The role of women on boards in corporate environmental strategy and financial performance: A global outlook

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The role of women on boards in corporate environmental strategy and financial performance: A global outlook

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ABSTRACT

This study examines the impact of board gender diversity on corporate environmental strategy and financial performance. Based on 12 corporate environmental policies in 3389 firms worldwide, we identified four types of corporate environmental strategies by using the latent class regression model: an *inactive strategy*, a *reactive strategy*, a *pollution prevention strategy* and a *sustainable development strategy*. The empirical evidence shows that women on boards contribute to the promotion of proactive environmental strategies, including the *pollution prevention strategy*, which is found to bring about sustained competitive advantage in both short-term and long-term financial performance, and the *sustainable development strategy*, which is positively associated with long-term financial performance. Following the natural-resource-based view of the firm, these findings indicate that women on boards can be seen as a key resource in the organizational process, which provides a shared vision of the future and strong moral leadership to the top management team.

Keywords: Women on Boards, Corporate Environmental Strategy, Latent Class Regression Model, Pollution Prevention Strategy, Sustainable Development Strategy

1. Introduction

The spread of national public policies to increase the percentage of women on boards (WoB) has been going on for over ten years. Norway first introduced a gender-balance law with quota regulations for corporate boards in 2003, and afterward, countries in the EU, such as Sweden, Germany, Italy, France, and Spain, followed this initiative to increase the representation of women on boards (Adams, 2016; Seierstad, Warner-Søderholm, Torchia, & Huse, 2017; Valls Martínez, Cruz Rambaud, & Parra Oller, 2019). In addition, developing countries, such as China (Yu Liu, Wei, & Xie, 2014), India and Middle Eastern countries (Rao & Tilt, 2016), have also made efforts to increase the number of WoB. In Australia, the Australian Securities Exchange requires listed companies to adopt and disclose their gender diversity initiatives and gender proportions at all levels, including boards (Ali, Ng, & Kulik, 2014). Increasing the representation of women on boards is based on both ethical and social factors and is related to the issue of gender equality. However, the effects of women on boards on corporate strategy and performance and through what mechanisms these effects are manifested remain unknown.

To address this issue, a large number of studies have investigated the financial benefits of women on boards, including enhanced board effectiveness (Adams & Ferreira, 2009; Kim & Starks, 2016) and the controversial association between women on boards and corporate financial performance (CFP) (Conyon & He, 2017; Joecks, Pull, & Vetter, 2013; Yu Liu et al., 2014; Post & Byron, 2015). However, the "business case" of female directors cannot sufficiently explain their impact (Ferreira, 2015). Gender role theory suggests that the prosocial behavior of women is thought to be more communal and relational (Eagly, 2009), which could support a collective, such as a group or organization. At the firm level, female directors are found to be more benevolent and universally concerned but less power-oriented than men (Adams & Funk, 2012); this finding is linked to stronger stakeholder orientation. In this regard, empirical evidence has suggested that female directors can outperform in issues related to corporate social responsibility (CSR) (Bear, Rahman, & Post, 2010; Harjoto, Laksmana, & Lee, 2015; Landry, Bernardi, & Bosco, 2016; McGuinness, Vieito, & Wang, 2017; Rao & Tilt, 2016), especially in corporate environmental management.

Prior studies have usually used the CSR information disclosure score (Hermalin & Weisbach, 2012; Kaymak & Bektas, 2017; Qiu, Shaukat, & Tharyan, 2016; Xie, Nozawa, Yagi, Fujii, & Managi, 2019), the CSR performance rating (Scalet & Kelly, 2010), and specific environmental initiative or particular aspects of environmental issues (Ben-Amar, Chang, & McIlkenny, 2017; C. Liu, 2018) as indicators of corporate environmental management to investigate the effect of WoB. Furthermore, Li et al. (2017) introduced a comprehensive measurement of six specific items related to firm environmental policies. However, using these indicators failed to capture the interdependency among corporate environmental policies or the systematic patterns of voluntary environmental policies, which is an important feature of corporate environmental strategies (Juan Alberto Aragón-Correa & A. Rubio-López, 2007). The aforementioned studies strengthened the finding that "women are greener" but did not provide evidence of the role of WoB from a strategic point of view in corporate environmental issues. From the natural-resource-based view (NRBV) of the firm, the strategic choices regarding a series of

corporate environmental policies reflect environmental strategy. Faced with a natural environmental challenge, the adoption of a corporate environmental strategy is based on the firm's capability to facilitate environmentally sustainable economic activities and gain a sustained competitive advantage (S. L. Hart, 1995). This capability is supported by the key resources a firm possesses, such as physical or financial assets, employees' skills and organizational processes (J. Barney, 1991; J. B. Barney, Ketchen, & Wright, 2011). In this context, female presence on boards can be seen as a key resource that plays an important role in promoting corporate environmental strategy. However, regarding the antecedent of environmental strategies, previous studies on corporate environmental strategy have mainly paid attention to environmental protection regulations, stakeholder norms and top managers' environmentally friendly mindsets (Yi Liu, Guo, & Chi, 2015), but few have investigated the role of WoB.

Against this backdrop, this study applied a latent class regression model (LCRM) that allows us to simultaneously identify the unobserved corporate environmental strategies and examine the effects of WoB on these strategic choices. Following the NRBV and based on 12 environmental policies of 3389 firms worldwide for the years 2011-2016, we identified four types of corporate environmental strategies: an *inactive strategy*, a *reactive strategy*, a *pollution prevention strategy* and a *sustainable development strategy*. Our findings indicate that female presence on boards has positive effects on promoting proactive environmental strategies, especially the *pollution prevention strategy*, which is found to bring about sustained competitive advantage in both short-term and long-term financial performance, and the *sustainable development strategy*, which is expected to enhance future performance.

This study contributes to the existing literature in the following aspects. First, unlike previous WoB and CSR studies that have used corporate environmental performance (CEP), environmental disclosure indexes or a single environmental policy to indicate corporate environmental management, this study employed the conceptual framework of corporate environmental strategy to investigate the impact of WoB. To the best of our knowledge, this study is the first to investigate the role of WoB from the corporate environmental strategy perspective. Second, this study extends the empirical research based on the NRBV. As pointed out by Hart and Dowell (2011), due to the difficulty of defining sustainable development in the business context (S. L. Hart & Milstein, 2003) and the lack of firms committed to sustainable development in the past decade after the theory of the natural-resource-based view of the firm was developed in 1995, the studies on corporate environmental strategy have mainly focused on a *pollution prevention strategy* but seldom on the *sustainable development strategy*. Our findings provide new empirical evidence to support Hart's propositions about the proactive environmental strategy's facilitation of a firm's sustained competitive advantage and emphasize the important role of female directors in promoting the *sustainable development strategy*. Third, this study provides significant insights into upper echelons theory by incorporating the impacts of WoB on the choice of corporate environmental strategy and highlighting the important role of WoB in the top management team (TMT). As Ferreira (2015) criticized, the benefits to society should not be ignored

when discussing the business case for female board representation. The question is not whether the presence of women on boards matters but rather how and under what circumstances women on boards can benefit firm performance. Our findings provide a perspective of corporate environmental strategy to investigate the impact of the TMT and useful guidance for business practitioners, corporate decision-makers, investors and policy-makers concerning board gender diversity and corporate environmental management issues.

The paper is organized as follows. Section 2 reviews the related literature on women on boards and the effect of having women on boards on corporate environmental strategy and firm performance. Section 3 describes the investigated sample and variables used in this study. Section 4 explains the methodology, including the latent class regression model and panel data regression models. Section 5 presents the empirical results and discussion. Finally, we conclude in Section 6.

2. Literature review

2.1 Women on boards and corporate environmental strategy

In decision-making regarding a firm's strategic direction and what influences firm performance, the board of directors plays an important role in monitoring and advising (Hambrick, 2007; Hambrick & Mason, 1984). Prior studies have argued that female directors can improve board effectiveness in many aspects, resulting in the better monitoring of management (Adams & Ferreira, 2009) and enhanced board advisory effectiveness (Kim & Starks, 2016). However, the business case for female board representation can hardly sufficiently explain the impact of female directors; as asserted by Ferreira (2015), "when discussing policies that promote women in business, it is better to focus on potential benefits to society that go far beyond narrow measures of firm profitability." From the view of gender role theory, the differences in male and female behavior originated from culturally shared gender role beliefs (Eagly, 1987), which could imply different prosocial behaviors for women and men (Eagly, 2009). In the domain of prosocial behaviors, women are thought to be more communal and relational compared to men who are more agentic and collectively oriented as well as strength intensive (Eagly, 2009). Adams and Funk (2012) further found consistent results at the board level, suggesting that female directors are more benevolent and universally concerned but less power-oriented than men. This gender difference at the board level implies that female directors are more likely to have a stakeholder orientation (Adams et al., 2011).

To this end, a large body of the literature has discussed this issue by exploring the effect of female directors on CSR performance (Rao & Tilt, 2016). For example, Landry et al. (2016) found that firms with a higher percentage of WoB are more likely to appear on corporate recognition lists, including the Most Admired Companies, the Most Ethical Companies, the Best Companies for Work, and the Best Corporate Citizens. McGuinness et al. (2017) found that female leadership and increased female board presence strongly support CSR performance ratings. For corporate environmental management, Ben-Amar et al. (2017) provided evidence of the positive relationship between female directors and the volunteer disclosure of climate change-related information. However, one limitation to these

studies is that using CSR performance ratings or one particular environmental policy as indicators to investigate the impact of female board presence fails to capture the decision-making process and the interdependency among corporate environmental policies. Li et al. (2017) introduced a score measured on six specific items of firm environmental policies as an indirect and objective measurement to investigate the impact of board gender diversity. This measurement provided a comprehensive evaluation of environmental policy engagement but still did not clarify how those policies combined to shape different corporate environmental strategies and their connections to female board presence.

From the natural-resource-based view of the firm, facing increasingly complex environmental challenges, a firm's competitive advantage depends on a set of strategic capabilities that facilitate environmentally sustainable economic activities (S. L. Hart, 1995). These capabilities are reflected by distinct corporate environmental strategies that contain systematic patterns of voluntary environmental policies, beyond regulatory requirements (Juan Alberto Aragón-Correa & A. Rubio-López, 2007). In this context, Hart (1995) introduced three levels of environmental strategies: *pollution prevention, product stewardship, and sustainable development*. Each of these strategies has different environmental driving forces, depends on different key resources and brings about different competitive advantages (S. L. Hart & Dowell, 2011). Specifically, a *pollution prevention strategy* aims to reduce waste and emissions by the continuous improvement of production processes that reduce the inefficient use of materials and human resources rather than through expensive "end-of-pipe" capital investment, thereby leading to a potential competitive cost advantage. The *product stewardship strategy*, integrating stakeholder perspectives into the firm's product development process, applies life cycle analysis to minimize the environmental impacts during the product's entire lifecycle, facilitating product differentiation that may be competitively preemptive. Finally, a *sustainable development strategy* attempts to minimize the environmental burden of firm growth and development, which entails a shared vision of the future that requires strong moral leadership and an empowering social process that penetrates deep into the TMT.

The NRBV suggests that the adoption of corporate environmental strategies is supported by the firm's key resources (S. L. Hart, 1995). The concept of key resources, derived from the resource-based view of the firm, refers to something valuable and nonsubstitutable that a firm possesses, including physical or financial assets, employees' skills and organizational processes (J. Barney, 1991; J. B. Barney et al., 2011). As suggested by Hart (1995), the three environmental strategies are interconnected, in which the accumulation of key resources plays an important role in determining the degree of a firm's environmental strategic proactivity. On the one hand, a particular sequence of resource accumulation exists from the least proactive to the most proactive strategy. For example, without the successful accumulation of resources to implement the *pollution prevention strategy*, it would be difficult to adopt next-level strategies such as the *product stewardship strategy* or *sustainable development strategy*. On the other hand, synergies exist across these strategies, indicating a simultaneous or overlapping accumulation of resources for all three strategies. For instance, the shared

vision of the future that is required in the *sustainable development strategy* could be applied to all three strategies.

Given that in the domain of prosocial behavior at the board level, female directors appear to be more stakeholder-oriented, female board presence can be seen as an important key resource associated with corporate environmental strategy. Corporate environmental strategy contains a series of voluntary environmental policies, a latent feature reflecting a firm's strategic capability. Empirically, prior studies have usually identified these strategies by analyzing the observable variables of environmental policies based on the conceptual framework of the environmental strategy. Buysse and Verbeke (2003) applied cluster analysis and identified three environmental strategies in large firms, namely, the reactive strategy, the pollution prevention strategy, and the environmental leadership strategy. The reactive strategy is equivalent to an "end-of-pipe" strategy and uses the terms *reactive*, *defensive*, *accommodative*, and *proactive* (RDAP scale) to characterize a corporate strategy on social responsiveness (Clarkson, 1995). The environmental leadership strategy is similar to Hart's sustainable development strategy. Aragón-Correa et al. (2008) used principal component analysis and followed those terminologies to describe environmental strategies at different stages in small firms. However, regarding the antecedents of proactive corporate environmental strategies, most prior studies have investigated factors including environmental protection regulations, stakeholder norms and top managers' environmentally friendly mindsets (Yi Liu et al., 2015) while seldom mentioning the role of WoB. The role of female board presence in adopting and promoting corporate environmental strategy remains unclear. Understanding the antecedents of environmental capabilities is an important area (S. L. Hart & Dowell, 2011), and further research on the effect of WoB on corporate environmental strategy needs to be conducted to fill this gap.

2.2 Women on boards and corporate financial performance

Upper echelons theory illustrate the organizational process of how the TMT influences strategic choices and therefore leads to different levels of financial performance (Hambrick, 2007; Hambrick & Mason, 1984). Following this idea, the effect of WoB on financial performance includes the direct impact from WoB and the financial consequences of corporate environmental strategies that are predicted by the feature of the TMT. In previous studies, the relationship between WoB and firm financial performance has been found to be ambiguous. Post and Byron (2015) investigated the mixed effects of WoB on CFP and found that the association varies across firms' legal/regulatory and sociocultural contexts, which can change from country to country. Another explanation for the controversial association may be traced to the idea proposed by Kanter (1977) and referred to as critical mass theory on board gender diversity: this theory postulates that when the board has only one or two female directors, the female directors may just serve in a "token role", and their impacts on corporate decisions will be limited. Women on boards in a boardroom dominated by male directors might face difficulty in voicing their opinions, unless the number of female directors reaches a certain number: the "magic number" seems to be three (Kristie, 2011). Conyon and He (2017) suggested that a

nonlinear relationship exists between WoB and firm performance. Joecks et al. (2013) further found a U-shaped relationship between gender diversity and firm performance and that the turning point occurs when there are approximately three female directors.

For the financial outcomes of corporate environmental strategies, the link between environmental strategies and sustained competitive advantage or financial performance differs at different stages (S. L. Hart, 1995). A large number of studies have revealed the effect of pollution prevention strategies across industries and countries (Chen, Ong, & Hsu, 2016; Song, Zhao, & Zeng, 2017), but due to the lack of available evidence, attention has seldom been paid to product stewardship and sustainable development strategies (S. L. Hart & Dowell, 2011). After investigating a large sample of global companies, Miroshnychenko et al. (2017) suggested that pollution prevention and green supply chain management are the major environmental drivers of financial performance. At the same time, research has also focused on the effect of environmental disclosure as a legitimacy strategy to enhance firms' image and reputation (Lokuwaduge & Heenetigala, 2017). Although there have been fewer empirical studies conducted on the other two strategies, Hart (1995) suggested that the sustainable development strategy that aims to reduce a firm's global environmental impact should not be expected to generate short-term profits but rather to affect future performance, reflected by measurements such as the price-to-earnings ratio or market value.

3. Data

We constructed a global sample from the Bloomberg ESG (Environmental, Social, and Governance) database which provides data that cover over 900 fields of ESG topics. Bloomberg Professional Services collects ESG data from firms' direct resources, such as CSR reports, annual reports, proxy statements and corporate governance reports, company websites, and Carbon Disclosure Project data. From this database, we obtained 20,334 firm-year observations from 3389 firms for the years 2011-2016.

3.1 Women on boards, board composition, and firm characteristics

From the corporate governance data, we gathered variables including the percentage of women on boards, the percentage of independent directors, CEO duality, the average age of board members, and board size. We used asset turnover (ATO) and return on asset (ROA), the accounting-based measures, and Tobin's Q, a market-based measure, as the proxies of financial performance. ATO is calculated from the firm's revenue and total assets to measure the efficiency of a company's use of its assets. ROA is calculated from earnings before interest and taxes, interest expenditure, tax expenditure, and total assets. Tobin's Q (total market value divided by total assets) is used to indicate the market value. Control variables consist of financial leverage, firm size, R&D intensity and ESG compensation. We took the natural logarithm value of the total assets to indicate firm size, and liabilities to assets ratio as financial leverage. ESG compensation indicates whether executive compensation is linked to ESG goals. The descriptive statistics of each variable are shown in **Table 1**.

[Insert Table 1 about here]

3.2 Corporate environmental policy

From the environmental data, we obtained data on 12 corporate environmental policies associated with the conceptual framework in the NRBV introduced by Hart (1995). **Table 2** shows the detailed descriptions of these 12 corporate environmental policies adapted from the Bloomberg ESG database. According to the features of each policy, we classified these 12 policies into six categories as follows: (1) pollutant reduction policies including emissions reduction initiatives and waste reduction policy; (2) energy-efficiency-related policies including green building policy and energy efficiency policy; (3) climate-change-related policies that consist of climate change policy, climate change opportunities discussed, risks of climate change discussed, and new climate-change-related products; (4) environmental-management-related policies that include environmental quality management policy and environmental supply chain management; (5) sustainability-related policies including sustainable packaging; and (6) biodiversity policy.

The original data on these environmental policies are dummy variables to indicate whether certain policies have been implemented. Missing values indicate that there is no information about such policy. We recoded the data to reflect the strategic choices on each environmental policy based on two issues: information disclosure and policy implementation. Therefore, 3 actions of strategic decisions can be observed. Specifically, the policy with missing values is treated as Action 1, denoting that the firm neither implemented a certain environmental policy nor disclosed the related information[1]. The original data of "0" are treated as Action 2, indicating that the firm did not implement a certain environmental policy but disclosed that the policy had not been implemented. The original data of "1" are treated as Action 3, indicating that the firm not only implemented a certain environmental policy but also disclosed this information. The strategic choices of each policy in the whole sample are shown in **Table 2**.

[Insert Table 2 about here]

4. Methodology

4.1 Latent class regression model

The latent class model (LCM) is frequently used when the observed indicators are highly interrelated. The LCM attempts to seek the source of confounding between observed indicator variables by identifying unobserved or latent categorical variables, in which conditional on the latent variables, the responses to all of the observed indicators are assumed to be statistically independent; this association is typically referred to as local independence (Hagenaars & McCutcheon, 2002; Linzer & Lewis, 2011). This kind of association can be frequently found in the field of social and behavioral sciences, economics and corporate governance. For instance, Katayama et al. (2018) applied the latent

[1] It is assumed that there is no firm that implemented an environmental policy but did not disclose the information. Thus, the missing value of environmental policy in the original data is treated as Action 1.

class model to analyze the decision-making structures in firms and identified four kinds of structures from the observed data.

In our case, as shown in **Table 3,** the observed decisions on corporate environmental policies are highly correlated. We identified latent classes with similar choices of corporate environmental policies, and this finding indicates different environmental strategies. Furthermore, given the role of WoB in decision-making regarding corporate environmental strategies, we investigated how WoB is related to each type of strategy. For this investigation, we used the LCRM to simultaneously examine the latent classes (or unobserved strategies) of corporate environmental policies and the associations between latent classes and WoB.

[Insert Table 3 about here]

The LCRM extends the basic latent class model by including covariates (or concomitant variables) to predict class membership (Dayton & Macready, 1988; Hagenaars & McCutcheon, 2002). Compared with the basic latent class model that calculates the predicted posterior class membership probabilities first and then uses these values as dependent variables in a regression model, the "one-step" technique of the LCRM approach avoids the biased coefficient estimator (Bolck, Croon, & Hagenaars, 2004).

In the LCRM approach, if we observe J kinds of corporate environmental policies, then each policy has K_j choices for firms $i = 1, \dots, N$. Let E_{ijk} denote the observed values of a certain observed corporate environmental policy; then, $E_{ijk} = 1$ indicates that firm i chooses the kth action of the jth corporate environmental policy, and otherwise, $E_{ijk} = 0$, in which $j = 1, \dots, J$ and $k = 1, \dots, K$. We assume that there are R latent classes of corporate environmental strategies: let π_{jrk} denote the class-conditional probability that the firms in class $r = 1, \dots, R$ choose the k_{th} action of the j_{th} corporate environmental policy. Within each latent class, for each certain corporate environmental policy, $\sum_{k=1}^{K_j} \pi_{ijk} = 1$. Furthermore, let p_{ri} represent the prior probability of latent class membership, which represents the unconditional probability that a firm belongs to each class before taking into account the choice of each environmental policy, and for each firm, $\sum_r p_{ri} = 1$. The probability that a firm in a certain latent class makes a set of strategic choices regarding corporate environmental policies can be expressed as **Equation (1)**.

$$f(E_i; \pi_r) = \prod_{j=1}^{J} \prod_{k=1}^{K_j} (\pi_{jrk})^{E_{ijk}} \quad (1)$$

Then, we have the probability density function across all classes as below.

$$P(E_i|\pi, p) = \sum_{r=1}^{R} p_{ri} \prod_{j=1}^{J} \prod_{k=1}^{K_j} (\pi_{jrk})^{E_{ijk}} \quad (2)$$

The posterior probability of each firm's class membership, conditional on the observed value of environmental policies, can be obtained as **Equation (3)** by using Bayes' rule.

$$\hat{P}(r_i|X_i; E_i) = \frac{\widehat{p_{ri}} f(E_i; \widehat{\pi_r})}{\sum_{q=1}^{R} \widehat{p_{qi}} f(E_i; \widehat{\pi_q})} \quad (3)$$

The basic LCM assumes that every observation has the same prior probabilities of the latent class member, while the LCRM allows for the priors to vary depending on their observed covariates (Linzer & Lewis, 2011). Let X_i represent the covariates including the variable denoting WoB, other variables for board composition. Here, to avoid the problem of reverse causality, following the approaches applied by Joecks et al. (2013) and Liu (2018), we used a one-year lagged WoB to predict class membership. We further controlled for ATO, financial leverage, and firm size, which are the major financial factors significantly related to the absolute CEP from the perspective of material flow cost accounting (Yagi & Managi, 2018). A multinomial logit link function was employed to reflect the effects of the covariates on the priors (Agresti, 2002). As shown in **Equation (4)**, let the first latent class represent the reference class and assume that the log-odds of latent class membership priors with respect to the first class are linearly related to the covariates.

$$\ln\left(\frac{p_{ri}}{p_{1i}}\right) = X_i\beta_r \tag{4}$$

As noted above, for each firm, $\sum_r p_{ri} = 1$. Thus, we obtain the unconditional probability that a firm belongs to a certain class as below.

$$p_{ri} = p_r(X_i;\beta) = \frac{e^{X_i\beta_r}}{\sum_{q=1}^{R} e^{X_i\beta_q}} \tag{5}$$

By replacing p_{ri} in **Equation (3)** with the function $p_r(X_i;\beta)$ in **Equation (5)**, the posterior class membership probabilities in the LCRM are obtained as below.

$$\hat{P}(r_i|X_i;E_i) = \frac{p_r(X_i;\widehat{\beta})f(E_i;\widehat{\pi_r})}{\sum_{q=1}^{R} p_q(X_i;\widehat{\beta})f(E_i;\widehat{\pi_q})} \tag{6}$$

Maximum likelihood estimation is utilized to estimate the parameters, including the coefficients of covariates $\widehat{\beta_r}$, the priors $\widehat{p_{ri}}$ and the class-conditional probabilities $\widehat{\pi_r}$. To determine the number of classes, we used the Akaike information criterion, or AIC (Akaike, 1998), and Bayesian information criterion, or BIC (Schwarz, 1978), as the indicators of goodness of fit. The preferred model is the one with the minimum values of AIC or BIC.

4.2 Panel data regression model

To investigate the relationships among female directors, corporate environmental strategy and financial performance, we specified the following panel data regression models. We examined how female directors are related to CFP, as shown in **Equation (7)**, in which $\mathrm{CFP}_{\mathrm{it}}$ indicates dependent variables including ATO, ROA and Tobin's Q. Here, both ATO and ROA are used to measure short-term financial performance, given that ROA is an unstable indicator since it can be decomposed into factors such as ATO and profit margin that may be negatively correlated with each other (Yagi & Managi, 2018). X_{it} controls for the variables of board composition and firm characteristics. Here, we used the one-year lag of WoB as the independent variable to deal with the problem of potential reverse causality (Joecks et al., 2013; C. Liu, 2018). By using the variables of the identified latent class

membership of environmental strategies, we further explored how the environmental strategies are related to CFP, as shown in **Equation (8)**.

$$\mathrm{CFP_{it}} = \alpha_0 + \beta_w Women\ on\ Board_{i,t-1} + \beta_x X_{it} + \nu_i + e_{it} \quad (7)$$

$$\mathrm{CFP_{it}} = \alpha_0 + \beta_c Class_{it} + \beta_x X_{it} + \nu_i + e_{it} \quad (8)$$

In both the LCRM and the panel data regression models, we controlled for board composition and firm characteristics. Board independence contains two dimensions: the independent director, which is proxied by the percentage of independent directors on the board, and CEO duality, which indicates whether the company's CEO is also the chairperson of the board. In terms of the CSR issue, directors' individual attitudes toward CSR play an important role in the decisions of CSR practice. Previous evidence has shown that outside directors are less profit-driven and more sensitive to philanthropic endeavors than are inside directors (Ibrahim & Angelidis, 1995). Many studies have also argued that outside directors present not only shareholders' interests but also other stakeholders' interests (Rao & Tilt, 2016; Zhang, 2012). According to agency theory, the concern of CEO duality is that the lack of board independence would fail to limit managerial entrenchment and opportunism (Jensen & Meckling, 1976), which would have a negative impact on financial performance and harm the interests of shareholders. Regarding CSR issues, a chairperson who is also the CEO may place much more attention on corporate operations than on environmental or social issues. Previous studies have also provided evidence that CEO duality has a negative effect on CSR performance (de Villiers, Naiker, & van Staden, 2011; Webb, 2004). In addition, age can be treated as an indicator of management experience and maturity in directing the business (Hafsi & Turgut, 2013). Here, we used the average age of board members as a control variable. Regarding board size, Jizi et al. (2013) found that a larger board, usually treated as one that supports shareholders' interests, also promotes stakeholders' interests. A larger board is linked to strong environmental performance (de Villiers et al., 2011). However, Amran et al. (2014) found that there is no significant relationship between board size and sustainability reporting quality. In this study, we controlled for board size by using the number of board members. Firm characteristics such as ESG compensation, financial leverage, firm size, and industry are controlled for in both the LCRM and the panel data regression models. In the panel data regression models, we further controlled for the country dummies, as the association between WoB and financial performance varies across countries, as pointed out by Post and Byron (2015).

5. Results

5.1 The latent corporate environmental strategy

We ran the LCRM from 2 to 5 classes on our data. For the data-driven process, the optimal number of classes is based on the AIC and BIC. Lower values of AIC or BIC indicate a better fit. As shown in **Table 4**, both the AIC and BIC of the 5 classes are the lowest, which indicates that based on the data-

driven results, 5 classes should be the optimal classification. However, the estimated results of four classes are found to be more concise and accordant with the NRBV introduced by Hart (1995)[2].

[Insert Table 4 about here]

Figure 1 displays the four identified latent corporate environmental strategies. Following the typology developed by Hart (1995) and Buysse and Verbeke (2003), we named each latent class after the feature of strategic choices in each category of environmental policy, which is illustrated by the conditional probabilities of choice for each corporate environmental policy. First, the Class 1 strategy is called the *inactive strategy*: firms in this class have a high probability of having an Action 1 response for all environmental policies, which means that these firms will neither implement nor disclose any investigated environmental policy. Then, the Class 4 strategy is called the *reactive strategy*, since firms in Class 4 opt for Action 2 for all environmental policies, responding to the survey and disclosing the information about their environmental policies. However, it is important to note that the action of information disclosure here refers to disclosing the unfavorable information that the firm did not implement certain environmental policies but only shows the least responsiveness to environmental issues. The remaining classes present two different types of proactive environmental strategies associated with the NRBV. Under the Class 2 strategy, two policies are highly likely to be implemented: emissions reduction initiatives in the category of pollution reduction and an energy efficiency policy in the category of energy efficiency. The Class 2 strategy is called the *pollution prevention strategy*, denoting the strategy in which firms aim to reduce environmental emissions through enhancing the efficient use of energy rather than through expensive "end-of-pipe" capital investment (Buysse & Verbeke, 2003; S. L. Hart, 1995; S. L. Hart & Dowell, 2011). Firms in Class 3 are likely to implement the following: both emissions reduction initiatives and waste reduction policies in the pollution reduction category; both environmental quality management policies and environmental supply chain management in the environmental management category; energy efficiency policies; and climate change policies. To reflect this implementation, Class 3 is labeled the *sustainable development strategy* since this approach integrates the environmental management system into the production process and entails making efforts to address the global issue of climate change; it is similar to Hart's sustainable development strategy. For the estimated class population share**,** 35.7% of the investigated firms are likely to practice the *inactive strategy*, followed by the *pollution prevention strategy* (25.4%), the *sustainable development strategy* (23.3%), and the *reactive strategy* (15.7%).

[2] In the estimated results of the five classes, based on the definition of corporate environmental strategy in the NRBV, two of the classes can be seen as an identical strategy, *pollution prevention strategy* (see **Supplementary Table A3 and Table A4**), and are therefore classified as a similar class in the results of the four classes (see **Supplementary Table A1 and Table A2**). Furthermore, as for the association between strategies and financial outcomes, the results of four classes are consistent with those of five classes (see **Supplementary Table A7 and Table A8**).

[Insert Figure 1 about here]

5.2 Women on boards and corporate environmental strategy

In this section, the effects of female directors on the strategic choices of corporate environmental strategies are examined. In **Table 5**, the dependent variables for LCRM are the log-odds of latent class membership priors with respect to the first class, the *inactive strategy*. Thus, the coefficients indicate the effect on the log-ratio prior probability $\ln(p_{ri}/p_{1i})$, which denotes to what extent firms will choose a certain strategy against an *inactive strategy*. A one-year lagged variable of women on boards is used to avoid the problem of reverse causality. For the *reactive strategy*, the *pollution prevention strategy*, and the *sustainable development strategy*, the percentage of WoB exhibits positive and significant effects. Particularly, considering the magnitude of the coefficients, the effect of WoB is found to be stronger in the *sustainable development strategy*, followed by the *pollution prevention strategy* and the *reactive strategy*.

[Insert Table 5 about here]

Given that the association between female directors and environmental strategy may result from the various environmental regulations in different sectors, we introduced sector fixed effects into the LCRM. Then, following **Equation (6)**, we converted the log-ratios into predicted prior probabilities for each latent class by sector to display the marginal effect of female directors on environmental policy strategy. The results are shown in **Figure 2**. For all sectors, as the percentage of WoB increases, the probabilities of choosing both the *inactive strategy* and the *reactive strategy* decrease. In terms of the *pollution prevention strategy*, a positive relationship is found in the energy, financials, telecommunications service, and real estate sectors. Furthermore, in all sectors, the *sustainable development strategy* presents a positive relationship with WoB.

[Insert Figure 2 about here]

These results indicate that firms that have a higher percentage of women on their board are more likely to engage in proactive environmental management, which is consistent with gender role theory and the hypothesis of female directors' stakeholder orientation. Regarding information disclosure, regardless of favorable or unfavorable information, our results are consistent with prior studies showing that female presence on boards is positively related to voluntary CSR information disclosure (Ben-Amar et al., 2017; Valls Martínez et al., 2019). Beyond the least responsible and responsive environmental practice by choosing the *reactive strategy*, firms with more female presence on boards are more likely to step forward to the next stages of corporate environmental strategy, such as the *pollution prevention strategy* and *sustainable development strategy*. It is worth noting that the strongest positive relationship between WoB and the *sustainable development strategy* indicates that from the

NRBV perspective, female presence on boards can be seen as a key resource in the organizational process that provides a shared vision of the future and strong moral leadership to the TMT for adopting the *sustainable development strategy*. Moreover, this resource accumulation can be applied to all the other proactive environmental strategies and promote the corporate environmental strategy from one stage to the next. Among the remaining control variables, firm size, as an indicator of physical or financial assets, also presents a similar relationship with corporate environmental strategies.

5.3 Women on boards, corporate environmental strategy and financial performance

Table 6 shows the relationship between WoB and financial performance, and the financial outcomes of corporate environmental strategies predicted by WoB. First, we directly examined the financial effect of WoB, and the results show that there is no significant effect on ATO and ROA but a significant and positive relationship with Tobin's Q.

For corporate environmental strategies, first, the *reactive strategy* presents a positive and significant relationship with ATO without deteriorating profitability, while it has no significant relationship with firm value. As a step toward pursuing a proactive environmental strategy, the strategy in which the firm assumes the least responsibility for and exhibits the least responsiveness on environmental issues results in better short-term financial performance but fails to increase firm value since there is no positive response of the market to such unfavorable information. However, this result implies that transparency does not jeopardize financial performance. Second, the *pollution prevention strategy* is positively and significantly related to both ATO and Tobin's Q, but presents no significant relationship with ROA. These results are consistent with previous studies, indicating that pollution control practices could be beneficial to short-term financial performance (S. L. Hart & Ahuja, 1996; Maas, Schuster, & Hartmann, 2014). Finally, the *sustainable development strategy* has no significant relationship with both ATO and ROA but is positively and significantly related to Tobin's Q. Hart (1997) distinguished the *pollution prevention strategy* as a "greening" strategy that solves the environmental issues on today's products and the *sustainable development strategy* as a "beyond greening" strategy that focuses on tomorrow's technologies and markets. In this regard, the uncertainty associated with achieving a competitive advantage driven by a sustainable development strategy can hardly result in a positive relationship with short-term financial performance. In contrast, the benefits of the *sustainable development strategy* are reflected by the firm's market value, which implies a long-term vision. The relatively larger coefficient of the *sustainable development strategy* compared with that of the *pollution prevention strategy* also indicates that both the favorable information disclosure and the potential future position achievable through substantial technological change bring about higher market valuation.

[Insert Table 6 about here]

Furthermore, we performed a robustness analysis on the panel data regression models. The results are reported in **Table 7**. Following critical mass theory (Joecks et al., 2013; Kanter, 1977), we replace the percentage of WoB by using the dummy variable that indicates three or more female directors on the board. It presents a weak negative relationship between WoB and ROA. The results of impacts on ATO and Tobin's Q are consistent. Then, we use the posterior class membership probability of each environmental strategy as an independent variable to replace each firm's predicted class membership and rerun the regression models. The results of corporate environmental strategies consistently hold. These results also show that proactive environmental strategies, especially the *sustainable development strategy*, are more strongly related to market-based than accounting-based measures of CFP, which are consistent with the CEP-CFP relationships in previous studies (Busch & Lewandowski, 2018; Dixon-Fowler, Slater, Johnson, Ellstrand, & Romi, 2013), indicating that the financial benefits of enhancing the degree of environmental strategic proactivity are expected at least in the long run. Furthermore, the different effects on accounting-based performance demonstrate that the improvement in short-term CFP is mainly reflected by ATO rather than ROA. Given the instability of ROA which often leads to inconsistent empirical results (Yagi & Managi, 2018), our finding also indicates that using solely ROA as CFP indicator may neglect other potential financial impacts of corporate environmental strategies.

[Insert Table 7 about here]

Regarding the problem of endogeneity between corporate environmental strategy and short term financial performance, the results show that ATO in the previous year can hardly be seen as an important factor affecting the strategic choice of environmental management. First, as for the *reactive strategy*, there is a significant and negative link between ATO in the previous year and the choice of a *reactive strategy* rather than an *inactive strategy* (see **Table 5**), which indicates that the higher the ATO in the previous year is, the lower the probability of choosing a *reactive strategy*. Second, there is no significant relationship between a one-year lagged ATO and the choice of a *pollution prevention strategy*. Regarding the financial outcome resulting from practicing these environmental strategies, both the *reactive strategy* and *pollution prevention strategy* are found to be significantly and positively related to ATO in the current year. These results indicate that practicing environmental strategies is not driven by ATO; antithetically, such strategies may enhance ATO. Furthermore, the *sustainable development strategy* is found to have no significant relationship with ATO in the current year. However, a one-year lagged ATO is significantly and positively related to the choice of a *sustainable development strategy*. In this regard, ATO can be seen as the resource necessary for practicing a *sustainable development strategy*. Given the difficulty in accumulating resources for this capability, firms with low ATO are unlikely to be able to adopt a *sustainable development strategy*. On the other hand, the environmental driving force of the *sustainable development strategy* makes it difficult to bring about better short-term CFP. In addition, the results of a one-year lagged ATO in the LCRM

show relatively low significance. Thus, no sufficient evidence was found to consider ATO as an important determinant of the corporate environmental strategy, especially for a *reactive strategy* and a *pollution prevention strategy*. Instead, the corporate environmental strategy could be the source of a competitive advantage reflected by the firm's ATO.

Given the effect of female directors on the choice of environmental strategy noted above, firms that have a higher percentage of WoB are more likely to adopt a proactive environmental strategy, especially a *sustainable development strategy*, which is positively associated with long-term financial performance. These results further indicate that female presence on boards, as a key resource, plays an important role in providing a shared vision of the future to promote corporate environmental strategy.

6. Conclusions

Gender diversity on the board of directors has been widely discussed for decades, but studying the business case for female board representation cannot sufficiently explain the impact of female directors (Ferreira, 2015). Prior literature has provided empirical evidence to support gender policy on boards, but now the question is not whether to have women on boards but rather how and under what circumstances women on boards could benefit firm performance.

In this study, we examined 3389 firms' corporate environmental policies for the years 2011-2016 and investigated the impact of WoB on corporate environmental strategy and financial performance. Based on the disclosure and implementation of 12 corporate environmental policies, four types of corporate environmental strategies are identified by using the latent class regression model, including an *inactive strategy*, a *reactive strategy*, a *pollution prevention strategy,* and a *sustainable development strategy*. Our finding suggests that firms choosing the *inactive strategy* occupied 35.7% of the investigated sample, followed by the *pollution prevention strategy* (25.4%), the *sustainable development strategy* (23.3%), and the *reactive strategy* (15.7%). The presence of women on boards has a significant and positive impact on promoting proactive environmental strategies, such as a *pollution prevention strategy* and a *sustainable development strategy*. Furthermore, the financial benefits of female directors are reflected by the positive impact on the firm's market value rather than its profitability. The financial consequences of corporate environmental strategies suggest that firms adopting a *reactive strategy or a pollution prevention strategy* are found to have a better short-term financial performance. A *pollution prevention strategy* or a *sustainable development strategy* could lead to higher market value.

This study provides significant insights into gender diversity on boards from an environmental strategy perspective. The evidence of the female director's positive effect on promoting proactive environmental strategy indicates that WoB can be seen as a key resource enhancing a firm's capability of environmental management. For policymakers concerned with corporate gender policy and environmental policy, our findings provide a clear picture of the current situation and possible development of the corporate environmental strategy. For business practitioners, corporate decision-makers, and investors concerned with board gender diversity and corporate environmental

management issues, our findings provide scenarios about possible strategic directions associated with corporate environmental strategy when increasing female presence on boards and how these environmental strategies perform financially.

One limitation of this study is that due to insufficient information, we fail to identify the product stewardship strategy, another important stage of proactive environmental strategies associated with the NRBV. The manifest variables gathered from secondary data can hardly cover all the items related to the theory, which limits the analysis of the latent corporate environmental strategy. However, the current situation is that it is difficult to collect such detailed information for a very large sample through a questionnaire survey (Li et al., 2017).

Regarding this issue, we propose some ideas for future research. First, conducting an in-depth survey on corporate environmental policies for regional target samples and collecting more integrated empirical evidence on corporate environmental strategies could enhance the accuracy of latent strategy analysis. Furthermore, collecting and integrating updated environmental policy-related information disclosed by firms and applying content analysis to build a large dataset could also provide more detailed evidence of the role of WoB in corporate environmental strategy. Future research could also consider the interaction effect of WoB and other factors, such as managerial factors inside firms or business environment factors outside firms, to deepen our understanding of the role of WoB in strengthening firms' dynamic capability to conduct corporate environmental strategies.

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Table 1. Descriptive statistics of the variables

Panel 1. Board composition				
	Mean	SD	Min	Max
Women on board $_{t-1}$ (percentage)	8.50	10.78	0.00	71.43
Independent director (percentage)	49.29	31.35	0.00	100.00
CEO duality	0.46	0.50	0.00	1.00
Average age	59.90	5.13	25.13	97.00
Board size	9.24	2.73	3.00	28.00
Panel 2. Firm characteristics				
	Mean	SD	Min	Max
ATO	0.96	0.72	0.00	11.68
ATO $_{t-1}$	0.98	0.73	0.00	12.13
ROA	0.06	0.06	-0.26	0.88
Tobin's Q	1.24	1.22	0.002	22.63
Leverage	0.49	0.20	0.00	0.99
Firm size	21.45	1.68	15.65	27.29
RD intensity	0.03	0.08	0.00	1.27
ESG compensation	0.06	0.24	0.00	1.00

Note: This table presents the descriptive statistics of the variables. The investigated samples cover 48 countries or districts, among which the United States accounts for 42.96%, followed by Japan (28.42%), China (10.15%), the United Kingdom (2.42%), Hong Kong (2.12%), Canada (2.10%), Australia (1.39%), France (1.36%), South Africa (1.33%), Sweden (0.97%), Malaysia (0.65%), etc. The sector distribution is as follows: energy (4.16%), materials (9.21%), industrials (20.60%), consumer discretionary (14.87%), consumer staples (6.23%), health care (7.38%), financials (15.37%), information technology (12.39%), telecommunications services (1.09%), utilities (2.92%), and real estate (5.78%).

Table 2. Description of corporate environmental policies

Environmental Policy			Description	Strategic Choices		
				Action 1 Obs./ Freq.	**Action 2** Obs./ Freq.	**Action 3** Obs./ Freq.
Pollutant reduction	E1	Emissions Reduction Initiatives	Initiatives to reduce its environmental emissions	7,266 (35.73%)	4,072 (20.03%)	8,996 (44.24%)
	E2	Waste Reduction Policy	Initiatives to reduce the waste generated during the course of its operations	7,277 (35.79%)	5,423 (26.67%)	7,634 (37.54%)
Energy efficiency	E3	Green Building Policy	Policy of using environmental technologies and/or environmental principles in the design and construction of its buildings	7,268 (35.74%)	10,337 (50.84%)	2,729 (13.42%)
	E4	Energy Efficiency Policy	Initiatives to make its use of energy more efficient	7,280 (35.80%)	3,443 (16.93%)	9,611 (47.27%)
Climate change	E5	Climate Change Policy	Policy to help reduce global greenhouse gas emissions that cause climate change through its ongoing operations and/or the use of its products and services	7,266 (35.73%)	6,417 (31.56%)	6,651 (32.71%)
	E6	Climate Change Opportunities Discussed	Discussion about business opportunities related to climate change in management discussion and analysis (MD&A) and its equivalent section of the company's annual report	7,271 (35.76%)	12,924 (63.56%)	139 (0.68%)
	E7	Risks of Climate Change Discussed	Discussion about business risks related to climate change in management discussion and analysis (MD&A) and its equivalent section of the company's annual report	7,268 (35.74%)	11,529 (56.70%)	1,537 (7.56%)
	E8	New Products - Climate Change	Policy of developing and/or launching products, during the current period only, which address future impacts of climate change and/or which mitigate customers' contributions to climate change by reduced greenhouse gas (GHG) emissions. The products may or may not be new to the market	7,287 (35.84%)	12,795 (62.92%)	252 (1.24%)

Environmental management	E9	Environmental Quality Management Policy	Policy to introduce any kind of environmental quality management and/or environmental management system to help reduce the environmental footprint of its operations	7,266 (35.73%)	5,890 (28.97%)	7,178 (35.30%)
	E10	Environmental Supply Chain Management	Initiatives to reduce the environmental footprint of its supply chain. Environmental footprint reductions could be achieved by reducing waste, by reducing resource use, by reducing environmental emissions, by insisting on the introduction of environmental management systems, etc. in the supply chain	7,277 (35.79%)	7,620 (37.47%)	5,437 (26.74%)
Sustainability	E11	Sustainable Packaging	Policies to make its packaging more environmentally friendly	7,277 (35.79%)	11,333 (55.73%)	1,724 (8.48%)
Biodiversity	E12	Biodiversity Policy	Initiatives to ensure the protection of biodiversity. This might include trees and vegetation as well as wildlife and endangered species. Field is part of the Environmental, Social and Governance (ESG) group of fields	7,267 (35.74%)	9,518 (46.81%)	3,549 (17.45%)

Note: The trend of strategic choices regarding corporate environmental policies from 2011 to 2016 is shown in **Supplementary Figure A1.**

Table 3. Correlation of strategic choices regarding corporate environmental policies

	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10	E11	E12
E1	1.000											
E2	0.803	1.000										
E3	0.726	0.726	1.000									
E4	0.877	0.829	0.724	1.000								
E5	0.837	0.751	0.714	0.801	1.000							
E6	0.708	0.706	0.707	0.705	0.709	1.000						
E7	0.707	0.705	0.709	0.704	0.707	0.715	1.000					
E8	0.708	0.707	0.708	0.705	0.711	0.715	0.707	1.000				
E9	0.783	0.799	0.710	0.791	0.762	0.709	0.707	0.709	1.000			
E10	0.775	0.802	0.726	0.773	0.755	0.706	0.705	0.711	0.770	1.000		
E11	0.720	0.737	0.712	0.723	0.717	0.705	0.704	0.707	0.719	0.737	1.000	
E12	0.753	0.753	0.716	0.738	0.764	0.712	0.712	0.710	0.751	0.757	0.716	1.000

Note: This table shows Cramér's V values among the variables of corporate environmental policy.

Table 4. The goodness of fit of the LCRM by number of classes

Number of Classes	BIC	AIC	Log-likelihood
2 classes	177,270	176,684	-88,268
3 classes	142,388	141,406	-70,579
4 classes	134,737	133,359	-66,506
5 classes	133,918	132,144	-65,848

Note: This table shows the goodness of fit of the LCRM. Smaller values of AIC or BIC indicate a better fit.

Table 5. Results of the LCRM predicted by the percentage of WoB (4 classes)

Variables	**Class 2** *Pollution Prevention Strategy*	**Class 3** *Sustainable Development Strategy*	**Class 4** *Reactive Strategy*
Women on board$_{t-1}$	0.028***	0.036***	0.016***
	(0.003)	(0.004)	(0.002)
Board composition			
Independent directors	-0.023***	-0.051***	0.004***
	(0.001)	(0.001)	(0.001)
CEO duality	-0.664***	-0.146**	-0.214***
	(0.053)	(0.063)	(0.049)
Board size	0.032***	0.048***	-0.034***
	(0.010)	(0.011)	(0.011)
Average age	-0.113***	0.041***	-0.016***
	(0.005)	(0.007)	(0.005)
Firm characteristics			
ESG compensation	0.832***	1.834***	0.479***
	(0.141)	(0.153)	(0.149)
ATO$_{t-1}$	-0.004	0.100*	-0.070*
	(0.040)	(0.053)	(0.039)
Leverage	-1.655***	-2.032***	-2.187***
	(0.137)	(0.166)	(0.135)
Firm size	0.966***	1.659***	0.587***
	(0.022)	(0.032)	(0.021)
(Intercept)	-10.433***	-32.103***	-9.043***
	(0.438)	(0.690)	(0.425)
Sector fixed	YES	YES	YES
Year fixed	YES	YES	YES
Observations	20,334	20,334	20,334

Note: The significance levels are as follows: * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$. To test the robustness of latent class regression estimation, based on the critical mass theory, we replaced the one-year lagged percentage of WoB by using the one-year lagged dummy variable of three or female directors (see **Supplementary Table A5**). The results are consistent.

Table 6. Results of the fixed effects regression on corporate financial performance

Variables	ATO		ROA		Tobin's Q	
L1.Women on board	0.0005		-0.0001		0.004**	
	(0.0004)		(0.0001)		(0.002)	
Reactive strategy		0.037***		0.004		0.034
		(0.011)		(0.002)		(0.053)
Pollution prevention		0.030***		-0.001		0.153***
		(0.009)		(0.002)		(0.049)
Sustainable development		0.017		-0.0001		0.229***
		(0.011)		(0.002)		(0.052)
Independent directors	-0.002***	-0.002***	-0.00004	-0.00004	0.002*	0.002*
	(0.0003)	(0.0003)	(0.0001)	(0.0001)	(0.001)	(0.001)
CEO duality	0.001	0.001	0.0003	0.0002	-0.01	-0.01
	(0.009)	(0.009)	(0.002)	(0.002)	(0.025)	(0.025)
Average age	0.002	0.002	-0.0002	-0.0002	0.014***	0.013***
	(0.002)	(0.002)	(0.0002)	(0.0002)	(0.005)	(0.005)
Board size	-0.004***	-0.004**	0.00002	0.00002	0.007*	0.007*
	(0.001)	(0.001)	(0.0003)	(0.0003)	(0.004)	(0.004)
ESG compensation	-0.022	-0.021	-0.003	-0.004	0.06	0.06
	(0.018)	(0.018)	(0.003)	(0.003)	(0.039)	(0.040)
Leverage	0.170***	0.172***	-0.105***	-0.105***	-0.481***	-0.471***
	(0.043)	(0.043)	(0.009)	(0.009)	(0.173)	(0.173)
Firm size	-0.233***	-0.233***	-0.010***	-0.010***	0.079	0.068
	(0.015)	(0.015)	(0.003)	(0.003)	(0.056)	(0.055)
RD intensity	-0.732***	-0.733***	-0.390***	-0.389***	-1.184	-1.208
	(0.072)	(0.072)	(0.084)	(0.084)	(1.115)	(1.108)
Sector fixed	YES	YES	YES	YES	YES	YES
Country fixed	YES	YES	YES	YES	YES	YES
Observations	16,171	16,171	14,721	14,721	12,514	12,514
Hausman test	***	***	***	***	***	***
R2	0.13	0.132	0.086	0.087	0.015	0.017

Note: The table shows the regression results of corporate environmental strategy and female directors on ATO, ROA, and Tobin's Q. Class membership is predicted by the percentage of WoB. The significance levels are as follows: * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$.

Table 7. Robustness test of regression on corporate financial performance

Variables	ATO		ROA		Tobin's Q	
L1.Female directors >= 3	0.002		-0.003*		0.043*	
	(0.007)		(0.001)		(0.024)	
Reactive strategy (Pr.)		0.038***		0.003		0.029
		(0.012)		(0.002)		(0.056)
Pollution prevention (Pr.)		0.033***		-0.001		0.161***
		(0.010)		(0.002)		(0.054)
Sustainable development (Pr.)		0.003		0.001		0.222***
		(0.013)		(0.003)		(0.052)
Independent directors	-0.002***	-0.002***	-0.00004	-0.00004	0.002**	0.002*
	(0.0003)	(0.0003)	(0.0001)	(0.0001)	(0.001)	(0.001)
CEO duality	0.001	0.001	0.0003	0.0002	-0.01	-0.01
	(0.009)	(0.009)	(0.002)	(0.002)	(0.025)	(0.025)
Average age	0.002	0.002	-0.0002	-0.0002	0.014***	0.013***
	(0.002)	(0.002)	(0.0002)	(0.0002)	(0.005)	(0.005)
Board size	-0.004**	-0.004**	0.00002	0.00002	0.007*	0.007*
	(0.001)	(0.001)	(0.0003)	(0.0003)	(0.004)	(0.004)
ESG compensation	-0.021	-0.019	-0.003	-0.004	0.068*	0.063
	(0.018)	(0.018)	(0.003)	(0.003)	(0.039)	(0.040)
Leverage	0.169***	0.172***	-0.105***	-0.105***	-0.479***	-0.471***
	(0.043)	(0.043)	(0.009)	(0.009)	(0.173)	(0.173)
Firm size	-0.232***	-0.232***	-0.010***	-0.010***	0.083	0.068
	(0.015)	(0.015)	(0.003)	(0.003)	(0.056)	(0.056)
RD intensity	-0.732***	-0.732***	-0.390***	-0.389***	-1.184	-1.21
	(0.072)	(0.072)	(0.084)	(0.084)	(1.113)	(1.107)
Sector fixed	YES	YES	YES	YES	YES	YES
Country fixed	YES	YES	YES	YES	YES	YES
Observations	16,171	16,171	14,721	14,721	12,514	12,514
Hausman test	***	***	***	***	***	***
R2	0.13	0.132	0.086	0.087	0.014	0.017

Note: The table shows the robustness test of the regression on ATO, ROA, and Tobin's Q. The class membership is predicted by the percentage of WoB. The significance levels are as follows: * denotes $p < 0.1$, ** denotes $p < 0.05$, and *** denotes $p < 0.01$. We further used the latent classes predicted by the dummy variable of three or more female directors as the independent variable. The results are reported in **Supplementary Table A6** and show consistency. Moreover, we replicated the panel data regression by using the estimated results of five classes predicted by the percentage of WoB and the dummy variable of three or more female directors (see **Supplementary Table A7 and Table A8**). The results are consistent and robust.

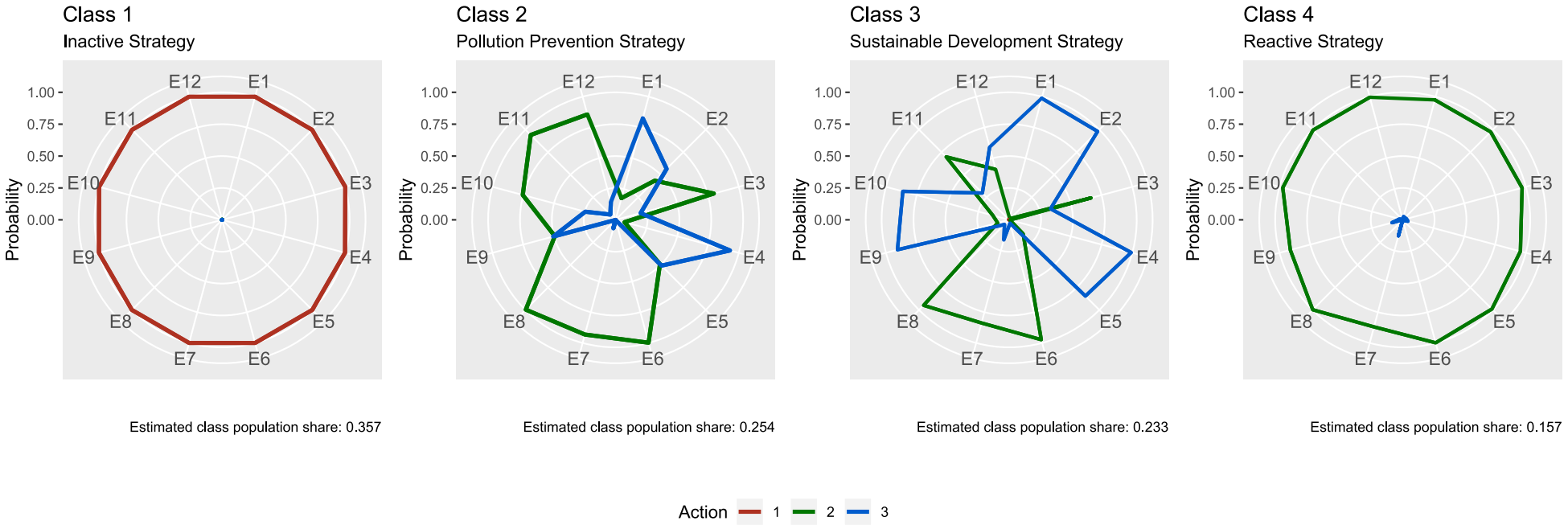

Figure 1. The four identified types of corporate environmental strategies

Note: Four types of corporate environmental strategies are identified as follows: Class 1, *inactive strategy*; Class 2, *pollution prevention strategy*; Class *3, sustainable development strategy;* and Class 4, *reactive strategy* (see **Supplementary Table A**1 for detailed results on the conditional probabilities of strategic choice for each corporate environmental policy).

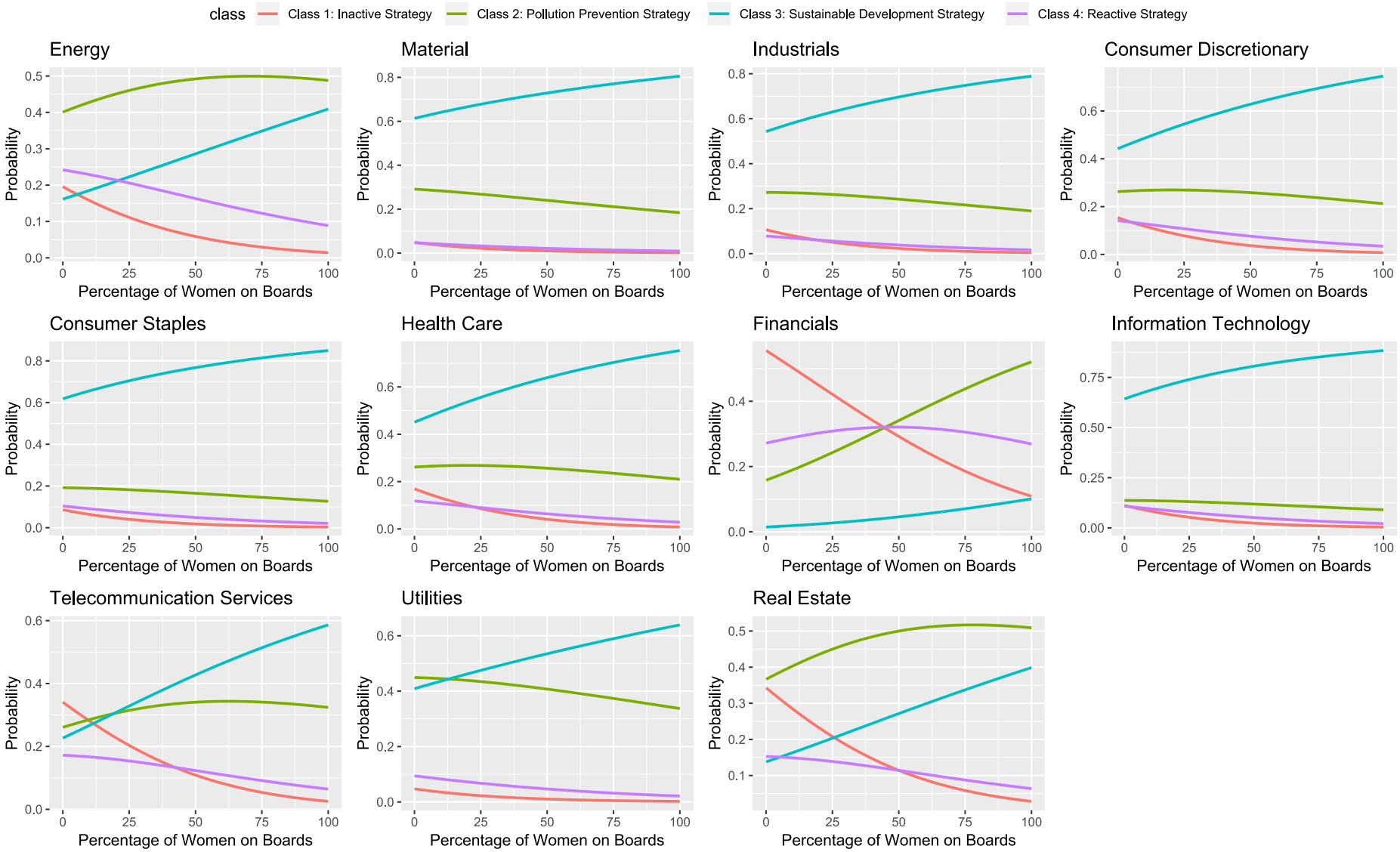

Figure 2. The marginal effect of women on boards on corporate environmental strategy by sector

Note: The figure shows the marginal effect of women on boards on the prior possibility of latent class membership by sector in 2015, given that the other variables are unchanged.