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Abstract

We examine how board gender diversity is associated with biodiversity disclosures of a firm, and whether the Global Reporting Initiative (GRI) and the EU biodiversity strategy reinforce this relationship. Using institutional theory and resource dependency theory, our sample comprises 4,013 firm-year observations from European corporations covering data from 2002 to 2016. We use panel regressions with country, time and industry dummy variables to analyse the disclosure of biodiversity initiatives (DBI) and logit regressions to explain biodiversity impact assessment (BIA). We find that board gender diversity is positively associated with the DBI and BIA of a firm, and that the GRI framework and the EU biodiversity strategy positively moderate this relationship. Moreover, the GRI framework and the EU strategic plan show positive relationship with the DBI, rather than BIA. Altogether, our evidence suggests that corporate boards with a higher proportion of female directors are more sensitive to the concerns of institutional pressures and respond to those concerns by increasing corporate biodiversity disclosures. Overall, we find that firms tend to comply with the GRI framework and the EU 2020 strategy by undertaking symbolic biodiversity disclosures, rather than providing a comprehensive disclosure of their impacts on biodiversity.

Keywords: Biodiversity accounting, Board gender diversity, Corporate biodiversity initiatives, EU biodiversity strategy, GRI

1. Introduction

We contribute to a limited body of literature on the disclosure of a firm's biodiversity initiatives such as biodiversity related policies, procedures and activities meant to protect native biodiversity. “Biodiversity, as a term, refers to the variety of life on earth…..it includes the vast array of genetically distinct populations within species, as well as the full variety of species and communities, and ecosystems of which they are parts” (Earthwatch, 2002, p.11). Biodiversity is essential for human survival, but its rapid decline and the dangers of global climate change have stimulated debate. It is an essential underpinning of human activity and the human quality of life (Jones, 2014, p.4). Biodiversity disclosures are therefore an important source of information and an emerging area of research.

The Global Reporting Initiative (GRI, 2007, p.7-8) observes that all organisations make direct (through own activities) and indirect (though supply chain partners) use of biodiversity resources, and thus contribute to changes in biodiversity’s quantity and quality. Consequently, corporate stakeholders (e.g., environmentalists, civil societies, regulators, and shareholders) exert pressure on firms to report and manage their impacts on biodiversity and ecosystems (GRI, 2007, p.8). Jones and Solomon (2013) contend that organisations should be held accountable for their actions on biodiversity. The UN Convention on Biological Diversity (CBD), established in Rio de Janeiro in 1992, is the main driving force to mobilise national and firm-specific initiatives to protect biodiversity. It is part of broad-based global efforts to combat biodiversity decline and climate change. The CBD has set out the Aichi biodiversity targets in Nagoya in 2010 and adopted the Strategic Plan for Biodiversity 2011-2020 (CBD, 2010a). Biodiversity has grown in importance since 2010. The UN declared 2011-2020 as the UN Decade on Biodiversity (CBD, 2010a). However, the CBD appears not to have shown noticeable success in reducing the rate of biodiversity loss (Siikamaki & Newbold, 2012). The European Union (EU) is widely considered to be a global leader in climate policy initiatives. It has adopted a ‘leadership-by-example’ approach. It has consistently advocated ‘targets and timetables’ for climate-related actions across economic sectors (Rayner & Jordan, 2016). Its Member States adopted the EU Biodiversity Strategy in 2011.

The EU biodiversity strategic plan includes operational targets and supporting action plans[1] to halt the loss biodiversity and to restore ecosystem from 2011-2020 (EC, 2015a). Therefore, the EU Biodiversity Strategy outlines guidelines, action plans and targets for industries and firms to develop, implement, disclose and monitor biodiversity related initiatives to protect biodiversity and ecosystems. However, since these action plans and targets are voluntary in nature, their implementations are largely dependent on firm-specific priorities and commitments.

Meanwhile, self-regulatory institutions such as the Global Reporting Initiative (GRI) have been instrumental in promoting corporate sustainability reporting (Milne & Gray, 2013). The GRI has joined other global institutions and national governments in influencing corporate initiatives to report and manage company impacts on biodiversity (GRI 2007, p.8).

The United Nations Global Compact (UNGC, 2012) highlights the significance of corporate boards in shaping a firm's sustainability agenda and addressing environmental concerns by integrating a firm's biodiversity and ecosystem issues. The UNGC maintains that biodiversity issues pose a number of potential risks for a firm, including operational, reputational, regulatory and legal, market and financial risks, which might constrain a firm's competitiveness, profitability and long-term viability (UNGC, 2012). Therefore, firms are exposed to pressures from corporate stakeholders and institutions to report and manage their impacts on biodiversity (GRI, 2007). Moreover, analysts, asset management companies, institutional investors and other market-oriented institutions use firm level environmental, social and governance (ESG) indicators including biodiversity disclosures and activities to rank companies better (see OECD, 2019). Consequently, firms can engage in corporate sustainability initiatives in order to mitigate those risks, address multiple stakeholders' concerns, and enhance financial performance and long-term survival capabilities (see de Villiers et al., 2011; Haque, 2017).

The notion of gender diversity is considered to be a critical consideration for addressing biodiversity-related challenges. The CBD and the International Union for Conservation of Nature (IUCN) have recently recognised the significance of gender diversity in managing and conserving biodiversity, and the need to integrate a gender perspective into the biodiversity framework (CBD, 2010b). For CBD (2015), the 2015-2020 Gender Plan of Action provides a mandate to address

[1] These targets and action plans maintain and restore ecosystems and their services; increase the contribution of agriculture and forestry in maintaining and enhancing biodiversity; and ensure the sustainable use of fisheries resources (EC, 2015a, p.2).

gender considerations. Nonetheless, as the CBD and IUCN highlight (CBD, 2015), there is a dearth of gender-sensitive biodiversity research. It is, therefore, important to examine if corporate governance indicators such as board gender diversity influence a firm's biodiversity disclosures. Biodiversity disclosures appear to be particularly relevant in the European context, given the EU's longstanding commitments to protect biodiversity and to promote gender diversity. Regulators in several European countries such as France, Norway, Netherlands, Spain, Sweden and more recently Italy and the UK have, for example, adopted mandatory or voluntary provisions to enhance gender diversity on corporate boards (see, Rao & Tilt, 2016; Hollindale et al., 2019).

Nevertheless, the existing empirical literature has failed to address the effect of board gender diversity on firm's biodiversity disclosures. No studies have examined the effect of the interaction between the institutional context (such as the GRI framework and the EU biodiversity strategy) and board gender diversity on corporate biodiversity disclosures.

We examine the following two research questions: (i) Does board gender diversity influence the disclosure of biodiversity initiatives (DBI) and the biodiversity impact assessment (BIA) of a firm? (ii) How do the GRI framework and the 2020 EU biodiversity strategy moderate the influence of board gender diversity on DBI and BIA?

DBI is a disclosure score of overall biodiversity initiatives prepared by the authors. It is based on a firm's disclosure of its biodiversity related policies, procedures, and activities. These are intended to minimise the adverse effects of a firm's operations on biodiversity and to protect its native ecosystem and biodiversity. BIA is a dummy variable that measures whether or not a firm monitors its impacts on biodiversity through the usage of balanced scorecard or key performance indicators (KPIs). DBI and BIA provide alternative perspectives by measuring a firm's commitment to meet biodiversity-related challenges by disclosing information.

This study makes the following contributions to the extant literature. *First*, we are among the first to empirically examine the influence of board gender diversity on a firm's biodiversity-related disclosures, and thus respond to the calls of the CBD and IUCN to undertake more gender-specific biodiversity research (CBD, 2010b, 2015). We also complement other gender-specific research (e.g., Liao et al., 2015; Hollindale et al., 2019) by investigating whether female board members influence and enhance corporate biodiversity disclosures.

Second, unlike other studies, we examine how institutional factors (such as the EU 2020 biodiversity strategy and the GRI framework) moderate the effect of firm-specific corporate governance characteristics such as board gender diversity on biodiversity disclosures.

Third, most biodiversity studies are qualitative. This is therefore one of the first quantitative studies to examine the firm-level and institutional determinants of a firm's biodiversity disclosures and biodiversity impact assessment. Moreover, we use a new dataset (Thomson Reuters Asset4 database) on European listed firms covering a long-time horizon (2002-2016). We also compare biodiversity disclosures between different European countries.

Fourth, this study contributes towards a call for more evidence-based research, which is considered to be essential for the biodiversity global and national framework to ensure efficient monitoring and recording of biodiversity obligations, activities and outcomes (JNCC and Defra, 2012).

Overall, our evidence contributes to the literature of institutional theory and resource dependency theory in explaining both the individual and interactive effects of gender diversity, the GRI framework and the EU biodiversity strategic plan on the disclosure of biodiversity initiatives and biodiversity impact assessment.

The rest of the paper is structured as follows. Section 2 reviews the theoretical and empirical literature, and develops hypotheses. Section 3 explains our methods, and section 4 reports our findings. Section 5 provides discussions of our findings and section 6 concludes the paper.

2. Literature review and hypothesis development

2.1. Theoretical literature

According to institutional theory, organisations tend to comply with institutional rules, norms and expectations and maintain and enhance corporate legitimacy by complying with three forms of institutional isomorphism: coercive, mimetic and normative (DiMaggio & Powell, 1983). For DiMaggio and Powell (1983), coercive isomorphism influences organisational structures and procedures through direct (e.g., government policies and regulations) and indirect (e.g., cultural expectations from society) institutional pressures. Second, firms tend to respond to uncertainties in business environment by emulating the structures and best practices of successful industry peers, a process referred to as mimetic isomorphism. Finally, normative isomorphism refers to the values of the professional bodies and trade associations which lead firms and thus shape their organisational policies and practices.

Drawing on these institutional isomorphisms of DiMaggio and Powell (1983, 1991), Scott (2001) refers to legitimisation as a distinct firm-specific motivation that can drive an organisation's response to institutional pressure (see Ntim & Soobaroyen, 2013). Scott argues that institutional pressures and organisational forces can interact with each other and shape organisational norms and practices. Oliver (1991) explains that firms can adopt, a 'compromise' strategy due to conflicting institutional demands or inconsistencies between institutional demands and internal organisational objectives. Compromise strategy is defined as an organisation balancing, pacifying or bargaining with external constituents. Haque and Ntim (2018) also argue that firms might conform to the neo-institutional theory by adopting sustainable corporate strategies to comply with environmental policies and regulations in order to gain, maintain and repair organisational legitimacy.

Institutional theory can explain the influence of institutional factors on firm-level initiatives. For example, institutional isomorphism can explain the influence of the GRI framework and the EU biodiversity strategic plan on corporate biodiversity disclosures. Firms tend to follow these institutional actors by adopting culturally acceptable social and environmental practices (e.g., 'mimetic and normative isomorphisms' or mandatory reporting guidelines (e.g., 'coercive isomorphism'). As Perez-Batres et al. (2012) argue, the adherence to GRI guidelines or UNGC codes provides a firm with the 'normative pillar' and 'mimetic isomorphism' to adopt sustainable social and environmental practices of global institutions, professional associations, and industry peers.

Following Jones's (1996, 2003) seminal work on the natural inventory model, several recent studies (e.g., Cuckston, 2013; Samkin et al., 2014; Siddiqui, 2013; Tregidga, 2013; Jones, 2010; Boiral, 2016; Rimmel & Jonall, 2013; Gaia & Jones, 2017) examine biological assets and biodiversity accounting from a variety of perspectives. For example, Boiral and Hras-Saizarbitoria (2017a) argue that an organisation's impact on biodiversity is likely to cause strong external pressures, which in turn damages an organisation's reputation to operate within society. They then find biodiversity management initiatives of mining and forestry firms are driven by institutional pressures and the need to maintain corporate legitimacy. For Jones (2003), organisations tend to collect and disclose data on natural assets to demonstrate their social obligations and to enhance their organisational legitimacy. Samkin et al. (2014) also argue that organisations are increasingly focusing on biodiversity related reporting to avoid tension with stakeholder groups and institutions.

Hillman and Dalziel (2003) use resource-dependency theory to explain the resource provisioning role of the board of directors. Several recent studies (e.g., Mallin & Michelon, 2011; Ben-Amar et al., 2017; Hollindale et al., 2019) use this theory to explain the influence of corporate boards on social and environmental performance. Mallin and Michelon (2011) outline several reputational attributes that can promote sustainable corporate performance and corporate legitimacy. These include counselling and advice on critical issues such as climate change, corporate legitimacy, communications with external institutions and powerful stakeholders, and negotiations with suppliers and financiers for superior access to resources such as capital, technology and raw materials.

From this perspective, resource dependency theory appears more appropriate than other related theories (e.g., agency theory) to address the impact of board gender diversity on firms' biodiversity disclosures. The distinctive human and relational capital of female board members can shape a firm's environmental strategies and performance, leading to greater efficiency, legitimacy and competitive advantage (see Hollindale et al., 2019).

Altogether, contemporary literature highlights the significance of multiple theories in explaining corporate environmental practices, in general, and corporate biodiversity disclosures, in particular. Therefore, this study builds on institutional and resource dependency theories to examine the effects of board gender diversity and its interactions with institutional forces (such as the GRI framework and the EU strategic plan for biodiversity) on a firm's biodiversity disclosures.

Figure 1[2] summarises the theoretical framework to explain individual and interactive effects of board gender diversity and two institutional variables on biodiversity disclosures.

[2] We are grateful to one of the anonymous reviewers for summarising this framework and for allowing us to use this.

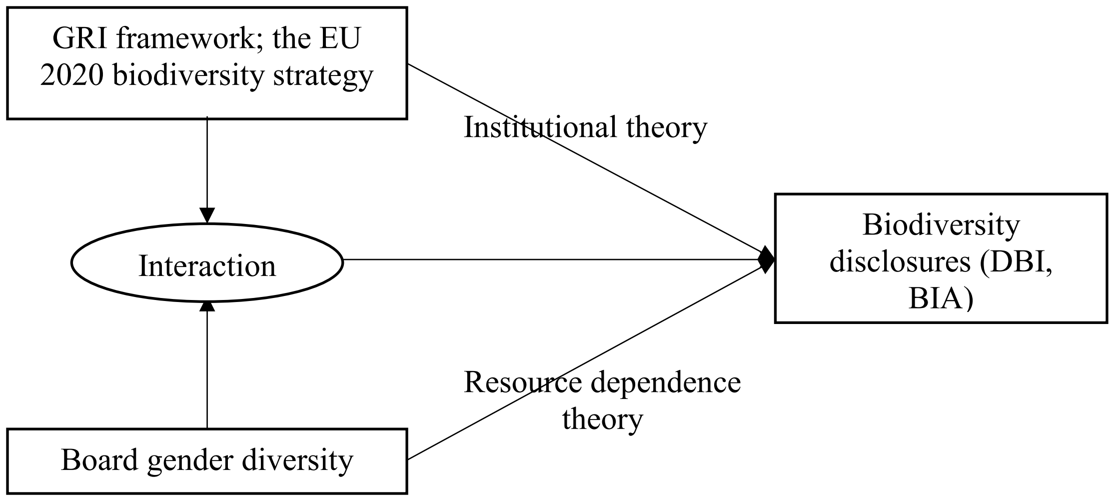

Figure 1: Summary of the theoretical framework

2.2. Empirical literature and hypotheses development

2.2.1. Board gender diversity

Recent studies (such as, Mallin & Michelon, 2011; Haque, 2017) refer to several resource-provisioning roles of female directors with respect to human and relational capital. These are critical in shaping a firm's environmental strategy and performance and in mitigating the global environmental challenges such as GHG emissions and loss of biodiversity.

Firstly, due to communal characteristics, female board members exhibit greater sensitivity towards relationship building and societal stakeholders' concerns such as biodiversity risks. They therefore engage in sustainable corporate strategies and actions, and focus on long-term corporate performance indicators, in order to make a positive contribution to society and to environmental and sustainable development (Braun, 2010; Mallin & Michelon, 2011; Glass et al., 2016; Liao et al., 2015). *Secondly*, female board members encourage open discussion, information sharing and greater participation, and thus, reduce the level of conflict in the board decision-making process and enhance high-quality board decisions, especially on climate and biodiversity issues (Nielsen & Huse, 2010; Bear et al., 2010). For Hollindale et al. (2019), female board members provide human capital through 'value attunement' and enhance a board's understanding of the ethical and social demands of stakeholders, especially on climate change.

Board gender diversity can therefore bring critical advice and resources that can influence board decisions in adopting sustainable environmental policies and programmes and mitigate global environmental challenges such as the loss of biodiversity. However, as Rao and Tilt (2016) and Galbreath (2011) observe, gender diversity might have a negative impact on board decision-making processes due to a lack of consensus between groups and gender-based biases. Low et al. (2015) also suggest that both tokenism and stereotype threats tend to constrain female board members' ability to perform successfully. Moreover, female board representation below a critical mass (e.g., at least three members) might not be able to influence a board's strategic decision-making process (Ben-Amar et al., 2017)

Empirically, Glass et al. (2016) Liao et al. (2015) Mallin and Michelon (2011) and Ben-Amar et al. (2017) find that board gender diversity positively influences sustainable corporate performance. Nonetheless, Prado-Lorenzo and Garcia-Sanchez (2010) find that board gender diversity does not influence carbon disclosures of S&P 500 firms. Moreover, Randøy et al. (2006) also show that board gender diversity does not have a statistically significant relationship with financial performance among the largest Scandinavian companies. Overall, there are mixed theoretical findings and empirical evidence.

However, on balance we feel that the prior research supports the resource-provisioning role of female board members. We, therefore, overall expect a positive relationship between board gender diversity and biodiversity disclosures:

> Hypothesis 1: *Ceteris paribus*, gender diversity in corporate boards has a positive relationship with the firms' disclosure of biodiversity initiatives (DBI) and biodiversity impact assessment (BIA).

2.2.2. The EU (and UN) Biodiversity Strategic Plan and the GRI framework

Organisations respond to institutional pressures, such as the Climate Change Act or the Kyoto Protocol by engaging in climate-related actions so as to gain corporate legitimacy (see, Freedman & Jaggi, 2005; Comyns & Figge, 2015). This is broadly consistent with the notion of 'coercive isomorphism' (DiMaggio & Powell, 1983). The United Nations Global Compact (UNGC) and the International Union for Conservation of Nature (IUCN) have developed a framework for corporate management to develop, implement and disclose biodiversity policies and practices, in order to reduce biodiversity risks, manage related impacts and seize opportunities (UNGC, 2012, p.5). This framework provides comprehensive guidelines and action plans for companies in four broad-based areas of biodiversity and ecosystem services (i) review of the various risks and opportunities (ii) integration of strategies into firms' operations (iii) collaborations with stakeholders and business partners, and (iv) monitoring, evaluating and disclosing firms' performance (UNGC, 2012, pp.5-6).

Consequently, the EU Biodiversity Strategy 2011 was adopted with specific operational targets and action plans to be implemented from 2011-2010 (EC, 2015a). As part of this, the EU Business and Biodiversity Platform was established to integrate firm-specific biodiversity policies and operations through natural capital accounting, sector-specific guidelines on biodiversity, business opportunities, and innovations and biodiversity financing (EC, 2015a, 2015b). The EU Strategy also sets out guidelines for corporations to make a comprehensive assessment of the economic and social benefits of biodiversity and ecosystem and seeks to integrate these benefits into the corporate disclosure framework (EC, 2015a).

The UK also showed a similar commitment towards the strategic plan for biodiversity (2011-2020)[3] by undertaking the National Ecosystem Assessment (NEA) in 2011 in order to analyse economic, health and social values of diversity and ecosystem, and to develop strategies to halt the loss of biodiversity (JNCC & Defra, 2012). Therefore, we consider that both the EU biodiversity strategy and the UK National Ecosystem Assessment provide roughly similar institutional arrangements for firm-level biodiversity initiatives. Altogether, the UN and EU biodiversity strategies and action plans, although they are non-mandatory, tend to have a normative influence on firms.

The GRI, being one of the most influential self-regulatory institutions, provides an intellectual framework for global sustainable development and sustainability reporting (Milne & Gray, 2013). The GRI (2007) framework facilitates biodiversity by encouraging managers to report five performance indicators covering a firm's direct and indirect impacts on biodiversity, and firm-specific biodiversity strategies and action plans (pp.8-9). This framework has been instrumental in shaping sustainable organisational practices, establishing a 'normative pillar' (Scott, 2001) or moral base of organisational legitimacy, and enabling firms to demonstrate DiMaggio and Powell's 'mimetic isomorphism' through imitating best practices of leading players in the industry (Milne & Gray, 2013; Perez-Batres et al., 2012).

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[3] Available at: http://jncc.defra.gov.uk/page-4229 Accessed: 24 October 2019.

Empirically, Lokuwaduge and Heenetigala (2017) find that ESG reporting by Australian firms is highly influenced by GRI guidelines and listing regulations. Freedman and Jaggi (2011) report that corporate carbon disclosures in countries that ratified the Kyoto Protocol (such as, Canada, Japan and EU countries) are more comprehensive than those of US firms, as the US did not ratify the Protocol. Tauringana and Chithambo (2015) show that the adoption of the DEFRA guidance enhances carbon disclosures of UK firms. Chang et al. (2015) also find similar evidence among Chinese firms.

Other related studies suggest that firms might exhibit greater biodiversity disclosures and practices to enhance corporate legitimacy but without demonstrating actual performance in protecting biodiversity. Since all biodiversity disclosure is voluntary, companies do not have to follow either the UN or the EU strategies, or the GRI guidelines. Boiral (2016) observes that organisations use impression management techniques to defend their social legitimacy, without showing clear and measurable accounts of biodiversity. Boiral and Hras-Saizarbitoria (2017a; 2017b) observe that it is difficult to find organisations that adopt comprehensive and substantial biodiversity practices, since there is a lack of external pressures or regulatory requirements. Jones (2003) also argues that companies might disclose selective biodiversity data without demonstrating better environmental management. Gaia and Jones (2017) show that UK local councils tend to adopt a pragmatic/instrumental approach[4] in their biodiversity accounting and reporting practices. Haque and Ntim (2018) also find that firms respond to institutional pressures, such as the Climate Change Act symbolically by demonstrating superior carbon management performance rather than improving actual carbon performance. Moneva et al. (2006) also observe that GRI reporting helps firms to legitimise management decisions and actions, rather than demonstrating an improvement in critical sustainability indicators.

Based on the above theoretical arguments and empirical evidences, we contend that corporations will tend to conform to the EU (and UN) biodiversity strategy and the GRI framework symbolically by demonstrating superior biodiversity related initiatives, instead of undertaking substantive biodiversity impact assessment. Thus, we develop the following hypothesis:

[4] According to an instrumental approach, "human beings can value biodiversity for its economic benefits, for its contribution in supporting life on Earth, for the pleasure, spiritual or aesthetic satisfaction they get from it, and so on (Gaia & Jones, 2017, p. 1618).

Hypothesis 2a: *Ceteris paribus,* the EU 2020 Biodiversity Strategy and the GRI-compliance are positively associated with biodiversity disclosures of a firm, and these relationships are stronger for the disclosure of biodiversity initiatives (DBI) than biodiversity impact assessment (BIA).

Following our discussion of board gender diversity, female board members are likely to be proactive in complying with the EU (and UN) biodiversity strategic plan and the GRI's biodiversity framework by providing critical advice and resources to enhance biodiversity related disclosures. In other words, the EU Biodiversity Strategy and the GRI framework are likely to strengthen the positive relationship between board gender diversity and firms' biodiversity disclosures. Therefore, we test the following hypothesis:

Hypothesis 2b: *Ceteris paribus,* the EU2020 Biodiversity Strategy and the GRI framework reinforces a positive influence of board gender diversity on DBI and BIA.

3. Research methodology

3.1. Data and sample

This study is based on a panel dataset of 4,013 firm-year observations from listed companies in 13 European countries from 2002 to 2016. Unlike other biodiversity-related studies, our dataset captures a longer time span. We use the Thomson Reuters Asset4 database to collect corporate governance, biodiversity and other environmental, social and corporate governance related data, and the Worldscope database to gather financial data. We use panel regressions with country, time and industry fixed effects to analyse the disclosure of biodiversity initiatives (DBI) and logit regressions to explain biodiversity impact assessment (BIA). As we explain later, we measure DBI and BIA based on the biodiversity related data collected by the Thomson Reuters. The Worldscope database is also a part of the Thomson Reuters that provide comprehensive historical financial data on global public and private companies.

Table 1 presents the country- and industry-specific breakdown of the sample. Our sample selection is based on the availability of biodiversity-related data from the Asset4 dataset. This leading global database provides a wide variety of firm-level data on environmental, social and corporate governance (ESG) issues (see also Trumpp et al., 2015). As shown in Table 1, our sample comprises 2,246 observations from the UK, and the remaining 1,767 observations from another 12 European countries. The prime reason for the inclusion of so many UK firms in our sample is the availability of biodiversity-related data from the Asset4 dataset. We have included the UK with the other 12 European countries given our findings of a commonality in institutional arrangements between the EU biodiversity strategy and the UK National Ecosystem Assessment to assess and monitor firm-level disclosure of biodiversity initiatives. Table 1 also shows that our sample includes companies from 11 industrial sectors, with the services sector having the largest proportion of the sample (19.8%), followed by industrials (13.9%), construction (12.3%), and oil & gas 11.2%). In addition, utility and mining sectors comprise 6.0% and 5.6% of the sampled firms, respectively.

Insert Table 1 about here

3.2. Empirical model and variables

We use univariate (e.g., t-tests), bivariate (e.g., correlations) and multivariate (fixed-effects and logit regressions) analyses to investigate the influence of board gender diversity on biodiversity disclosures. In order to analyse the disclosure of biodiversity initiatives (DBI), we use three-way fixed-effects regression by adopting the least square dummy variable (LSDV) model to control unobserved heterogeneity across countries, industries and time. Following related studies (e.g., Tauringana & Chithambo, 2015), we use fixed-effects regression models to investigate the effects of gender diversity, the GRI framework (GRI), and the EU 2020 biodiversity strategy on biodiversity disclosures. A fixed-effects model provides greater consistency and efficiency in estimations and offers more accurate inferences by controlling omitted variable problems and addressing the unobserved heterogeneity among the sampled firms over a period of time (see, Hsiao, 2007; Gallego-Alvarez et al., 2015).

In order to test Hypotheses 1 and 2, we develop the following empirical model:

$$DBI_{it} = \beta_0 + \beta_1 Diversity_{it} + \beta_2 GRI_{it} + \beta_3 Bio2020_{it} + \beta_4 B.Size_{it} + \beta_5 B.Exp_{it} + \beta_6 Connections_{it} + \beta_7 Independence_{it} + \beta_8 Separation_{it} + \beta_9 ESG_{it} + \beta_{10} CSR_{it} + \beta_{11} EMS_{it} + \beta_{12} Q_{it} + \beta_{13} Size_{it} + \beta_{14} Profitability_{it} + \beta_{15} Leverage_{it} + \beta_{16} Employees_{it} + \beta_{17} Shareholders_{it} + \beta_{18} Slack_{it} +$$

$\beta_{19I}Intensity_{it} + \beta_{20}Capex_{it} + \beta_{21}Growth_{it} + \beta_{22}Country_{i} + \beta_{23}Industry_{i} + \beta_{24}Year + u_{it}$ (1)

In the Equation, DBI is a function of board gender diversity (diversity), GRI framework (GRI), the 2020 EU biodiversity strategy (Bio2020), ESG-related control variables, financial characteristics and the error term u. This model also includes country, industry and time dummy variables. In order to avoid multicollinearity problems in using individual and interactive variables in a single regression, we follow, among others, Morse et al. (2011) and Cordeiro and Sarkis (2008) in testing Hypothesis 2a by using each moderating variable to split the sample into two and run regression. Therefore, we estimate Equation (1) for two sub-samples of GRI-compliant and non-compliant firms, and for two sub-samples covering post-biodiversity strategy period (2011-2016) and pre-strategy period (2002-2010).

We follow several related studies (e.g., Bhattacharyya & Cummings, 2015; Boiral & Hras-Saizarbitoria, 2017b) in using an overall measure of biodiversity related policies, procedures, and activities, as disclosed by the sampled firms and compiled by Thomson Reuters. This is referred to as the disclosure of biodiversity initiatives (DBI) score, with higher DBI indicating greater disclosure of biodiversity-related initiatives of a firm. The DBI score is based on eight indicators of biodiversity policies, processes, restoration or protection, reduction of impact, toxic chemicals, hazardous waste or wastewater, land use, and management monitoring (see dependent variables in Table 2). We examine the environment (emission reduction) related indicators of the Asset4 database to identify and collect those indicators disclosing biodiversity initiatives. These are based on disclosures of biodiversity related policies, processes and initiatives to protect its native ecosystem or biodiversity and minimise the adverse effects of a firm's operations on biodiversity. These indicators are broadly in line with the GRI's biodiversity performance indicators covering a firm's impacts on biodiversity, together with firm-specific strategies and actions to mitigate negative impacts and to enhance positive impacts (GRI, 2007).

Insert Table 2 about here

Biodiversity impact assessment (BIA) is a more explicit measure of biodiversity. We re-estimate Equation (1) by replacing DBI with BIA. BIA is a dummy variable that represents a firm's engagement in monitoring its impacts on biodiversity through the usage of balanced scorecard or key performance indicators (KPIs). Since BIA is a dummy variable, we follow, among others, Matsumura et al. (2014) in using a logit regression model. BIA does not necessarily mean that a firm actually monitors its biodiversity performance by using KPIs, as we rely on a firm's disclosure to measure this variable.

Table 2 outlines the details of DBI and BIA, alongside other variables of the empirical model. We outline three independent variables (board gender diversity, GRI and Bio2020). We measure board gender diversity as the percentage of female board members (Diversity), and we expect this to be positively related to biodiversity disclosures. GRI is a dummy variable that measures if a firm discloses its compliance with the GRI framework in publishing its sustainability report. We use the Thomson Reuters Asset4 database to collect data for DBI, BIA and GRI. We also use Bio2020 as a dummy institutional variable that equals 1 if the observation captures the time period from 2011 to 2016, and 0 otherwise. This is intended to examine if the European Commission's adoption of the biodiversity strategy in 2011 shows any positive impact on firms' biodiversity disclosures. We predict that both GRI and Bio2010 will show a positive association with a firm's biodiversity disclosures, and we expect that this relationship is greater for biodiversity initiatives (DBI) than for biodiversity impact assessment (BIA).

We follow related studies (such as de Villiers et al., 2011; Haque, 2017) in using several governance-related control variables, which include board experience (B.exp), board connections (Connections), board size (B.size), board independence (Independence), and CEO-Chair separation (Separation) (see Table 2).

From the perspective of resource dependency theory, board experience and connections can facilitate a firm's access to critical advice and external resources. This can help a firm to engage in sustainability initiatives (see, Ortiz-de-Mandojana et al., 2012). A large board tends to suffer from free-rider problems and conflicting views in board decisions, which causes poor environmental disclosures (see, Prado-Lorenzo & Garcia-Sanchez, 2010). A more independent board is likely to influence executive management to improve social and environmental performance (see Michelon & Parbonetti, 2012).

We also use a number of stakeholder-oriented measures that might drive a firm's biodiversity disclosures. These include, CSR committee of the board , ESG-oriented remuneration policy and the ISO14001 environmental management system . All three stakeholder-oriented measures are predicted to have a positive association with biodiversity indicators (Peters & Romi, 2014; Haque, 2017). We also use several financial characteristics as control variables by following related empirical studies (e.g., de Villiers et al., 2011). These include firm size, profitability, financial slack, leverage, firm value (Tobin's Q[5]), number of shareholders, number of employees, capital expenditure, capital intensive assets and growth prospects (see financial control variables in Table 2). We use the Worldscope database to collect data for these financial control variables. Finally, our regression models include country, industry and year dummy variables to control for country- industry- and time-specific influences in our estimation results.

4. Empirical results

4.1. Descriptive statistics and univariate analysis

Table 3 shows summary statistics of the variables. It shows that the mean value of the DBI score is 2.91 with a standard deviation of 1.95, on a scale of 0 to 8. The disclosure of biodiversity initiatives of the sampled firms therefore seems quite low although there is no set benchmark on this in the absence of comparable studies. However, a relatively high standard deviation indicates that the DBI values of firms are quite spread out from the mean value. The table also shows that only around 0.03 or 3% of the sampled firms tend to adopt biodiversity impact assessment (BIA). This suggests that an exceptionally large majority of firms do not demonstrate substantial engagement in monitoring their impacts and actions on biodiversity through key performance indicators or a balanced scorecard. As we discuss later, this supports the arguments and evidences of Bioral (2016) and Gaia and Jones (2017) in relation to impression management and an instrumental approach to corporate biodiversity disclosures.

Insert Table 3 about here

Table 3 further shows that the percentage of female directors is around 14%, with a standard deviation of 12.29, suggesting a wide variation of female board members' representation among the sampled firms. This suggests that the female board representation in European firms is

[5] Tobin's Q is a widely used measure of firm valuation, which is the ratio of market value of the firm to its replacement cost.

relatively higher than that of the UK firms. This trend is consistent with our country-specific estimation of mean values of gender diversity, which we show in Table 4 (also see below). In addition, the mean value of GRI (a dummy variable) indicates that 65% of the sampled firms disclosed that they have adopted the GRI-framework in preparing corporate sustainability reports. Moreover, 50% of the total observations fall under the post-biodiversity strategy period from 2011 and 2016.

Below we highlight the most common governance related control variables (board size and independence) plus the three most common sustainability-oriented control variables (ESG, CSR, EMS). We find that the sampled firms have an average of around nine board members (as the natural logarithm of mean board size is 2.23), and that around 52% of the board members are independent. This is comparable with the evidence of Tauringana and Chithambo (2015). Table 3 further shows that 68% of the sampled firms adopt ISO 14001 environmental management system, 63% of the firms maintain CSR committee of the board, and around 33% of the firms have an ESG-based compensation policy. Among the financial indicators, we then report some of the important control variables including firm value (Tobin's Q), profitability, leverage, capex, and growth.

Insert Table 4 about here

Table 4 shows the mean values of DBI, BIA and gender diversity across countries and industries. It is evident that firms in Italy and France demonstrate the greatest disclosure of biodiversity initiatives (DBI), followed by Spain, Austria, Netherlands, Austria, Sweden, Finland, Germany and UK. In terms of board gender diversity, Scandinavian countries play a leading role, with firms in Norway having the highest proportion of female board members (31.77%), followed by Sweden (24.59%), Finland (21.75%), and Denmark (14.13%). Surprisingly, firms of these Scandinavian countries do not seem to show greater activism in biodiversity protection initiatives compared to firms from other EU countries, with the mean Danish values of DBI and BIA being the lowest among the sampled countries. Whilst Norwegian firms have the highest degree of board gender diversity, their biodiversity disclosure is below the total average, whereas Italian firms show the best biodiversity disclosure with a moderate degree of gender diversity. Moreover, firms from Austria, Netherlands and Spain demonstrate better biodiversity disclosures in spite of having a relatively low gender diversity. This evidence of Scandinavian firms having greater gender diversity and poorer biodiversity disclosure tend to contradict our hypothesised positive relationship between board gender diversity and biodiversity disclosures. Overall, Southern European countries such as Italy and Spain and several Central European countries such as France, Austria and Netherlands exhibit greater disclosure of biodiversity initiatives. As we explain later, the UK firms demonstrate relatively lower biodiversity disclosures and board gender diversity than a majority of its European counterparts.

Table 4 also shows that the polluting industries have the highest levels of DBI and BIA. The utility-sector (gas, water and electricity) firms demonstrate the greatest biodiversity disclosure, followed by mining, construction materials, oil & gas, and food producers. Table 4 also shows that these industries tend to have relatively high board gender diversity with the proportion of female board members ranging from 12.9% in the construction sector to 14.4% in the oil & gas sector, although mining is much lower at 10.0%. Overall, , the retail sector has the highest level of board gender diversity (16.5%), followed by food producers (14.9%).

Table 5 presents *t*-test results to show the differences in mean values of DBI and BIA between five different categories: GRI and non-GRI compliant firms; pre-and post-Biodiversity strategy 2020 periods; firms with and without board gender diversity; biodiversity sensitive (e.g., polluting) and insensitive industries; and UK and EU. All five categories show a 1% statistical significance level. GRI-compliant firms exhibit greater DBI and BIA than the non-GRI compliant firms supporting the findings of Lokuwaduge and Heenetigala (2017) that GRI enhances sustainable corporate reporting. Panel B also shows that firms demonstrate statistically greater disclosure for both biodiversity indicators after the adoption of the EU biodiversity strategy in 2011. Our evidence corroborates related studies (e.g., Chang et al., 2015; Freedman & Jaggi, 2011) that show a positive influence of the Kyoto Protocol and environmental policy on environmental disclosures and performance. This is also comparable with the evidence of Gaia and Jones (2017) in relation to a positive effect of the International Year of Biodiversity on biodiversity disclosures of UK firm.

Insert Table 5 about here

Panel C shows statistically significant evidence that companies with at least one female director exhibit greater biodiversity disclosure than their counterparts in terms of both DBI and BIA confirming Hypothesis 1. Moreover, Panel D demonstrates that biodiversity sensitive or polluting industries (such as utilities, mining, construction materials, oil & gas, and industrials) show a statistically significant improvement in biodiversity disclosure compared to other industries. This evidence broadly supports institutional theory that polluting firms come under closer scrutiny from the various institutions and stakeholders, and hence, they demonstrate greater biodiversity disclosure to maintain or enhance corporate legitimacy. Finally, Panel E shows that European firms have more statistically significant DBI and BIA disclosures than the UK firms. This evidence indicates that the UK's National Ecosystem Assessment (NEA) and biodiversity working group appear to show little success in monitoring and improving a firm's biodiversity obligations, activities and disclosures.

Insert Table 6 about here

Table 6 shows bivariate correlations among the biodiversity measures and some important variables. It is evident that DBI has a moderate positive correlation with board gender diversity (diversity), GRI-framework (GRI), and EU biodiversity strategy (Bio2020), with the correlation coefficients ranging from 0.25 to 0.56. BIA maintains a weaker relationship with these variables. This might be due to the reluctance of a sizable proportion of the sampled firms to use balanced scorecards to trace biodiversity impact and progress. Overall, these correlation results are broadly in line with our Hypotheses 1 and 2. We also compute correlations among all independent and control variables. The lower correlations values indicate that there is no multicollinearity problem.

Overall, our univariate and bivariate results are supportive of the main hypotheses with respect to a positive relationship between independent variables (such as gender diversity, GRI framework and the EU biodiversity strategy) and corporate biodiversity disclosures.

Insert Table 7 about here

4.2. Multivariate results

Table 7 shows the results of three-way fixed-effects regressions of the disclosure of biodiversity initiatives (DBI) against three independent variables (e.g., board gender diversity, GRI framework, the EU biodiversity 2020 strategy) and all control variables specified in Equation (1). Column 1 shows the regression results for the whole sample: Diversity, GRI and Bio2020 have positive associations with DBI, and these relationships are significant at the 1% level.

Columns 2 and 3 of Table 7 show estimation results of Equation (1) for the sub-samples of GRI-compliant and GRI non-compliant firms, respectively. We find that board gender diversity is positively associated with DBI in both sub-samples, and is higher for the GRI-compliant than the non-compliant firms. In addition, Bio2020 shows positive association with DBI only among the GRI non-compliant firms. This implies that the GRI non-compliant firms appear to have responded to the EU strategy by improving their disclosures of biodiversity initiatives. This might be because a group of firms tend to exhibit greater engagement in biodiversity issues by voluntarily complying with both the GRI guidelines and the biodiversity strategy to enhance corporate legitimacy. Columns 4 and 5 show estimation results of Equation (1) for the sub-samples of post-biodiversity strategy period (2011-2016) and pre-strategy period (2002-2010), respectively. It is evident that board gender diversity has a positive relationship with DBI with the relationship being slightly higher during the post-strategy period than in the pre-strategy period. In addition, GRI shows a positive association with DBI in both sub-samples.

Among the control variables, board CSR committee, firm size and intensity largely maintain positive relationships with DBI in all the estimations. Table 7 further shows that ESG-based compensation policy (ESG), ISO14001 environmental management system (EMS) and board independence show a positive relationship with DBI among the whole sample and the sub-samples of GRI non-compliant firms and pre-strategy period.

To measure the effects of board gender diversity, GRI framework, the EU biodiversity strategy on biodiversity impact assessment (BIA), we ran logit regressions by replacing DBI with BIA in the Equation. Table 8 shows the results of the regressions of BIA against three independent and all control variables. Column 1 shows that both diversity and GRI have statistically significant positive relationships with BIA, as expected. However, Bio2020 shows a negative relationship with BIA. Columns 2 and 3 show estimation results for BIA for the sub-samples of GRI-compliant and non-compliant firms, respectively. As predicted, diversity shows highly significant positive relationship with BIA only among the GRI-compliant firms. In addition, Bio2020 maintains a negative association with BIA only among the GRI-compliant firms. Columns 4 and 5 show that diversity has a positive relationship with BIA during the post-strategy period, as predicted. Moreover, GRI maintains positive relationship with BIA during the pre-strategy period.

Altogether, these results imply that the GRI and the EU Biodiversity strategy tend to reinforce the positive influence of board gender diversity on BIA. In other words, female board members seem to respond to these institutional factors by encouraging firms to monitor their biodiversity impacts. The negative relationship between Bio2020 and BIA for the whole sample and for the GRI-compliant firms seems surprising. This might be because GRI-compliant firms are reluctant to comply with specific EU guidelines to measure biodiversity impact assessment. They therefore show more biodiversity initiative disclosures and less biodiversity impact assessments. They seem to indulge in biodiversity impression management by stressing their biodiversity actions, but not disclosing their impacts.

Among sustainability oriented control variables, only EMS maintain a largely positive relationship with BIA, indicating that firms that have adopted EMS are more likely to adopt biodiversity impact assessment. Among the financial control variables, financial slack shows an inverse association with BIA, implying that firms with less available cash are less likely to adopt BIA.

Insert Table 8 about here

Robustness tests

We carried out three robustness tests. a firm fixed-effects model, an alternative gender diversity variable and re-estimated Equation (1) by introducing variables one by one. In all three cases, we found no noticeable differences in our overall findings.

Finally, we tried to measure the impact of a variable that captures the adverse outcome on biodiversity. We, therefore, used the disclosure of environmental violation incidents as an additional independent variable in our regression estimations. This is a dummy variable that equals 1 if the sampled firms report environmental violation incidents, and 0 otherwise. Our estimation results (not reported) suggest that this new variable is statistically insignificant ($t = 0.53$, $p > 0.10$). We also find that only 56 out of 4013 observations have environmental violation incidents, implying that the vast majority of the sampled firms do not disclose incidents on environmental violations. This evidence is in line with our overall arguments that firms tend to follow biodiversity impression management techniques by focusing on symbolic disclosures rather than disclosing the adverse impact of their activities.

5. Discussion

Overall, our estimation results confirm Hypothesis 1 that boards with greater female representation have a positive relationship with both firm biodiversity indicators (e.g., DBI and BIA). This evidence is consistent with several recent empirical studies (e.g., Hollindale et al., 2019; Mallin & Michelon, 2011; Glass et al., 2016; Bear et al., 2010) that reveal a significant positive influence of board gender diversity on corporate social and environmental strategies, disclosures and performance. This evidence also corroborates the resource provisioning role of female directors. They can provide human and relational capital to influence and facilitate sustainable corporate actions (see also, Hollindale et al., 2019, Mallin & Michelon, 2011).

Our estimation results (shown in Tables 7 and 8) further suggest that the GRI framework and the EU strategic plan on biodiversity (2011-2020) have positive associations with DBI, but their relationship with BIA appears inconclusive. This supports Hypothesis 2a that the biodiversity strategy and the GRI framework have positive relationships with biodiversity disclosures, and these relationships are stronger for the disclosure of biodiversity initiatives than for biodiversity impact assessment. This evidence tends to corroborate the evidence of the related literature (such as, Isaksson & Steimle, 2009; Moneva et al., 2006; Haque & Ntim, 2018) in that the symbolic adherence to the GRI guidelines might help firms to legitimise management decisions and actions. However, it does not necessarily reflect an improvement in substantive or actual biodiversity performance. This might be due to the weak GRI framework and EU strategic plans that promote voluntary disclosure rather than mandatory requirements to demonstrate actual biodiversity performance or progress. (see also, Boiral & Hras-Saizarbitoria, 2017a; 2017b). Our results also support the evidence of Gaia and Jones (2017), who find that the UK local councils' declaration of 2010 as the International Year of Biodiversity has a positive effect on biodiversity disclosures, even though these disclosures focus more on human welfare ecology and resource conservation, and less on environmental stewardship and ecocentric philosophies. This is broadly in line with a pragmatic or instrumental approach (Gaia & Jones, 2017) to corporate biodiversity management.

This is primarily intended to protect and/or enhance environmental legitimacy and promote commercial interests using impression management techniques (Boiral, 2016).

One notable aspect of our estimation results is that the degree of disclosures of biodiversity initiatives and biodiversity impact assessment is reasonably low, although there is no set benchmark to compare our results. Surprisingly only around 3% of the sampled firms adopt biodiversity impact assessment (BIA) or balanced scorecards to measure a firm's impact on (or improvement in) biodiversity. This percentage is, however, slightly higher after the adoption of the EU strategic plan in 2011 (4%), and for firms that adopt the GRI framework (around 4%), as shown in Table 5. This approach can be referred to as a 'strategic planning' phase, rather than as performance/implementation' and 'evaluation' phases, as outlined in the biodiversity framework of Samkin et al. (2014). Boiral (2016) finds that firms demonstrate symbolic commitments and successful rhetoric, rather than clear and measurable accounts, in their biodiversity reports. One possible interpretation is that good disclosure of biodiversity initiatives does not assess their actual impacts (e.g., BIA).

Our regression results (in Table 7) indicate that board gender diversity has a positive relationship with DBI, and that this relationship is higher among GRI-compliant firms and for the post-Biodiversity strategy period. Moreover, as Table 8 shows, board gender diversity is found to be positively related to BIA for the whole sample but only among GRI-compliant firms and for the post-Biodiversity strategy period. This evidence is consistent with Hypothesis 2b, implying that the GRI and the EU 2020 biodiversity strategy reinforce the positive influence of board gender diversity on a firm's biodiversity disclosures. Overall, this suggests that female board members promote corporate sustainability and influence a board's decision by providing critical advice and resources on biodiversity policies and programmes. Moreover, they also remain proactive in responding to normative or mimetic isomorphisms of institutional factors such as the GRI and the EU (and UN) biodiversity strategy.

Nevertheless, given the poor overall biodiversity disclosures and firms' symbolic compliance with the institutional factors, critics might argue that board gender diversity enhances corporate hypocrisy by influencing firms to engage in biodiversity initiatives symbolically rather than substantially. Moreover, as our descriptive statistics (in Table 4) show, Scandinavian firms exhibit greater board gender diversity and poorer overall biodiversity disclosures than firms from other European countries. This evidence is contradictory to our hypothesis that suggests a positive relationship between board gender diversity and biodiversity disclosures. Our descriptive statistics also indicate that several Southern European countries (e.g., Italy and Spain) and several Central European countries (e.g., France, Netherlands and Austria) demonstrate an improved biodiversity disclosure. However, overall biodiversity disclosure of the UK firms is relatively lower than that of a majority of its European counterparts. We also find that organisations representing the polluting industries (e.g., utility, mining, construction materials, oil & gas) tend to exhibit improved disclosures for both indicators of biodiversity. This evidence is largely supportive of the legitimisation aspect of the institutional theory.

Altogether, our evidence supports an integrated framework of institutional and resource dependency theories. *Firstly*, a group of firms might have appointed more female board members as part of their compliance with regulatory requirements in several countries (such as France, Norway, Spain, Sweden), and this can be considered as coercive isomorphism. Moreover, another group of firms might have been driven by normative isomorphism in promoting board gender diversity due to a contemporary shift in professional values surrounding the role of females in society. Similarly, as we argued in the literature review, firms' decisions to comply with the GRI guidelines or the EU and UN biodiversity strategy seem to conform the coercive, normative or mimetic isomorphisms. This results of growing pressures from regulators, professional bodies, industry peers and other stakeholders to demonstrate greater activism on sustainability. *Secondly*, a board with greater gender diversity recognises global and local institutions' concerns (such as GRI and EU regulators) about the long-term consequences of a firm's actions on biodiversity. *Thirdly*, female board members influence board decisions to improve the disclosures of biodiversity initiatives a firm, and provide critical advice and resources to implement those initiatives.

Among the sustainability-oriented control variables, ISO14001 environmental management system, and ESG-based compensation policy maintain a positive association with both DBI and BIA for the whole sample, although these relationships are inconsistent for sub-samples. In addition, the CSR committee maintains a positive association with DBI. These results are broadly consistent with the predictions of the institutional theory that firms tend to follow mimetic or normative isomorphisms by adopting sustainable environmental practices, which enhance a firm's biodiversity disclosures. This evidence also supports Rankin et al. (2011) and Haque (2017) who respectively find a positive association between ISO14001 and carbon disclosures of Australian firms, and the sustainable compensation policy and carbon performance of UK companies. Moreover, board independence and board size show a positive relationship with DBI, rather than BIA, even though these results are inconsistent for the sub-samples. The evidence is broadly comparable with de Villiers et al. (2011) and Liao et al. (2015), as both studies report similar results in the context of US firms' environmental performance and UK firms' GHG disclosures, respectively.

Among the financial control variables, capital intensity largely maintains a positive relationship, whereas financial slack shows a negative relationship, with both biodiversity indicators. This is also consistent with the theoretical arguments that firms with higher capital-intensive assets can enhance energy efficiency, leading to an improved biodiversity disclosure (see, Luo et al., 2012). However, de Villiers et al. (2011) find a negative relationship between capital intensity and environmental activism of US companies. Their results might be driven by the difference in sample (e.g., US firms), together with a limited period of data coverage (2003 and 2004). Our results also suggest that that firms with less free cash flows are less likely to disclose biodiversity initiatives and biodiversity impact assessment. Moreover, leverage shows a negative relationship, and firm size shows a positive relationship, with DBI, rather than BIA. Our evidence on leverage is consistent with the arguments that a levered firm is unlikely to show greater commitment to climate-related initiatives due to its short-term focus on operations and investment, and an obligation to pay interest (see Haque, 2017). Our evidence also suggests that large firms tend to respond to a growing scrutiny from the stakeholders by engaging in greater biodiversity disclosures.

6. Conclusion

This study examined how firm-specific governance characteristics (e.g., board gender diversity) and institutional factors (e.g., the Global Reporting Initiative and the EU 2020 strategic plan for biodiversity) individually and interactively influence two firm biodiversity performance indicators: disclosure of biodiversity initiatives (DBI) and biodiversity impact assessment (BIA). We used three-way fixed-effects regressions and logistic regression models to analyse data on 4,013 firm-year observations from European listed companies from 2002-2016.

Overall, our estimation results suggest that board gender diversity is positively associated with a firm's DBI and BIA, and these relationships are positively moderated by the GRI framework and the EU 2020 biodiversity strategy. These results indicate that boards with greater gender diversity show greater sensitivity towards the legitimate concerns of institutions and societal stakeholders such as the GRI framework and the EU biodiversity Strategy. Gender diverse boards tend to be more proactive in disclosing biodiversity initiatives of a firm, supporting these initiatives by counselling, greater participation and lower conflict in the board decision-making process, and sharing information with stakeholders. This eventually mitigates the biodiversity-related risks of a firm and enhances corporate legitimacy. However, given the relatively low degree of overall biodiversity disclosures, critics might argue that board gender diversity tends to support corporate hypocrisy by influencing firms to engage in impression management.

Our results further suggest that the GRI guidelines and the EU 2020 biodiversity strategy tend to enhance the disclosure of biodiversity initiatives (such as biodiversity policies, processes and disclosures), but do not seem to persuade firms to report their impacts on biodiversity. This indicates a more symbolic, rather than a substantive engagement with biodiversity initiatives, and thus supports the legitimisation aspect of the institutional theory.

Moreover, we find a poor overall biodiversity disclosure of the sampled firms for both DBI and BIA. Our descriptive statistics also suggest that firms from several Southern European countries (e.g., Italy and Spain) and several Central European countries (e.g., France, Netherlands and Austria) demonstrate greater biodiversity disclosures than Scandinavian and UK firms. In addition, our t-test results show that (non-UK) European firms as a whole show greater biodiversity disclosure than the UK firms. We also find that biodiversity sensitive or polluting industries demonstrate an improved biodiversity disclosure than other industries.

Altogether, our evidence supports both the institutional theory and resource dependency theory. On the one hand, good corporate governance and sustainability practices of a firm such as the appointment of female board members, the adoption of GRI-based biodiversity reporting guidelines and the compliance with the EU biodiversity strategy, are consistent with coercive as well as normative or mimetic isomorphisms of the institutional theory. On the other hand, female board members can play a resource-provisioning role by introducing unique human and relational capital and thus improve the disclosure of biodiversity initiatives and biodiversity impact assessment of a firm. These good corporate governance and sustainability practices enhance corporate legitimacy.

Our evidence has several policy implications. *First*, our results confirm the significance of an integrated framework of gender diversity and biodiversity. This has been advocated by the CBD and the IUCN. In other words, board gender diversity tends to exert influence in promoting the disclosure of biodiversity initiatives such as the management and conservation of biodiversity. *Second*, our evidence suggests an interactive effect of gender diversity and institutional factors such as GRI framework and the EU 2020 reinforcing the positive effect of board gender diversity on DBI and BIA. This suggests an interdependence between internal corporate governance factors and external institutional factors. Hence, policymakers could enhance an alignment between gender-specific corporate governance reform and sustainable environmental regulations to combat biodiversity losses. This can be done, among other things, by setting out regulations to increase female representation in firms' boards, *Third*, our inconclusive results of the effects of GRI and Bio2020 on BIA, together with the poor overall biodiversity disclosure, suggest that the adoption of voluntary reporting guidelines such as GRI or a generic biodiversity strategic plan (such as the EU 2020 strategy) are unlikely to influence firms to improve biodiversity disclosures or have substantial engagements with biodiversity initiatives. Therefore, policymakers should enact mandatory regulations on biodiversity with explicit industry-and firm-specific guidelines and verifiable sustainable targets on biodiversity initiatives, their impacts and improvements.

One of the caveats of this study is that we used self-reported environmental violation incidents as an additional independent variable in our robustness tests, but this indicator might not indicate actual environmental violations. Therefore, future studies can use an external source of data for this variable in order to triangulate this with the self-reported data. Second, future research can compare shareholder-based corporate governance systems (such as the US, UK and Australia) with stakeholder-based systems (such as Continental Europe and Japan). Third, future studies might consider in-depth case studies and interviews with board members, executives, shareholders, and other stakeholders to examine their views on corporate biodiversity initiatives. Fourth, given that our descriptive statistics on Scandinavian countries are surprisingly contradictory to the hypothesised positive association between gender diversity and biodiversity disclosures, future researchers can undertake an in-depth analysis or a mixed methods approach to address this topic in Scandinavia.

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Tables

Table 1

Distribution of sample based on country and industry

Country	Obs	Percent	Industry	Obs	Percent
Austria	62	1.54	Aerospace & Defence	204	5.08
Belgium	44	1.10	Construction Materials	493	12.29
Denmark	96	2.39	Food producers	254	6.33
Finland	171	4.26	Utilities	242	6.03
France	287	7.15	Healthcare	309	7.70
Germany	187	4.66	IT&Electronics	156	3.89
Italy	66	1.64	Industrials	558	13.90
Netherlands	142	3.54	Mining	225	5.61
Norway	122	3.04	Oil&Gas	450	11.21
Spain	151	3.76	Retailers	326	8.12
Sweden	170	4.24	Services	796	19.84
Switzerland	269	6.70			
UK	2246	55.97			
Total	4013	100	Total	4013	100

Table 2

Variable definitions

Variables	*Symbols*	*Definitions*
Dependent variables		
Corporate Biodiversity Initiatives	DBI	A DBI score is based on the sum of eight dummy variables representing a firm's disclosure of biodiversity initiatives as disclosed by the sampled firms and compiled by Thomson Reuters. These are biodiversity policies and processes, restoration or protection of biodiversity, reduction of impact, reduction of toxic chemicals, recycling of hazardous waste or wastewater, biodiversity impact on land use, and management monitoring of biodiversity initiatives.
Biodiversity impact assessment	BIA	A dummy variable: 1 if the company monitors its impacts on biodiversity through the balanced scorecard or key performance indicators (KPI), and 0 otherwise.
Independent variables		
Board gender diversity	Diversity	Percentage of female board members

GRI reporting	GRI	A dummy variable: 1 if the firm complies with the GRI guidelines in publishing the sustainability report and 0 otherwise.
EU Biodiversity Strategy 2020	Bio2020	A dummy variable: 1 if the observation captures the time period from 2011 to 2016, and 0 otherwise.
<u>ESG-related Control variables</u>		
Board size	B.size	Natural logarithm of the number of board of directors
Board experience	B.exp	Natural logarithm of the average tenure of the board of directors
Board affiliation	Connections	Natural logarithm of the average corporate affiliations of board of directors
Board independence	Independence	Percentage of independent board members
CEO-Chair separation	Separation	A dummy variable: 1 if the CEO and board chairperson are two different individuals, and 0 otherwise
ESG-based compensation	ESG	A dummy variable: 1 if the firm adopts a sustainability oriented compensation policy and 0 otherwise
CSR committee	CSR	A dummy variable: 1 if the firm has a board CSR committee, and 0 otherwise.
Environmental management system	EMS	A dummy variable: 1 if the firm has adopted an ISO14001 certified environmental management system, and 0 otherwise.
<u>Financial control variables</u>		
Firm value	Tobin's Q	Ratio of total assets minus book value of equity plus market value of equity to total assets.
Firm size	Size	Natural logarithm of total assets
Return on Assets	Profitability	The ratio of net income to the average of last year's and current year's total assets * 100
Leverage	Leverage	Total debt to total assets
Employees	Employees	Natural logarithm of the number of employees.
Shareholders	Shareholders	Natural logarithm of the number of shareholders.
Slack	Slack	Total cash and equivalents over total assets.
Capital intensity	Intensity	The ratio of property, plant and equipment to total assets.
Capital expenditure	Capex	Total capital expenditure divided by total sales.
Growth	Growth	Market value over book value of equity.

Table 3

Descriptive statistics

Variables	Obs	Mean	Std.Dev.	Min	Max
Dep. variables:					
DBI (Score)	4013	2.91	1.95	0.00	8.00
BIA	4013	0.03	0.02	0.00	1.00
Ind. variables:					
Diversity (%)	4013	14.12	12.29	0.00	66.67
GRI	4013	0.65	0.48	0.00	1.00
Bio2020	4013	0.50	0.50	0.00	1.00
ESG-related control variables					
B.size (Ln)	4013	2.23	1.60	1.99	3.22
B.exp (Ln)	4013	1.72	0.44	-2.53	3.08
Connections (Ln)	4013	0.27	0.77	-2.81	2.84
Independence (%)	4013	52.32	24.30	0.00	100
Separation	4013	0.84	0.37	0.00	1.00
ESG	4013	0.33	0.47	0.00	1.00
CSR	4013	0.63	0.48	0.00	1.00
EMS	4013	0.68	0.46	0.00	1.00
Financial control variables:					
Tobin's Q	4013	0.93	0.59	0.03	8.45
Size (Ln)	4013	15.41	1.60	8.01	19.98
Profitability (%)	4013	6.84	8.90	-116.48	106.82
Leverage	4013	24.26	16.34	0.00	126.12
Employees (Ln of n)	4013	7.69	0.97	1.10	8.67
Shareholders (Ln of n)	4013	12.46	1.45	4.91	17.09
Slack	4013	0.11	0.10	0.00	0.93
Intensity	4013	0.58	0.39	0.00	3.14
Capex	4013	7.64	14.90	0.00	266.85
Growth	4013	462.75	245.25	1.00	1123.00

Note: Please see Table 2 for variable definitions

Table 4

Mean values of important variables across countries and industries

Country	DBI	BIA	Diversity	Industry	DBI	BIA	Diversity
Austria	3.33	0.05	7.13	Aerospace & Defense	2.92	0.00	9.89
Belgium	2.42	0.04	11.38	Construction Materials	3.68	0.07	12.95
Denmark	1.98	0.00	14.13	Food producers	2.60	0.03	14.91
Finland	2.90	0.01	21.75	Utilities	4.49	0.09	13.67
France	4.23	0.00	16.75	Healthcare	2.29	0.01	13.57
Germany	2.85	0.02	9.81	IT&Electronics	1.62	0.00	8.71
Italy	4.33	0.17	10.66	Industrials	2.53	0.01	13.53
Netherlands	3.28	0.01	11.75	Mining	4.01	0.06	9.98
Norway	2.31	0.01	31.77	Oil&Gas	3.08	0.03	14.43
Spain	3.62	0.08	10.20	Retailers	2.23	0.01	16.47
Sweden	2.92	0.05	24.59	Services	1.83	0.01	11.70
Switzerland	2.01	0.04	7.67				
UK	2.48	0.02	11.49				
Total	2.91	0.03	14.12	Total	2.91	0.03	14.12

Table 5

T-test results showing the variations in disclosure of biodiversity initiatives (DBI) and biodiversity impact assessment (BIA) across several categories of sub-samples.

Variables		Sample	Mean	Difference	t-statistics	Pr(T > t) (H_A: diff > 0)
***Panel A:** GRI and non-GRI compliant firms:*						
DBI	GRI=1	2258	3.05	0.67***	12.61	0.000
	GRI=0	3410	2.38			
BIA	GRI=1	2280	0.04	0.02***	5.34	0.000
	GRI=0	3416	0.01			
***Panel B:** Pre- and post-Bio2020 Strategy periods:*						
DBI	Post-Bio2020	2436	3.35	0.99***	19.15	0.000
	Pre- Bio2020	3232	2.35			
BIA	Post- Bio2020	2448	0.04	0.02***	5.34	0.000
	Pre- Bio2020	3248	0.02			
***Panel C:** Firms with and without board gender diversity:*						
DBI	FemDir=1	3802	3.19	1.22***	22.63	0.000
	FemDir=0	1855	1.96			
BIA	FemDir=1	3824	0.04	0.03***	5.87	0.000
	FemDir=0	1861	0.01			
***Panel D:** Biodiversity-sensitive and biodiversity-insensitive industries:*						
DBI	Bio-sensitive ind	2897	3.34	1.15***	22.70	0.000
	Bio-insensitive ind	2771	2.19			
BIA	Bio-sensitive ind	2923	0.04	0.05***	7.94	0.000
	Bio-insensitive ind	2773	0.01			
***Panel E:** UK and other European countries:*						
DBI	EU	2930	3.06	0.58***	11.08	0.000
	UK	2766	2.45			
BIA	EU	2930	0.04	0.02***	4.12	0.000
	UK	2766	0.02			

Notes: *** indicates statistical significance at 1% level. GRI=1 indicates GRI-compliant firms that publish sustainability reports based on the GRI guidelines. Post-Bio2020 indicates a period from 2011 to 2016. FemDir represents a board with at least one woman director. Bio-sensitive industries include five industrial sectors such as gas & utilities, mining, construction materials, oil & gas, and industrials that cause greater environmental pollutions.

Table 6

Correlation matrix

Variables	DBI	BIA	Diversity	GRI	Bio2020	B.size	B.exp	Independ ence	Separation	ESG	CSR	EMS
DBI	1.00											
BIA	0.30***	1.00										
Diversity	0.26***	0.06***	1.00									
GRI	0.56***	0.17***	0.26***	1.00								
Bio2020	0.25***	0.07***	0.36***	0.23***	1.00							
B.size	0.35***	0.12***	0.04***	0.30***	-0.02	1.00						
B.exp	0.05***	0.04***	-0.01	0.06***	0.09***	0.09***	1.00					
Independence	0.06***	0.02	0.06***	0.03	-0.07***	-0.22***	-0.08***	1.00				
Separation	-0.12***	-0.02	-0.06***	-0.08***	0.00	-0.18***	-0.17***	0.05***	1.00			
ESG	0.24***	0.07***	0.15***	0.14***	0.27***	-0.01	-0.02	0.08***	0.10***	1.00		
CSR	0.49***	0.09***	0.29***	0.39***	0.36***	0.15***	0.02	0.05***	-0.01	0.29***	1.00	
EMS	0.34***	0.08***	0.05***	0.32***	0.10***	0.22***	0.03	0.02	-0.07***	0.08***	0.23***	1.00
Size	0.55***	0.14***	0.13***	0.46***	0.05***	0.59***	-0.02	0.01	-0.16***	0.12***	0.29***	0.33***

Note: Please see Table 2 for variable definitions. *** indicates statistical significance at 1% level.

Table 7

Three-way fixed-effects regression of Disclosure of biodiversity initiatives (DBI) score against gender diversity, institutional and control variables (Equation 1)

Variables	(1) Whole sample	(2) GRI-compliant firms	(3) GRI non-compliant firms	(4) Post-BioStrategy Period	(5) Pre-BioStrategy Period
Diversity	0.0128***	0.0157***	0.0108***	0.0121***	0.0106***
	(0.00228)	(0.00377)	(0.00280)	(0.00313)	(0.00331)
GRI	0.758***			0.604***	0.843***
	(0.0622)			(0.0888)	(0.0852)
Bio2020	0.637***	-0.0743	0.703***		
	(0.207)	(1.231)	(0.211)		
B.size	0.235**	0.395**	0.0461	0.396***	0.150
	(0.0916)	(0.167)	(0.112)	(0.126)	(0.135)
B.exp	0.0948*	-0.0246	0.126**	0.167*	0.0498
	(0.0492)	(0.0996)	(0.0558)	(0.0862)	(0.0606)
Connections	0.00446	-0.0761	0.0255	-0.0184	0.0384
	(0.0331)	(0.0621)	(0.0389)	(0.0497)	(0.0453)
Independence	0.00215**	-0.000655	0.00558***	0.00218	0.00329**
	(0.00100)	(0.00166)	(0.00127)	(0.00142)	(0.00138)
Separation	-0.124*	-0.0614	-0.209**	-0.296***	0.112
	(0.0690)	(0.109)	(0.0835)	(0.0984)	(0.0956)
ESG	0.202***	0.144	0.218***	0.117*	0.256***
	(0.0511)	(0.0933)	(0.0616)	(0.0679)	(0.0784)
CSR	0.531***	0.478***	0.460***	0.813***	0.346***
	(0.0542)	(0.118)	(0.0619)	(0.0791)	(0.0751)
EMS	0.139***	-0.0553	0.236***	0.0403	0.205***
	(0.0533)	(0.116)	(0.0583)	(0.0778)	(0.0728)
Tobin's Q	0.0495	0.223**	-0.00368	0.0790	-0.0147
	(0.0370)	(0.0941)	(0.0399)	(0.0560)	(0.0492)
Size	0.390***	0.523***	0.295***	0.394***	0.376***
	(0.0273)	(0.0471)	(0.0344)	(0.0380)	(0.0389)
Profitability	0.00350	0.0166***	0.00208	0.00643*	0.00163
	(0.00241)	(0.00582)	(0.00225)	(0.00374)	(0.00311)
Leverage	-0.0050***	-0.00668**	-0.00344**	-0.0067***	-0.00351*
	(0.00150)	(0.00296)	(0.00170)	(0.00227)	(0.00203)
Employees	0.00275	0.0323	-0.0101	-0.00669	-0.00240
	(0.0202)	(0.0331)	(0.0248)	(0.0282)	(0.0293)
Shareholders	0.0421*	0.0151	0.0760**	0.0942***	0.00930
	(0.0242)	(0.0416)	(0.0296)	(0.0332)	(0.0336)
Slack	-0.503**	-1.839***	-0.0797	-0.0532	-0.934***
	(0.203)	(0.503)	(0.212)	(0.297)	(0.288)
Intensity	0.650***	0.810***	0.575***	0.730***	0.580***
	(0.0677)	(0.116)	(0.0809)	(0.0895)	(0.0969)
Capex	-0.000992	0.00414	-0.00366	3.67e-05	-0.00475
	(0.00215)	(0.00259)	(0.00284)	(0.00290)	(0.00325)
Growth	-0.000141	-0.000154	-0.00023**	-0.0004***	0.000220*
	(8.93e-05)	(0.00017)	(0.00010)	(0.00013)	(0.00013)
Constant	-6.370***	-7.358***	-4.940***	-6.799***	-5.694***
	(0.444)	(1.422)	(0.550)	(0.559)	(0.608)
Country_Dy	Yes	Yes	Yes	Yes	Yes
Year_Dy	Yes	Yes	Yes	Yes	Yes
Industry_Dy	Yes	Yes	Yes	Yes	Yes
Observations	4,013	1,544	2,469	2,014	1,999
R-squared	0.582	0.479	0.433	0.585	0.567

Notes: ***, ** and * indicate statistical significance at 1%, 5% and 10% levels, respectively. The heteroskedasticity-adjusted robust standard errors are shown in parentheses.

Table 8

Logit regression of biodiversity impact assessment (BIA) against gender diversity, institutional and control variables

Variables	(1) Whole sample	(2) GRI-compliant firms	(3) GRI non-compliant firms	(4) Post-BioStrategy Period	(5) Pre-BioStrategy Period
Diversity	0.0391***	0.0424***	-0.0187	0.0459***	0.0349
	(0.0122)	(0.0139)	(0.0781)	(0.0174)	(0.0224)
GRI	1.134***			0.153	2.572***
	(0.409)			(0.434)	(0.778)
Bio2020	-2.307**	-6.729***	-4.646		
	(1.051)	(1.263)	(3.888)		
B.size	1.064	2.078***	-2.507	0.722	1.746
	(0.661)	(0.773)	(4.880)	(1.180)	(1.265)
B.exp	0.467	-0.428	12.82***	0.834	0.290
	(0.402)	(0.342)	(3.960)	(0.733)	(0.595)
Connections	-0.111	-0.0217	-1.900	0.142	-0.0699
	(0.174)	(0.246)	(1.567)	(0.222)	(0.324)
Independence	0.000650	0.00302	0.0651	-0.00504	0.0110
	(0.00483)	(0.00589)	(0.0465)	(0.00811)	(0.0130)
Separation	0.146	0.183	-8.525	-0.304	1.025
	(0.312)	(0.383)	(6.657)	(0.393)	(0.972)
ESG	0.579**	0.355	2.947*	1.001**	-0.151
	(0.279)	(0.320)	(1.532)	(0.419)	(0.753)
CSR	-0.500	-0.897*	-1.611	-1.054**	-0.174
	(0.421)	(0.458)	(1.791)	(0.537)	(0.648)
EMS	1.329***	1.680***	3.995**		-0.0520
	(0.416)	(0.652)	(1.586)		(0.634)
Tobin's Q	-0.299	-0.00159	-11.24**	-0.440	-0.638
	(0.300)	(0.404)	(5.334)	(0.439)	(0.448)
Size	0.279*	0.427**	-2.827**	0.261	0.115
	(0.154)	(0.192)	(1.177)	(0.240)	(0.257)
Profitability	-0.0148	-0.0257	0.109	0.00775	-0.0372**
	(0.0126)	(0.0181)	(0.0677)	(0.0179)	(0.0182)
Leverage	0.00131	-0.0256**	0.0256	-0.000236	0.0149
	(0.00904)	(0.0108)	(0.0603)	(0.0120)	(0.0205)
Employees	0.251*	0.292*	1.293***	0.378***	0.0537
	(0.136)	(0.175)	(0.443)	(0.141)	(0.285)
Shareholders	0.203	0.0491	5.915**	0.213	0.293
	(0.126)	(0.136)	(2.663)	(0.159)	(0.214)
Slack	-6.715***	-10.88***	-33.44**	-6.994***	-6.547
	(2.231)	(2.724)	(15.66)	(2.671)	(4.247)
Intensity	1.008***	0.750	9.123**	1.238***	0.850
	(0.344)	(0.459)	(3.991)	(0.452)	(0.814)
Capex	0.00998**	0.0160***	0.0294	0.0142	0.0216***
	(0.00397)	(0.00578)	(0.0765)	(0.0130)	(0.00757)
Growth	3.45e-05	-0.000140	0.00121	0.000271	-0.000109
	(0.000579)	(0.000893)	(0.00349)	(0.000764)	(0.000953)
Constant	-18.92***	-22.82***	-11.26*	-17.16***	-19.97***
	(2.668)	(3.572)	(6.088)	(3.492)	(5.076)
Country_Dy	Yes	Yes	Yes	Yes	Yes
Year_Dy	Yes	Yes	Yes	Yes	Yes
Industry_Dy	Yes	Yes	Yes	Yes	Yes
LR Chi^2	408.02***	282.05***	75.31***	138.92***	212.19***
Pseudu R^2	0.339	0.309	0.698	0.315	0.401
Observations	3,026	1,920	542	788	1,273

Notes: ***, ** and * indicate statistical significance at 1%, 5% and 10% levels, respectively. The heteroskedasticity-adjusted robust standard errors are shown in parentheses. We use logit regression to explain BIA, which is a binary dependent variable (see, Matsumura et al., 2014). For logit regressions, Pseudu R^2 measures how well the independent variables explain the dependent variable, with higher Pseudu R^2 value indicating better explanatory power of the model.