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Digital orientation and environmental performance in times of technological change

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ABSTRACT

Digitalization is increasingly seen as a strategic means for firms to yield competitive and environmental advantages. Still, current empirical research does not yet provide ample evidence on how a firm's strategic posture towards digitalization connects to environmental performance. This study examines the link between digital orientation and environmental performance as well as the moderating role of technological turbulence. The natural-resource-based view and literature on strategic orientations provide the conceptual foundations. The hypotheses are tested with data from 515 U.S. Standard and Poor's 500 companies with 2,800 firm observations from 2009 to 2019. The results indicate that, first, a firm's digital orientation has a significant and positive effect on environmental performance and, second, this effect is even more pronounced in technologically turbulent business environments. In sum, our findings suggest that managers can improve their firm's environmental performance and competitive position by increasing the digital orientation within their organizations. We thus add to the literature on the natural-resource-based view by identifying digital orientation as a strategy aligned with the natural environment. Finally, we derive practical implications for managers and policymakers aiming to bring together digitalization and green strategies.

1. Introduction

Advancing climate change is putting pressure on firms to address environmental challenges (George et al., 2020) – that is, to minimize the "repercussions on the natural environment that stem from the productive activities of a company and the social perception of this impact" (De Burgos Jiménez and Céspedes, 2001, p. 1561). Across all industries, firms are considering digitalization to confront these challenges (George et al., 2020; Ghobakhloo, 2020). Practitioners have called for managers to go beyond individual technology initiatives and embrace digitalization as a strategic opportunity to unleash its full potential as a driver of what is termed "technology ecoadvantage" (BCG, 2021). In this vein, the car manufacturer Mercedes-Benz (2022) has committed to a net zero strategy as part of its sustainability program and is aiming to reduce emissions from its vehicle fleet and entire value chain to zero by 2039: "As part of our sustainable business strategy, we want to exploit the significant potential of digitization". Similar strategies have also been applied by companies like FedEx, Analog Devices, and NRG Energy, which recognize digitalization as an opportunity to improve their environmental performance. Specifically, Analog Devices' (2022) strategic commitments note, "We are committed to using our technology, people, and voice to protect the planet and improve quality of lives to drive positive change for future generations" (p. 15). Concerning the role of digital technology, Analog Devices further emphasized, "We recognize and embrace our responsibility in seeing meaningful progress towards the social development goals and see a direct tie to what our technology enables" (p. 20). In this regard, Analog Devices more specifically commits to (1) invest in the development and deployment of breakthrough technologies to improve its own environmental performance and that of its customers; (2) improve its digital capabilities, such as its technical software workforce, to prepare them for tomorrow's challenges; (3) enter into collaborations and work with ecosystem partners to co-create technologies that can address tomorrow's environmental challenges more effectively; and (4) improve its operations through technology to achieve climate goals and preserve resources.

However, while in practice, digitalization appears to be increasingly understood as a strategic effort to improve environmental performance, there is little empirical evidence to substantiate this relationship. Previous research has tended to examine the impact of individual digital technology initiatives on firms' environmental performance (e.g.,

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Chatterjee et al., 2023; Isensee et al., 2020; Li et al., 2020; Xie et al., 2022), with a number of studies limited to specific industries (e.g., Benzidia et al., 2021; Liang et al., 2022). As a consequence, the extant research is scattered, and its results are inconsistent for different types of technologies, such as big data analytics (positive impact on environmental performance; Benzidia et al., 2021) or Internet of Things (IoT) applications (no impact on environmental performance; Saunila et al., 2019). Apart from these individual technology initiatives, we have yet to understand how a holistic strategic digital orientation that captures, for example, a firm's digital ecosystem coordination affects firms' environmental performance. It also remains unclear whether companies in industries experiencing rapid technological change – recently identified as a key driver of digital strategy (Li et al., 2022; Yeow et al., 2018) and sustainable development (UNCTAD, 2020) – are particularly effective in leveraging a digitally oriented strategy for improving their environmental performance.

This study addresses these gaps using a strategic orientation lens to analyze the impact of a company's digital orientation on its environmental performance. Drawing on the natural-resource-based view (NRBV; Hart, 1995), we argue that a firm's level of digital orientation has a significant effect on its environmental performance, which is key to creating a sustainable competitive advantage. More precisely, we argue that Kindermann et al.'s (2021) dimensions of digital orientation – digital technology scope, digital capabilities, digital ecosystem coordination, and digital architecture configuration – enhance an organization's products, services, internal processes, and external networks in ways that directly support the three NRBV dimensions of pollution prevention, product stewardship, and sustainable development. Moreover, we suggest that the pressure to adapt to a technologically turbulent business environment may lead to even greater effectiveness in translating digital orientation into environmental performance.

We used a panel dataset of 515 U.S. Standard and Poor's (S&P) 500 firms with 2,800 firm-year observations to examine these predictions for the period from 2009 to 2019. We leveraged employee reviews from Glassdoor.com to measure digital orientation with dictionary-based text analysis and extracted information on environmental performance from the Refinitiv's Environmental, Social and Corporate Governance (ESG) database.

Our study contributes to the interface between strategic management and environmental science. First, we flesh out a concrete manifestation of the NRBV by identifying digital orientation as a strategic orientation that can alleviate environmental challenges. We enhance earlier findings on individual digital initiatives (see Chatterjee et al., 2023; Saunila et al., 2019; Zhang et al., 2019) and apply them to the firm level by concretizing how organizational digital anchoring can lead to an environmental advantage. Thereby, we add a building block to the convergence of the digital strategy and environmental performance literature streams.

Second, we reveal technological turbulence as a pivotal contingency factor for the digitalization–environment nexus in a focal firm. We thus support the recent notion that organizations in technologically dynamic surroundings are particularly effective in digitalizing their organization and associated business models (Coreynen et al., 2020). This aligns the recent digital strategy and environmental performance streams with traditional resource scholars' views by explaining how competitive advantage can be maintained in fast-paced environments (Hart, 1995).

The remainder of this paper is structured as follows. Section 2 outlines our research's conceptual background and derives our hypotheses. Section 3 describes our research method and illustrates the applied measures and the data for the empirical analysis, while Section 4 presents the empirical results and robustness tests. Finally, in Section 5, we discuss the main findings of our research, derive implications, and carve out directions for future research.

2. Theoretical analysis and hypotheses development

2.1. Theoretical background

The basic premise of the classical resource-based view (RBV) is that a firm can achieve sustainable competitive advantage by developing or acquiring resources and capabilities that are valuable, rare, inimitable, and non-substitutable (Barney, 1991). The progression of climate change and the increasing urgency to act against it suggests that in the future, firms will be able to compete only if they develop strategies that align with environmental and sustainability issues. Thus, as an extension of the RBV with a lens on nature, Hart (1995) introduced the NRBV, which describes the fundamental dependence of a firm's competitive advantage on creating resources that are compatible with the natural environment and support sustainable development. Specifically, within the NRBV framework, Hart (1995) identified three interrelated strategic capabilities that firms must address: (1) *pollution prevention*, (2) *product stewardship*, and (3) *sustainable development*. Each of these dimensions, in turn, relates to an environmental driving force that in one way or another can foster competitive advantage creation. *Pollution prevention* means minimizing or preventing emissions, effluents, and waste, which can lead to significant cost savings in areas such as operations or waste disposal, creating a cost advantage over competitors. *Product stewardship* refers to incorporating the perspective of external stakeholders throughout the product life cycle to minimize the environmental impact and life cycle costs of the product system, for example, by avoiding waste, reusing materials, or avoiding toxic substances. This can help to pre-empt the competition to remain competitive. *Sustainable development* means continuously driving innovation and change to minimize negative environmental impacts resulting from the company's growth and development, thus creating long-term competitive advantage in harmony with the natural environment.

Prior research has drawn on the underlying arguments of NRBV to analyze relationships between corporate social responsibility and financial performance (Okafor et al., 2021), sustainability investments and financial performance (Khan et al., 2016), and environmental disclosure quality and firm value (Plumlee et al., 2015). While the previous research has focused primarily on examining the relationship between environmental and sustainability practices and financial performance (Hart and Dowell, 2011), scholars have paid less attention to the actual antecedents of environmental performance, including firms' strategic orientation.

Generally, strategic management research has relied on resource-based theories as an underlying framework to understand why firms differ in performance, studying firms' strategic orientations – "strategic directions a firm adopts to create the right behaviors for continuous superior performance of the firm" (Gatignon and Xuereb, 1997, p. 78) – as sources of sustainable competitive advantage (e.g., Adams et al., 2019; Guo et al., 2020; Kim et al., 2013; Slater et al., 2006). Three prominent strategic orientations are *entrepreneurial orientation* (Miller, 1983), *market orientation* (Kohli and Jaworski, 1990), and *technology orientation* (Gatignon and Xuereb, 1997). More recently, the increasing relevance of digital transformation issues (Kraus et al., 2022; Trischler and Li-Ying, 2022) – including the implementation of digital strategies (Bharadwaj et al., 2013; Ritala et al., 2021), business model digitalization (Bouncken et al., 2021), and the shift to digital value creation (Amit and Han, 2017) – has been "gradually eroding the competitive advantage that previously studied strategic orientations can provide, either on their own or jointly" (Kindermann et al., 2021, p. 647). Therefore, Kindermann et al. (2021) recently introduced *digital orientation* as a new strategic orientation to achieve sustainable competitive advantage.

Kindermann et al. (2021) defined *digital orientation* as "an organization's guiding principle to pursue digital technology-enabled opportunities to achieve competitive advantage" (p. 649). Furthermore, based on previous research on digital strategy (e.g., Henderson and Venkatraman, 1999; Nambisan et al., 2019), Kindermann et al. (2021) proposed the presence of four dimensions within digital orientation: (1) *digital technology scope*, (2) *digital capabilities*, (3) *digital ecosystem coordination*, and (4) *digital architecture configuration*. The authors described *digital technology scope* as "the set of digital technologies that allow the firm to realize strategic growth. This set can include technologies such as sensors, blockchain, and IoT solutions as both ingredients and outcomes of digitalization processes" (p. 648). Firms that score high on this dimension enhance their products, services, or solutions with digital technologies to create additional value for customers, meet market needs, and generate additional profits (Bharadwaj et al., 2013; Kindermann et al., 2021). Kindermann et al. (2021) described *digital capabilities* as "organizations' efforts to develop and maintain routines that leverage human capital and knowledge assets to engage with a specific set of digital technologies" (p. 648). Firms that perform strongly in this dimension can strengthen or acquire the necessary skills and expertise to enhance their internal competencies and enable their digital strategy. *Digital ecosystem coordination* captures how "effectively firms interact with stakeholders in open technological ecosystems" (p. 648). Firms that score high in this dimension effectively access information and gain positive network effects from their stakeholders, for example, through open-source platforms or application programming interfaces. A tool that supports this dimension is innovation management software, which can stimulate innovation ecosystems by bringing together innovation programs, actors, and resources in one place (Endres et al., 2022). Finally, *digital architecture configuration* is "digitalization by specifying organizational structures and responsibilities that cater to technological change (e.g., having a chief digital officer), as well as by digitizing their internal processes (e.g., through algorithm-driven automation in Industry 4.0 settings)" (Kindermann et al., 2021, p. 649). Firms that perform high in this dimension design or redesign their infrastructure, internal processes, and organizational landscape to leverage their digitalization efforts and react dynamically to potential changes.

To identify firms' strategic orientation, scholars often rely on public corporate statements, such as shareholder letters (e.g., Noble et al., 2002) or management discussion and analysis sections of 10-K filings (e.g., McKenny et al., 2018). However, in such outlets, firms may communicate a socially desirable narrative (Aragón-Correa et al., 2016; Siano et al., 2017), which can limit findings on strategic orientation–performance relationships. In contrast, information gleaned from employee reviews can provide an insider's perspective, i.e., important insights into the actual situation in firms (Pitt et al., 2019). Consequently, we used text reports from anonymous employee reviews in this study to capture firms' strategic orientation and determine whether firms practice what they preach.

Taken together, the dimensions of digital orientation capture a company's digital value proposition, capabilities, and organizational structure, all of which may contribute to the creation of competitive advantage. However, in times of growing ecological issues, the NRBV posits that achieving a competitive advantage depends significantly on creating resources that are compatible with the natural environment and that support sustainable development. Thus, whether a competitive advantage can be achieved through strategic digital orientation will also depend heavily on whether this can improve environmental performance.

2.2. Hypotheses development

In the following sections, we delve deeper into the extent to which digitally oriented companies can meet the requirements of the NRBV framework. We conceptually derive the potential mechanisms through which digital orientation can actually serve as an antecedent for firms' environmental performance.

2.2.1. Digital orientation and environmental performance

Research on the antecedents of environmental performance is still nascent from a strategic perspective (Kraus et al., 2020; Latan et al., 2018). Initial studies have addressed the impact of individual aspects and initiatives, such as types of *corporate governance* (e.g., Kock et al., 2012), *board characteristics* (e.g., De Villiers et al., 2011), *management control systems* (e.g., Henri and Journeault, 2010), *internal green practices and supplier monitoring* (e.g., Li et al., 2018) on environmental performance. More recently, attention has also focused on the positive impacts of digitalization on environmental performance. For example, George et al. (2020) conceptually derived specific ways that entrepreneurial and incumbent companies can leverage digitalization to address climate change and promote sustainable development. Benzidia et al. (2021) and Li et al. (2020) empirically examined the impact of individual digital technologies (e.g., IoT, cloud computing, big data analytics, and artificial intelligence) in manufacturing companies and the hospital environment, respectively, and found that they have a positive impact on environmental and economic performance. Likewise, other studies have found positive effects of firms' digital technology initiatives on environmental performance, such as technology-based green process innovations (Xie et al., 2022) or electronic vendor relationship management (Chatterjee et al., 2023). However, not all studies have shown a positive effect of digital technology initiatives on environmental performance; for example, the results of studies on IoT are inconsistent (e.g., Saunila et al., 2019; Zhang et al., 2019). Along similar lines, Hart and Dowell (2011) contended that such individual initiatives will not be sufficient to sustainably improve environmental performance and maintain long-term competitive advantage and that firms need to develop holistic breakthrough strategies that address all the dimensions of the NRBV. Following these lines of thought, the following sections explain how digital orientation may affect each of Hart's (1995) NRBV dimensions.

2.2.1.1. Pollution prevention. The combination of increased digital technology scope and digital capabilities fosters an organization's ability to continuously reduce emissions. De Sousa Jabbour et al. (2018) proposed that increasing the scope of digital technologies enables environmentally sustainable manufacturing processes and reduces emissions. This proposition has been supported by other researchers, such as Peukert et al. (2015), who showed that carbon footprint analyses enabled by digital technologies can reduce greenhouse gas emissions. A greater digital technology scope means that firms can offer digital services that are better than old-fashioned analog services. One example of this is the ability to digitally upgrade or repair smart, connected products remotely before the entire hardware is in need of replacing, for example, operating system updates on computers and smartphones, remote maintenance of machines through IoT solutions, and on-demand functions in cars (Schulz et al., 2021). This advancement has the potential to extend product lifecycles, thus reducing waste (by making products less quickly outdated and unrepairable) and emissions (because fewer new products have to be produced) (Raff et al., 2020).

In addition to these beneficial effects, enhanced digital capabilities can foster the digitalization of value creation processes or outcomes (Kindermann et al., 2021), which is crucial for emission prevention. One way to increase digital capabilities is to integrate new digital tools and skills into internal systems and train employees to accept and apply them (Kindermann et al., 2021), especially with the increasing need to establish remote workplaces (Amankwah-Amoah et al., 2021; Baig et al., 2020). The expansion of digital capabilities enables firms to introduce remote working and virtual meetings, lowering emissions through reduced travel times and office space. An analysis by the International Energy Agency showed that one day of home working per week would result in an estimated annual reduction of 24 million tons of carbon dioxide (CO_2) emissions worldwide, and this result took into account both reduced transport emissions and increased household energy demand (Crow and Millot, 2020). Finally, digital ecosystems can reduce emissions. The New Energy Opportunities Network is a global community and digital market platform with >300 firms that facilitates the cleantech purchasing process by connecting firms with experts, projects, technologies, and market information to become more efficient and ultimately reduce CO_2 emissions (Accenture, 2021).

2.2.1.2. Product stewardship. On the one hand, the increasing use of technology (both the increasing scope of digital technology and digital capabilities) is leading to greater consumption of energy and raw materials (Belkhir and Elmeligi, 2018; Lange et al., 2020) needed to build and run digital devices. On the other hand, the increasing digital orientation of a firm can offset its consumption of resources. For example, smart meters – an IoT digital technology – can increase energy efficiency in factories and offices by 10 to 20 % as well as reduce water consumption by detecting leaks (Manyika et al., 2015; Wunderlich et al., 2012). Moreover, so-called "green software engineering" – a digital capability – can help reduce the negative impact of the increasing consumption of energy and resources resulting from increasing digitalization (Naumann et al., 2011). Finally, robotic waste management systems in smart factories – configurations of digital architecture – can contribute to a more efficient use of resources, reduce waste, and promote the recycling of materials (Sarc et al., 2019).

2.2.1.3. Sustainable development. Product innovation, investments in green technology, and a focus on green research and development (R&D) support a firm's sustainable development (Kraus et al., 2020), as do the firm's digital technology scope and digital capabilities. For example, cloud-based technologies and big data analytics capabilities that enhance the information flow within an organization can enable green product development and innovation (Dubey et al., 2019; Wu et al., 2015). Boland et al. (2007) attributed "wakes of innovations" (p. 631) in the construction industry to the infusion of new digital technologies such as 3D visualizations of projects, demonstrating how the scope of digital technology and digital capabilities drives innovation. In addition, research has found that the effective coordination of the digital ecosystem and subsequent adoption of digital platforms can foster innovation (Yoo et al., 2012). Yoo et al. (2012) stated that this coordination requires the implementation or adaptation of new infrastructure and processes that permeate the entire company. For instance, a novel digital architecture configuration in the form of an internet backbone or broadband mobile network must be implemented to fully leverage the potential of digitalization efforts and drive innovation.

All things considered, while a clear picture has emerged concerning the positive impact of digital orientation on the sub-dimensions of pollution prevention and sustainable development, a mixed picture has emerged for product stewardship (see Chen et al., 2020). In sum, we expect that the benefits of digital orientation will outweigh its shortcomings and ultimately improve environmental performance. Thus, we hypothesize:

H1. Digital orientation is positively related to an organization's environmental performance.

2.2.2. The moderating role of technological turbulence

Industries can be marked by the instability and dynamism around them. A manifestation here is environmental turbulence, which refers to development and change as well as uncertainty (Dess and Beard, 1984; Miller and Friesen, 1983). Environmental turbulence, in the form of competitive intensity, market turbulence, and technological turbulence, has been analyzed across different business contexts and mechanisms of action, mostly in its moderating role (see Calantone et al., 2003; Coreynen et al., 2020; Danneels and Sethi, 2011; Kohli and Jaworski, 1990).

In the present study, we place a particular emphasis on the contingency effect of *technological turbulence*, defined as "the rate of technological change in the industry" (Jaworski and Kohli, 1993, p. 57). The United Nations Conference on Trade and Development has identified rapid technological change as a key factor in sustainable development, posing strategic opportunities but also risks for business and society (UNCTAD, 2020). Yet, previous studies did not discuss the extent to which technological turbulence may in fact shape the relationship between holistic strategic digital orientation and environmental performance. Against this backdrop, we explore the moderating role of technological turbulence in this study.

For industries experiencing significant technological change, competitive advantages are temporary, as products and services swiftly become obsolete (Calantone et al., 2003). This puts pressure on firms to adapt and maintain their competitive edge. Previous research has shown that this pressure means that such firms are more experienced and effective at managing technological change than firms in industries with less technological turbulence (Heckmann et al., 2016). Recent studies have shown that firms acting in technologically turbulent business environments are particularly effective at digitalization initiatives (e.g., Coreynen et al., 2020) and green practices (e.g., Ogbeibu et al., 2020; Wang et al., 2022). We thus expect that firms in turbulent settings will be more effective at putting their digital orientation into action and thus achieve greater environmental benefits. Thus, we hypothesize:

H2. Higher levels of technological turbulence strengthen the positive relationship between digital orientation and environmental performance.

In sum, we posit that a company's digital orientation is positively related to its environmental performance and that the environmental condition of technological turbulence moderates this relationship. Fig. 1 shows a graphic representation of our research model.

3. Methodology

Having reviewed the literature and developed our hypotheses, we needed to make the data manageable and create variables for the constructs. Fig. 2 shows our research flow and summarizes the steps of the analytical procedure, which are described in more detail in the following sections.

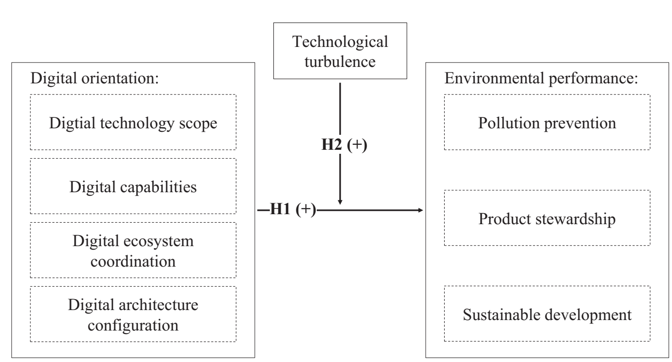

Fig. 1. Research model.

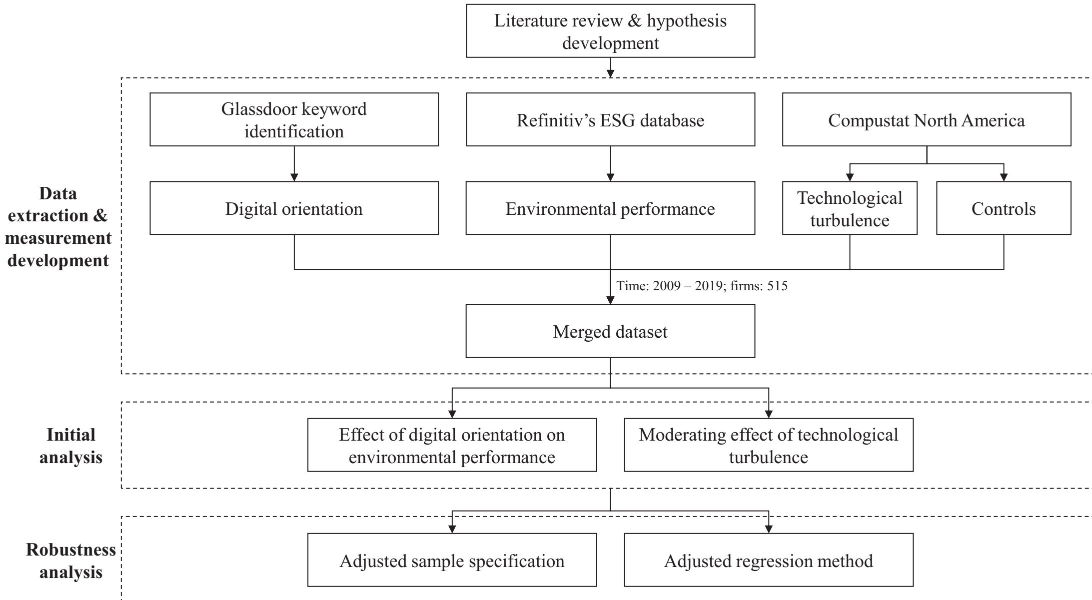

Fig. 2. Research flow and analytical procedure.

3.1. Sample and data collection

To test our hypotheses, we utilized a cross-industry sample of 515 firms that were part of the S&P 500 index (at least temporarily) between 2009 and 2019. For these firms, we collected >1.5 million anonymous employee reviews from Glassdoor.com, a public company review website. We then aggregated the positive text ratings per firm per year to create a holistic picture of the firm for the respective year and combined these reviews with data from the Refinitiv ESG database. Using publicly available data, this ESG database measures an organization's performance in distinct categories, including resource usage, emissions, human rights, and management, relative to the company's industry benchmark. The results are presented as percentiles based on Refinitiv's (2021) formula, as illustrated in Eq. (1):

$$\text{ESG Score} = \frac{\text{no.of firms with a worse value} + \frac{\text{no.of firms with the same value}}{2}}{\text{no.of firms with a value}} \quad (1)$$

We merged these datasets with the Compustat North America database to obtain company-specific information, such as the number of employees, R&D investments, firm age, sales, and performance. Including only firm-years for which all variables were available resulted in our final panel of 515 firms with 2,800 firm-year observations.

3.2. Measurement

3.2.1. Dependent variable

As outlined above, the environmental performance of a firm depends on the extent to which it addresses the NRBV dimensions. The NRBV dimensions connect with the subcategories of the environmental pillar from Refinitiv's (2021) ESG score.

Refinitiv's ESG score combines the subcategory scores from the following categories: (1) *emissions* (emissions and waste), (2) *innovation* (product innovation, green revenues, R&D, and capital expenditures), and (3) *resource usage* (water and energy). Each of these subcategories connects to one of the dimensions of the NRBV framework by Hart (1995). That is, *emissions* relate to the NRBV dimension of pollution prevention (minimizing emissions, effluents, and waste), as it concerns CO_2 emissions and total waste. *Resource usage* relates to the NRBV dimension of product stewardship (minimizing the life-cycle cost of products) through its focus on water and energy consumption. *Innovation* relates to the NRBV dimension of sustainable development due to its focus on product innovation as well as green revenues, R&D, and capital expenditures.

To measure our dependent variable *environmental performance*, we used the environmental pillar score from Refinitiv's (2021) ESG score (e.g., Cheng et al., 2014; Garcia et al., 2017). We collected the overall environmental pillar score for each firm-year and divided it by 100 to obtain an environmental performance score between 0 and 1.

3.2.2. Independent variable

Following Kindermann et al. (2021), we defined our independent variable *digital orientation* along the four dimensions of *digital technology scope*, *digital capabilities*, *digital ecosystem coordination*, and *digital architecture configuration*. To measure digital orientation, we followed prior research and applied text analysis to the aggregated text sections of the collected employee reviews (Pitt et al., 2019). More specifically, we used computer-aided text analysis (CATA) and the CAT Scanner tool developed by McKenny et al. (2012) to capture digital orientation. This tool utilizes established dictionaries to measure digital orientation (Kindermann et al., 2021) and counts the frequency of identified words. The word lists for digital orientation originally established by Kindermann et al. (2021) appear in Table 1.

To enable comparability of the results, we divided the number of identified words by the total number of available words, resulting in a score between 0 and 1. We calculated the score for each dimension individually and then summed up the scores to derive one overall digital orientation score per firm-year. We included only firm-years with at least five employee reviews and a combined total word count of 500 words to reduce the potential impact of personal biases.

Table 1
Wordlist for digital orientation from Kindermann et al. (2021).

Digital orientation	Content analysis words and phrases
Digital technology scope	Advanced communications, advanced technology, advanced technologies, app, apps, bandwidth, blockchain, bot, broadband, cloud, cloudbased, control system, control systems, drone, drones, electronics, high-speed, information management, internet of things, IoT, internet, IT solutions, network services, programmed, sensor, sensors, software, telematics, telemedicine, virtual, virtualize, virtualized, virtualization, wifi, wi-fi
Digital capabilities	Analytics, artificial intelligence, AI, autonomous, big data, Bluetooth, compute, computing, connectivity, customizable, deep learning, designer, designers, developer, developers, electronic, engineer, engineers, functionality, functionalities, informatics, integrated solutions, interface, machine learning, mobile, programmable, programmer, programmers, self-driving, smart, streaming, technologist, technologists, technology-enabled, ubiquitous, user experience, user interface, wireless
Digital ecosystem coordination	Application programming interface, API, APIs, desktop, desktops, device, devices, ecommerce, e-commerce, enterprise resource planning, ERP, multi-channel, network infrastructure, omnichannel, online, on-line, open source, phone, resource planning system, SaaS, smartphone, social media, software as a service, tablet, tablets, technology platform, technology platforms, web, webs, website, websites
Digital architecture configuration	3-D printed, 3-D printing, 3D printing, additive manufacturing, advanced manufacturing, algorithm, algorithms, analytical tool, analytical tools, automated, automating, automation, chief digital officer, chief information officer, CIO, computer, computers, cyber, cybersecurity, data, database, databases, digital, digitalization, digitally, digitization, fintech, hardware, information security, information systems, information technology, IT infrastructure, IT infrastructures, IT system, IT systems, operating system, operating systems, real time, real-time, remote monitoring, robot, robots, robotics, standardize

3.2.3. Moderating variable

To measure our moderator *technological turbulence* – the rate of technological change in an industry – we utilized data from Compustat to calculate the ratio of R&D investments to sales by firms in the same two-digit North American Industry Classification System code (Moon, 1998).

3.2.4. Control variables

In our analysis, we controlled for firm and industry characteristics that we selected mainly based on previous research. To calculate the company- and industry-specific controls, we used data from the Compustat North America database.

Prior studies have identified that larger firms place a stronger managerial focus on environmental matters and subsequently manage these more efficiently (Al-Tuwaijri et al., 2004; Clarkson et al., 2008). Thus, we controlled for *firm size* by using the natural log of the number of employees. Furthermore, we controlled for *firm age*, measured as the number of years between January 1, 2020, and the first effective date of a link in Compustat. The inclusion of firm age as a control variable was based on a study by Mohan-Neill (1995), in which the author identified firm age as a significant predictor for seeking and collecting environmental information. We additionally included *firm profitability* in our analysis to control for the positive relationship between firm profitability and environmental performance, as has been done in previous studies (e.g., Al-Tuwaijri et al., 2004). To measure firm profitability, we followed Jayachandran et al. (2013) and calculated it as net profit divided by total assets. We included *financial leverage*, measured as total debt divided by total assets, as it positively relates to environmental disclosure and subsequent improvement in environmental performance (Clarkson et al., 2008; De Villiers et al., 2011). Additionally, we controlled for capital expenditures (*capex*) to account for the firm's investments in newer and cleaner technologies, which may reduce its emissions (Clarkson et al., 2008). We measured *capex* by dividing the total capital expenditures by total sales. Finally, we controlled for *industry concentration*, measured through the Herfindahl–Hirschman Index, to account for the competitive pressure that can influence a firm's environmental performance (Duanmu et al., 2018). Following Hendricks et al. (2009), we measured industry concentration as one minus the Herfindahl–Hirschman Index. The index itself is defined as "the sum of the squared fraction of industry sales of each firm that is in the industry" (Hendricks et al., 2009, p. 240). We based our calculations on the three-digit North American Industry Classification System. Table 2 provides an overview of the applied variables as well as respective definitions and sources.

4. Empirical analysis and results

We utilized fractional logistic regression to evaluate our hypotheses on environmental performance and potential contingency effects because our dependent variable, *environmental performance*, is bound between 0 and 1. This follows a recent study by Villadsen and Wulff (2019), who examined a decade of strategy and management research and found that despite the more accurate results provided by fractional logistic regression, most studies rely on Tobit models or linear and log-odds regressions when dealing with fractional outcome variables. To test the robustness of our models, we also ran the analysis with a different sample specification (increasing the threshold for included employee reviews) and a different model specification (fractional probit regression), yielding similar results. For our analysis, all continuous independent and control variables were winsorized at the 1 % and 99 % levels to account for potential outliers. We also lagged our independent and control variables by one year to avoid reverse causality and utilized robust standard errors to account for heteroskedasticity. Furthermore, all models included time- and industry-fixed effects to control for systematic effects.

4.1. Descriptive results

Table 3 presents the descriptive sample statistics and bivariate correlation coefficients for all variables in our models. The results in Table 3

Table 2
Variable definitions and source.

Variable	Definition	Data source
ESG environmental score	Overall environmental pillar score from Refinitiv for each firm-year, divided by 100 to obtain a score between 0 and 1	Refinitiv
Digital orientation	Share of words counted based on digital orientation dictionaries in relation to total word count for all Glassdoor reviews in this firm-year	Glassdoor
Technological turbulence	Ratio of R&D investments to sales by firms in the same two-digit North American Industry Classification System code	Compustat
Firm size	Natural log of the number of employees	Compustat
Firm age	Number of years between January 1, 2020, and the first effective date of a link in Compustat	Compustat
Firm profitability	Net profit divided by total assets	Compustat
Financial leverage	Total debt divided by total assets	Compustat
Capex	Total capital expenditures divided by total sales	Compustat
Industry concentration	One minus the Herfindahl–Hirschman Index	Compustat

Table 3
Descriptive sample statistics and bivariate correlation coefficients.

	Variables	Mean	SD	Min	Max	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1)	ESG environmental score	0.465	0.291	0.000	0.914	1.00								
(2)	Digital orientation	0.003	0.004	0.000	0.022	0.00	1.00							
						(0.89)								
(3)	Technological turbulence	0.025	0.024	0.000	0.059	0.11	0.30	1.00						
						(0.00)	(0.00)							
(4)	Firm size	3.331	1.309	−1.130	5.861	0.47	−0.18	−0.08	1.00					
						(0.00)	(0.00)	(0.00)						
(5)	Firm age	33.747	16.516	6.058	57.956	0.37	−0.12	0.13	0.33	1.00				
						(0.00)	(0.00)	(0.00)	(0.00)					
(6)	Firm profitability	0.067	0.068	−0.256	0.273	0.03	0.01	0.03	0.01	0.06	1.00			
						(0.12)	(0.56)	(0.06)	(0.78)	(0.00)				
(7)	Financial leverage	0.252	0.180	0.000	0.931	0.05	−0.10	0.03	0.02	0.01	−0.18	1.00		
						(0.01)	(0.00)	(0.09)	(0.38)	(0.76)	(0.00)			
(8)	Capex	0.052	0.074	0.000	0.794	0.03	0.01	0.00	−0.10	−0.01	−0.08	0.14	1.00	
						(0.09)	(0.77)	(0.86)	(0.00)	(0.77)	(0.00)	(0.00)		
(9)	Industry concentration	0.787	0.182	0.000	0.967	0.00	0.06	0.26	−0.23	0.04	0.01	−0.06	−0.04	1.00
						(0.85)	(0.00)	(0.00)	(0.00)	(0.03)	(0.47)	(0.00)	(0.01)	

Notes: All continuous variables have been winsorized at the 1 %- and 99 %-levels.
All independent variables and controls lagged by one year; *P*-values of correlations in parentheses below coefficients.
$N = 2,800$.

Table 4
Results of fractional logistic regression with environmental performance as the dependent variable.

Dependent variable	Environmental performance (ESG environmental pillar)		
Variables	Model 1 Controls only	Model 2 Main effect	Model 3 Moderation
Digital orientation		52.02***	29.01*
		(6.65)	(13.41)
Digital orientation × technological turbulence			674.44*
			(316.05)
Technological turbulence			−0.31
			(4.08)
Firm size	0.51***	0.53***	0.54***
	(0.02)	(0.02)	(0.02)
Firm age	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)
Firm profitability	0.38	0.32	0.29
	(0.32)	(0.31)	(0.31)
Financial leverage	−0.41**	−0.32*	−0.30*
	(0.13)	(0.13)	(0.13)
Capex	0.17	0.12	0.11
	(0.29)	(0.29)	(0.29)
Industry concentration	0.20	0.23†	0.21
	(0.12)	(0.13)	(0.13)
Time fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Constant	−1.97***	−2.22***	−2.15***
	(0.23)	(0.24)	(0.23)
Observations	2,800	2,800	2,800
Number of firms	515	515	515

Notes: Robust standard errors in parentheses. All independent and control variables are lagged by one year. All continuous variables have been winsorized at the 1 %- and 99 %-levels.
*** $p < 0.001$.
** $p < 0.01$.
* $p < 0.05$.
† $p < 0.1$.

demonstrate that all pairwise correlations between our variables were below |0.5|. We computed the variance inflation factors (VIFs) and noted that all VIFs were below the threshold of 2.50 (Johnston et al., 2018), with a mean VIF of 1.19 (excluding the interaction term). Following Kalnins (2018), we conducted separate regressions with a controls-only model first and then added the factors of interest separately. When comparing the effects' direction, size, and statistical significance across the regressions, we observed consistent results (Harrison et al., 2019). Based on these results, we assumed that multicollinearity was unlikely to affect our findings.

4.2. Regression results

Table 4 reports the regression results for our analyses. In this table, the results are divided into three models. Model 1 includes only the controls; in Model 2, we introduced digital orientation as the independent variable; and in Model 3, we introduced the interaction term between digital orientation and technological turbulence.

The results of Model 2 in Table 4 demonstrate a statistically significant and positive relationship between digital orientation and an organization's environmental performance ($\beta = 52.02$; $p < 0.001$), supporting H1. Fig. 3 further illustrates the predictive margins of the

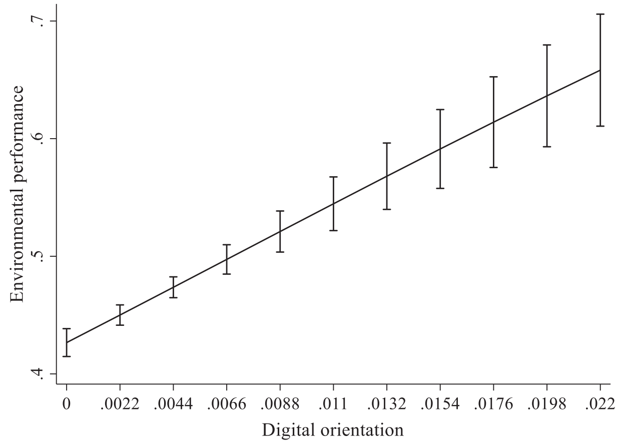

Fig. 3. Predictive margins of the direct effect of digital orientation.

effect of changes in digital orientation, supporting the positive effect on environmental performance.

To further exemplify that this connection holds across different industries, we selected five firms from our sample: Teradata Corporation (software), Goldman Sachs (financial services), Seagate Technology (computer hardware manufacturing), Schlumberger (offshore oil drilling), and Analog Devices (semiconductor). Taking a closer look at exemplary strategic commitments among some of these companies provided initial indications that they are in fact using digitalization strategically to achieve sustainability and environmental goals. For example, in its 2021 ESG report, Teradata (2021) committed to developing technology products and services for a sustainable future (digital technology scope). It also committed to leveraging digital tools for video conferencing and virtual workplaces for its employees to achieve environmental goals such as resource efficiency (digital capabilities). Moreover, Goldman Sachs (2022) committed to continuously improving the sustainability of its technology offerings (digital technology scope), investing in energy retrofits (digital architecture configuration), and using digital work-from-home collaboration tools to reduce travel volume and increase energy efficiency (digital technology scope and digital capabilities). Seagate (2021) and Schlumberger (2022) are committed to using novel data-driven technologies and digital solutions to reduce greenhouse gas emissions and resource waste in their operations (digital architecture configuration).

Next, we conducted a separate analysis of changes in digital orientation and environmental performance for these five companies, comparing the 2012–2014 and 2017–2019 periods. This comparison showed that digital orientation increased between these two periods in all five cases and was associated with an improvement in environmental performance, which further supports our findings (Table 5).

The results of Model 3, presented in Table 4, show a significant interaction ($\beta = 674.44$; $p < 0.05$): a higher level of technological turbulence strengthens the positive relationship between digital orientation and environmental performance, supporting H2. To observe the pattern of the interaction effect, we plotted the relationship between digital orientation and environmental performance at three levels of technological turbulence (high technological turbulence = mean + 1 standard deviation (SD); mean technological turbulence = mean; low technological turbulence = mean − 1 SD). Fig. 4 displays the increasing impact of digital orientation on environmental performance in an environment with high technological turbulence. To determine whether the slopes for different levels of technological turbulence were significantly different from zero, we conducted a slope test. The results of this test, displayed in Table 6, reveal that the slopes for all three levels of technological turbulence were significantly different from zero ($p < 0.05$), thus supporting the argument for the moderated relationship.

4.3. Robustness checks

We ran robustness tests to ensure the validity of our results. First, we ran our analysis with a different sample specification to ensure that our

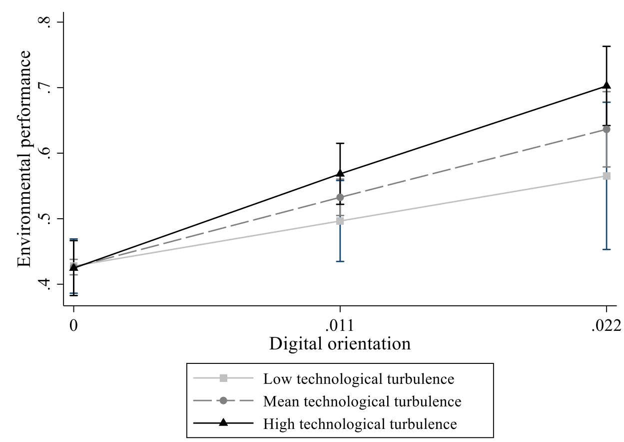

Fig. 4. Moderating effects on the relationship between digital orientation and environmental performance.

Table 6
Slope tests for interaction term for three levels of digital orientation.

Digital orientation (DO)	DO (low)	DO (mean)	DO (high)
H2: Environmental performance			
Slope for technological turbulence = 0.001	6.19*	6.29*	6.19*
Slope for technological turbulence = 0.025	9.55***	9.68***	9.07***
Slope for technological turbulence = 0.049	12.91***	12.93***	11.21***

*** $p < 0.001$.
* $p < 0.05$.

Table 5
Digital orientation and environmental performance for selected case firms (comparing the periods 2012–2014 and 2017–2019).

Firm	Variables	Average 2012–14	Average 2017–19	Growth
Teradata	Digital orientation	0.011	0.017	54 %
	Environmental performance	58.150	68.153	17 %
Goldman Sachs	Digital orientation	0.010	0.012	12 %
	Environmental performance	82.263	94.087	14 %
Seagate Technology	Digital orientation	0.005	0.006	6 %
	Environmental performance	40.027	46.320	16 %
Schlumberger	Digital orientation	0.004	0.005	27 %
	Environmental performance	66.393	77.687	17 %
Analog Devices	Digital orientation	0.011	0.012	12 %
	Environmental performance	81.940	91.127	11 %

Table 7
Results of fractional logistic regression with environmental performance as the dependent variable and a different sample specification.

Dependent variable	Environmental performance (ESG environmental pillar)		
Variables	Model 1 Controls only	Model 2 Main effect	Model 3 Moderation
Digital orientation		63.71***	30.17†
		(8.50)	(16.51)
Digital orientation × technological turbulence			1047.85**
			(399.61)
Technological turbulence			−2.72
			(4.64)
Firm size	0.54***	0.56***	0.57***
	(0.02)	(0.02)	(0.02)
Firm age	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)
Firm profitability	−0.01	0.02	−0.06
	(0.39)	(0.38)	(0.38)
Financial leverage	−0.53***	−0.41**	−0.37*
	(0.16)	(0.16)	(0.16)
Capex	0.28	0.16	0.19
	(0.39)	(0.39)	(0.39)
Industry concentration	0.03	0.18	0.11
	(0.18)	(0.19)	(0.18)
Time fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Constant	−1.75***	−2.21***	−2.08***
	(0.27)	(0.29)	(0.28)
Observations	2,032	2,032	2,032
Number of firms	476	476	476

Notes: Robust standard errors in parentheses. All independent and control variables are lagged by one year. All continuous variables have been winsorized at the 1 %- and 99 %-levels.
*** $p < 0.001$.
** $p < 0.01$.
* $p < 0.05$.
† $p < 0.1$.

Table 8
Results of fractional probit regression with environmental performance as the dependent variable.

Dependent variable	Environmental performance (ESG environmental pillar)		
Variables	Model 1 Controls only	Model 2 Main effect	Model 3 Moderation
Digital orientation		31.28***	17.18*
		(4.03)	(8.11)
Digital orientation × technological turbulence			413.19*
			(191.89)
Technological turbulence			−0.28
			(2.44)
Firm size	0.31***	0.32***	0.33***
	(0.01)	(0.01)	(0.01)
Firm age	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)
Firm profitability	0.25	0.22	0.20
	(0.19)	(0.19)	(0.19)
Financial leverage	−0.25**	−0.19*	−0.18*
	(0.08)	(0.08)	(0.08)
Capex	0.10	0.07	0.06
	(0.17)	(0.17)	(0.17)
Industry concentration	0.12	0.14†	0.12
	(0.08)	(0.08)	(0.08)
Time fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Constant	−1.21***	−1.36***	−1.32***
	(0.14)	(0.14)	(0.14)
Observations	2,800	2,800	2,800
Number of firms	515	515	515

Notes: Robust standard errors in parentheses. All independent and control variables are lagged by one year. All continuous variables have been winsorized at the 1 %- and 99 %-levels.
*** $p < 0.001$.
** $p < 0.01$.
* $p < 0.05$.
† $p < 0.1$.

results were not dependent on the specific employee review selection. Here, we tested our models with an increased aggregated word count of 1,000 words per firm-year and a minimum of 10 employee reviews in that year. The results, reported in Table 7, are robust to the adapted sample specifications.

Second, we utilized a probit regression instead of the logit regression that was employed in our main analyses. These methods have different underlying assumptions about the distribution of the error term. We thus used a fractional probit regression to re-estimate our regressions. The results of this probit regression are reported in Table 8 and yielded similar results for the main effect and interaction term.

5. Discussion and conclusion

5.1. Principal findings

The central proposition of our research is that digital orientation allows organizations to enhance their environmental performance. To explore this connection, we drew on the NRBV to examine the impact of firms' digital orientation on their environmental performance across the four key dimensions of digital orientation: digital technology scope, digital capabilities, digital ecosystem coordination, and digital architecture configuration. In addition, we examined the moderating impact of technological turbulence. Our results support both of our projected relationships: that a firm's digital orientation has a positive relationship with environmental performance and that this relationship is strengthened in technologically turbulent business environments.

5.2. Theoretical contributions

Our research makes several contributions to strategic management and environmental science research. To start with, we contribute by going beyond capturing individual digital initiatives by adopting the holistic perspective of a strategic orientation. Using employee ratings to examine firms' strategic orientation, we thus introduce a new level of analysis to objectively determine whether companies digitally put into practice what they claim in public statements. While previous findings on the effects of digital technology have been partially inconsistent (e.g., Saunila et al., 2019; Zhang et al., 2019), have focused only on individual initiatives (e.g., Chatterjee et al., 2023; Xie et al., 2022), or specific industries (e.g., Benzidia et al., 2021; Liang et al., 2022), our results show that beyond individual digitalization initiatives and across industries, a holistic strategic digital orientation has a positive impact on firms' environmental performance. In doing so, we contribute an important new perspective to the ongoing multi-faceted and lively debate among environmental scientists about the relationship between digitalization and the environment (e.g., George et al., 2020; Lange et al., 2020; Li et al., 2022; Xie and Teo, 2022).

We also contribute by establishing digital orientation as an antecedent of environmental performance. By theorizing and testing the influence of the former on the latter, we bring the hitherto loosely connected literature streams of digital strategy and environmental performance closer together. In doing so, our paper is, to the best of our knowledge, the first to identify digital orientation as a strategic orientation that is aligned with environmental and sustainability issues, which, according to Hart (1995), translates into competitive advantage in times of climate change. We thus contribute to the NRBV and add to the rich tradition of research studies examining the relationship between a firm's strategic orientation and performance outcomes (e.g., Covin and Slevin, 1991; Jaworski and Kohli, 1993; Wiklund, 1999). Here, we demonstrate that the NRBV is useful not only as an analytical framework but also as a guide for empirical performance analysis. In this way, we help NRBV scholars to shift from analytical to numerical modes of theorizing (Makadok et al., 2018) and substantiate their variable selection when working with subcategories of Refinitiv's ESG scores.

We further show that technological turbulence is an important contingency factor in the relationship between digital orientation and environmental performance. In general, companies facing rapid technological change are exposed to strong adaptation pressures. We propose that they can utilize this development to improve their environmental performance by leveraging digital practices. We thus support the recent notion that companies in technologically turbulent environments are particularly effective at digitalizing their organizations and associated business models (Coreynen et al., 2020). On a more general level, we reinforce the point that competitive advantages can be gained quickly in fast-paced, technology-driven environments (Calantone et al., 2003; Heckmann et al., 2016). Our study shows that this rationale also holds true when a firm's competitive edge depends on resources and capabilities compatible with the natural environment, as suggested by the NRBV.

5.3. Practitioner implications

The issues addressed in this research have a range of implications for managers and policymakers. The most straightforward one is that managers can benefit from integrating their digital and environmental strategies. As our findings show, managers and executives can improve their firm's environmental performance by increasing the strategic digital orientation within their organization, leading to a potential competitive advantage. This arrangement can give them an edge in the labor market when looking for new human capital, as more people are considering environmental and sustainability issues in their job searches (Presley et al., 2018; Turban and Greening, 1997).

Moreover, investors and fund managers are increasingly interested in ESG factors as essential elements of investment decisions (Amir and Serafeim, 2018; Van Duuren et al., 2016). Thus, in times of structural divestment from firms with poor environmental performance, the position of environmentally progressive firms in the capital markets may strengthen (Alkaraan et al., 2023; Unruh et al., 2016). Ultimately, environmental responsibility has been shown to have a positive impact on financial indicators, such as returns on assets and equity (Lee, 2021).

In addition, managers in industries characterized by a high pace of technological change can recognize that digital orientation is essential when building and maintaining competitive advantage in an increasingly sustainability-driven business environment. These managers may want to pay specific attention to mastering environmental changes and developing organizational mindfulness to identify green opportunities from technological changes at an early stage (Li et al., 2021). With the right approach, firms can quickly capture, internalize, and adapt to technological change.

The present study can also help managers translate strategic digital orientation into informed operational actions. By conceptually demonstrating how the four dimensions of digital orientation relate to Refinitiv's ESG score, managers can directly use their underlying aspects as a digital-to-green toolbox for pro-environmental actions. In the digital technology dimension, for example, remote maintenance of machinery with an IoT solution can reduce the carbon footprint. Retrofitting and on-demand functions in smart, connected products can extend hardware lifetime and avoid e-waste. From a digital architecture perspective, implementing execution management systems can enable firms to manage their full range of business processes in an intelligent and data-driven way. Thus, sustainability can be promoted by identifying the causes of inefficiencies and optimizing processes.

Moreover, the positive link between digital orientation and environmental performance can help managers accelerate digital transformation processes. Such transformation processes often encounter resistance from selected employees, who may slow down profound strategic changes (Lapointe and Rivard, 2005; Niemand et al., 2021). As pressure to address sustainability issues increases (Geradts and Bocken, 2019), our results can provide firms with good arguments to convince employees to adopt these technologies, and thus help drive digitalization processes forward more quickly.

Finally, the results of our study hold important implications for policymakers. First, an important step for policymakers could be to set attractive incentives for companies to vigorously promote digitalization. Policymakers could, for example, subsidize investments in digital technologies that have a proven positive impact on environmental performance. This could be done either directly through bonuses on the interest rates of respective loans or through tax relief. Moreover, such measures should be designed to encourage investments early in the process rather than deferring them to a later stage. Moving forward, policymakers will need to address the specific question of how to design effective subsidy and tax relief models (see also Chen et al., 2023).

Second, policymakers must also promote the expansion of digital infrastructures, such as the rollout of optical fiber infrastructures, 5G networks, and data centers (see also Wang et al., 2023). Companies can only be expected to drive digitalization at all business levels if the foundation of a functioning and robust infrastructure is in place. In addition, politicians must advocate "digitalization for environmental performance" in their own institutions, such as public authorities. This can create a "trickle-down effect" that carries the idea even more effectively into the private sector.

Third, policymakers could consider incorporating binding legal requirements for digitalization into (a climate protection) law. These requirements could, for example, prescribe the extent to which certain digitalization targets must be achieved. This might involve certain requirements for the procurement of new information technology (e.g., prescribing technologies specifically certified as green or giving clear efficiency standards for data centers). In this respect, policymakers need to address the question of what meaningful standards might look like and how they can be monitored.

5.4. Limitations and future research

Our study has limitations that call for future research. First, we relied on environmental performance data from the Refinitiv (2021) database, which provides environmental performance scores based on firms' emissions, innovations, and resource use. Substantial amounts of publicly available information were used to derive the values. However, Drempetic et al. (2020) questioned the reliability of these scores. Future research could draw on additional indicators to measure environmental performance to generate further insights.

Second, our measurement of digital orientation relies on a CATA approach and data from Glassdoor. While Glassdoor uses a two-step process that includes an algorithm and human moderators to prevent corporate fraud and self-promotion, it still cannot completely prevent biased reviews due to employees' personal feelings or the site's screening process. Therefore, future research should complement the robustness of our findings with other methodological approaches, such as longitudinal case studies of firms that seek to leverage digitalization to improve their environmental performance. In addition, future research could engage in a structured scale development process combining qualitative and quantitative approaches aimed at developing a measurement instrument for strategic digital orientation (see MacKenzie et al., 2011). This would allow researchers to apply and triangulate different measurement approaches to digital orientation and thus help to increase the validity of our results.

Third, our focus on S&P 500 firms might limit the generalizability of our findings concerning firm size and geographical location. The importance and implementation of digital strategies could vary significantly by firm size, firm age, and region. Future research could therefore apply a more granular perspective and examine the propositions and findings of this study across other contexts, such as small and medium-sized enterprises (SMEs) or start-ups.

Apart from these methodological limitations, future researchers may also want to broaden the conceptual scope of our framework. While we answered research calls to shed light on the connection between an organization's digital orientation and important firm outcomes, such as environmental factors (Kindermann et al., 2021; Verhoef et al., 2021), identifying further peculiarities of this connection would be of particular interest. For example, future research could delve deeper and examine how the specific dimensions of digital orientation affect each of the dimensions of environmental performance. In addition, scholars may want to examine how the effect of digital orientation on environmental performance changes when combined with other strategic orientations, such as entrepreneurial orientation or customer orientation. In this regard, previous research in the SME context has shown that firms should not rely on a single strategic orientation and that a combination of different strategic orientations can be beneficial for innovation (see Eggers et al., 2020).

5.5. Conclusion

We studied the effect of companies' strategic digital orientation on environmental performance, including the moderating effect of technological turbulence. According to the results of our analysis, we reached the following two main conclusions. First, strategic digital orientation is positively associated with environmental performance. Second, a higher level of technological turbulence strengthens this relationship.

Our research thus shows that taking a strategic digital orientation can pay off in the form of environmental performance. As such, we not only bridge the literature on digital strategy and environmental performance but contribute to the NRBV by explaining that digital strategies present a major opportunity for creating a sustainable competitive advantage in times of climate change, particularly in technologically turbulent market environments. In summary, we hope our findings will stimulate and support future research in this critical area, just as we hope that practitioners will find starting points in our research to drive the convergence of their digitalization and environmental strategies to improve their firms' environmental performance.

CRediT authorship contribution statement

David Bendig: Resources, Supervision, Project administration, Investigation, Writing - Reviewing and Editing. Colin Schulz: Conceptualization, Validation, Writing - Reviewing and Editing, Project administration. Lukas Theis: Conceptualization, Methodology, Data curation, Formal analysis, Investigation, Writing - Original draft preparation. Stefan Raff: Conceptualization, Writing - Reviewing and Editing, Visualization, Project administration.

Data availability

The data that has been used is confidential.

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