

# **Environmental sustainability and board independence: What effects on innovation ambidexterity?**

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## **Abstract**

This study aims to investigate the relationship between environmental sustainability and innovation ambidexterity, also considering the role of board independence in moderating this relationship. To this end, a research model is developed by drawing on both the natural resource-based view theory and agency theory. A survey is conducted on 111 Italian companies listed on the Milan Stock Exchange. A moderated hierarchical regression has revealed that environmental sustainability positively influences exploitation innovation and exploration innovation. Moreover, board independence strengthens the effect of environmental sustainability on innovation ambidexterity. These findings contribute to the innovation ambidexterity literature identifying environmental sustainability as strategic key to resolve the tensions between exploitation and exploration in firms' innovations as well as suggesting that the increasing presence of independent directors on the board foster the joint pursuit of the two contradictory activities.

*Key words:* environmental sustainability, board independence, innovation ambidexterity, exploitation innovation, exploration innovation

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## Sommario

*Sostenibilità ambientale e indipendenza del Consiglio di Amministrazione: Quali effetti sull'innovazione ambidestra?*

Lo studio si ripropone di esaminare la relazione tra i concetti di sostenibilità ambientale e innovazione ambidestra, analizzando contestualmente il ruolo che l'indipendenza del Consiglio di Amministrazione svolge nel moderare la relazione stessa. A tal fine, un modello di ricerca viene sviluppato alla luce della teoria dell'impresa basata sulle risorse naturali e della teoria dell'agenzia. Un'inchiesta campionaria viene condotta su 111 imprese italiane quotate alla Borsa di Milano. Una regressione gerarchica moderata ha rivelato che la sostenibilità ambientale influenza positivamente l'innovazione sfruttativa ed esplorativa. Inoltre, l'indipendenza del Consiglio di Amministrazione rafforza l'effetto esercitato dalla sostenibilità ambientale sull'innovazione ambidestra. Tali risultati contribuiscono alla letteratura sull'innovazione ambidestra, sia perché identificano la sostenibilità ambientale quale chiave strategica per risolvere le tensioni tra sfruttamento ed esplorazione nelle innovazioni delle imprese, sia perché suggeriscono che la crescente presenza di direttori indipendenti nel Consiglio di Amministrazione favorisce il perseguimento congiunto delle due opposte attività.

*Parole chiave:* sostenibilità ambientale, indipendenza del Consiglio di Amministrazione, innovazione ambidestra, innovazione sfruttativa, innovazione esplorativa

## 1. Introduction

In recent years, global warming and climate change across the world have led to environmental degradation and business organizations are accused of being the primary contributors to this natural and social disaster (Burritt, 2018). A similar situation has led to global stakeholders demanding more sustainable business operations along the whole value chain, with more emphasis on environmental sustainability than short-term economic returns (Eide *et al.*, 2020). Consequently, businesses around the world face increasing pressure to reconfigure their orientation with actions geared towards resources' renewal, pollution reduction, and elimination of dangerous processes in response to global calls for environmental protection and sustainable development (Bakos *et al.*, 2020).

Together with the sustainability imperative, organizations also face innovation challenges that play a crucial role in their long-term survival, enabling them to improve their competitive advantage (Pisano, 2015; Ciasullo *et al.*, 2020). In a business arena where tough competition, rapid technological development and permanently changing customer needs prevail, organiza-

tions need ambidextrous innovation that means to innovate simultaneously by exploiting their established knowledge as well as renewing their portfolio of knowledge in search of new opportunities (Levinthal and March, 1993; Jansen *et al.*, 2006).

In this context, board of directors is a key governing body in both addressing sustainability issues to shareholders and other stakeholders (Shaukat *et al.*, 2016) and initiating and organizing innovation projects (Berraies and Rejeb, 2019). The board's contribution to sustainability and innovation is linked to its characteristics including composition of different members. In particular, board independence is the most frequent diversity characteristics related to board composition (Cucari *et al.*, 2018) and is usually related to the presence of independent directors that are individuals not employed as officers of the company (Chen, 2011). Moreover, it represents the paramount internal control mechanism of governance of corporations (Jiraporn *et al.*, 2018) because independent directors, with their directorship as one single tie to the companies, are more effective in limiting managerial discretion by monitoring and advising managers, also punishing them if objectives are not achieved (Fama and Jensen, 1983; Balsmeier *et al.*, 2017).

Against this backdrop, research in the fields of corporate governance, sustainability issues, and innovation has gained increased attention among scholars, practitioners, and policy makers. Anyway, few studies capture these aspects together: for instance, Galia *et al.* (2015) have empirically shown that board composition influences the environmental innovation, while Scherer and Voegtlin (2020) have conceptually debated on the responsible innovations enabled by corporate governance to avoid harm and do good. Conversely, two streams have prevailed in the research on board of directors and corporate governance: one focused on the link between board composition and sustainability/corporate social responsibility (Zhang *et al.*, 2013; Shaukat *et al.*, 2016; Endrikat *et al.*, 2020), the other one referred to the connection between board directors and innovation (Galia and Zenou, 2012; Balsmeier *et al.*, 2017).

Within the first research stream, there has been an interest in the relationship between board characteristics and environmental outcomes of firms (Ortiz-de-Mandojana and Aragón-Correa, 2015; Haque and Ntim, 2018), also investigating the responsibility of the board of directors in environmental disclosure (Ben-Amar and McIlkenny, 2015; Baalouch *et al.*, 2019). However, how board of directors' structure plays a role in responding to sustainability issues raised by shareholders and other stakeholders is an emerging research question (Naciti, 2019). Regarding the second research stream, previous studies have examined the effects of the top and middle management on ambidextrous innovation (Cantarello *et al.*, 2012;

Berraies and Bchini, 2019). Anyway, there is still an important unanswered question in the literature concerning the contribution of boards of directors in ensuring a balance between exploitative and exploratory innovation (Oehmichen *et al.*, 2017; Wong *et al.*, 2017; Rejeb *et al.*, 2019).

To address and shed light on these issues, this paper aims to develop the understanding of the board independence-environmental sustainability-innovation ambidexterity nexus. A better knowledge of these relationships represents a critical step in searching of effective responses to global pressures for strategic postures that combine responsibility and competitiveness of the firms. Specifically, the links between environmental sustainability (ES) and innovation ambidexterity (IA) are explored, also considering the role of board independence (BI) in moderating the aforementioned relationship. Thus, the following research questions arise:

RQ1: *What is the relationship, if any, between ES and IA?*

RQ2: *Does BI affect the relationship between ES and IA?*

Drawing on the natural resource-based view (NRBV) theory and agency theory, a research model is developed highlighting the links between the variables ES, IA, and BI. In particular, this study proposes that ES has a positive relationship with IA, and BI moderates this relationship. The research model is tested with empirical observations collected from a sample of 111 Italian-listed firms, employing a moderated hierarchical regression (Baron and Kenny, 1986).

The paper contributes to the sparse literature on ES, IA, and BI in at least three ways. First, these variables are contextually investigated for the first time through a model that is theoretically derived and empirically examined. Second, important quantitative evidence is provided that shows that ES plays the role of antecedent to a balance of exploitative and explorative innovation fostering competitive advantage. Third, the research reveals that, by acting on BI, the effect of ES on IA increases in terms of better integration of exploitative and explorative innovation of the firms.

This paper is divided into 5 sections. Following this introduction, an overview of the relevant literature is presented and our hypotheses are introduced. The next section includes information on the methodology. Then the findings are presented, followed by discussion and conclusion of the study.

## 2. Theory and hypotheses

### 2.1. Environmental sustainability and innovation ambidexterity

Originally, sustainable development is described as the development that “*meets the need of the present without compromising the ability of future generations to meet their own needs*” (WCED, 1987). This definition is completed with the introduction of social, environmental, and economic pillars (UN, 2002). Thus, sustainable development is intended as social and economic development that should be also environmentally sustainable (Moldan *et al.*, 2012). These pillars can be contradictory or complimentary to each other, as well as embracing seemingly equally desirable goals (Mollenkopf *et al.* 2010; Purvis *et al.*, 2019). For instance, conservation and protection of nature have become a priority for regulatory bodies and many organizations because of the uncontrolled consumption of resources that has compromising the global environment situation (Ji and Zhang, 2019). Therefore, environmental sustainability has gained increasing importance as a precondition to achieving economic and social sustainability based on a healthy environment (Bilgili and Ulucak, 2020).

The concept of ES was developed by Goodland (1995) who metamorphosed the existing terms “environmentally responsible development” (World Bank, 1992) and “environmentally sustainable development” (Serageldin and Streeter, 1993). It aims to improve human welfare by safeguarding raw material sources, minimizing wastage, and preventing harm to humans (Goodland, 1995). From a biophysical point of view, environmental sustainability sustains the integrity of life supporting systems on Earth (i.e. terrestrial, aquatic, climatic systems and so on) by means of conservation and proper use of air, water, and land resources (Holdren *et al.*, 1995). At firm level, ES is known as key dimension of corporate sustainability together with social and economic ones from the Triple Bottom Line (TBL) standpoint (Elkington, 1998, 2006).

Basic principles of ES are comprised of regeneration in terms of renewable resources, substitutability of non-renewable resources, compliance with the assimilative capacity of hazardous or polluting substances, and avoiding irreversibility (OECD, 2001). These principles usually create advantages for firms including improvement in operational performance (cost savings on energy/water usage, reduction in wastage), social outcomes (stakeholder satisfaction and trust), and strategic benefits (flexibility and improved competitiveness) (Parboteeah *et al.*, 2012; Akhtar *et al.*, 2020). In addition, firms going “green” also face disadvantages such as extra time to follow burdensome bureaucratic procedures, as well as extra costs relating

to environmental audit and assurance, and/or for the adoption of new technology (Nidumolu *et al.*, 2009; Collins *et al.*, 2010).

IA is a key dynamic capability that allows organizations to simultaneously pursue the contradictory strategies of exploitation and exploration leading to innovation (Tushman and O'Reilly, 1996; Kortmann, 2015; Wong *et al.*, 2017). Exploitative innovation refers to incremental improvements of products, services and/or processes by leveraging existing knowledge stock to meet customers' current needs. Exploratory innovation on the other hand, reflects radical changes in products, services and/or processes by leveraging new knowledge that enriches the existing skill and competence stocks to meet customers' emerging needs (Benner and Tushman, 2003; Jansen *et al.*, 2006). In other words, exploitation is associated with growth in efficiency of innovation implementation and execution, while exploration is linked to openness to learning and connecting insights to catch-up on new opportunities (March, 1991).

Organisations should engage in both exploitative and exploratory innovation as both are crucial to their performance and success (Gupta *et al.*, 2006; Cao *et al.*, 2009). An overemphasis on exploitative innovation may hinder adaptation to changes and cause knowledge obsolescence, reducing a firm's competitiveness in the long-term (March, 1991). Meanwhile, an unbalanced focus on exploratory innovation may lead a firm to operational inefficiency, increased costs, and negative returns in the short-term in a context of increased uncertainty (Tsai and Huang, 2008). Thus, avoiding these detrimental effects known as the "success trap" (generated by too much exploitation) and the "failure trap" (generated by too much exploration) (Levinthal and March, 1993), has proven to be challenging for organizations pursuing these two types of innovation at the same time in order to attain optimum performance and competitiveness. This is due to the fact that the exploitative and exploratory innovations complement each other and their balancing allows a reconciliation between short-term profits generated by exploitative innovation, and future customer needs and market evolutions in the long-term anticipated by exploratory innovation (Wang and Li, 2008; Schambergeret *et al.*, 2013).

Little is known about how sustainability affects different types of innovation – such as technological, service, and business model innovations (Rantala *et al.*, 2018) – and various kinds of eco-innovation that might be eco-products or eco-processes (Triguero *et al.*, 2013), and technological or nontechnological forms (Demirel and Kesidou, 2019). In this context, the specific relationship between ES and IA has not received much attention and thereby remains unclear (Kortmann, 2015), although a narrow linkage of environmental management and green practices to firm innovativeness is

reported in the literature (Pérez-Valls *et al.*, 2015; Albort-Morant *et al.*, 2016; Graafland, 2018).

This study adopts the NRBV (Hart, 1995), as an extension to the resource-based view, to clarify the relationship between ES and IA. NRBV suggests that the configuration of firm resources according to environmental constraints can enable sustaining a competitive advantage. Constraints imposed by the natural environment are overcome with strategies of product stewardship, pollution prevention, and sustainable development (Hart and Dowell, 2011). These strategies represent the basis for innovations that boost the enhancement of firms' environmental performance and their achievement of competitive advantage (King and Lenox, 2002; De Stefano *et al.*, 2016).

In this logic, core aspects of ES (Galdeano-Gómez *et al.*, 2013) significantly contribute to the implementation of these strategies. In particular, a decrease in the impact of products on the environment leads to product stewardship, for example, responsible waste management, reduction in emissions for cleaner air and water ensure pollution prevention; and conservation of natural and renewable resources enables sustainable development. By contributing to each of these strategies, ES drives a variety of innovations that in turn enhance the firm's competitiveness. Consequently, ES is proposed as an antecedent – that unites product stewardship, pollution prevention and sustainable development – of exploitative and exploratory innovations in line with NRBV. Taking into account the foregoing arguments, this paper introduces the following hypothesis:

*H1: ES has a significant positive impact on IA.*

## *2.2. Moderating effect of board independence*

The corporate governance literature has variously investigated the role of board of directors in ES. Specifically, some scholars have studied the board's commitment to environmental reporting, while other researchers have focused on the relationships between board characteristics and environmental performance (Prado-Lorenzo and Garcia-Sanchez, 2010; Liao *et al.*, 2015; Ben-Amar *et al.*, 2017). Concerning the board characteristics, structure and diversity are frequently described in academia by using BI as a determinant (Cucari *et al.*, 2018). It refers to the presence on the board of independent directors identified as non-executive directors who are external to the organization and who are not part of the management team (Chen, 2011; García Martín and Herrero, 2019).

Studies show the importance of BI given that every strategic decision in corporations, including their stance on the natural environment, is shaped by the board of directors (Kassinis and Vafeas, 2002; Duque-Grisales *et al.*, 2020) whose effectiveness, it is argued, relies on the presence of outsiders among board members (Chen and Hsu, 2009). Unsurprisingly, many countries recommend the integration of independent directors in their codes of good governance.

According to agency theory, external directors have a greater incentive to avoid possible conflicts of interest between managers and shareholders with regard to the strategic decisions of the firm (Hill and Jones, 1992). These agency conflicts can arise due to a divergence in objectives since managers seek to enhance their prestige, power, security, and outcome, while shareholders look to maximize the value of their investment (Fama and Jensen, 1983; Quattrociochi *et al.*, 2019). Thus, independent external directors take on the role of supervising and monitoring to ensure that executive directors act to satisfy owner interests and prevent opportunistic behaviour (Cabrera-Suárez and Martín-Santana, 2015).

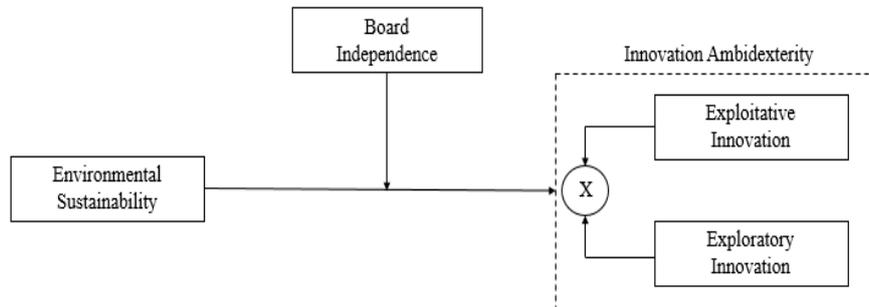
The contribution of BI in terms of greater objectivity and alignment of managers and shareholders' interests suggests that external directors effectively monitor decisions on the environment, fostering a greater sensitivity towards the environmental responsibilities of the firm (Hussain *et al.*, 2018; García Martín and Herrero, 2019). Similarly, some scholars support the idea that independent external directors reinforce the board's contribution to innovation. Similarly, it is generally believed that independent external directors reinforce the board's contribution to innovation. For instance, Zhao and Wen (2011) highlight that organizations with a higher proportion of independent directors invest in technological innovation significantly higher than those with a lower proportion of independent directors. In the same direction, Jiraporn *et al.* (2018) suggest that a higher proportion of independent directors leads to higher corporate innovation investments and innovation productivity, reducing managerial myopia related to managers' focus on short-term results. According to Chen (2013), independent directors are effective in ensuring that managers implement risky and profitable innovations given heterogeneous background and experiences of the outsiders. Likewise, Balsmeir *et al.* (2017) stress their new knowledge that nurtures board and offers advice to managers on innovation strategies. Wong *et al.* (2017) report that independent directors prevent abuses of power by CEOs with regard to allocating resources for innovation. Hence, outsiders on the board allow that those innovation strategies are considered beyond the individual vision of top managers, avoiding a myopic R&D investment (Garcia Osma, 2008). Indeed, a recent study demonstrates that the

behavioral preferences of decision-makers influence their innovation adoption decisions (Kuntadi *et al.*, 2020). Lastly, Hoskisson *et al.* (2002) emphasize that BI plays a key role in searching for an optimal combination of exploratory and exploitative innovations. Thus, in the light of the above theoretical analysis, this paper introduces the following hypothesis:

*HP2: BI strengthens the relationship between ES and IA.*

Figure 1 below presents the research model and hypotheses of the study.

*Fig. 1 – Research model*



### 3. Method

#### 3.1. Sample selection

The study was conducted on Italian companies listed on the Milan Stock Exchange. Listed firms were investigated because their corporate governance information is widely accessible. In addition, listed companies represent an interesting setting to study the innovation topic because the stock market allows them to raise funds that nurture continuous innovation aimed at preserving a positive brand image among investors globally (Ben Rejeb *et al.*, 2019). The focus is limited to Italy to remove cross-national sources of variability that might complicate the analysis. Moreover, larger, listed companies operating in Italy have been subject to environmental, social, and governance (ESG) ratings (Cucari *et al.*, 2018; Clementino and Perkins, 2020).

A total of 375 Italian listed companies were taken from the Borsa Italiana at the end of 2019. The sample size was calculated using the formula for a finite population. Specifically, it was considered satisfactory to set a confidence level at 95% (standard value of 1.96); a standard deviation of

0.5 resulted from a pilot survey conducted on a small number of units; finally, 5% was considered allowable error. Therefore, a sample composed of 231 units was considered representative of the population.

The final sample includes mainly large-sized firms (56.4%) operating in a great variety of industry sectors. In particular, among the sampled firms, 54.9% are manufacturing companies, 23.8% operate in the service sector, and 21.3% are financial companies.

### *3.2. Data collection and analysis*

Data were collected between December 2019 and March 2020 through a survey in keeping with the research purpose. By using the Bureau van Dijk's Aida database and corporate websites, participants were identified from among environmental managers, R&D managers, board members and board secretaries, who were either senior managers or management controllers. They were initially contacted through LinkedIn and then by email to inform them about the research project and its objectives and to invite them to complete an online survey.

The survey, created and managed within the Qualtrics platform, was written in Italian and consisted of four sections and 24 closed questions. The first section briefly described the survey purpose, the identity of the researchers, and the average time required to complete the survey. How the collected data would be used and guarantees of the confidentiality of answers were also specified. The second section comprised four questions useful to define the sample profile in terms of industry, firm size in terms of employees' number (OECD, 2020), board size, and BI. The third section contained 8 questions on ES. Finally, the fourth section contained 12 questions dedicated to IA, 6 on each type of innovation. Before the full-scale formal survey, a pilot test was conducted involving a convenience sample of 20 executives to assess the response latency and check for correct understanding of the questions (Lavrakas, 2008).

A total of 115 responses were received, of which 4 were discarded because they were incomplete or had response set problems. Therefore 111 valid responses were used, representing a 48% effective response rate.

Collected data were analysed by performing a moderated hierarchical regression using the SPSS v 22 software package.

### 3.3. Measures

The survey instrument was developed using valid and well-defined constructs from the literature, namely ES, IA, and BI.

ES is taken as the independent variable of the model. The ES scale is adopted from Gupta and Gupta (2020) which is based on a reliable and valid scale on corporate sustainability, Triple Bottom Line (TBL), developed by Aktin and Gergin (2016). The environmental dimension of TBL is thereby used to evaluate the ES variable. The measures considered refer to pollution containment through reductions in harmful emissions and carbon footprints, recycling of waste and waste management, practices and compliance according to environment guidelines (i.e., ISO-14001) (Tab. 1). To measure the ES variable, a seven-point Likert scale was used, where “1” is defined as “not at all” to “7” as “to a large extent”.

Tab. 1 – Measurement items

<p><b>Environmental Sustainability</b> (adapted from Gupta and Gupta, 2020)</p> <p>ES1 - We take precaution to reduce CO2 emissions of our products</p> <p>ES2 - We perform recycling and waste management practices within our company</p> <p>ES3 - We care about the water and electricity consumption levels of our company</p> <p>ES4 - We prefer to sell environment-friendly products</p> <p>ES5 - The resources we use in our production are ecologically safe and harmless to human health</p> <p>ES6 - Our company is aware of ISO14001 environmental standards</p> <p>ES7 - Our company also serves its other customers according to the ecological standards</p> <p>ES8 - Our company has environmental compliance certificates</p>
<p><b>Exploitative Innovation</b> (adapted from Jansen <i>et al.</i>, 2006)</p> <p>EXPLOI1 - Our company frequently refines the provision of existing products and services</p> <p>EXPLOI2 - Our company regularly implements small adaptations to existing products and services</p> <p>EXPLOI3 - Our company introduces improved, but existing products and services for our local market</p> <p>EXPLOI4 - We improve our provision’s efficiency of products and services</p> <p>EXPLOI5 - We increase economies of scales in existing markets</p> <p>EXPLOI6 - We expand services for existing clients</p>
<p><b>Exploratory Innovation</b> (adapted from Jansen <i>et al.</i>, 2006)</p> <p>EXPLOR1 - Our company accepts demands that go beyond existing products and services</p> <p>EXPLOR2 - Our company invents new products and services</p> <p>EXPLOR3 - Our company experiments with new products and services in our local market</p> <p>EXPLOR4 - We commercialize products and services that are completely new to our unit</p> <p>EXPLOR5 - We frequently utilize new opportunities in new markets</p> <p>EXPLOR6 - We regularly use new distribution channels</p>
<p><b>Board Independence</b> (Rejeb <i>et al.</i>, 2019)</p> <p>Proportion of independent directors compared to the board’s total size</p>

IA is taken as the dependent variable of the model. The scale on the IA is adopted from Jansen *et al.* (2006). The IA is measured by dividing the scale into two dimensions of exploitative (EXPLOI) and exploratory (EXPLOR) innovation. The exploitative innovation measure assess the degree to which a firm builds on existing knowledge and meets the needs of existing customers, while exploratory innovation captures the degree to which a firm departs from existing knowledge and pursues innovation for emerging customers and markets. All the dimensions of the IA are measured using a seven-point Likert scale, where “1” is defined as “not at all” to “7” as “to a large extent”.

BI is taken as the moderator variable of the model. It is captured via the proportion of independent directors compared to the board’s total size (Rejeb *et al.*, 2019). A majority of outsiders significantly influences the strategic decisions rather than a merely residual influence with no real power on the board (Cabrera-Suárez and Martín-Santana, 2015).

To support the robustness of research findings and improve their explanatory strength, firm size and board size are taken as control variables of the model because prior studies have considered their influence on ambidextrous innovation (Raisch and Birkinshaw, 2008; Berraies and Rejeb, 2019). Firm size was measured by the natural logarithm of the number of year-round employees (Wong *et al.*, 2017), while board size is assessed by the logarithm of the total number of directors (Duque-Grisales *et al.*, 2019).

### 3.4. Reliability and validity

The Cronbach’s Alpha value of every variable is well above the cut-off point of 0.7, indicating that our theoretical constructs exhibit good internal reliability (Nunnally, 1978). In addition, convergent validity is ensured as demonstrated by (1) the composite reliability (CR) that exceeds 0.7; (2) the average variance extracted (AVE) for each construct that exceeds 0.5; and (3) the CR that is higher than the AVE for each construct (Hair *et al.*, 1998), see table 2 below.

Tab. 2 – Reliability and construct validity

Variable	Cronbach’s $\alpha$	AVE	CR
ES	0.86	0.59	0.90
BI	0.80	0.63	0.85
EXPLOI	0.78	0.66	0.81
EXPLOR	0.82	0.65	0.88

Note. AVE = average variance extracted; CR = composite reliability

#### 4. Results

Descriptive statistics and correlations for each of study variables are reported in Table 3. The modest correlation coefficients of the variables suggest that multicollinearity should not be an issue.

Prior to the regression analyses the independent and moderator variables were mean-centred following Aiken and West (1991). To test the hypotheses a moderated hierarchical regression was used (Baron and Kenny, 1986) and the results are reported in Table 4 according to the analysis stages of four models for each dimension of innovation ambidexterity that acted as a dependent variable.

Tab. 3 – Descriptive statistics and correlation matrix

Variable	M	SD	1	2	3	4
1. ES	4.29	0.54	1.00			
2. BI	2.97	1.31	0.33**	1.00		
3. EXPLOI	3.13	1.02	-0.05	0.01	1.00	
4. EXPLOR	5.16	0.99	0.24*	0.11	0.47**	1.00

\*\*p < 0.01; \*p < 0.05.

Note. M = mean; SD = standard deviation

Tab. 4 – Results of regression analyses

Variables	EXPLOI				EXPLOR			
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
<i>Controls</i>								
Firm size	0.05	0.30	0.43	0.02	0.51	0.18	0.21	0.17
Board size	0.24**	0.18***	0.12**	0.11**	0.39**	0.36***	0.31*	0.22***
<i>Main effects</i>								
ES		0.32***	0.25*	0.14**		0.38***	0.33**	0.27*
BI			0.23**	0.19*			0.29**	0.21*
<i>Interaction</i>								
ES x BI				0.55*				0.65*
<i>Model metrics</i>								
F	2.76*	5.82*	5.21***	4.35***	3.12**	11.29***	7.55***	9.96***
R <sup>2</sup>	0.11	0.18	0.27	0.33	0.14	0.24	0.29	0.37
Δ R <sup>2</sup>		0.07*	0.09**	0.06***		0.01**	0.05***	0.08*

\*p < 0.10. \*\*p < 0.05. \*\*\*p < 0.01.

Note. Standardized coefficients are reported

First, only control variables were entered as predictor variables in Models 1 and 5. Results indicate that board size has a positive and significant relationship with EXPLOI ( $\beta = 0.24, p < 0.05$ ) and EXPLOR ( $\beta = 0.39, p < 0.05$ ). Second, Models 2 and 6 includes ES and shows a positive and significant association with EXPLOI ( $\beta = 0.32, p < 0.01$ ) and EXPLOR ( $\beta = 0.38, p < 0.01$ ). Moreover, the significant  $R^2$  change when comparing it to Model 1 ( $\Delta R^2 = 0.07, p < 0.10$ ) and Model 6 ( $\Delta R^2 = 0.01, p < 0.05$ ) is significant. Thus, HP1 was supported. Third, Models 3 and 7 added the moderator variable BI and a significant  $R^2$  change when comparing it to Model 2 ( $\Delta R^2 = 0.09, p < 0.05$ ) and Model 6 ( $\Delta R^2 = 0.05, p < 0.01$ ) is also seen. Finally, Models 4 and 8 added the interaction term of ES and BI leading to a significant  $R^2$  change when comparing it to Model 3 ( $\Delta R^2 = 0.06, p < 0.01$ ) and Model 7 ( $\Delta R^2 = 0.08, p < 0.10$ ). With a positive and significant interaction term in prediction of EXPLOI ( $\beta = 0.55, p < 0.10$ ) and in prediction of EXPLOR ( $\beta = 0.65, p < 0.10$ ), HP2 was supported.

## 5. Discussion and conclusion

This research, drawing upon the theoretical insights from NRBV theory and Agency theory, argued that ES positively influences IA. The empirical results strongly support this prediction. Thus, ES not only acts as a means of fostering sustainability performance, but also serves as an antecedent to balance exploitative and explorative innovation. In this way, ES is considered as a strategic key to resolve the tensions surrounding the exploitation-exploration paradox in firms' innovations (Zeng *et al.*, 2017), enabling the joint pursuit of the two contradictory activities. Such balance does not represent a bland compromise, but a truly excellent integration of exploitation and exploration (Andriopoulos and Lewis, 2009).

In balancing the two dimensions of IA there are bound to be conflicts of interest within top management teams. Thus, support for the idea that the effect of ES on IA increases along with BI was found. The results indicated that with an increasing BI, the relationship between ES and IA is strengthened. This evidence is consistent with previous studies. The latter underline that independent directors use their broader vision, diverse skills, experience of other sectors, and belonging to the boards of several companies to bring valuable knowledge on the importance of making long-term environmental investments as a source of competitive advantage (Ortiz-de-Mandojana *et al.*, 2012; Calza *et al.*, 2016; Duque-Grisales *et al.*, 2020). So outsiders are characterized by an ES orientation

that allows them to provide counsel and advice to top managers, formulate corporate strategy and facilitate access to resources to innovate in an ambidextrous way. Thus, independent directors can be viewed as “eco-influencers” of other board members: support creativity, advancing new ideas, encouraging risk-taking in line with the environmental protection and sustainability.

Finally, results also reveal that board size is significantly linked to IA. This is in line with the scholars who stressed that a larger board both improves a firm’s innovativeness and is likely to incorporate independent directors (Zahra *et al.*, 2000; Rejeb *et al.*, 2018).

This study tackled an issue related to the link between ES and IA that has never been explored before, as well as examining the moderator role of BI in this relationship. The originality of the research compared to previous ones is that these topics, to the best of the authors’ knowledge, are contextually investigated for the first time. The study adds a more granular understanding of ES, IA, and BI through a model that is theoretically derived and empirically examined. Consequently, this is among the first works yielding empirical findings on the relationship between sustainability and IA as a promising field of research that needs further investigation (Sulphery and Alkahthani, 2017).

On a theoretical note, the study has three implications for academia. First, the paper proposes to use the NRBV beyond the sustainability literature, where it is mainly employed, spanning it to the field of IA. In so doing, a different perspective is offered to explain the relationship between natural environmental constraints and exploitative and explorative innovation. Second, the findings here contribute to the corporate governance literature by reinforcing the importance of BI as a valued mechanism of governance that moderates the effect of ES on IA: in fact, a higher proportion of outsiders leads to enhance the contribution that the ES gives to the implementation of the two types of innovation. Third, this study enriches the body of knowledge related to dynamic capabilities for competitiveness because empirical evidence shows ES as new antecedent of IA that is a key dynamic capability of the firm. In this way, the call of literature to identify new insights on the drivers of IA is also answered (Raisch and Birkinshaw, 2008; Lavie *et al.*, 2010; Turner *et al.*, 2013).

Interesting managerial implications are also offered. The study suggests that companies looking to improve the effectiveness of their decisions on the environment by fostering innovation ambidexterity have to pay attention to board composition. In particular, a higher proportion of outsiders should be recruited on to the board. Their alternative viewpoints and new strategic perspectives on ES add value in terms of support to the executive

directors in engaging in exploratory projects rather than only in exploitative projects. By doing so, outsiders promote the achievement of the organization's competitive edge. In this way, an environmental consciousness represents an important requirement of independent directors beyond just their neutrality, and financial control and audit skills.

This research is subject to some limitations. First, the survey was conducted on 111 Italian-listed businesses. Sample size and its nature necessitate caution regarding the findings' generalization to non-listed Italian firms. Second, our research model includes one (BI) moderating variable. Nevertheless, other variables may moderate the link between ES and IA such as age, nationality or background of directors. Besides, board gender could also be incorporated into future studies. Finally, future research should design cross-country studies to compare the relationship between ES, IA, and BI in various national and international settings.

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