Variable	Symbol	Operationalization
EMS Certification	EMSC	ISO 14000, EMAS or external EMS certification *(dummy variable)*
Tobin's Q	TQ	Market capitalization plus total liabilities, divided by total assets
Environmental Performance Score	EPS	Environmental pillar score (0-100; directly obtained from Refinitiv)
Emissions Score	ES	Emissions score (0-100; directly obtained from Refinitiv)
Environmental Innovation Score	EIS	Environmental innovation score (0-100; directly obtained from Refinitiv)
Resource Use Score	RUS	Resource use score (0-100; directly obtained from Refinitiv)
Firm Size	SIZE	Natural logarithm of full-time employees and full-time equivalents of part-time or temporary employees
Financial Leverage	LEV	The ratio of total debt to total equity
Company Growth	GROWTH	Percent change in net sales
Sensitive Industry	SENSITIVE	Environmentally sensitive industry *(dummy variable)*
ISO 9000 Certification	ISO9	ISO 9000 or any industry-specific certification *(dummy variable)*

Table 1. Overview of Variables

We employed EMS certification as our main explanatory variable. Due to data unavailability, our study focuses on EMS certification as a proxy for the implementation of EMSs. Based on the Refinitiv data point "ISO 14000 or EMS" that is related to the question: "Does the company claim to have an ISO 14000 or EMS certification?" we constructed a dummy variable *EMSC* that takes the value one if the company has ISO 14001, EMAS and/or any other external EMS certification and zero otherwise (King et al., 2005, pp. 1095-1096; Miroshnychenko et al., 2017, p. 343).

For modeling financial performance, we used Tobin's q. Tobin's q measures a firm's market value relative to the replacement costs of its assets (Lindenberg & Ross, 1981). We followed prior studies in using this measure as a proxy for financial performance on the impact of environmental performance (e.g., Dowell et al., 2000) and in the IS field (e.g., Bharadwaj et al., 1999). Moreover, Tobin's q as a market-based measure captures the value of long-term investments, such as investments in environmentally friendly activities (Dowell et al., 2000). This is especially important as financial outcomes of environmental management practices may not necessarily be realized in the short term. In this study, we applied Chung and Pruitt's (1994) formula to approximate Tobin's q:

$$\text{Approximate Tobin's q} = \frac{\text{MVE} + \text{PS} + \text{DEBT}}{\text{TA}}$$

where:

MVE is the market value of equity calculated as the product of a firm's closing share price at the end of the year and the number of common stock shares outstanding;

PS is the liquidating value of the firm's outstanding preferred stock;

DEBT is the value of current liabilities net of current assets, plus the book value of inventories and long-term debt;

TA equals the book value of total assets (Bharadwaj et al., 1999; Chung & Pruitt, 1994).

Consistent with previous studies (e.g., Dal Maso et al., 2020), we proxied companies' environmental performance by using the Environmental Pillar Score. This score assesses the impact of a company's impact on both living and non-living natural systems, such as air, land and water, as well as entire ecosystems. It measures how effectively a company employs best management practices to minimize environmental risks and take advantage of environmental opportunities in order to create long-term shareholder value (Refinitiv, 2021). In addition, Refinitiv's score comprises three categories—emission reduction, resource use, and environmental innovation—for each of which scores are available (Refinitiv, 2022). The emission reduction score "measures a company's commitment and effectiveness towards reducing environmental emissions in its production and operational processes" (Refinitiv, 2022, p. 25). The resource use score "reflects a company's performance and capacity to reduce the use of materials, energy or water, and to find more eco-efficient solutions by improving supply chain management" (Refinitiv, 2022, p. 25).

The environmental innovation score "reflects a company's capacity to reduce the environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes, or eco-designed products" (Refinitiv, 2022, p. 25). All environmental performance scores are measured on a numerical scale in percentages. The minimum value is zero and the maximum value is 100, indicating poor and good performance respectively.

We included a number of control variables that have been commonly used in the analysis of EMS, environmental performance, and financial performance to control for potential influences on environmental performance and financial performance. These include firm size (SIZE), the degree to which the company is financially leveraged (LEV), the annual growth of the company (GROWTH), whether the company is operating in an environmentally sensitive industry (SENSITIVE), and whether the company has obtained ISO 9000 certification (ISO9) (e.g., King & Lenox, 2001; Nirino et al., 2021; Tan et al., 2017; Ziegler & Nogareda, 2009).

Data Analysis

Due to the unrealistic assumptions that pooled ordinary least squares (OLS) regressions make for panel data models in terms of heterogeneity control and correlated error terms (Andreß et al., 2013), we statistically tested the appropriateness of fixed effects (FE) and random effects (RE) models. In our specific research setting, by conducting F-tests for the significance of fixed individual effects and Breusch and Pagan (1980) Lagrange multiplier tests. The result indicated that FE and RE estimators are preferred to pooled OLS estimators. An FE model assumes individual differences in intercepts and the same slopes across all units but does not allow for estimating time-constant variables. In contrast, an RE model includes time-independent and time-constant independent variables and assumes that the individual effects are a random variable that is not correlated with any regressor (Andreß et al., 2013). From a theoretical point of view, FE estimators are more appropriate for our study as we mainly intend to investigate the effects of time-varying variables. By using FE estimators, we can minimize the potential for firms' fixed characteristics to interfere with our analysis. We employed a series of panel data regressions to test the hypothesized relationships:

$$EPS_{i,t} = \beta_1 EMSC_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 GROWTH_{i,t} + \beta_5 SENSITIVE_{i,t} + \beta_6 ISO9_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t}. \quad (1)$$

$$TQ_{i,t} = \beta_1 EMSC_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 GROWTH_{i,t} + \beta_5 SENSITIVE_{i,t} + \beta_6 ISO9_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t}. \quad (2)$$

$$TQ_{i,t} = \beta_1 EPS_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 GROWTH_{i,t} + \beta_5 SENSITIVE_{i,t} + \beta_6 ISO9_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t}. \quad (3)$$

$$TQ_{i,t} = \beta_1 EPS_{i,t} + \beta_2 EMSC_{i,t} + \beta_3 SIZE_{i,t} + \beta_4 LEV_{i,t} + \beta_5 GROWTH_{i,t} + \beta_6 SENSITIVE_{i,t} + \beta_7 ISO9_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t}. \quad (4)$$

$$TQ_{i,t} = \beta_1 EPS_{i,t} * EMSC_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 LEV_{i,t} + \beta_4 GROWTH_{i,t} + \beta_5 SENSITIVE_{i,t} + \beta_6 ISO9_{i,t} + \alpha_i + \lambda_t + \varepsilon_{i,t}. \quad (5)$$

Furthermore, we tested for heteroscedasticity and serial correlation, as these potential issues lead to inefficient estimates and biased standard errors (Andreß et al., 2013). We performed the modified Wald test for groupwise heteroscedasticity (Baum, 2001; Greene, 2000) and the Wooldridge test for serial correlation in panel data (Drukker, 2003). The null hypotheses of homoscedasticity and no serial correlation were strongly rejected for all models ($p < .01$), indicating that heteroscedasticity and autocorrelation were present in our panel dataset. Therefore, we used cluster-robust standard errors nested in firms (Baltagi, 2021; Drukker, 2003; Stata, 2021). Due to the possibility of time-specific effects, we tested whether time FE are needed by performing Wald tests on the significance of year dummies (e.g., King et al., 2005). Again, for all models, we rejected the null hypothesis that the coefficients for all year dummies are jointly equal to zero ($p < .05$). Thus, we added time FE by including year dummy variables into each model.

Next, we determined whether FE or RE are appropriate. As we identified heteroscedasticity and serial correlation, we ran the Sargan-Hansen test of overidentifying restrictions to test between FE and RE rather than a standard Hausman test (Baltagi, 2021; Schaffer & Stillman, 2010). The null hypothesis of both estimators being consistent (Baltagi, 2021) was rejected except for one estimated model. Nevertheless, due to reasons of comparability among models, we used FE for all models. In summary, we estimated firm and year FE models with robust standard errors clustered at the firm level. We ran all analyses with Stata 17.

Results

Descriptive Statistics

Table 2 shows the means, medians, standard deviations, minimum and maximum values, and pairwise correlation coefficients for all study variables. The independent variable EMSC had a mean value of 0.808 and a standard deviation equal to 0.394. This indicates that firms were EMS certified for about 80.8% of observations. The environmental performance variable EPS had an average value of 64.219 and a standard deviation of 22.054. Further, ES, EIS, and RUS had a mean of 70.407, 44.75, and 71.396, with standard deviations of 24.801, 32.525, and 25.511, respectively. The high standard deviations of the environmental performance measures suggested high variation across firms. The dependent variable TQ had a mean value of 1.597 with a standard deviation of 0.795, implying that firms in the sample were rather overvalued.

We performed Pearson's correlation. Multicollinearity, indicated by absolute values of correlation coefficients close to or exceeding 0.8 (Shrestha, 2020), are no concern except for two correlation coefficients that exceed this critical level. These were the correlations between ES and EPS ($r = 0.834$, $p < .01$) and RUS and EPS ($r = 0.836$, $p < .01$). However, this was not a cause for concern as ES and RUS are dimensions comprised by EPS and these correlations were therefore to be expected. Moreover, the variables were regressed in different models. It was also found that the correlations between the independent and control variables were rather small and moderate, suggesting that multicollinearity was unlikely to be a problem in this study (Allen 1997; Aslam et al. 2021). We found that EMSC was significantly positively correlated with EPS ($r = 0.219$, $p < .01$), ES ($r = 0.225$, $p < .01$), EIS ($r = 0.103$, $p < .01$), and RUS ($r = 0.204$, $p < .01$) but negatively with TQ ($r = -0.192$, $p < .01$). Further, EPS, ES, EIS, and RUS were significantly negatively correlated with TQ ($r = -0.243$, $p < .01$; $r = -0.204$, $p < .01$; $r = -0.199$, $p < .01$; $r = -0.143$, $p < .01$). Overall, with regard to TQ, these correlations did not confirm all our research hypotheses. For the control variables, we found predominantly significant correlations.

	Variables	Mean	Median	Std. Dev.	Min	Max	1	2	3	4	5	6	7	8	9	10	11
1	EMSC	0.808	1.000	0.394	0.000	1.000	1.000										
2	EPS	64.219	68.113	22.054	0.515	98.386	0.219*	1.000									
3	ES	70.407	77.632	24.801	0.000	99.776	0.225*	0.834*	1.000								
4	EIS	44.750	50.000	32.525	0.000	99.813	0.103*	0.635*	0.294*	1.000							
5	RUS	71.396	78.001	25.511	0.000	99.832	0.204*	0.836*	0.712*	0.327*	1.000						
6	TQ	1.597	1.394	0.795	0.244	4.703	-0.192*	-0.243*	-0.204*	-0.199*	-0.143*	1.000					
7	SIZE	10.116	10.028	1.385	6.637	13.407	0.120*	0.472*	0.418*	0.321*	0.442*	-0.337*	1.000				
8	LEV	0.702	0.560	0.529	0.000	2.778	0.017	0.169*	0.147*	0.093*	0.105*	-0.283*	0.196*	1.000			
9	GROWTH	3.461	3.371	10.033	-36.510	43.397	-0.051*	-0.122*	-0.115*	-0.065*	-0.075*	0.198*	-0.057*	-0.095*	1.000		
10	ISO9	0.593	1.000	0.492	0.000	1.000	0.391*	0.215*	0.160*	0.166*	0.199*	-0.207*	0.133*	0.096*	-0.065*	1.000	
11	SENSITIVE	0.272	0.000	0.445	0.000	1.000	0.158*	0.188*	0.211*	-0.044*	0.145*	-0.006	-0.135*	0.016	-0.077*	0.174*	1.000

*Note. N = 1392. * p < .1. EMSC: EMS certification; EPS: environmental performance score; ES: emissions score; EIS: environmental innovation score; RUS: resource use score; TQ: Tobin's q; SIZE: firm size; LEV: financial leverage; GROWTH: company growth; ISO9: ISO 9000 certification; SENSITIVE: sensitive industry.*

Table 2. Descriptive Statistic and Correlation Matrix

Regression Results

The results of the main effect analyses for models 1 to 5 are summarized in Table 3. The column for model 1 reports estimated results with EPS as the dependent variable, whereas columns for the remaining models report estimated results with TQ as the dependent variable.

	Model 1 EPS	**Model 2** TQ	**Model 3** TQ	**Model 4** TQ	**Model 5** TQ
EMSC	3.573**	0.060	-	0.061	-0.110
	(1.776)	(0.066)	-	(0.066)	(0.172)
EPS	-	-	-0.000	-0.000	-0.003
	-	-	(0.001)	(0.001)	(0.003)
EMSC#EPS	-	-	-	-	0.003
	-	-	-	-	(0.003)
SIZE	1.821	-0.186	-0.179	-0.186	-0.192
	(2.462)	(0.115)	(0.115)	(0.115)	(0.117)
LEV	-1.103	-0.044	-0.048	-0.044	-0.044
	(1.105)	(0.070)	(0.070)	(0.070)	(0.069)
GROWTH	-0.015	0.003***	0.003***	0.003***	0.003***
	(0.021)	(0.001)	(0.001)	(0.001)	(0.001)
SENSITIVE	-	-	-	-	-
	-	-	-	-	-
ISO9	0.997	-0.015	-0.010	-0.015	-0.014
	(1.447)	(0.044)	(0.043)	(0.044)	(0.044)
CONSTANT	40.511	3.420***	3.395***	3.429***	3.625***
	(24.676)	(1.146)	(1.148)	(1.147)	(1.198)
Number of observations	1392	1392	1392	1392	1392
Number of firms	232	232	232	232	232
R-squared	0.121	0.078	0.076	0.078	0.080
F-statistic	5.480***	15.488***	15.383***	14.122***	13.058***

*Note. Year dummies are estimated but not presented. Robust standard errors are in parentheses. *** p < .01, ** p < .05, * p < .1. Firm-fixed effects and Year-fixed effects given in Models 1-5. EMSC: EMS certification; EPS: environmental performance score; TQ: Tobin's q; SIZE: firm size; LEV: financial leverage; GROWTH: company growth; ISO9: ISO 9000 certification; SENSITIVE: sensitive industry. SENSITIVE variable has been omitted in all FE analyses due to its time-invariability (Andreß et al., 2013; Kohler & Kreuter, 2017).*

Table 3. Regression Results for Models 1 to 5

The results for model 1, for which we regressed EPS on EMSC, indicate that EMSC is positively related to EPS at the 5% level of significance (b = 3.573, p < .05). For models 2 and 3, in which TQ was used as the dependent variable, the coefficients of EMSC (b = 0.060, p > .1) and EPS (b = -0.000, p > .1) were insignificant. Similarly, we did not find any significant coefficients for both EMSC (b = 0.060, p > .1) and EPS (b = 0.060, p > .1) when estimating model 4, in which we added both EMSC and EPS with TQ as the dependent variable. As the results for model 5 show, neither the individual coefficients for EMSC (b = -0.110, p > .1) and EPS (b = -0.003, p > .1), nor the coefficient of the interaction term (b = 0.003, p > .1) generated statistically significant results.

When considering the individual environmental performance dimensions ES, EIS, and RUS, the results showed that for the effects of EMSC on ES, EIS, and RUS the coefficient of EMSC was positive and strongly significant at the 1% significance level (b = 7.468, $p < .01$) only for ES as the dependent variable. For the effects of the dimensions of EPS on TQ, we did not find any statistically significant results. The coefficients of ES (b = -0.000, $p > .1$), EIS (b = -0.000, $p > .1$), and RUS (b = 0.000, $p > .1$) were all close to zero and statistically insignificant. For the models with EMSC and a dimension of EPS as independent variables and TQ as the dependent variable, we did not find any significant associations. The coefficients for EMSC (b = 0.064, $p > .1$; b = 0.059, $p > .1$; b = 0.059, $p > .1$) and for ES (b = -0.001, $p > .1$), EIS (b = -0.000, $p > .1$), and RUS (b = 0.000, $p > .1$) were insignificant.

Furthermore, we regressed TQ on the interaction terms (ES * EMSC), (EIS * EMSC), and (RUS * EMSC), respectively. Neither the individual coefficients for EMSC (b = -0.112, $p > .1$; b = 0.045, $p > .1$; b = -0.018, $p > .1$), ES (b = -0.003, $p > .1$), EIS (b = -0.001, $p > .1$), and RUS (b = -0.001, $p > .1$), nor the coefficients of the interaction terms (EMSC * ES) (b = 0.003, $p > .1$), (EMSC * EIS) (b = 0.000, $p > .1$), and (EMSC * RUS) (b = 0.001, $p > .1$) were found to be statistically significant.

Post-hoc Analysis

We detected differences in the results when estimating the models separately for each industry. However, it should be noted that for some industries, the number of companies was rather small. For model 1, the coefficient of EMSC was positive and significant only for consumer discretionary (b = 7.416, $p < .05$) and telecommunications (b = 10.627, $p < .01$). However, the coefficient was negative and significant at the 5% level for technology (b = -14.916, $p < .05$). For model 2, in which we regressed TQ on EMSC, we found positive and significant coefficients for technology (b = 0.642, $p < .01$) and basic materials (b = 0.308, $p < .05$), but a negative coefficient for financials (b = -0.288, $p < .01$). For model 3 in which we regressed TQ on EPS, none of the coefficients of EPS were significant.

Furthermore, we conducted several robustness checks. The first robustness check had already been performed because instead of EPS, we used its dimensions ES, EIS, and RUS. Therefore, we could refrain from further substitution of the environmental performance variables, as the metrics we could have used as substitutes were all already included in the respective Refinitiv scores. However, unlike some previous studies, we did not include a measure of financial performance other than TQ. Therefore, we estimated our models by including return on assets as the main dependent variable. We found that the coefficient of the interaction term (EMSC*EPS) was positive at the 1% level of significance (b = 0.061, $p < .01$). To further examine this relation, we found the individual coefficient of RUS (b = -0.042, $p < .05$) to be negative and the coefficient of the interaction term (EMSC*RUS) (b = 0.038, $p < .05$) to be positive both at the 5% level of significance.

Discussion and Implications

Our study was motivated by the fact that the relationships between EMS certification, environmental performance, and financial performance have gained scientific attention, but produced inconclusive results. Following the suggestions of Melnyk et al. (2003) to further investigate the direct and indirect relationships between EMSs and performance, we reassessed the puzzle and empirically investigated the relations between EMS certification, environmental performance, and financial performance.

We found a significant positive effect of EMS certification on environmental performance, and especially of EMS certification on emission reduction. We did not find significant associations between EMS certification and financial performance and between environmental performance and financial performance. Moreover, the results neither confirmed the existence of a mediating role of environmental performance between EMS certification and financial performance nor did this study find evidence for a moderating role of EMS certification on the environmental-financial performance nexus.

Our results suggest that EMS certification improves environmental performance and, in particular, emission reduction. Hence, EMS certification is likely to contribute positively to an organization's environmental performance. Although our analyses could not provide statistically significant evidence that EMS certification and environmental performance contribute to financial performance, additional analyses could partly clarify that the effectiveness of EMS certification concerning environmental and financial performance depends on the industry in which a company operates. Another explanation for not finding a significant effect of EMS certification and environmental performance on financial performance could be time lags. Turning EMSs and environmental performance into net-positive effects on financial performance requires changes in business models and strategies that create competitive advantage as well as organizational adoptions which may require more time (Kranz et al., 2021; Lo et al., 2012; Tan et al., 2017). Financial performance improvements may start with the implementation of EMSs, but only develop their full effectiveness down the line when internal and external stakeholders such as employees, investors, and customers have confidence in and build on EMSs and their environmental performance (Delmas, 2001). Therefore, a better understanding on EMSs' effects on organizational practices, culture, and structure and their boundary conditions (e.g., through the application of qualitative research designs and meta-analyses) is crucial (Boiral et al., 2018).

Although we cannot prove the direction of causality, in relation to our research question, we can conclude that EMS certification contributes positively to improving environmental performance without significantly affecting an organization's financial performance. Our results further highlight the central role of emission reduction in the relationship between EMS certification and environmental performance. We agree with other researchers (Albertini, 2013; King & Lenox, 2001; Nawrocka & Parker, 2009; Trumpp & Guenther, 2017) that future research should focus on how and when EMSs contribute to organizational performance and ultimately to their reduced environmental impact, rather than on whether such impacts exist. Understanding how relationships unfold can be a promising way to disentangle the complex relations between EMS certification, environmental performance, and financial performance.

Implications

Our study's first theoretical contribution lies in its conceptual distinction between the direct and indirect effects and its consideration of the multidimensional nature of environmental performance (Melnyk et al. 2003). Overall, our research model incorporates both direct and indirect effects of the relationships between EMS certification, environmental performance, and financial performance. By considering these factors, we account for the interplay of EMSs, environmental performance, emission reduction, resource use, environmental innovation, and financial performance through multiple pathways. This approach enriches the existing body of literature by providing a novel approach to disentangle the complex relationships (e.g., Voinea et al., 2020) that future researchers can build on to delve deeper into exploring the intricate relationships among these variables.

Second, we theoretically add to the understanding of IS-enabled systems, such as EMSs, as resources that have the potential of competitive advantage. Since RBV and NRBV provided the theoretical lens to the relation between environmental and financial performance (Hart & Dowell, 2011), our study bridges disciplines and provides a new perspective to the management literature on strategic resources and sustained competitive advantage (Grant, 1991; Hart, 1995). We find empirical evidence that resources such as EMSs can provide positive outcomes for the natural environment, especially a reduction of emissions, with the potential for competitive advantage as it increases a firm's future performance relative to its competitors (Hart, 1995; Hart & Dowell, 2011).

From a practitioners' point of view, our findings may help companies facing difficult decisions in allocating their limited resources and prioritizing strategic initiatives (Feng & Wang, 2016). Our results show the environmental effectiveness and strategic importance of EMSs and should encourage organizations to implement EMSs. In light of companies' increasing pressure to evaluate and mitigate their sustainability impacts, our findings contribute by showing how IS can support companies faced with reducing their sustainability impacts. While the costs associated with environmental management practices have been found to pose one of the major inhibitors of adoption (Boiral et al., 2018), certain benefits of EMS certification, such as reputation, can be difficult to measure (Steger, 2000). Therefore, our findings that EMSs positively affect environmental performance without negatively affecting financial performance can guide managers' decision making. Our results suggest that decision makers should not hesitate to implement EMS certification and/or other environmental practices because they anticipate negative financial impact.

Limitations and Future Research

Our study has limitations that offer potential for future research. Firstly, this study relies on EMS certification rather than EMS implementation due to data availability for the EMS construct. Second, results may have been biased by firms seeking EMS certification solely for image-building purposes (Rondinelli & Vastag, 2000). The third limitation is that the analysis of data from the STOXX 600 may restrict the generalizability of the findings. We therefore encourage future research to replicate this study with a more comprehensive range of companies, company sizes, and ownership structures. The study also has limitations in terms of its methodology. Although we controlled for unobservable or unmeasurable characteristics that are constant over time by using FE, endogeneity, particularly unobserved heterogeneity due to characteristics that vary, remains a concern (Hill et al., 2020). Consistent with research findings that linear FE models often fail to estimate causal effects (Collischon & Eberl, 2020), our study is limited in that causality cannot be inferred from the established relationships. We therefore encourage researchers to use more sophisticated methods to address endogeneity issues through techniques such as propensity score matching or regression discontinuity. The focus of further research should be on demonstrating causality rather than mere correlation. At the same time, our study raises concerns about reverse causality. The impact of EMS on performance may require organizational changes, which in turn could take additional time (e.g., Kranz et al., 2021). For this reason, it is suggested that researchers examine the temporal aspect of these effects more comprehensively using e.g., cross-lagged panel models or dynamic panel estimation methods to incorporate time lags. Additionally, we suggest further research employs unbalanced panel data models or implements winsorized methods to not exclude data due to missing values. Finally, we emphasize the need for a systematic and theoretically ground operationalization of constructs and caution against using aggregate measures to draw overarching conclusions about the impact of EMSs.

Conclusion

The IS discipline in general (vom Brocke et al., 2013; Watson et al., 2010) and the implementation of EMSs in particular (Kranz et al., 2021; Loeser et al., 2017) present unique opportunities to contribute to solving the pressing issues of environmental sustainability. Our empirical results confirmed that EMSs' potential to systematically gather, process, and make available information on corporate environmental performance (El-Gayar & Fritz, 2006) improves organizations' environmental performance, primarily through a reduction of emissions. Thereby, our study provides a new perspective on the effectiveness of EMSs and provides an urgently needed opportunity to bring sustainability into action (Watson & Kranz, 2021). Future research and practice can build on our study to combat climate change.

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