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Navigating toward the promised land of digitalization and sustainability convergence

Jesús Valero-Gil [a,d], Inés Suárez-Perales [a,c,*], Concepción Garcés-Ayerbe [a,c], Pilar Rivera-Torres [b,c]

[a] Department of Management, University of Zaragoza, Gran Vía, 2, Zaragoza, Spain
[b] Department of Marketing, University of Zaragoza, Gran Vía, 2, Zaragoza, Spain
[c] IEDIS Institute, University of Zaragoza, Gran Vía, 2, Zaragoza, Spain
[d] CIRCE Institute, University of Zaragoza, C/ Mariano Esquillor, 15, Zaragoza, Spain

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ABSTRACT

In recent years, companies have updated their strategic goals, adding the goal of digitalization to the already commonly accepted goal of sustainability. The convergence between these two strategic goals, digitalization, and sustainability (D—S) convergence, is the complete and conjoint attention to both strategic goals. This paper analyzes this phenomenon in depth by studying the implementation of sustainable and digital measures in companies. In doing so, we categorize firms' strategies from less to more D—S convergence, analyzing the factors that promote the full attention to both strategic goals, emphasizing those that enhance the mentioned D—S convergence. The findings from the analysis of a sample of >16,000 small and medium-sized enterprises (SMEs) worldwide reveal that companies that devote more effort to business growth, innovation, exports and that perceive the environment as favorable are more likely to achieve full D—S convergence.

1. Introduction

Globalization has changed the way we do business. Companies have to compete with other organizations around the world, in some cases with those located in markets with different labor, human and economic rights, which sometimes makes it difficult to gain a competitive advantage. Today, the challenge for companies is to adapt to a changing environment almost immediately, using increasingly limited resources and promoting respect and care for the environment and social rights. To that end, there are two strategic resources whose convergent implementation (i.e., the effort and attention devoted to their implementation occur under equivalent conditions) can be extraordinarily effective: digitalization and sustainability (D—S).

1.1. D—S convergence

On the one hand, digitalization can serve as a strategy for value creation and increased internal efficiency in companies (Björkdahl, 2020). It also entails a study, analysis and reconfiguration of business structures, processes, and activities prior to its implementation. On the other hand, sustainability reflects the integration of sustainability considerations into the company's business strategy, which is also reflected in a reconfiguration of the company's structures, processes, and activities (Adomako et al., 2021). Consequently, digitalization can be understood as a resource aimed at achieving a high degree of efficiency in companies (Björkdahl, 2020), whereas sustainability can be understood as a resource aimed at achieving a high degree of environmental and social responsibility (Adomako et al., 2021; Björkdahl, 2020; Sun et al., 2023).

The advantages of achieving advanced positions in both aspects, efficiency and responsibility, can be explained by the Theory of dynamic capabilities (Teece et al., 1997): By implementing both digitalization and sustainability in a way that leverages resources and such that they complement each other, companies can generate extra value from the nexus that links them (Chauhan et al., 2022; Brenner and Hartl, 2021; Del Río Castro et al., 2021; Seele and Lock, 2017), making the outcome or value of joint implementation greater than that of separate implementation (Song et al., 2005; Schweiger et al., 2019). For example, the development of digital systems makes it possible to optimize inventory management to minimize waste in the use of resources and maximize

* Corresponding author.
E-mail address: isuarez@unizar.es (I. Suárez-Perales).

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their utilization. This greater use of resources, which will also enhance and favor the implementation of sustainability throughout the value chain, improves a company's reputation, brand image and trust, ensuring that relations with stakeholders can be based on digital media and devices in which communication and cooperation are maximized.

1.2. Current state of the art

D—S convergence is a relatively recent phenomenon that is beginning to gain traction and seems to offer great opportunities to shape a better economy and society (Atos, 2018; Denicolai et al., 2021; Ghobakhloo et al., 2021; Kiron and Unruh, 2018). For this reason, although the common nexus between both strategic challenges is little studied (Ardito, 2023; Brenner and Hartl, 2021; Del Río Castro et al., 2021), the recent literature has focused on the following aspects:

First, the literature that analyze the relationship between digitalization and sustainability generally conclude that the former promotes or enables the latter. (Ardito, 2023; Bendig et al., 2023; Broccardo et al., 2023; Guandalini, 2022; Liu et al., 2023; Zhang et al., 2023). These studies confirm that the implementation of digitalization measures in companies leads to an improvement in their sustainability. However, this relationship can sometimes be an unintended consequence of the efficiency gains brought by digitalization (Ghobakhloo et al., 2021), as its implementation can result in, for example, improved energy efficiency or better working conditions.

Second, several studies analyze the consequences of the joint implementation of digitalization and sustainability. Although some studies question the positive consequences of joint application (for more information, see the D—S paradox in Hellemans et al., 2021; Liu et al., 2023), the advantages of these synergies are, among others, related to business results such as improved competitiveness (Liu et al., 2023) or improved financial performance (Broccardo et al., 2023); related to the availability of resources and the use made of them such as improved innovation (Ardito, 2023), higher export intensity (Denicolai et al., 2021); or in relation to the integration of the preferences of different stakeholders, such as higher consumer engagement through circular business models (Bruyne and Verleye, 2023), or other stakeholders through communication tools (Piccarozzi et al., 2023).

1.2.1. How can D—S convergence be achieved?

The literature analyzed above demonstrate that the advantages of D—S convergence can be expected. However, achieving such a state is a complex task for companies, as it requires an attention capability that not all companies possess (Joseph and Ocasio, 2012). In fact, the attention allocation problem (Ardito et al., 2021) suggests that the implementation of digitalization and sustainability strategies in parallel may lead to a trade-off in attention allocation, where firms need to decide which challenge to prioritize or allocate more resources to (Battisti et al., 2021; Hsiao et al., 2020). For example, firms may need to choose between investing in green technologies that increase their environmental responsibility or focusing on digital platforms that increase efficiency and reduce costs. Therefore, research suggests that firms may face difficulties in pursuing both agendas simultaneously, leading to potential conflicts or suboptimal outcomes in the implementation of digitalization and sustainability (Cui et al., 2021; Zhang et al., 2020).

Knowing the factors and conditions that can help to overcome these difficulties, favoring and facilitating the dedication of attention to both aspects in conditions of equivalence is of great academic interest and great utility for company managers. To date, some works have analyzed the effect that the management mode has on both strategic challenges (Isensee et al., 2020; Zhang et al., 2023). The moderating effect on this relationship has also been justified with the study of the effect of perceiving a turbulent environment (Bendig et al., 2023), as well as the effect of COVID-19 (Di-Maria et al., 2023). Finally, some papers have also analyzed the effect of resource availability (Broccardo et al., 2023).

1.3. Aim, objectives and points of discussion

In view of previous studies, there seems to be a need to know the reality of the implementation of these two strategic challenges: It is necessary to advance in the knowledge of the relationship between digitalization and sustainability as two organizational capabilities with possible synergies between them. Additionally, research that analyze the factors favoring D—S convergence are scarce and are not focused on the convergence between the two challenges. For these reasons, in this paper, we aim to shed light on these gaps in the existing literature, and we establish two main goals: First, we analyze the strategic profiles of companies in implementing the two combined strategies (digitalization and sustainability) until reaching D—S convergence. Second, we analyze the factors that can motivate and drive the implementation of D—S convergence. Specifically, we explore four factors related to business needs to stay on the path to achieving the two-dimensional D—S convergence goal and that can enable the realization of the benefits of converged implementation: the availability of resources to address both strategic challenges at the same time (growth); the capacity and knowledge to use these resources in an appropriate way (innovation); previous experience in different contexts (exports); and counting on "the wind at its back" (business environment).

To achieve the proposed objectives, this study analyzes the strategic profiles of >16,000 small and medium-sized enterprises (SMEs) worldwide in terms of implementing digitalization and sustainability. We decide to focus on a population of SMEs due to their relevance in the global economic system (e.g., 99.8 % of companies and 64.4 % of the workforce employed in the European Union (EU)) and to ensure that our results contribute from an empirical perspective. Previous empirical research on the matter has used small samples of SMEs, with a focus on one country/region (e.g., Broccardo et al., 2023; Denicolai et al., 2021), or research has been based on large companies that are far from being representative of the real economy (e.g., Forcadell et al., 2020; Niehoff, 2022), challenging the generalizability of the results and the ability to bridge the gap between theory and practice.

This significant (>16,000 observations), multinational (39 countries worldwide), and multisector database analysis empirically contributes to better obtaining important results about the relationship between digitalization and sustainability for practitioners and policymakers. Additionally, our results allow us to contribute to the previous literature on strategic sustainability and digitalization management, taking a step forward in studying, from an integrated perspective, the two fundamental challenges that companies must face today.

2. Factors facilitating the achievement of D—S convergence

According to the Theory of Dynamic Capabilities (Teece et al., 1997; Teece, 2007), if companies jointly implement digitalization and sustainability, a series of complementarities will be generated between them that will lead to the creation of greater value (Ennen and Richter, 2010). For example, joint implementation can reduce the carbon footprint by eliminating the need to print documents, to physically travel for meetings, and to have a physical office for all employees. Therefore, it can also increase firms' efficiency (Kristoffersen et al., 2020). Digitalization can help automate and optimize processes, while sustainability measures can drive resource efficiency and waste reduction. Together, these two strategies can significantly improve the efficiency and effectiveness of business operations. Similarly, digitalization and sustainability can also improve data management practices (Bendig et al., 2023). By digitizing data, companies can better track and manage their energy and resource usage and identify opportunities for waste reduction and efficiency gains, enabling companies to better understand their environmental impact and develop strategies to mitigate it. Finally, stakeholder engagement can be enhanced through the joint implementation of digitalization and sustainability (Garcés-Ayerbe et al., 2019). For example, offering digital solutions such as online ordering

and delivery can reduce the need for customers to travel, while implementing sustainable packaging and waste reduction practices can reduce environmental impact (Niehoff, 2022).

At this point, the following question arises: Why do not all companies achieve convergence and benefit from the advantages of their complementarities? In this regard, resource allocation theory offers an explanation (Maritan and Lee, 2017): Competition is increasing, and company boundaries are becoming increasingly blurred, while resources such as attention remain limited. Therefore, companies must learn, evolve and develop capabilities that allow them to navigate in turbulent oceans so that they can have a multiobjective profile (Witt, 2019). Drawing upon the naval analogy, it is easy to explain what the necessary elements are to achieve D—S convergence or, in naval language, to stay afloat and win the race in these increasingly turbulent seas.

First, a good ship, i.e., one that has the necessary characteristics to sail to different destinations and that makes it possible to take on complicated navigational routes, is required. The availability of resources, both tangible and intangible, to "move freely on the ocean" can be measured through the business growth strategy (Raza et al., 2018; Xu et al., 2019; Temouri et al., 2022). The resource-based view (RBV) has been widely adopted to address the importance of valuable resources in the growth process (Mishina et al., 2004; Naldi and Davidsson, 2014; Temouri et al., 2022). Second, it is necessary to have crew members who know how to make use of available resources and who have the necessary skills to know how to navigate the ship. These skills, ideas, behaviors, and systems, that create value in the organization and make better use of available resources, can be simulated for innovation (Le Bas et al., 2015; Kumar et al., 2012). Third, experience at sea means that many ports have been visited, different naval teams have been encountered and much of the value of the whole is found in the knowledge of the captain and crew. In the case of companies, this experience and knowledge can be measured in the presence in other markets, i.e., in their exports (Johanson and Vahlne, 1990; Henrique da Rocha et al., 2014). Finally, as a result of uncertainty, the success of a ship's voyage depends to a large extent on the avoidance of storms, on the sea currents, and on favorable winds. Therefore, the last factor to consider is having a favorable environment (Greenwood et al., 2014). The relationship between these four factors and D—S convergence is justified below.

2.1. Growth strategy

A company's growth strategy is the result of an internal decision on how much resources will be allocated to achieve such growth, taking into account the opportunity costs involved in carrying out a series of other management decisions (Zou et al., 2010). From the resources and capabilities approach (Barney, 1991; Klassen and Whybark, 1999; Wernerfelt, 1984), if a company carries out a growth strategy and this growth proves to be effective, more resources will be available to the company.

Digitalization could be positively related to a growth strategy, as it is considered a versatile and cost-effective resource that allows companies to experiment with new ways of organizing economic activities and business operations (Verhoef et al., 2021; Falahat et al., 2020; Pergelova et al., 2019). Consequently, implementing digitalization, such as artificial intelligence or robotics, enables companies to grow both internally, increasing their size, and externally, establishing a virtually global presence (Brouthers et al., 2016). Some examples of the relationship between digitalization and business growth also materialize in business model developments, such as e-businesses (e.g., Amazon) or companies based on digital platforms (e.g., Airbnb). The literature on sustainability has a unanimous idea about its positive effect on business growth (Christmann, 2004; Porter and Linde, 1995). Implementing sustainable measures in the production process means that, in the medium or long term, the company manages to grow, increasing its size and gaining a competitive advantage, thus alleviating the scarcity of resources.

Research has shown that a company's growth can facilitate the convergence of digitalization and sustainability individually. For instance, Raza et al. (2018) found that larger firms tend to have greater resources, capabilities, and opportunities to implement sustainable and digital practices. Similarly, Spreitzer et al. (2017) highlighted that companies that experience growth often need to address environmental and social challenges, which can lead to the development of sustainable and digital solutions. Additionally, Xu et al. (2019) argued that companies that pursue both growth and sustainability are more likely to adopt digital technologies that can reduce environmental impacts and increase operational efficiency.

Based on previous studies, we consider that a company pursuing a growth strategy will lead to the development of specific capabilities that will enable it to face new challenges. If harnessed and projected to achieve digital and sustainable objectives, these capabilities will increase D—S convergence. With these arguments, the following hypothesis is proposed:

H1. A growth strategy directly and positively affects D—S convergence.

2.2. Innovation

The RBV affirms that firms' generation of competitive advantages can be based on their ability to take advantage of the valuable resources at their disposal, such as assets, knowledge, capabilities, skills or relationships (Barney, 1991; Wernerfel, 1984). Dynamic capability extension focuses on how firms can adapt to changing environments by reconfiguring their resources and capabilities, which include R&D routines, technology or knowledge transfer, alliance and acquisition capabilities, and resource allocation routines (Eisenhardt and Martin, 2000; Teece, 2007). From this theoretical perspective, digitalization and sustainability can be explained as aligned joint resources supporting firms in adapting them to volatile environmental requirements (Wernerfelt, 1984). In doing so, organizations could achieve D—S convergence, producing complementarities and dynamic capabilities from the alignment of digitalization and sustainability.

Innovation can be defined as the adoption of an idea, behavior, system, policy, program, invention, process, product or service that is new in the organization and allows the company to create value from the greater use of opportunities and better management of the environment (Le Bas et al., 2015; Kumar et al., 2012; Balodi, 2014). The characteristics of an innovative company allow us to intuit that those that accumulate information and knowledge related to digitalization and sustainability will be technologically more prepared to adapt quickly to the new demands of the environment (Sharma et al., 2007). For example, installing digital platforms to reshape product design, the manufacturing process and distribution channels requires objectives and investment in innovation. In this situation, a company would be advancing their strategies of sustainability and digitalization simultaneously, which would be much more challenging if it does not carry out innovation practices (Schiavone et al., 2022).

Many of the current solutions to the problems caused by the mismanagement of limited resources involve the use of innovation for digital and sustainable purposes. Innovation can play a critical role in supporting the implementation of digital and sustainable measures in companies by providing new technologies, processes, and business models that enable more efficient and effective operations while minimizing environmental impact (Linde et al., 2021). By embracing innovation, companies can unlock new opportunities to address the challenges of digitalization and sustainability in a more integrated and cohesive way, leveraging the synergies between them to drive greater value and competitive advantage (Kemp and Pontoglio, 2011).

Consequently, we propose that implementing innovative measures in the firm throughout the production process will enable the firm to develop dynamic capabilities that will help it deal with a changing

environment and foster the success of D—S convergence. Based on this approach, we propose the following working hypothesis:

H2. Innovation directly and positively affects the development of D—S convergence.

2.3. Exports

Exports can be understood as the first step toward an internationalization strategy, i.e., the beginning of a sequential learning process that ends with the establishment of a production unit in the target market (da Rocha et al., 2014). This process refers to the increment of international trade, international relations and alliances with other companies. In general, business presence in various markets and technological progress have been considered enemies of sustainability, especially due to their association with pollution, contamination or the use of natural resources (Denicolai et al., 2021). In fact, in addition to the search for growth and investment opportunities (Penrose, 1995), the search for depleted or limited resources in the country of origin is one of the most representative causes of export activities or internationalization strategies (Dunning, 1999; Tanriverdi and Venkatraman, 2005). In other words, companies use technological and digital resources to initiate a process of internationalization through exports as a first step to continue growing and using resources that are difficult to obtain in the market of origin. However, some authors claim that the link between the presence in several markets, i.e., exports as the first step of internationalization strategy, and digital development can lead companies to control progress and global prosperity only if the internationalization strategy is carried out through sustainability (Kusi-Sarpong et al., 2019; Maksimov et al., 2019).

In this line, some studies have found positive relationships among export activity, digitalization and sustainability. For example, Henrique da Rocha et al. (2014) conclude that companies with greater presence in different markets through exports use their investments in technological and digital innovation to integrate sustainable practices in developing products and processes. Similarly, the presence in other markets and countries means that organizations are exposed to additional regulatory pressures (Gadenne et al., 2009) or pressures from various stakeholder groups (Murillo-Luna et al., 2008) in terms of sustainable practices. In this sense, a company that adapts to different market pressures will have a higher level of D—S convergence than companies that have not initiated an internationalization process and are thus not exposed to these pressures.

We also expect a positive relationship between exports and D—S convergence since the internalization process could be vital in obtaining new resources, know-how and skills to improve resource management abroad. In this way, a company that is effectively carrying out an internationalization strategy could be in contact with companies in other markets, increasing its learning and acquiring new ways of managing and new skills (Teece, 1998). In this way, the company could accumulate more resources and manage them more efficiently to improve and achieve D—S convergence. Based on the above, the following hypothesis is proposed:

H3. Exports have a positive and significant effect on D—S convergence.

2.4. Business environment

Institutional theory attempts to justify that certain characteristics of business behavior result from the impact of common norms, rules, routines or imposed guidelines, generating a similar response from several companies (DiMaggio and Powell, 1983). The authors who have contributed most to the theoretical framework of institutional theory try to answer the question of "why do firms behave similarly?" (DiMaggio and Powell, 1983; Meyer and Rowan, 1977; Zucker, 1987) by analyzing institutional factors with a similar positive impact on firms operating in specific markets, such as cultural persistence (Zucker, 1987) or the modernization of society (Meyer and Rowan, 1977). In this sense, given the previous works, it is understandable to think that the environment in which a given firm operates determines its technological level (Leyva-de la Hiz et al., 2019), its level of digitalization (Ahmadova et al., 2022) or its level of sustainability (Christmann, 2004).

Some recent theoretical studies have gone a step further by asserting that the actors who manage firms, specifically their environmental perceptions and the perceived quality of institutions, could be vital in determining business behaviors (Voronov and Weber, 2020). Under this new approach, a company's managers largely determine business behavior through decisions related to their adaptation to the environment. In fact, several studies focus on individuals (managers) as the main actors to analyze a firm's behavior in response to the pressures of its environment (Ferrón-Vílchez et al., 2021; Garcés-Ayerbe et al., 2012; Oswald et al., 1997). Based on this institutional approach, managers consider the environment as an opportunity or a threat, that is, in an optimistic way or a pessimistic way. Thus, if managers consider institutions to be of quality, decisions will be made more optimistically, perceiving less risk and uncertainty.

Some studies have followed this approach and obtained revealing results in relation to the capacity of the institutional environment to affect organizational decisions. For example, Ali et al. (2019) find that the environment in which companies are located is a fundamental factor for CO2 emissions and that these can potentially be reduced if the environment is considered to be optimistic or of high quality. Additionally, Jones and Manuelli (2001) studied the relationship between pollution and growth, concluding that the perception of the environment is a key variable in this relationship. In turn, Ahmadova et al. (2022) proved that institutional pressures in higher-quality environments, which tend to exist in developed countries more than in emerging countries, favor the advantages of digitalization.

For all the reasons above, we think that companies in an environment considered favorable tend to develop D—S convergence more optimally than those operating in an unfavorable environment. Thus, managers in charge of decision-making will see the optimistic environment as an encouraging scenario to assume more risks by implementing and developing both strategies at the same time in an efficient way. Therefore, we propose the following hypothesis:

H4. Favorable environments directly and positively affect the development of D—S convergence.

3. Empirical works

3.1. Data

This work uses data from Flash Eurobarometer 486 SMEs, start-ups, scale-ups, and entrepreneurship (European Commission, 2020). Eurobarometer is a long-standing, high-quality public opinion survey conducted by the European Commission in the EU since 1973. Data from these surveys are typically used for research in academic publications (e.g., Bencsik and Chuluun, 2021; Escario et al., 2022; Lee et al., 2021). The Flash Eurobarometer 486 was administered between February and May 2020, with standard Eurobarometer items and thematic-study items on specific issues, such as corporate sustainability and digitalization strategies. The inclusion of these issues suggests the growing influence of this matter from an institutional perspective. This database is the most detailed cross-national survey on these issues to date, focused on the barriers and challenges that SMEs face when growing and transitioning to more sustainable and digital business models. >16,000 telephone interviews were conducted in 39 countries worldwide (EU-27 and an additional 12 non-EU countries) in the appropriate national language.

3.2. Measures

3.2.1. Dependent variable

Using a series of dichotomic indicators *(0 = no; 1 = yes)* that reflect the presence of various business practices, we construct a set of variables to synthesize the level of proactivity on sustainability and digitalization strategies. Considering these practices, we produce three summative-scale variables to collect the level of proactivity in the *DIGITALIZATION* (7 items), *ENVIRONMENT* (4 items), and *SOCIAL* (4 items) strategies (Table 1). These indicators enable us to quantify the degree of application of different measures related to our dependent variable, D—S convergence. Using continuous variables, we measure from 0 to 7 the intensity of digitalization measure application, from 0 to 4 the intensity of environmental measure application, and from 0 to 4 the intensity of social action application.

In the Flash Eurobarometer, participants were also asked whether they have digitalization and sustainability strategies implemented in their company *(0 = no; 1 = yes)*. Taking advantage of these metrics, we create an additional dummy measure of D—S STRATEGIES with a value of 1 when companies have both digitalization and sustainability strategies implemented and in operation.

3.2.2. Independent variables

3.2.2.1. Growth. We include a dummy variable to capture whether the company is in the middle of a growth process. Constructing this measure, we assign a value of 1 to companies that show growth in terms of employees and sales during the last year and plan to continue growing in the following years.

3.2.2.2. Innovation. Participants were asked to indicate whether their companies had achieved some important results from their innovation policy during the last year. In concordance with the proposal of OECD (2005), innovation indicators were categorized as follows: 1) launch a new product or service in the market – product innovation; 2) obtain a new or improved process method – process innovation; 3) implement a new organizational method or a new business model – organizational innovation; and 4) implement a new way to sell the products or services – marketing innovation. Based on the scope of these achievements, we construct a summative scale from 0 to 4 to discern companies in terms of their innovation efforts.

Table 1
Digitalization and sustainable strategy indicators.

Digitalization practices – In the last year, what of the following digital technologies had implemented your company?	
D.1	Artificial Intelligence
D.2	Cloud Computing
D.3	Robotics
D.4	Smart Devices
D.5	Big Data Analysis
D.6	High-Speed Infrastructure
D.7	Blockchain

Environmental practices – In the last year, what of the following actions had occurred in your company?	
E.1	Recycling or Reusing Materials
E.2	Natural Resource Reduction
E.3	Energy Efficiency and RES
E.4	Sustainable Product Development

Social practices – In the last year, what of the following actions had occurred in your company?	
S.1	Improvement in Work Conditions
S.2	Promotion of Diversity and Equity
S.3	Social Impact Assessment
S.4	Employee Management Participation

3.2.2.3. Exports. We include a dummy variable *(0 = no; 1 = yes)* to discern whether the company sold any product or service outside its country of activity last year.

3.2.2.4. Environment assessment. We measure the suitability of the environment for do business in terms of eight items: 1) the power and the capacity of the business environment; 2) the access to funding; 3) the quality of public and private support services; 4) the access to different commercial partners; 5) the administrative and legal environment; 6) the availability of services of support for sustainability; 7) the availability of appropriate human resources; and 8) the technical infrastructure to support business development. For all of these items, respondents value whether their position regarding these characteristics is very good, fairly good, fairly poor, or very poor (scale from 1 to 4). We split the sample by considering the mean of all these items and constructing a new dummy variable based on the mean value of our sample (*0 = below the mean; 1 = above the mean)*.

3.2.3. Control variables

3.2.3.1. COVID-19. Due to the significant impact of the COVID-19 pandemic and its control measures in our sample countries, we decided to include a dummy variable with a value of 1 for survey answers collected in March–April 2020, when the effects and control of the pandemic increased severely.

3.2.3.2. Country. We include country dummies for each of the thirty-nine *countries in our sample* (Table 2).

3.2.3.3. Industry. We also include sector dummies for each of the sixteen industries in our sample according to the first-level NACE Classification (Table 3).

3.2.3.4. Size. Size was established in a categorical variable comprising four categories (Table 4) according to the number of employees (micro - 1 to 9; small - 10 to 49; medium - 50 to 249; and large - >250).

Table 5 details the descriptive statistics and the correlation matrix of the variables used in our empirical works.

3.3. Data analysis

Given the statistical distribution and the characteristics of the measurement items in our dataset, the exploratory analysis of D—S convergence is based on the results of a hierarchical cluster analysis applied to the SOCIAL, ENVIRONMENTAL, and DIGITALIZATION variables to capture the different D—S convergence groups in our sample. Clustering is a statistical technique that groups similar observations such that the observations in the same group are more similar to each other than the observations in other groups. Cluster analysis is a suitable practice for categorizing levels of development in terms of corporate strategy (Garcés-Ayerbe et al., 2016).

An ANOVA (equality of mean vector) and the consequent Duncan tests (multiple range) were performed using all the independent variables previously presented and the individual items used for their construction. These analyses help us to statistically test the differences between the companies in each group, validating the cluster analysis construction and guaranteeing the robustness of our group variable as a consistent measure of D—S convergence. Thus, the grouping variables resulting from the cluster analysis were included as our dependent variable, capturing the different D—S convergence strategies and, consequently, the application level of proactive digitalization, environment, and social measures.

Table 2
Tabulation of countries.

Country	N	Percent	Cum.
FR – France	503	3.07	3.07
BE – Belgium	500	3.06	6.13
NL – The Netherlands	500	3.06	9.18
DE – Germany	500	3.06	12.24
IT – Italy	500	3.06	15.29
LU – Luxembourg	200	1.22	16.52
DK – Denmark	500	3.06	19.57
IE – Ireland	500	3.06	22.63
GB – The United Kingdom	502	3.07	25.70
GR – Greece	500	3.06	28.75
ES – Spain	502	3.07	31.82
PT – Portugal	500	3.06	34.87
FI – Finland	501	3.06	37.93
SE – Sweden	500	3.06	40.99
AT – Austria	500	3.06	44.05
CY – Cyprus (Republic)	201	1.23	45.27
CZ – The Czech Republic	501	3.06	48.33
EE – Estonia	500	3.06	51.39
HU – Hungary	500	3.06	54.45
LV – Latvia	500	3.06	57.50
LT – Lithuania	500	3.06	60.56
MT – Malta	201	1.23	61.78
PL – Poland	500	3.06	64.84
SK – Slovakia	503	3.07	67.91
SI – Slovenia	503	3.07	70.99
BG – Bulgaria	500	3.06	74.04
RO – Romania	500	3.06	77.10
TR – Turkey	300	1.83	78.93
HR – Croatia	500	3.06	81.99
MK – Macedonia	202	1.23	83.22
RS – Serbia	200	1.22	84.44
NO – Norway	300	1.83	86.28
IS – Iceland	201	1.23	87.50
JP – Japan	300	1.83	89.34
US – The USA	501	3.06	92.40
BR – Brazil	344	2.10	94.50
BA – Bosnia and Herzegovina	200	1.22	95.72
RS-KM – Kosovo	200	1.22	96.94
CA – Canada	500	3.06	100.00
Total	16,365	100.00	

Table 3
Tabulation of industries.

Industries	Freq.	Percent.	Cum.
B – Mining and quarrying	90	0.55	0.55
C – Manufacturing	3184	19.46	20.01
D – Energy supply	100	0.61	20.62
E – Water supply, sewerage, waste management	167	1.02	21.64
F – Construction	1576	9.63	31.27
G – Wholesale and retail trade	4532	27.69	58.96
H – Transportation and storage	929	5.68	64.64
I – Accommodation and food service activities	919	5.62	70.25
J – Information and communication	625	3.82	74.07
K – Financial and insurance activities	344	2.10	76.17
L – Real estate activities	376	2.30	78.47
M – Professional, scientific, and technical activities	1524	9.31	87.78
N – Administrative and support service activities	720	4.40	92.18
P – Education	383	2.34	94.52
Q – Human health and social work activities	622	3.80	98.33
R – Arts, entertainment, and recreation	274	1.67	100.00
Total	16,365	100.00	

Finally, to contrast our research hypotheses, we estimate different hierarchical ordered probit models. We opt for this methodology given the characteristics of our dependent variable. As the group variable resulting from the cluster analysis is categorical and ordinal, it should be modeled as a function of covariates using a hierarchical ordered probit model (Greene and Hensher, 2010). Pearson correlations among the explanatory variables do not show any absolute value over 0.21 (Table 5), and the average VIF factor was 1.09, so it does not show any collinearity problem.

Table 4
Tabulation of size.

Size	Freq.	Percent.	Cum.
1 to 9 employees	8995	54.96	54.96
10 to 49 employees	4162	25.43	80.40
50 to 249 employees	2363	14.44	94.84
250 employees or more	845	5.16	100.00
Total	16,365	100.00	

4. Results

4.1. D—S convergence

The results of cluster analysis show that there are four significantly different groups. Fig. 1 offers a graphical description of the cluster group's formation and summarizes the size of the four groups found and the group mean values for the variables used in the cluster analysis. Table 6 shows the differences between groups based on the variables used for their construction and those used to confirm the suitability of our categorization. Thus, it is possible to observe the differences between groups based on the intensity of the implantation of ENVIRONMENTAL, SOCIAL, and DIGITALIZATION measures and the presence of D—S STRATEGIES. Based on the analysis of variance and the Duncan tests, these first descriptive results show great significance in the definition of the four groups of D—S convergence, so a high degree of consistency is ensured thanks to the subsequent description of the groups.

These descriptive statistics confirm four behavior groups in terms of D—S convergence. From more to less convergence, the first group is the most numerous and shows low levels of advancement in both digitalization and sustainability strategies. As shown in Table 6, on average, no digitalization or sustainability measures have been implemented. The second group has similarly low levels in implementing digitalization measures since the only measure implemented, on average, is cloud computing. However, it can also be seen that all measures are implemented, on average, in firms categorized in Group 2. Group 3 has similarly low levels of digitalization with a sliding increase compared to Group 2. Table 6 shows that the digitalization measures implemented on average are smart devices and high-speed infrastructure, in addition to cloud computing. In addition, the increase in the implementation of sustainability measures is much larger. As shown, in Group 3, a qualitative step related to sustainability items is taken because all of them, regarding social and environmental measures, are implemented on average. Finally, the last group shows the same implementation of sustainability measures as the previous group, while significantly increasing the presence of digitalization measures. This group presents evidence of true D—S convergence, although it appears to be less done through digitalization than through mature sustainability strategies. The D—S STRATEGIES dummy confirms all of these statistics in terms of group formation (Table 6). In particular, our exploratory results show an incremental percentage of companies with both sustainability and digitalization strategies over the advancement of different groups until showing a significant (48.49 %) level of presence of both strategies in the last group (Group 4).

4.2. What leads to D—S convergence?

We perform additional statistical efforts to explore the factors that help companies achieve higher levels of D—S convergence by testing our previous hypotheses. These additional multivariate statistical analyses estimate different hierarchical ordered probit models where the dependent variable takes the values of 1–4 regarding belonging to every group generated with the cluster analysis. The estimation results appear

Table 5
Descriptive statistics.

Variable	(1)	(2)	(3)	(4)	(5)	(6)	Obs	Mean	SD	Min	Max
1. D—S groups							16,275	2.09	1.01	1	4
2. Covid	0.04						16,365	0.37	0.48	0	1
3. Size	0.21	0.01					16,365	1.7	0.9	1	4
4. Growth	0.11	0.01	0.05				14,939	0.28	0.45	0	1
5. Innovation	0.37	0.03	0.14	0.17			16,365	0.85	1.06	0	4
6. Exports	0.10	−0.05	0.21	0.09	0.15		16,115	0.33	0.47	0	1
7. Environment	0.12	0.03	0.13	0.09	0.07	0.01	16,341	0.55	0.5	0	1

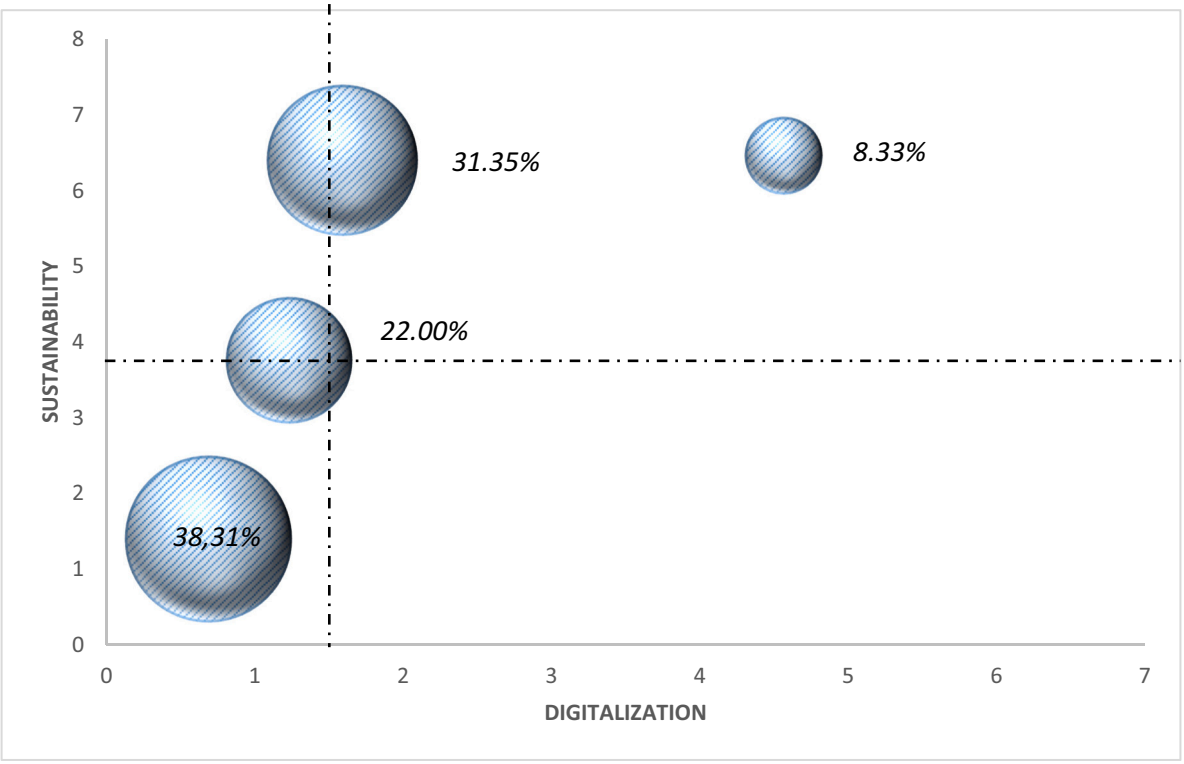

Fig. 1. Description of groups.

Table 6
Description of groups.

	G1	G2	G3	G4			
	$\overline{x_1}$	$\overline{x_2}$	$\overline{x_3}$	$\overline{x_4}$	$\overline{x}$	ANOVA	Duncan test
	$N = 6235$	$N = 3581$	$N = 5103$	$N = 1356$			
Digitalisation (1–7)	*0.69*	*1.23*	*1.59*	*4.56*	31.11 %	5970.71***	**
D.1 Artificial intelligence	2.39 %	3.63 %	4.80 %	49.41 %	7.65 %	1695.44***	**
D.2 Cloud computing	27.83 %	49.90 %	57.57 %	94.99 %	47.88 %	942.35***	**
D.3 Robotics	3.42 %	4.55 %	7.49 %	44.32 %	8.57 %	1014.01***	$X_1 = X_2$
D.4 Smart devices	13.65 %	20.69 %	33.53 %	85.69 %	27.80 %	1268.03***	**
D.5 Big data analysis	5.42 %	9.72 %	12.91 %	69.99 %	14.47 %	1737.13***	*
D.6 High-speed infrastructure	15.80 %	33.04 %	40.66 %	88.42 %	33.74 %	1143.34***	**
D.7 Blockchain	0.80 %	1.65 %	1.69 %	22.86 %	3.31 %	729.63***	$X_2 = X_3$
Environment (1–4)	*0.96*	*1.10*	*3.35*	*3.16*	*1.92*	9471.92***	**
E.1 Recycling or reusing materials	36.30 %	45.46 %	91.57 %	86.87 %	59.79 %	1946.11***	**
E.2 Natural resource reduction	21.56 %	26.56 %	91.55 %	82.89 %	49.56 %	4008.05***	**
E.3 Energy efficiency and RES	27.30 %	26.11 %	88.79 %	79.06 %	50.53 %	2869.00***	$X_1 = X_2$
E.4 Sustainable product development	11.08 %	12.09 %	62.69 %	66.96 %	32.01 %	2312.41***	$X_1 = X_2$
Social (1–4)	*0.45*	*2.67*	*3.06*	*3.32*	*1.99*	5944.95***	**
S.1 Improvement in work conditions	28.56 %	93.77 %	94.14 %	96.09 %	68.96 %	4967.52***	$X_2 = X_3$
S.2 Promotion of diversity and equity	6.85 %	78.44 %	85.28 %	91.67 %	54.08 %	7113.49***	**
S.3 Social impact assessment	2.36 %	31.08 %	53.56 %	63.13 %	29.65 %	1975.02***	**
S.4 Employee management participation	6,80 %	63,92 %	72,98 %	80,75 %	46,12 %	3577.22***	**
D-S strategies	9.55 %	13.48 %	24.85 %	48.49 %	18.82 %	453.605***	**

in Table 7, and their interpretation should be complemented by the predictive margins graphically presented in Figs. 2 and 3. Fig. 2 shows the predicted values of the probability of belonging to each of the D—S convergence groups as a function of the categorical independent and control variables except for the sector, which is presented in Fig. 3. These predicted values are calculated with the coefficients estimated in Table 7 for the respective groups of firms.

Model 1 estimates the influence of our control variables in the cluster groups, offering us some previous ideas about how firms advance toward D—S convergence. We anticipate that D—S convergence is affected by company size and the country and sector of operation, while the COVID-19 pandemic did not disturb our study results. According to Fig. 2, as the size of companies increases, the probability of achieving D—S convergence (Group 4) also increases. Additionally, we can highlight that operating in Scandinavian and in Anglo-Saxon and Central European countries and in information, communication, education, and energy supply sectors (Fig. 3) increases the probability of being in the advanced group of D—S convergence (Group 4). In contrast, operating in Southern and Eastern Europe and in the construction, transportation and storage sectors increase the probability of being far from D—S convergence (Groups 1 & 2).

In terms of what can help companies advance toward D—S convergence, Models 2–5 in an isolated form and Model 6 conjointly help us test our theoretical hypotheses in this regard. The estimation results in these models confirm positive and significant ($p < 0.001$) effects of the GROWTH, INNOVATION, EXPORTS and ENVIRONMENT variables on the D—S convergence group. The results on growth show that an implemented strategy in this regard increases the probability of belonging to Group 4, where we can find D—S convergence. However, the absence of a growth strategy increases the probability of belonging to Groups 1 and 2, categorized by lower levels of D—S convergence. Accordingly, the probability that a firm belongs to the D—S convergence group (Group 4) is approximately 0.1 for firms with an implemented growth strategy and falls to 0.08 for firms without a growth strategy. All of this evidence supports Hypothesis 1, affirming that following a growth strategy positively affects the development of D—S convergence.

Hypothesis 2 states that innovation positively affects the development of D—S convergence. Our results confirm this hypothesis because the probability of belonging to the advanced D—S convergence group (Group 4) increases as innovation intensity increases, while the probability of low levels of development (Groups 1 & 2) decreases. Thus, the probability that a firm belongs to the D—S convergence group (Group 4) is approximately 0.2 for firms with higher levels of innovation intensity (4) and falls to 0.07 for firms with lower levels of innovation intensity (1).

Hypothesis 3 predicts that export activity positively affects the development of D—S convergence. Our results confirming that export activity increases the probability of D—S convergence also support this hypothesis. Thus, export activity increases the probability of belonging to Group 4 (D—S convergence) while decreasing the probability of belonging to Groups 1 & 2, where companies show low levels of C—S convergence. Hence, the probability that a firm belongs to the D—S convergence group (Group 4) is approximately 0.1 for firms with exports and falls to 0.07 for firms operating only in their local country.

Finally, a favorable environment increases the probability of advancing toward D—S convergence and belonging to Group 4, while companies in unfavorable environments have an increased probability of belonging to a laggard group (Groups 1 & 2). That is, the probability that a firm belong to the D—S convergence group (Group 4) is approximately 0.09 for firms operating in favorable environments and falls to 0.07 for firms operating in unfavorable ones. Consequently, we also confirm Hypothesis 4, which states that favorable environments positively affect the development of D—S convergence.

5. Discussion

This paper analyzes how companies adapt to the main strategic challenges of the 21st century, digitalization and sustainability. In particular, we analyze the strategic profiles of companies approach D—S convergence. The results obtained allow us to contribute to the literature in the following ways:

5.1. D—S convergence strategic profiles

First, we provide evidence of a common nexus between the strategic challenges of sustainability and digitalization (Seele and Lock, 2017). Our results show that there is a progression in terms of the implementation of both challenges: The first step is the implementation of sustainability in its social dimension, followed by the environmental dimension and finally, changes related to digitalization. This finding represents a progressive advance in D—S convergence, from the most lagging group of companies that have made almost no progress on strategic challenges to the most convergent group, which has an advanced profile according to measures of sustainability and

Table 7
Hierarchical ordered probit regression estimates on D—S convergence.

	(1)	(3)	(2)	(5)	(4)	(6)
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Covid	0.02	0.01	0.01	0.02	0.01	0.01
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.03)
Small	0.32***	0.30***	0.27***	0.30***	0.32***	0.25***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Medium	0.58***	0.57***	0.53***	0.54***	0.57***	0.48***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Large	0.87***	0.88***	0.77***	0.82***	0.85***	0.75***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Country dummies	YES***	YES***	YES***	YES***	YES***	YES***
Industry dummies	YES***	YES***	YES***	YES***	YES***	YES***
Growth		0.23***				0.12***
		(0.02)				(0.02)
Innovation			0.31***			0.29***
			(0.01)			(0.01)
Exports				0.25***		0.15***
				(0.02)		(0.02)
Environment					0.12***	0.1***
					(0.02)	(0.02)
Observations	16,275	14,858	16,275	16,027	16,251	14,667
Wald $\chi 2$	5295.57***	4948.76***	6505.52***	5408.11***	5340.65***	5962.8***
McFadden's Pseudo R^2	0.128	0.131	0.157	0.132	0.129	0.159

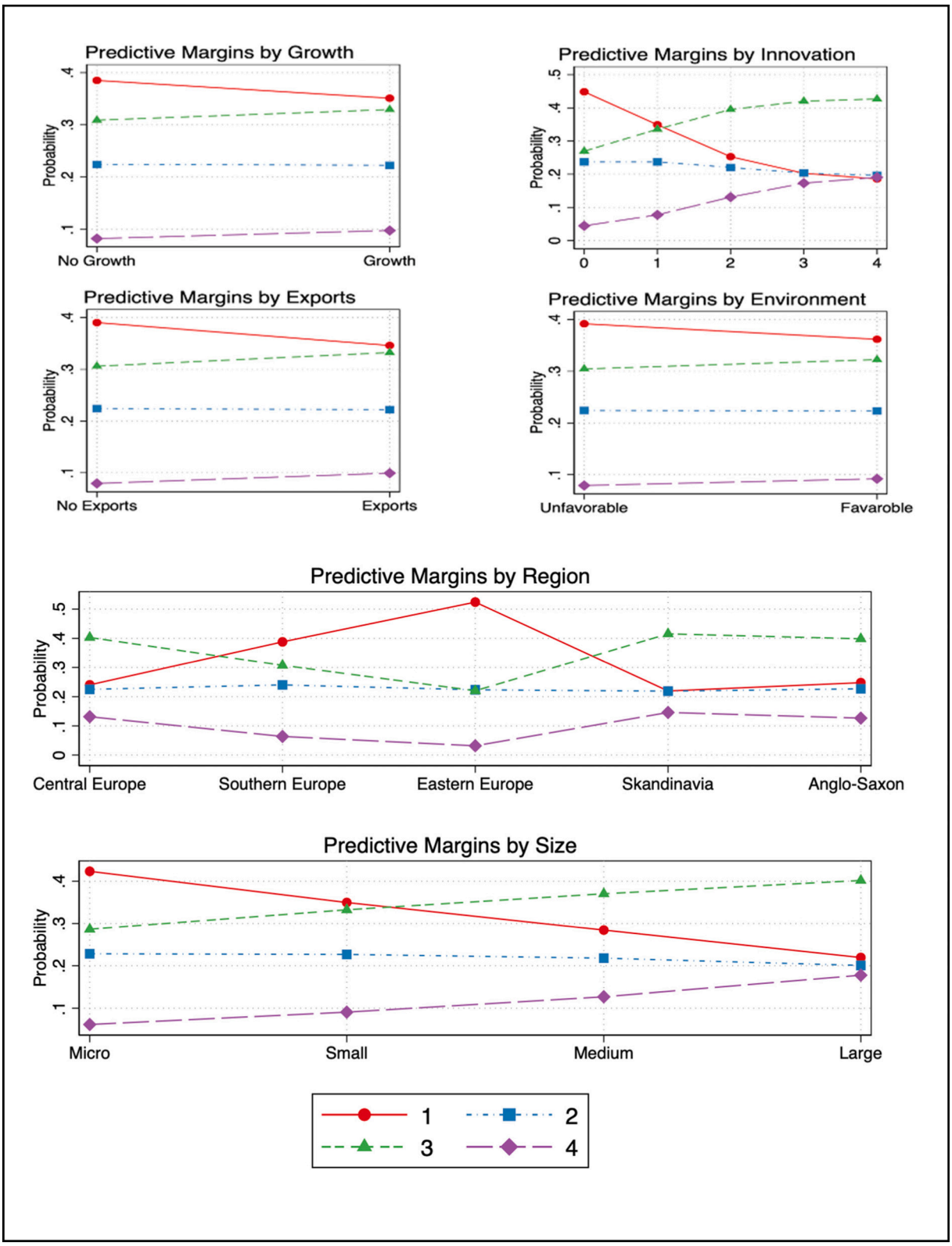

Fig. 2. Predicted probability for the different exogenous variables.

digitalization. This progression in the strategic profiles of the businesses analyzed is in line with the results obtained in the previous literature related to sustainability in the social dimension (Di-Maria et al., 2023), environmental dimension (Lee and Rhee, 2007; Garcés-Ayerbe et al., 2016) and digitalization (Brenner and Hartl, 2021; Del Río Castro et al., 2021; Denicolai et al., 2021).

The results obtained in this regard offer new points of view with respect to the literature. Thus, we confirm that companies initially use their resources to achieve sustainability objectives (progression from groups 1 to 3). These results are at odds with much of the previous literature (Ardito, 2023; Bendig et al., 2023; Broccardo et al., 2023; Liu et al., 2023; Zhang et al., 2023), where digitalization promotes the

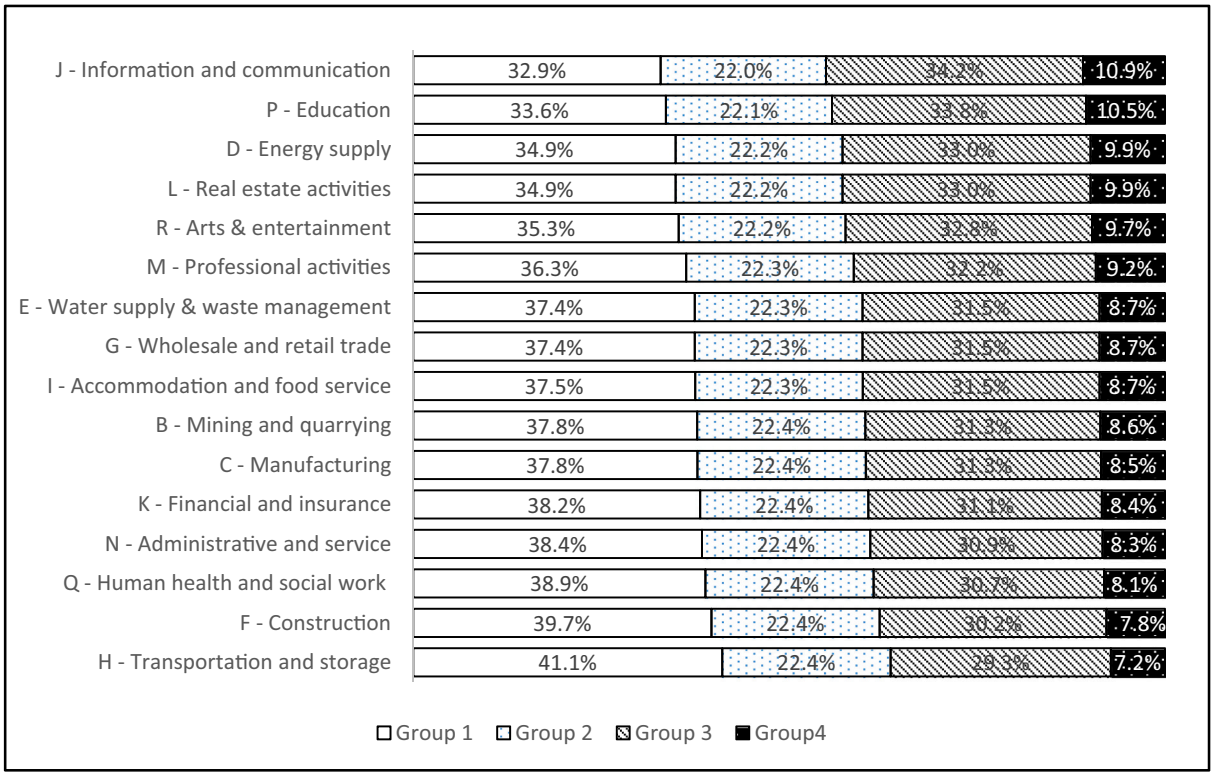

Fig. 3. Predicted probabilities by sector.

realization of the social and environmental dimensions of sustainability. However, the results obtained in this work show a snapshot of what the path looks like, providing evidence that the first step lies in sustainability rather than in digitalization. Once companies have consolidated their knowledge of sustainability, they turn their attention to digitalization, thus reaching the most advanced level of D—S convergence.

The novelty of the strategic challenge of digitalization could support these results. While sustainability has been a goal for companies in recent decades, the advancement of digitalization and its introduction into business strategy has begun in recent years (Björkdahl, 2020). In this sense, the literature has claimed that the growth of an industry accelerates the maturation of technology, reducing the risk levels inherent to the investment in the long term (Russo and Fouts, 1997). Therefore, based on the results of the present study, we conclude that specialization and progress in digital and advanced technologies are necessary to reduce the risks of their implementation and thus promote it.

5.2. *Factors that promote D—S convergence*

Another important contribution of this paper is the analysis of the factors that promote the development of D—S convergence:

First, the results obtained show that just as a ship that must sail the seas must first have, seek and develop the necessary resources to keep afloat and not sink, to achieve D—S convergence, the company must be immersed in a process of growth and must plan to continue growing in the near future. The positive effect of a growth strategy on D—S convergence can be explained by the fact that the need to grow, progress, and improve implies an exhaustive analysis of the company throughout the production process. In this way, the company analyzes its strengths to take advantage of them and its weaknesses to improve them, improving many internal processes (Zou et al., 2010). This self-analysis of the company not only has a positive effect on the growth strategy but also allows the company to adapt to strategic challenges in an effective, studied, and careful way. In addition, if the company is growing, it will have more resources to devote to the implementation of D—S convergence (Barney, 1991; Teece et al., 1997).

Second, to reach the promised land of D—S convergence, the crew must have the necessary knowledge to make use of the available resources and have the necessary skills to know how to navigate the ship. In this sense, the results show a higher probability of belonging to the group of more developed D—S convergent companies than of belonging to those companies with a higher innovation intensity. The explanation for this result may be linked to the nature of the most innovative firms, which generally achieve greater success, take more risks and tend to grow more (Mat and Razak, 2013). It is to be expected that companies with greater innovation intensity will have better managed resources and will make better use of them and that they will have developed capabilities that allow them to improve the efficiency and results of the utilization of these resources (Teece et al., 1997). In this sense, these types of companies that assume more risks and are more advanced in their innovation intensity may be more willing to apply two objectives or strategies at the same time to overcome the so-called attention allocation problem (Ardito et al., 2021). Moreover, being an innovative company encourages risk-taking and, therefore, the likelihood of belonging to the leading groups and benefiting from a first mover advantage (Kemp and Pontoglio, 2011).

Another factor favoring D—S convergence is, in the case of our ship, the experience of the crew. Our results show how companies with exporting activity also have greater D—S convergence. This result could be based on the acquisition of new knowledge, new learning, and new resources acquired by the company through the strategic alliances needed to export (Henrique da Rocha et al., 2014). This acquisition of resources and capabilities through participation and presence in other markets makes companies acquire risks, be predisposed to improve, change, and increase their learning from other companies in nondomestic markets, which will encourage them to carry out D—S convergence effectively (Maksimov et al., 2019).

Finally, having the wind at one's back is a key element in the search for the promised land. In this sense, as shown by the results obtained in

this study, a favorable perception of a company's environment is a factor that enhances and improves the path to achieving D—S convergence. These results coincide with previous findings according to which companies with a more favorable perception of their environment, i.e., companies that perceive that institutions are of high quality, that have access to resources, and that perceive similarity with other surrounding companies, tend to perceive less uncertainty and, consequently, dare to assume greater risks. (Jones and Manuelli, 2001; Ali et al., 2019; Ahmadova et al., 2022). In this sense, the perception of an optimistic environment will make decisions related to the implementation of a multiobjective strategy (D—S convergence) seem more favorable for companies, with lower risks and greater advantages. In other words, companies that feel that the business environment favors them will overcome the attention barrier and will be more likely to decide to focus on two objectives at the same time, as they see more possible advantages than disadvantages of this joint implementation (Voronov and Weber, 2020).

Finally, it is to be expected that the effect of the four factors analyzed in this paper will change depending on other organizational dimensions. Drawing upon the naval analogy used throughout the paper, the effect of the factors affecting the sea voyage will not be the same depending on the type of voyage. For example, imagine a vessel dedicated to the maritime transport of goods, where the destination and the duration of the voyage are clearly defined and the voyage has been carried out on numerous occasions. It is expected that the most relevant factors will be the availability of resources (growth strategy) and previous experience (exports). On the other hand, if the vessel is on an expedition or exploratory voyage, where there is no prior knowledge of the route, it is expected that the ability to use available resources (innovation) as well as having the wind at one's back or not running into a storm (favorable environment) will be somewhat more important. In short, although the four factors analyzed in this paper have a positive and significant effect on the achievement of D—S convergence, a more exhaustive study of different strategic factors that may influence this relationship, such as the company's strategic objectives, industry maturity or diversification strategy, is necessary. These factors, among others, could show different results from those obtained in this work.

5.3. Theoretical contributions

The present work also makes some theoretical contributions. In general, the theoretical approach established by the previous literature on the implementation of digital and sustainable measures has been limited by the so-called attention allocation problem (Ardito et al., 2021). According to this approach, due to limited resources, companies and their managers prioritize a single objective or several closely related objectives to pay as much attention as possible to this end (Ocasio, 1997). The results obtained in the cluster analysis suggest that Groups 2 and 3 follow this approach, concentrating most of their energy, effort and attention on sustainable objectives. However, as observed in Group 4, which shows full D—S convergence, dealing with both strategic challenges in a comprehensive and advanced manner is possible. In conclusion, we provide new evidence that the most advanced companies in D—S convergence do not prioritize one of the challenges over the other. Therefore, companies in the most convergent group have dealt with both strategic challenges, implementing simultaneously sustainable and digital practices. This phenomenon could be generated by the synergies between the implementations of these strategies, which support companies creating greater value and being more efficient in using resources, as Milgrom and Roberts (1995) predict under their complementarities view.

6. Conclusions and future research directions

This study has certain limitations, which can serve as a call for future research on the topic:

First, our results show what the path to full implementation of D—S convergence looks like, that is, the implementation of two strategic objectives or challenges at the same time in a company: sustainability and digitalization. On this path, which is observed through a static picture, it is possible to predict how companies implement the different challenges, starting with sustainability objectives, followed by environmental objectives and ending with digital objectives. Although one might initially think that this order is a logical order that has been followed over the last twenty years (one of the first academic works in this field of management was that of Hart (1995), who developed the strategy of sustainable development) and that digitalization is a much more current concept as a result of the rise of new technologies in recent years, reference should be made to the uneven development of the two strategic challenges. While sustainability has been ingrained in the business world for decades, digitalization is a novel challenge that is currently at an early stage, so it is understandable and not considered that companies are still in the first steps of its implementation. New studies should overcome these limitations in the future, once digitalization reaches a maturity level like that of sustainability.

Second, closely linked to the first, it is striking how little attention the literature has paid to the social dimension. In this sense, our findings have implications for future research and highlight the need to examine the social part of the factors encompassing sustainability more closely.

Third, we have adopted an approach that suggests the benefits of the convergence between digitalization and sustainability outweigh the costs, we have not tested this assumption in our research. Therefore, future research should focus on examining the effectiveness and efficiency of implementing both strategies simultaneously in various contexts and industries. Doing so would help further refine our understanding of the potential advantages and disadvantages of D—S convergence and provide more specific guidance for companies seeking to enhance their performance in these areas.

The fourth limitation lies in not knowing concretely when sustainability and digitalization practices have been implemented in companies. The database used in the empirical study refers to implementing this type of measure in the company without paying attention to the intensity with which or the moment at which they were implemented. Unfortunately, we did not participate in constructing the items included in the survey, which should be addressed in the future.

Another limitation that allows us to propose a future research avenue lies in the fact that this study does not consider other organizational issues that may be relevant to achieving D—S convergence. As mentioned in the discussion section, drawing upon the naval analogy, the effect of factors on the probability of developing full D—S convergence will depend on the type of voyage taken by the vessel, i.e., whether it is a normative voyage or an exploratory voyage. Therefore, the moderating effect that different organizational factors, such as industry maturity or diversification strategy, may have on the relationships analyzed in this paper is proposed as a future line of research.

Finally, it is important to highlight the negative side of the current development of digitalization in companies. Although, as has been argued in this study, the joint implementation of sustainability and digitalization measures can lead a company to an advanced profile in the field of strategic convergence, it is important to consider rebound effects, which the recent literature has referred to as the paradox between digitalization and sustainability (Hellemans et al., 2021; Liu et al., 2023). In other words, there is a risk that environmental and social improvements, as a consequence of D—S convergence, could be compensated for in part or in full by increased production and consumption patterns. In the same way, and due to its novelty, the consequences in terms of waste production and waste of the advance of digitalization as a strategic challenge have not been studied in depth. For example, Del Río Castro et al. (2021) refer to the fact that the digital sector could be responsible for 14 % of greenhouse gas emissions and that, due to the vulnerabilities of the interconnected global system, the negative cascading effects could have catastrophic consequences if the

negative impact of digitalization were to increase. For this reason, future studies should analyze the consequences of D—S convergence in companies to determine whether they are truly implemented effectively or whether, on the contrary, they are symbolic strategies carried out by companies.

CRediT authorship contribution statement

Jesus Valero-Gil: Data curation, Writing – review & editing. **Inés Suárez-Perales:** Writing – original draft, Writing – review & editing. **Conchita Garcés-Ayerbe:** Conceptualization, Funding acquisition, Project administration, Resources, Supervision. **Pilar Rivera-Torres:** Formal analysis, Funding acquisition, Methodology, Project administration, Resources, Validation.

Declaration of generative ai and ai-assisted technologies in the writing process

During the preparation of this work, the authors used DeepL Translate to improve the language and readability of the manuscript. After using this tool, the authors reviewed and edited the content as needed, and they take full responsibility for the content of the publication.

Declaration of competing interest

None.

Data availability

Data will be made available on request.

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References

Adomako, S., Amankwah-Amoah, J., Tarba, S.Y., Khan, Z., 2021. Perceived corruption, business process digitization, and SMEs' degree of internationalization in sub-Saharan Africa. J. Bus. Res. 123, 196–207.
Ahmadova, G., Delgado-Márquez, B.L., Pedauga, L.E., Leyva-de la Hiz, D.I., 2022. Too good to be true: the inverted U-shaped relationship between home-country digitalization and environmental performance. Ecol. Econ. 196, 107393.
Ali, R., Bakhsh, K., Yasin, M.A., 2019. Impact of urbanization on CO2 emissions in emerging economy: evidence from Pakistan. Sustain. Cities Soc. 48, 101553.
Ardito, L., 2023. The influence of firm digitalization on sustainable innovation performance and the moderating role of corporate sustainability practices: an empirical investigation. Bus. Strateg. Environ. 1–21.
Ardito, L., Raby, S., Albino, V., Bertoldi, B., 2021. The duality of digital and environmental orientations in the context of SMEs: implications for innovation performance. J. Bus. Res. 123, 44–56.
Atos, 2018. Journey 2018 Your business technologists. Powering progress the 3rd chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://atos.net/wp-content/uploads/2016/06/atos-ascent-journey-2018-whitepaper.pdf.
Balodi, K.C., 2014. Strategic orientation and organizational forms: an integrative framework. Eur. Bus. Rev. 26 (2), 188–203.
Barney, J., 1991. Firm resources and sustained competitive advantage. J. Manag. 17 (1), 99–120.
Battisti, F., Hollenbeck, C.R., Savona, M., 2021. Digital transformation and green innovation: the role of organizational cognition and attention allocation. Technol. Forecast. Soc. Chang. 163, 120454.
Bencsik, P., Chuluun, T., 2021. Comparative well-being of the self-employed and paid employees in the USA. Small Bus. Econ. 56, 355–384.
Bendig, D., Schulz, C., Theis, L., Raff, S., 2023. Digital orientation and environmental performance in times of technological change. Technological Forecasting & Social Change 188, 122272–122285.
Björkdahl, J., 2020. Strategies for digitalization in manufacturing firms. Calif. Manag. Rev. 1–20.
Brenner, B., Hartl, B., 2021. The perceived relationship between digitalization and ecological, economic, and social sustainability. J. Clean. Prod. 315, 128128–128140.
Broccardo, L., Truant, E., Dana, L.-P., 2023. The interlink between digitalization, sustainability, and performance: an Italian context. J. Bus. Res. 158, 113621–113630.
Brouthers, K.D., Geisser, K.D., Rothlauf, F., 2016. Explaining the internationalization of ibusiness firms. J. Int. Bus. Stud. 47, 513–534.
Bruyne, M.-J.D., Verleye, K., 2023. Realizing the economic and circular potential of sharing business models by engaging consumers. J. Serv. Manag. 34 (3), 493–519.
Chauhan, C., Parida, V., Dhir, A., 2022. Linking circular economy and digitalization technologies: a systematic literature review of past achievements and future promises. Technol. Forecast. Soc. Chang. 177, 121508.
Christmann, P., 2004. Multinational companies and the natural environment: determinants of global environmental policy. Acad. Manag. J. 47 (5), 747–760.
Cui, L., Liu, Y., Shi, Y., 2021. The impact of attention allocation on green and digital innovation: evidence from China. J. Clean. Prod. 280, 124529.
Del Río Castro, G., Camino-González-Fernández, M., Uruburu-Colsa, A., 2021. Unleashing the convergence amid digitalization and sustainability towards pursuing the sustainable development goals (SDGs): a holistic review. J. Clean. Prod. 280, 122204–122240.
Denicolai, S., Zucchella, A., Magnani, G., 2021. Internationalization, digitalization, and sustainability: are SMEs ready? A survey on synergies and substituting effects among growth paths. Technological Forecasting & Social Change 166, 120650–120665.
DiMaggio, P.J., Powell, W.W., 1983. The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. Am. Sociol. Rev. 147–160.
Di-Maria, E., Bettiol, M., Capestro, M., 2023. How Italian fashion brands beat COVID-19: manufacturing, sustainability, and digitalization. Sustainability 15, 1038–1058.
Dunning, J.H., 1999. Multinational Enterprises and the Global Economy. Addison Wesley, London.
Eisenhardt, K.M., Martin, J.A., 2000. Dynamic capabilities: what are they? Strateg. Manag. J. 21 (10−11), 1105–1121.
Ennen, E., Richter, A., 2010. The whole is more than the sum of its parts—or is it? A review of the empirical literature on complementarities in organizations. J. Manag. 36 (1), 207–233.
Escario, J.-J., Rodriguez-Sanchez, C., Valero-Gil, J., Casaló, L.V., 2022. COVID-19 related policies: the role of environmental concern in understanding citizens' preferences. Environ. Res. 211 (October), 113082.
European Commission, 2020. Flash Eurobarometer 486: SMEs, start-ups, scale-ups and entrepreneurship, February–May 2020. TNS Political & Social [Producer]; GESIS Data Archive: ZA7637, dataset version 2.0.0. https://doi.org/10.4232/1.13639.
Falahat, M., Ramayah, T., Soto-Acosta, P., Lee, Y.Y., 2020. SMEs internationa- lization: the role of product innovation, market intelligence, pricing and marketing communication capabilities as drivers of SMEs' international performance. Technol. Forecast. Soc. Chang. 152, 119908.
Ferrón-Vílchez, V., Valero-Gil, J., Suárez-Perales, I., 2021. How does greenwashing influence managers' decision-making? An experimental approach under stakeholder view. Corp. Soc. Responsib. Environ. Manag. 28 (2), 860–880.
Forcadell, F.J., Aracil, E., Ubeda, F., 2020. Using reputation for corporate sustainability to tackle banks digitalization challenges. Bus. Strateg. Environ. 29 (6), 2181–2193.
Gadenne, D.L., Kennedy, J., McKeiver, C., 2009. An empirical study of environmental awareness and practices in SMEs. J. Bus. Ethics 84, 45–63.
Garcés-Ayerbe, C., Rivera-Torres, P., Murillo-Luna, J.L., 2012. Stakeholder pressure and environmental proactivity: moderating effect of competitive advantage expectations. Manag. Decis. 50 (2), 189–206.
Garcés-Ayerbe, C., Scarpellini, S., Valero-Gil, J., Rivera-Torres, P., 2016. Proactive environmental strategy development: from laggard to eco-innovative firms. J. Organ. Chang. Manag. 29 (7), 1118–1134.
Garcés-Ayerbe, C., Rivera-Torres, P., Suárez-Perales, I., 2019. Stakeholder engagement mechanisms and their contribution to eco-innovation: differentiated effects of communica- tion and cooperation. Corp. Soc. Responsib. Environ. Manag. 1–12.
Ghobakhloo, M., Iranmanesh, M., Grybauskas, A., Vilkas, M., Petraitė, M., 2021. Industry 4.0, innovation, and sustainable development: a systematic review and a roadmap to sustainable innovation. Bus. Strateg. Environ. 30, 4237–4257.
Greene, W., Hensher, D., 2010. Modeling Ordered Choices. Cambridge University Press, Cambridge.
Greenwood, R., Hinings, C.R., Whetten, D., 2014. Rethinking institutions and organizations. J. Manag. Stud. 51 (7), 1206–1220.
Guandalini, I., 2022. Sustainability through digital transformation: a systematic literature review for research guidance. J. Bus. Res. 148, 456–471.
Hart, S.L., 1995. A natural-resource-based view of the firm. Acad. Manag. Rev. 20 (4), 986–1014.
Hellemans, I., Porter, A.J., Diriker, D., 2021. Harnessing digitalization for sustainable development: understanding how interactions on sustainability-oriented digital platforms manage tensions and paradoxes. Bus. Strateg. Environ. 31, 668–683.
Hsiao, C., Chen, C., Chen, H., 2020. Greening digital transformation: a bibliometric and content analysis. J. Clean. Prod. 259, 120774.
Isensee, C., Teuteberg, F., Griese, K.-M., Topi, C., 2020. The relationship between organizational culture, sustainability, and digitalization in SMEs: a systematic review. J. Clean. Prod. 122944–122963.
Johanson, J., Vahlne, J.E., 1990. The mechanism of internationalisation. Int. Mark. Rev. 7 (4).
Jones, L.E., Manuelli, R.E., 2001. Endogenous policy choice: the case of pollution and growth. Rev. Econ. Dyn. 4 (2), 369–405.
Joseph, J., Ocasio, W., 2012. Architecture, attention and adaptation in the multibusiness firm: General Electric from 1951 to 2001. Strateg. Manag. J. 33, 633–660.

Kemp, R., Pontoglio, S., 2011. The innovation effects of environmental policy instruments—a typical case of the blind men and the elephant? Ecol. Econ. 72, 28–36.
Kiron, D., Unruh, G.. MIT Sloan blogs. Retrieved from MIT Sloan blogs. https://sloanreview.mit.edu/article/the-convergence-of-digitalization-and-sustainability/.
Klassen, R.D., Whybark, D.C., 1999. The impact of environmental technologies on manufacturing performance. Acad. Manag. J. 42 (6), 599–615.
Kristoffersen, E., Blomsma, F., Mikalef, P., Li, J., 2020. The smart circular economy: a digital-enabled circular strategies framework for manufacturing companies. J. Bus. Res. 120, 241–261.
Kumar, K., Boesso, G., Favotto, F., Menini, A., 2012. Strategic orientation, innovation patterns and performances of SMEs and large companies. J. Small Bus. Enterp. Dev. 19 (1), 132–145.
Kusi-Sarpong, S., Gupta, H., Sarkis, J., 2019. A supply chain sustainability innovation framework and evaluation methodology. Int. J. Prod. Res. 57 (7), 1990–2008.
Le Bas, C., Mothe, C., Nguyen-Thi, T.U., 2015. The differentiated impacts of organizational innovation practices on technological innovation persistence. Eur. J. Innov. Manag. 18 (1), 110–127.
Lee, C.K., Cottle, G.W., Simmons, S.A., Wiklund, J., 2021. Fear not, want not: untangling the effects of social cost of failure on high-growth entrepreneurship. Small Bus. Econ. 57, 531–553.
Lee, S.Y., Rhee, S.K., 2007. The change in corporate environmental strategies: a longitudinal empirical study. Manag. Decis. 45 (2), 196–216.
Leyva-de la Hiz, D.I., Hurtado-Torres, N., Bermúdez-Edo, M., 2019. The heterogeneity of levels of green innovation by firms in international contexts: a study based on the home-country institutional profile. Organ. Environ. 32 (4), 508–527.
Linde, L., Sjödin, D., Parida, V., Wincent, J., 2021. Dynamic capabilities for ecosystem orchestration a capability-based framework for smart city innovation initiatives. Technolo- gical Forecasting and Social Change 166, 120614.
Liu, S., Cai, H., Cai, X., 2023. The paradox of digitalization, competitiveness, and sustainability: a firm-level study of natural resources exploitation in post Covid-19 for China. Res. Policy 85, 103773–103781.
Maksimov, V., Wang, S.L., Yan, S., 2019. Global connectedness and dynamic green capabilities in MNEs. J. Int. Bus. Stud. 1–18.
Maritan, C.A., Lee, G.K., 2017. Bringing a resource and capability Lens to resource allocation. J. Manag. 43 (8), 2609–2620.
Mat, A., Razak, R.C., 2013. Technological innovation implementation: a proposed model on organizational learning capability with moderating effect of knowledge complexity. Afr. J. Bus. Manag. 7 (12), 926.
Meyer, J.W., Rowan, B., 1977. Institutionalized organizations: formal structure as myth and ceremony. Am. J. Sociol. 83 (2), 340–363.
Milgrom, P., Roberts, J., 1995. Complementarities and fit strategy, structure, and organizational change in manufacturing. J. Account. Econ. 19 (2–3), 179–208.
Mishina, Y., Pollock, T.G., Porac, J.F., 2004. Are more resources always better for growth? Resource stickiness in market and product expansion. Strateg. Manag. J. 25, 1179–1197.
Murillo-Luna, J.L., Garcés-Ayerbe, C., Rivera-Torres, P., 2008. Why do patterns of environmental response differ? A stakeholders' pressure approach. Strateg. Manag. J. 29 (11), 1225–1240.
Naldi, L., Davidsson, P., 2014. Entrepreneurial growth: the role of international knowledge acquisitions as moderated by firm age. J. Bus. Ventur. 29, 687–703.
Niehoff, S., 2022. Aligning digitalisation and sustainable development? Evidence from the analysis of worldviews in sustainability reports. Bus. Strateg. Environ. 31 (5), 2546–2567.
Ocasio, W., 1997. Towards an attention-based view of the firm. Strateg. Manag. J. 18 (S1), 187–206.
OECD, 2005. Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data. Organisation for Economic Co-operation and Development, Paris.
Oswald, S.L., Mossholder, K.W., Harris, S.G., 1997. Relations between strategic involvement and managers' perceptions of environment and competitive strengths: the effect of vision salience. Group Org. Manag. 22 (3), 343–365.
Penrose, E., 1995. The Theory of the Growth of the Firm. Basil Blackwell, Oxford and New York, NY.
Pergelova, A., Manolova, T., Simeonova-Ganeva, R., Yordanova, D., 2019. Democratizing entrepreneurship? Digital technologies and the internationalization of female-led SMEs. J. Small Bus. Manag. 57 (1), 14–39.
Piccarozzi, M., Stefanoni, A., Silvestri, C., 2023. Industry 4.0 technologies as a lever for sustainability in the communication of large companiers to stakeholders. Eur. J. Innov. Manag. https://doi.org/10.1108/EJIM-11-2022-0641.
Porter, M.E., Linde, C.V.D., 1995. Toward a new conception of the environment-competitiveness relationship. J. Econ. Perspect. 9 (4), 97–118.
Raza, S.A., Zhu, Q., Raza, S.A., 2018. Sustainable and digital supply chain manage- ment: a review and future directions. Int. J. Prod. Res. 56 (8), 2764–2776.
da Rocha, Henrique, Vencato, C., Maffini Gomes, C., Luciane Scherer, F., Marques Kneipp, J., Schoproni Bichueti, R., 2014. Strategic sustainability management and export performance. Management of Environmental Quality: An International Journal 25 (4), 431–445.
Russo, M.V., Fouts, P.A., 1997. A resource-based perspective on corporate environmental performance and profitability. Acad. Manag. J. 40 (3), 534–559.
Schiavone, F., Leone, D., Caporuscio, A., Lan, S., 2022. Digital servitization and new sustainable configurations of manufacturing systems. Technol. Forecast. Soc. Chang. 176, 121441.
Schweiger, S.A., Stettler, T.R., Baldauf, A., Zamudio, C., 2019. The complementarity of strategic orientations: a meta-analytic synthesis and theory extension. Strategic Manage- ment Journal 40 (11), 1822–1851.
Seele, P., Lock, I., 2017. The game-changing potential of digitalization for sustainability: possibilities, perils, and pathways. Sustain. Sci. 12, 183–185.
Sharma, S., Aragón-Correa, J.A., Rueda-Manzanares, A., 2007. The contingent influence of organizational capabilities on proactive environmental strategy in the service sector: an analysis of north American and European ski resorts. Canadian Journal of Administrative Sciences/Revue Canadienne des Sciences de l'Administration 24 (4), 268–283.
Song, M., Droge, C., Hanvanich, S., Calantone, R., 2005. Marketing and technology resource complementarity: an analysis of their interaction effect in two environmental contexts. Strateg. Manag. J. 26 (3), 259–276.
Spreitzer, A., Neumann, P., Hammerschmid, G., 2017. Sustainability and innovation: drivers of firm growth? A study of European food SMEs. J. Small Bus. Manag. 55 (S1), 220–238.
Sun, D., Zhang, Y., Meng, X., 2023. Green side of informal institutions: social trust and. Business Ethics, the Environment & Responsibility 1352–1375.
Tanriverdi, H., Venkatraman, N., 2005. Knowledge relatedness and the performance of multibusiness firms. Strateg. Manag. J. 26 (2), 97–119.
Teece, D.J., 1998. Capturing value from knowledge assets: the new economy, markets for know-how, and intangible assets. Calif. Manag. Rev. 40 (3), 55–79.
Teece, D.J., 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. Strateg. Manag. J. 28 (13), 1319–1350.
Teece, D.J., Pisano, G., Shuen, A., 1997. Dynamic capabilities and strategic management. Strateg. Manag. J. 18 (7), 509–533.
Temouri, Y., Shen, K., Pereira, V., Xie, X., 2022. How do emerging market SMEs utilize resources in the face of environmental uncertainty? Bus. Res. Q. 25 (3), 212–223.
Verhoef, P.C., Broekhuizen, T., Bart, Y., Bhattacharya, A., Dong, J.Q., Fabian, N., Haenlein, M., 2021. Digital transformation: a multidisciplinary reflection and research agenda. J. Bus. Res. 122, 889–901.
Voronov, M., Weber, K., 2020. People, actors, and the humanizing of institutional theory. J. Manag. Stud. 57 (4), 873–884.
Wernerfelt, B., 1984. A resource-based view of the firm. Strateg. Manag. J. 5 (2), 171–180.
Witt, M.A., 2019. De-globalization: theories, predictions, and opportunities for international business research. J. Int. Bus. Stud. 50, 1053–1077.
Xu, X., Chen, H., Zhang, Y., Chen, Y., 2019. Strategic orientation, sustainability commitment, and firm performance in emerging markets: evidence from China. J. Bus. Res. 97, 365–378.
Zhang, C., Mirza, S.S., Ahsan, T., Usman, S.M., 2023. Corporate digitalization, managerial power distance and corporate sustainability performance: evidence from China. Bus. Process. Manag. J. 29 (4), 1031–1056.
Zhang, X., Li, J., Liu, Y., Wang, Y., 2020. Attention allocation in digital and sustain- able transformation: evidence from China's manufacturing industry. Sustainability 12 (19), 7846.
Zou, H., Chen, X., Ghauri, P., 2010. Antecedents and consequences of new venture growth strategy: an empirical study in China. Asia Pac. J. Manag. 27, 393–421.
Zucker, L.G., 1987. Institutional theories of organization. Annu. Rev. Sociol. 13 (1), 443–464.

Dr. **Jesus Valero-Gil** is an associate professor at the Department of Management of the University of Zaragoza. He is the manager of the Energy and Sustainability Socioeconomics Group at CIRCE Institute. Dr. Valero-Gil has participated in several R&D projects at the National and European levels in the field of eco-innovation and energy resources management. Some of his papers have been published in Research Policy, Organization & Environment, International Journal of Project Management, Business Strategy and the Environment, among others. His main research interests are strategic management in the context of corporate environmental, eco-innovation, and organizations and the natural environment.

Dr. **Inés Suárez-Perales** is an associate professor in the Department of Management of the University of Zaragoza (Spain). She belongs to the Sustainability Group in the IEDIS institute. Her research topics are proactivity of environmental strategy, circular economy, eco-innovation, and other issues related to environmental management. She has also been involved in several papers related to the determinants of advanced environmental strategies, as well as the results of these strategies. She has published several works in top journals such as Energy policy, Corporate Social Responsibility and Environmental Management or Journal of Cleaner Production, among others.

Dr. **Concepción Garcés-Ayerbe** is Professor of Business Administration at the University of Zaragoza, and co-principal researcher of CREVALOR Research Group, a group of 37 researchers. She is currently director of the sustainability research line at the University Research Institute for Employment, Digital Society and Sustainability (IEDIS). Her main line of academic research is Environmental Management, in which she has specialized since working on her doctoral studies in 1996. Currently, her main line of research is sustainability in general and, more particularly, business environmental strategies, environmental proactivity, circular economy, eco-innovation and environmental disclosure.

Dr. **Pilar Rivera-Torres** is Professor of Marketing at the University of Zaragoza, and member of the CREVALOR Research Group and of the Sustainability Group in the IEDIS institute. She is a multidisciplinary researcher who is actively pursuing several lines of research in parallel. She applies the most suitable quantitative multivariate models and management theories to understand managerial and institutional concerns. She is currently working on the implications of business environmental strategies as regards innovativeness and governance, and the drivers and effects of implementing performance measurement and management systems.