ENERGY TRANSITION DISCLOSURES AND FEMALE DIRECTORS: DO GENDER EGALITARIAN SOCIETIES MATTER?

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ABSTRACT

The fight against climate change and the energy transition requires significant business transformations and changes. In this sense, the information that companies report on their energy strategy is essential to understand and value business interest and efforts to contribute to the protection of ecosystems and human life on the planet.

In this regard, the aim of this article is to analyse the role that women directors are playing in business transparency in energy matters and whether their role is determined by the level of gender parity that characterizes the countries of origin of the companies analysed. The academic and practical interest lies in theories that associate gender equality with a greater concern for vulnerable systems and elements.

For a sample of 8,757 companies based in 65 countries, we observed that gender parity at the country level positively affects the information that companies report regarding their energy transition strategy towards more responsible models that help mitigate climate change. We also identified a mediating effect of board gender diversity on this relationship. The findings align with changes in methodological specifications. This evidence confirms the existence of a direct and indirect impact of equal development between women and men in a society on the energy transition and business inclusivity. Additionally, although these relationships are observed for the entire period analysed (2016-2022), the effect of the disruptive phenomena that occurred between 2020 and 2022 favours both business transformations and inclusivity.

Keywords: decarbonization; energy transition; board of directors; gender diversity; gender equality

INTRODUCTION

Climate change is a phenomenon that threatens the adequate maintenance of ecosystems (Ben-Amar & McIlkenny, 2015; Prado-Lorenzo and García-Sánchez, 2010) and exacerbates inequality among the population, especially affecting the groups with the greatest dependence on nature for their subsistence (Bashir et al., 2023; Makpotche et al., 2023). In this sense, the international community is strongly committed to the fight against climate change and the environmental and social damage that it entails, aiming for the neutrality of polluting emissions into the atmosphere between 2050-2100. Among the initiatives promoted to contain the increase in the planet's temperature, energy decarbonisation is essential (Ferreira et al., 2019).

In the business sphere, decarbonisation requires the adoption and implementation of an energy transition strategy focused on the use of renewable and/or less polluting energy, as well as the implementation of energy efficiency measures that facilitate a solid and adaptive business transition (Lee et al., 2020; Loock, 2020; De La Peña et al., 2022). Knowing and valuing the real efforts and resources that companies are allocating to these projects is strongly conditioned by the information that these organisations provide to their stakeholders.

In accordance with previous empirical evidence for other dimensions of sustainability, we can affirm that the energy transition and the information that companies disclose in this regard will

be strongly influenced by endogenous factors linked to the main corporate decision-making bodies (i.e. Raimo et al., 2021; Bravo & Reguera-Alvarado, 2019; García-Sánchez et al., 2023a), and by exogenous forces related to the pressure exerted by stakeholders and other institutional factors (i.e. Vitolla et al., 2019a; Zanellato & Tiron -Tudor, 2021).

More specifically, we know that the information provided by companies will be decisive in evaluating the progress and effectiveness of the transition (i.e., García-Sánchez et al., 2023b) and gender diversity is key in this area (i.e., Enciso-Alfaro & García-Sánchez, 2024a). The presence of women on boards of directors (WonB) promotes environmental protection, improving performance (i.e., Burkhardt et al., 2020; Birindelli et al., 2019; Lu & Herremans, 2019; Glass et al., 2016) and corporate transparency (i.e., Enciso-Alfaro & García-Sánchez, 2024a; Liao et al, 2015), while also avoiding greenwashing practices (Zahid et al., 2020).

However, there is a growing interest in understanding the role that female directors play in promoting specific environmental issues (Atif et al., 2021; Lemma et al., 2022; Gull et al., 2022; García-Sánchez et al., 2023b), as women usually assume responsibilities for the softer dimensions of sustainability (Campopiano et al., 2023) or exhibit an inverted U-shaped relationship with complex environmental policies (García-Sánchez et al., 2023a). Additionally, the work of Enciso-Alfaro & García-Sánchez (2024a) shows that implications in terms of the circular economy are conditioned by the cultural traits of masculinity and power distance in society.

In this sense, the objective of this study focuses on analysing the effect that a higher development of the essential pillars that equalise the opportunities between women and men in society (EFW) has on the information that companies report regarding their energy strategy for combating climate change (ESD). This is justified by the need to understand how gender equality can influence sustainable practices in companies, a topic that is unexplored in the current literature (Atif et al., 2021; Enciso-Alfaro & García-Sánchez, 2024a), and is specifically associated with the direct impact of the collectivism and femininity dimensions of national culture (Baldini et al., 2018; Miska et al., 2018; Vitolla et al., 2019b). In this vein, our research objective is divided into two research questions:

• Our first research question (RQ1) is: What is the direct effect that workplace gender equality has on business transparency, based on stakeholder and institutional theories?

According to these paradigms, companies respond to the information demands of their stakeholders and environments, in such a way that the interaction and feedback between both parties allow the establishment of effective strategies (i.e., Vitolla et al., 2019a; Boura et al., 2020; Zanellato & Tiron-Tudor, 2021). In this regard, we argue that the concerns of egalitarian societies are especially oriented toward protecting systems and elements in conditions of climate vulnerability, determining the specific interrelation in the case of information on the business energy transition (strategy to combat climate change).

• The second research question (RQ2) is: Is there an indirect effect of workplace gender equality on business transparency, associated with the mediating effect of female directors' presence in such decisions?

In this sense, we argue that the gender parity of a society improves WonB and, according to agency theory and upper echelons theories, WonB promote corporate transparency so that interest groups can evaluate the energy commitment and efforts that companies are making. Female concern for vulnerable groups and ecosystems is strongly associated with their learning processes and social interrelationships (Liao et al., 2015; Jizi, 2017; Qureshi et al., 2020; Alkhawaja et al., 2023; Issa & Zaid, 2023). In this sense, we argue that they contribute to the

resolution of these issues from the leadership positions they reach in environments that favour the acquisition of a solid base of technical and scientific knowledge, as well as experiences.

To answer both questions, we use a sample of 49,826 observations resulting from an unbalanced panel of 8,757 companies over the period 2016-2022. The results obtained allow us to accept the proposed research hypotheses, showing that EFW directly and indirectly impacts the information that companies present to different interest groups regarding their energy strategy. The analysis of the indirect effect allows us to confirm that societies that dignify the role of women through the establishment of essential pillars encourage a greater proportion of women in the boardroom, a diversity that drives the business transparency analysed.

Our findings contribute to the existing literature in several ways. Firstly, following García-Sánchez et al. (2023a) and Enciso-Alfaro & García-Sánchez (2024a), we present a novel measure to examine the information disclosed about corporate energy transition policies. The objective of our proposal is to assess the efforts and readjustments that organizations have implemented to achieve an effective and solid energy transformation, considering their commitments, actions and performance. To do this, we consider the various energy initiatives being developed within businesses to reduce the consumption of polluting energy through energy efficiency and the use of clean alternatives throughout the value chain. This approach extends the work of Atif et al. (2021), who focused on WonB and energy efficiency by exclusively considering renewable energy consumption.

Secondly, we contribute to the specialized literature on gender and business from works such as García-Sánchez et al (2023c; 2023d), Amorelli & García-Sánchez, (2023), Carvajal et al. (2022), Atif et al. (2021) and Liao et al. (2015), who study the impact that the presence of women in organizational leadership positions has on environmental proactivity. In this sense, we expand previous knowledge by identifying the existence of direct and indirect effects of advances in gender equality in society. Thus, the study of the degree of development of the essential pillars that dignify women and girls in society shows that providing them with the necessary resources is vital to advance corporate inclusivity and influence business actions in environmental matters.

Thirdly, the study of the direct effect allows us to expand the existing knowledge about the role that the institutional environment has in relation to female leadership. Works such as those of Uribe-Bohorquez et al. (2019), Atif et al. (2021) or Enciso-Alfaro & García-Sánchez (2024a) have shown that certain social patterns, especially those associated with more masculine cultures and greater power stratification, influence the business status of female directors. Thus, our research includes a more exhaustive and integrated approach, considering the degree of dignity of the role of women in society through the establishment of the essential pillars.

This document is structured into seven sections. Followed by the introduction, the next section reflects the conceptual framework from which we derive our research hypothesis. In the third section, we establish the measures and variables used, the empirical models to contrast the hypotheses and the econometric techniques employed. The fourth section presents the results obtained from the basic and robust models. The fifth section contains complementary results for the analysis of the essential pillars that dignify women at the level of business location regions. The sixth section presents the discussion of the findings. Finally, the seventh section presents the main conclusions, limitations and future directions of our research.

1. CONCEPTUAL FRAMEWORK, LITERATURE REVIEW AND RESEARCH HYPOTHESIS

2.1. Energy decarbonisation: a social necessity

Greenhouse gas (GHG) emissions such as carbon dioxide (CO_2), generated mainly by industrial activities carried out for decades, have negative effects on all types of life existing on planet Earth, affecting terrestrial, marine, and freshwater ecosystems (Enciso-Alfaro & García-Sánchez, 2024b).

The effect of climate change on terrestrial systems has caused an increase in diseases, mass mortality of plants and animals, and the loss of local species. Furthermore, the increase in temperature forces the movement of animals and plants to higher areas or latitudes, increasing the risk of extinction of certain species (Enciso-Alfaro & García-Sánchez, 2024a).

The consequences of a higher CO_2 concentration generate the alteration of the carbonate ion concentration in surface seawater (Richardson et al., 2023), which makes it difficult to build and maintain the structural integrity of organisms such as corals, among others. This can lead to the disappearance of reproduction spaces for marine species and, therefore, to the loss of marine biodiversity and the livelihoods of coastal communities (European Environmental Agency, 2024).

Climate change also leads to accelerated melting of glaciers, rising sea levels and flooding, affecting dependent coastal communities (Hock & Huss, 2021). To this must be added the alterations in rainfall patterns, the increase in torrential rains, and the intensity and prolongation of droughts (Burt et al., 2016). Extreme events that affect forests and grasslands increase the risk of forest fires and condition activities such as agriculture and livestock, affecting food security and economic development (Sturrock et al., 2011). Furthermore, the disappearance of species affects the balance of ecosystems and decreases their resilience to other challenges, such as deforestation and pollution (European Environmental Agency, 2024).

To mitigate its effects, it is necessary to reduce GHG emissions, and the promotion of responsible business models is vital. In this sense, corporate energy decarbonization represents a commitment to using fewer polluting technologies (Vestrelli et al., 2024). To do this, it is necessary to establish business strategies that allow for progressive and rapid change, in such a way that the threat of environmental degradation and the loss of the only natural environments where human life and the development of social and economic activities take place is mitigated (Hettler & Graf-Vlachy, 2024).

The commitment to the energy transition is the indisputable pillar of this demanded business change. In this regard, it entails a structural change in energy systems in the medium and long term with the aim of ensuring that companies can have the energy they need to operate without polluting. This model represents a clear commitment to reducing the current energy footprint by identifying energy efficiency opportunities and exploring renewable energy sources.

The information on energy transition reported by the company will constitute a useful instrument for analysing its commitment and real performance, helping to describe internal phenomena that, otherwise, would be very difficult to offer to public opinion. This information also serves the function of supporting decision-making by authorities and providing transparency in environmental information to the general public.

2.2. Gender parity in society and energy transition disclosures

The stakeholder theory (Freeman, 2010; Vitolla et al., 2019a) proposes that different interest groups play a determining and significant role in aspects such as sustainable performances or sustainable information disclosure through direct or indirect channels. These pressures arise because their interests, values and expectations require that they have the necessary information to examine and evaluate business actions (Yang et al., 2024).

In this sense, the institutional theory (Powell & DiMaggio, 2012; DiMaggio & Powell, 1983), proposes that companies are immersed in social structures that can facilitate or inhibit the corporate social purpose through the establishment of laws or shared social concepts that guide human and business behaviour, through formal or informal institutions. Along these lines, companies seek to legitimize themselves before their stakeholders, by becoming isomorphic and adapting to social concepts, aligned with social expectations and demands (Miska et al., 2018). For example, companies receive pressure in the form of demands to eliminate or correct possible harmful behaviours such as aquatic pollution (Oyewo et al., 2024) and waste dumping (Gull et al., 2022). They can also receive recognition for establishing sustainable environmental strategies and reporting on achievements (Helfaya & Moussa, 2017; Tingbani et al., 2020; Raimo et al., 2021).

The pressure that companies receive from stakeholders regarding the dissemination of information on environmental sustainability involves cultural values and perceptions (Vitolla et al., 2019a; Zanellato & Tiron-Tudor, 2021). In this sense, the findings of Mohamed Adnan et al. (2018) suggest that the pressure exerted by social demands is stronger than direct pressures from legislators, highlighting the importance of shared cultural knowledge on environmental preservation.

In this regard, Boura et al. (2020) show that the most environmentally transparent companies are those that listen to and involve society's demands in their corporate strategy. This integration is carried out by taking into account the formal and informal contractual responsibilities they have with the society where they are located. Likewise, Lemma et al. (2022) observed that the probability of companies disclosing sustainability information increases when they are located in societies with high concern for groups of individuals and disadvantaged elements of their environment, such as ecosystems.

On the other hand, in cultural contexts with high equality of opportunity and social cohesion, the environmental information revealed is less. According to Baldini et al. (2018), this is because managers identify that the local community is not in conditions of real vulnerability and, therefore, social well-being would be assured, regardless of business actions in social and environmental matters. Along these lines, Vitolla et al. (2019b) find that companies located in cultural contexts with strong characteristics of masculinity provide lower quality environmental information in their integrated reports. This effect is due to the fact that social and cultural beliefs are oriented towards achieving material success, paying little importance to the care of the weak and the implicit risks that could lead to a state of environmental vulnerability, so the stakeholders´ pressure on the disclosure of environmental information decreases.

Likewise, Miska et al. (2018) provide evidence on the important role that cultural values and practices based on gender egalitarianism play in business efforts to establish environmental sustainability practices. These authors argue that cultures that seek to minimize gender differences tend to diminish traditional thinking of focusing on self-expansion, focusing instead on community aspects of collaboration, care and protection, which are in line with the

underlying postulate of environmental sustainability (safeguarding the natural environment and reducing the environmental footprint of companies).

In this sense, the most gender egalitarian societies seek to eradicate the level of disparity in the opportunities offered to men and women through the establishment of EFWs that favour the advancement of women in terms of access to health services, educational achievements, and economic and political empowerment. Furthermore, they value women's opinions more and have greater empathy with the less fortunate (Hofstede, 1984, 2015). In this regard, we understand that these traits make them societies that are more sensitive to environmental problems and more demanding of business proactivity and the information that companies disclose.

Thus, according to previous literature, these demands will give rise to a business feedback process, where the behavioural pattern of local communities is the protagonist (Hillman et al., 2002; Tingbani et al., 2020; Zahid et al., 2020; Yang et al., 2024). To guarantee business survival in a social environment with great demands for ecosystem conservation, corporations will disclose clear and precise information about their current practices, the progress made and the challenges to be met regarding environmental care ((Ben-Amar & McIlkenny, 2015; Zahid et al., 2020; Konadu et al., 2022), in general, and with respect to the energy transition, in particular, in such a way that they find support and approval from their stakeholders (Feng et al., 2024; Lin et al., 2024; al., 2021). In this regard, we propose the first research hypothesis:

H1: A higher development of the essential pillars that equalize the opportunities between women and men in society (*EFW*) has a positive impact on energy transition disclosures (*ESD*), constituting a direct effect.

2.3. Women on boardroom and energy transition disclosures in inclusive societies

Over the years, the business world has made progress in achieving diversity in the workforce, but this progress remains limited in leadership positions where the glass ceiling persists due to business, societal and intrinsic reasons related to women's career choices (McKinsey & Company, 2023). In this regard, society's values shape and determine expectations of gender roles, inhibiting or favouring the promotion of WonB and supervisors (Tyrowicz et al., 2020: García-Sánchez et al., 2023c; Uribe Bohorquez & García Sánchez, 2023).

According to agency theory (Jensen & Meckling, 1979), the board of directors serves as an effective supervision, monitoring and control mechanism to prevent and correct opportunistic behaviours and information asymmetries (Vitolla et al., 2020). In this vein, female directors, compared to male directors, behave in accordance with an ethical standard that promotes quality and corporate transparency, enhancing the monitoring and supervision functions of this body (García-Sánchez et al., 2019a; Bravo & Reguera-Alvarado, 2019; Nadeem et al., 2020; Centinaio, 2024; Thus, it has been proven that WonB favour the reporting of environmental information derived from their efficiency in exercising their monitoring and control functions (Raimo et al., 2021) and reduce environmental violations within the companies they monitor. (Marchini et al., 2022).

Likewise, according to the upper echelons' theory (Hambrick & Mason, 1984), women directors bring different communication styles, beliefs, knowledge, skills and experiences. In this sense, their concerns are usually associated with the care of vulnerable elements of the environment (Huse & Grethe Solberg, 2006; Nadeem et al., 2020; Kyaw et al., 2022; Altunbas et al., 2022; García-Sánchez et al., 2023b). These concerns are derived from their learning processes (Ben Rejeb et al., 2019) and social interactions (Eagly & Steffen, 1984; Gilligan, 1993; Vitolla et al., 2019b; Zahid et al., 2020; Enciso-Alfaro et al, 2024). These traits mean

that women directors are more likely to reconcile and attend to the different perspectives of stakeholders (Altunbas et al., 2022) as these traits of benevolence and universalism guide them to promote strategies focused on ecosystem care and the dissemination of information on progress made (Carvajal et al., 2022).

Empirical research focused on the gender of directors indicates that WonB optimize the decision-making process associated with the prevention and mitigation of risks linked to the well-being of natural ecosystems, as well as the consequent disclosure of information (Liao et al., 2015). Previous research shows an improvement in corporate information disclosure practices on biodiversity conservation (Haque & Jones, 2020), climate change (Ben-Amar et al., 2017), circular economy (Enciso-Alfaro & García-Sánchez, 2024a), sustainable development (Jizi, 2017), ESG (Nuhu & Alam, 2023) and CSR (Lu & Wang, 2021), as well as the implementation of innovation strategies to combat climate change and polluting emissions (Nadeem et al., 2020; Kyaw et al., 2022; García-Sánchez et al., 2023a; Bazel-Shoham et al., 2024) or the adoption of SGDs (Taglialatela et al., 2023). However, some research shows a negative relationship due to problems of critical mass or the token effect that directors can display in certain contexts (Amran et al., 2014; Cucari et al., 2018; Kouloukoui et al., 2020).

In accordance with the above, we argue that in countries that seek to guarantee equal opportunities for men and women through EFW, women could acquire a solid base of technical and scientific knowledge, as well as experiences, that would enable them to perform an active role in business leadership positions, such as the boardroom. From these positions, they will express the importance of mitigating environmental problems and will promote the dissemination of information that allows us to understand business efforts regarding the energy transition. Therefore, we propose the second research hypothesis:

H2: A higher development of the essential pillars that equalise the opportunities between women and men in society (*EFW*) has a positive impact on energy transition disclosures (*ESD*), through women directors' active participation on the boardroom (*WonB*), constituting an indirect effect.

Figure 1 summarizes the relationships between essential pillars that equalize the opportunities between women and men in society, the dissemination of information on energy and the mediating role of gender diversity of the boardroom.

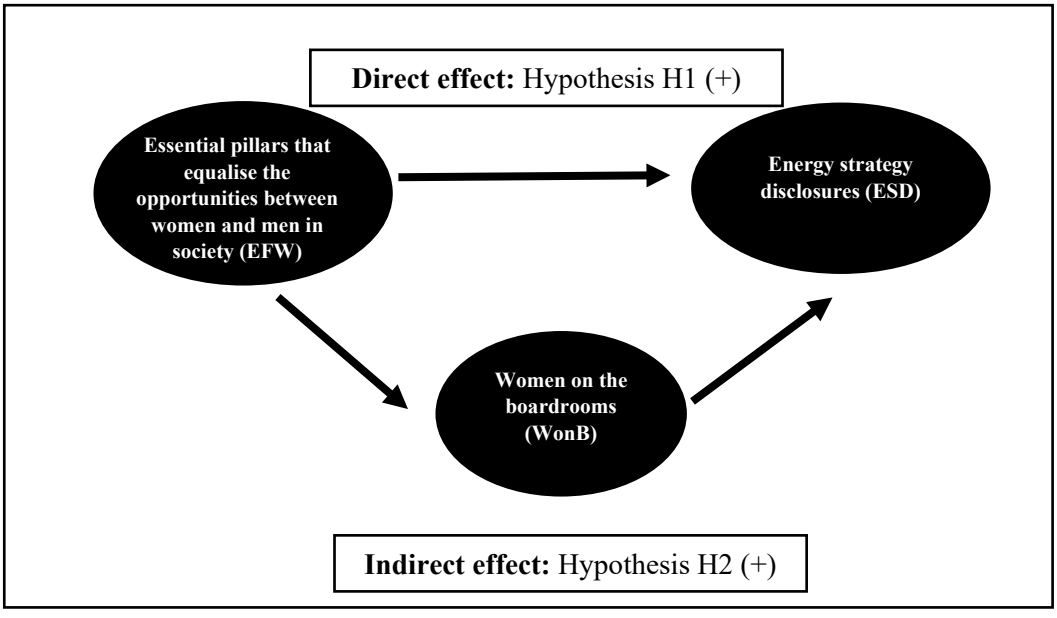


Figure 1. Gender equalitarian societies, female directors and energy disclosures

3. METHOD

3.1. Population and sample

To test the two research hypotheses, we considered the largest corporations worldwide as the target population, following the approach of previous studies. These large firms are the ones that show a greater commitment to sustainability and are subject to greater demands regarding the two aspects addressed in this work: the promotion of the energy transition (Lee et al., 2020; Bashir et al., 2023; Makpotche et al., 2023) and the contribution to full gender equality (Ben-Amar et al., 2017; Liao et al., 2015; García-Sánchez et al., 2023d). The consideration of an international approach allows for greater heterogeneity regarding the level achieved in EFW.

The initial population was determined by the number of large companies whose corporate information (ESG and economic-financial) is available in the Refinitiv database, which consists of more than 15,000 companies headquartered in 76 countries. The analysis period (2016-2022) was justified by the availability of information on the indicators of the essential pillars at the country level prepared by different organizations, considering one-year delay with respect to the year of publication.

The selection criteria for identifying companies of interest required that they had information related to the ESG score and economic-financial data during the period analysed. The criterion of availability of economic-financial information should be understood as a proxy for the quality of the companies' accounting information, which is fundamental for measuring financial performance and closely linked to the overall quality of corporate information (Martínez-Ferrero et al., 2015). The ESG score measures business performance regarding social, environmental and governance dimensions. Ensuring the availability of this information throughout the analysed period for each company guarantees a stable commitment to sustainability rather than isolated initiatives. Additionally, the existence of information for this score indicates that all projects the companies have implemented in relation to sustainability have been assessed. Thus, missing variables indicate that the company has not launched specific initiatives.

In this context, the final sample comprises a total of 49,826 observations related to 8,757 companies for the period 2016-2022. The headquarters of these companies are located in 65 companies located in 8 different geographical regions. Table 1 reflects the descriptive statistics of sample representativeness and the means of the main variables according to the region.

Table 1. Sample description

Region	Sample (%)	ESD	EFW	WonB
East Asia and the Pacific	29.20	6.08	0.69	13.59
Eurasia and Central Asia	0.66	7.78	0.64	14.17
Europe	22.25	6.82	0.78	28.81
Latin America and the Caribbean	3.78	6.20	0.72	9.87
Middle East and North Africa	1.76	4.44	0.65	7.14
North America	38.83	4.61	0.74	20.51
Southern Asia	2.02	7.05	0.65	15.35
Sub-Saharan Africa	1.49	6.53	0.77	27.48

3.2. Empirical models and variables conceptualization

Our research hypotheses propose that the degree of advancement of the essential pillars that equalise opportunities between women and men in society (EFW) has a direct and indirect

impact on the information that companies reveal regarding their energy strategy. The indirect effect is associated with a greater presence of women on the boardroom *(WonB)*. To test the existence of the mediating effect of WonB and the direct and indirect relationship between EFW and ESD, following Monteiro et al. (2022), we adopt the three-step procedure of Baron & Kenny (1986). This approach involves the estimation of 3 equations: in the first equation, we regress WonB (the mediator) on EFW (the independent variable); in the second, we regress ESD (dependent variable) on EFW t (he independent variable); and in the third, we regress ESD (dependent variable) on both WonB (the mediator) and EFW (the independent variable).

Equation 1. The dependency model allows to identify the effect of the *EFW* independent variable on the *WonB* mediator variable. In this equation we include a vector with different control variables to avoid biased results.

$$\mathbf{WonB}_{it} = \beta_0 + \beta_1 \mathbf{EFW}_{it} + \sum_{j=2}^{18} \beta_j \mathrm{Control}_{it} + \mu_{it} + \eta_i \textbf{ (Eq. 1)}$$

Equation 2. It is designed in order to determine the isolated effect of the independent variable (*EFW*) on the dependent variable (*ESD*). We also include a vector of control variables.

$$\mathbf{ESD}_{it} = \alpha_0 + \alpha_1 \mathbf{EFW}_{it} + \sum_{j=2}^{19} \beta_j \mathrm{Control}_{it} + \mu_{it} + \eta_i \textbf{ (Eq. 2)}$$

Equation 3. This model considers how the independent and mediator variables, *EFW* and *WonB*, impact jointly on the dependent variable (*ESD*).

$$\mathbf{ESD}_{it} = \delta_0 + \delta_1 \mathbf{EFW}_{it} + \delta_2 \mathbf{WonB}_{it} + \sum_{j=3}^{20} \delta_j \mathrm{Control}_{it} + \mu_{it} + \eta_i \textbf{ (Eq. 3)}$$

Where ***i*** ranges from company 1 to 8,757 and ***t*** takes the values of the years from 2016 to 2022. $\boldsymbol{\beta}$, $\boldsymbol{\alpha}$ and $\boldsymbol{\delta}$ are the estimated coefficients from all the variables -constant, independent, mediator and control- included in the three equations.

The existence of an indirect effect requires that in the first equation, *EFW* variable has a positive and significant impact on *WonB* mediator variable ($\beta_1 > 0$). In the third equation, the coefficient of *WonB* mediator is positive and statistically significant ($\delta_2 > 0$), and the effect of the *EFW* variable must be lower in this third equation than in the second equation ($\alpha_1 > \delta_1 > 0$). The direct effect of *EFW* variable implies that $\delta_1 > 0$ and is significant.

To determine the disclosure of information about the energy transition strategy at the business level, following Enciso-Alfaro & García-Sánchez (2024a) and García-Sánchez et al. (2023a), we have designed the ESD score that takes values between 0 and 13. This score is configured by aggregating 13 dummy variables that identify information about the commitment, actions and performance of companies in relation to their energy efficiency policy, their investment in renewable energies, and their implementation within the organization and its value chain. Table 2 shows the items used in creating the aggregate ESD indicator, as well as their frequency.

The indicators used to create the ESD score have been selected following the recommendations of international organizations such as the European Corporate Reporting Lab, the Sustainability Accounting Standards Board (SASB) or the Global Reporting Initiative (GRI), as well as the approaches used in previous works, although these are based on the use of total or renewable energy consumption (i.e., Atif et al., 2021) as a proxy for disclosure practices.

The information for the creation of the 13 items ENE1 to ENE13 has been extracted from Refinitiv according to a double verification process. To this end, the authors have jointly created a coding protocol and applied it individually. Subsequently, divergences in their assessments were identified and consensus was reached. This approach has been used in

various works (i.e., Zampone et al., 2023; Gallego-Álvarez and Pucheta-Martínez, 2020; Enciso-Alfaro & García-Sánchez, 2024a).

Table 2. ESD Score compositions

Energy commitment (0-3 points)	**1.35 (±1.05)**
ENE1. Information on energy efficiency policy.	64.25%
ENE2. Information on energy efficiency goals and objectives.	19.66%
ENE3. Information about how the policy includes its supply chain in the company's efforts to improve energy efficiency.	51.79%
Energy actions (0-5 points)	**1.72 (±1.20)**
ENE4. Information on environmental investments related to green buildings (associated with energy efficiency and the use of renewable energy).	22.28%
ENE5. Information on environmental investments related to clean technologies (associated with energy efficiency and the use of renewable energy).	22.70%
ENE6. Information on the reduction of energy requirements of sold products and services.	37.20%
ENE7. Information on green transport initiatives.	19.32%
ENE8. Information on environmental evaluation, audit or certification procedures (associated with energy efficiency and the use of renewable energy).	70.89%
Energy performance (0-5 points)	**2.61 (±0.75)**
ENE9. Energy consumption within the organization (in joules or multiples). • Total energy consumption. • Energy consumption by type of fuel. • Consumption by type of energy (i. electricity consumption; ii. heating consumption; iii. cooling consumption; iv. steam consumption).	99.93%
ENE10. Use of renewable energy by differentiating energy consumption between renewable and non-renewable sources.	41.11%
ENE11. Energy intensity according to specific parameters (denominator) for the previous items.	99.80%
ENE12. Reduced energy consumption as a result efficiency initiatives (excluding reductions due to outsourcing or reduction of production or productive capacity).	18.44%
ENE13. Information on energy consumption outside the firms (supply chain).	10.65%
Score ESD (0-13 points)	**5.69 (±2.61)**

The independent variable EFW corresponds to the total score of the Global Gender Gap Index prepared by World Economic Forum (2024), with the score expressed on a scale from 0 to 100 points. This index annually measures the situation of equal development between men and women at the country level and the efforts made to reduce the gaps that still exist, based on four essential pillars or key dimensions: survival, educational achievements, economic empowerment and political empowerment.

The first pillar, Survival, covers food security and access to health services, allowing girls and women to retain a set of natural capabilities that they can use for their human development (Agarwal, 2018). The second pillar, educational achievements, involves access to education for women in rural and urban environments facilitating the acquisition of technical and specialized knowledge and enabling formal employability (Carlsen, 2020). The third pillar, economic empowerment, includes opportunities and participation in the labor market allowing women to achieve economic autonomy (Awaworyi Churchill et al., 2019). The fourth pillar, political empowerment, guarantees the participation and incorporation of women in legislative development (Toh & Leonardelli, 2012).

In this context, the scores received by each country can be interpreted as the progress made in each society towards the joint achievement of the essential pillars, while the distance from that value to 100 indicates the percentage of gender disparity yet to be closed. The report published corresponding to the 18th edition compares the EFW in 146 countries, showing that it maintains the 101 countries present in all previous editions. This time series provides a basis

for a solid analysis of the level of achievement of the essential pillars between countries and their dynamic evolution over the analyzed period. The authors have compiled the information related to each country for each of the years from 2016 to 2022 and have merged it with the information base available in Refinitiv.

The mediating variable WonB, which identifies the gender diversity of the board of directors, corresponds to the proportion of female directors in this corporate governance body (i.e., Atif et al., 2021; Amorelli & García-Sánchez, 2020). This information is available in Refinitiv.

To avoid bias results, we include a vector of control variables for different firm, board and environmental characteristics according to Amorelli & García-Sánchez (2020), García-Sánchez et al. (2019a), Issa & Zaid (2023), Cucari et al. (2018), Liao et al. (2015), Haque & Jones (2020) and Konadu et al. (2022) among others. The variables related to business characteristics are proxies for the resources and capabilities available to companies and their visibility. These aspects are of great relevance in the promotion of sustainability initiatives and the dissemination of information because they represent the companies' ability to meet these demands and the pressure their public positioning entails (Vitolla et al., 2020). Corporate governance mechanisms are related to the effectiveness of the board of directors and the presence of institutional investors, all of which ensure more exhaustive supervision of corporate performance and transparency (Enciso-Alfaro & García-Sánchez, 2024a). The variables representative of the environment allows us to control the influence of different institutional pressures, in line with works such as those of Vitolla et al. (2019a and 2019b).

Additionally, we included numerical variables representing the heterogeneity of region, country, industry and year. Table 3 presents the definitions of the variables, the previous literature on which they are based, the expected sign, and the descriptive statistics of all control variables.

The ESD score and the WonB variable are censored taking values between a lower and an upper limit. Therefore, it is appropriate to estimate the proposed equations using Tobit regressions for panel data. This methodology allows for controlling the censored nature of the dependent variables and the consideration of the limits of their value intervals. This methodology involves a maximum likelihood estimator and random effects, whose consistency is guaranteed (Hair et al., 2017).

Furthermore, to ensure the robustness of our results against methodological specifications, we will estimate the proposed equations using linear regressions for panel data with fixed and random effects. The use of linear models provides great flexibility, simplicity, versatility and precision, making them suitable for data with different natures. This approach allows us to confirm the robustness and confidence of the evidence obtained using the Tobit methodology. The consideration of fixed and random effects also serves the same purpose, as censored regression only allows the use of random effects. Thus, the fixed effects model will confirm the results by correcting the bias generated by omitted observable variables that do not vary over time.

The indicated regressions correspond to models designed for panel data, which favor the control of unobservable heterogeneity, i.e., the existence of unobservable latent effects specific to each company analyzed, generally constant over time, that affect how they make the analyzed decisions. Additionally, panel data models increase variability and reduce collinearity between variables, leading to greater precision in the results obtained.

In the field of sustainability, researchers have identified endogeneity problems between the explanatory variables and the error term in a regression model, which can lead to inconsistent and biased estimates. To address this, we correct endogeneity problems by using a time lag in

the explanatory variables of the different equations. The use of time delay as an instrument corrects the correlation with the error term and guarantees it adequately represents the instrumented variable. The statistical program used is Stata and all estimates incorporate specifications to correct multicollinearity and heteroscedasticity problems.

Table 3. Variables

Panel A. Independent and mediator variables

Variable	Definition	Mean	Std.dv.
EFW	Essential pillars that equalise the opportunities between women and men in society	0,73	0,05
	• Survival: health and Survival score.	0,97	0,01
	• Educational achievements: educational Attainment score.	0,99	0,02
	• Economic empowerment: economic Participation and Opportunity score.	0,71	0,09
	• Political empowerment: political Empowerment score.	0,26	0,15
WonB	Proportion of women directors on the boardroom.	19,66	14,27

Panel B. Control variables

Variable	Definition	Authors	Expected sign	Mean/Freq.	Std.dv.
Social	Social score from the ESG measures of Refinitiv (0-100 points).	(Amorelli & García-Sánchez, 2020)	+	46,23	23,67
GRI	Dummy, takes value of 1 if the firms use this standard.	(Ali et al., 2023; Haque & Jones, 2020)	+	45%	
Assurance	Dummy, takes value of 1 if the sustainability report has been assured.	(García-Sánchez et al., 2019a)	+	33%	
Bact	Numbers of meetings of the board of directors.	(Issa & Zaid, 2023; Liao et al., 2015)	+	9,48	5,47
Bindep	Proportion of independent directors on the board.	(Cucari et al., 2018; Liao et al., 2015)	+	60,58	24,92
Duality	Dummy, takes value of 1 if the CEO is also the chair of the board.			33%	
CSRcomm	Dummy, takes value of 1 if the firms has created a sustainability committee in the board.	(Haque & Jones, 2020; Konadu et al., 2022)	+	50%	
Fsize	Logarithm of total assets as proxy of firms' size.	(Amorelli & García-Sánchez, 2023; Ben-Amar et al., 2017)	+	21,91	2,01
ROA	Return on assets as proxy of profitability.	(García-Sánchez et al., 2019b; Gull et al., 2022)	+	0,18	0,20
Leverage	Debt ratio.	(García-Sánchez et al., 2019b; Issa & Zaid, 2023)	-	0,00	6,92
WC	Working capital.	(Amorelli & García-Sánchez,	+	1,11	5,22

		2023; Konadu et al., 2022)			
Div	Annual dividend distribution policy-	(García-Sánchez et al., 2023b)	-	1,29	1,66
Invest	Annual firms' investment in tangible and intangible.	(García-Sánchez et al., 2023a)	+	19,14	1,89
InstInv	Presence of strategic investors in the shareholding measured by percentage of shares.	(García-Sánchez et al., 2023a)	+	5,99	8,45
EU	Dummy, takes value 1 for European Union member states since 2014, representing the sustainable initiatives in this region.	(Ali et al., 2023)	+	14%	
Shock	Dummy variable that takes value of 1 from 2020-2022 period in order to control the COVID-19 and Ukraine war events.	(Enciso-Alfaro & García-Sánchez, 2024a)	+	51%	
Region	Categorical variable that controls the institutional characteristics at geographic region level.	(Lemma et al., 2022; Mohamed Adnan et al., 2018)			
Country	Categorical variable that controls the institutional characteristics at country level.				
Industry	Categorical variable that controls the institutional characteristics at industry level.				
Year	Categorical variable that measures the particularities of the time period.				

4. RESULTS AND DISCUSSION

Table 4 shows the bivariate correlations between the variables designed to test the research hypotheses. The values indicate the absence of multicollinearity problems.

Table 4. Bivariate correlations (*** p<0.01, ** p<0.05, * p<0.1)

		1	2	3	4	5	6	7	8
1	ESD	1							
2	EFW	-0.01***	1						
3	WonB	0.18***	0.46***	1					
4	Social	0.70***	0.13***	0.29***	1				
5	GRI	0.48***	-0.06***	0.04***	0.48***	1			
6	Assurance	0.40***	0.01**	0.10***	0.42***	0.62***	1		
7	Fsize	0.44***	-0.21***	0.05***	0.43***	0.36***	0.32***	1	
8	Leverage	0.05***	0.09***	0.05***	0.08***	0.07***	0.05***	0.11***	1
9	ROA	0.01**	0.00	0.01*	0.01***	0.00	0.00	0.03***	0.00
10	WC	0.13***	-0.07***	-0.03***	0.11***	0.07***	0.07***	0.22***	-0.02***
11	Div	0.03***	0.02***	0.01*	0.02***	0.01	0.01**	0.02***	0.00
12	Invest	0.46***	-0.15***	0.09***	0.43***	0.29***	0.29***	0.73***	0.07***
13	InstInv	0.01	-0.01***	-0.01	-0.01**	0.02***	0.01**	0.00	-0.01***
14	Bact	0.07***	-0.02***	0.03***	0.06***	0.06***	0.05***	0.10***	-0.01**
15	Bindep	-0.11***	0.40***	0.31***	0.10***	-0.06***	-0.01***	-0.06***	0.14***
16	Duality	-0.05***	0.01***	-0.02***	-0.01**	-0.03***	-0.01***	0.02***	0.07***
17	CSRComm	0.60***	0.00	0.17***	0.56***	0.41***	0.30***	0.37***	0.05***
18	EU	0.23***	0.38	0.30***	0.23***	0.16***	0.21***	0.03***	-0.01**
19	Shock	0.10***	0.19	0.17***	0.10***	-0.07***	-0.13***	-0.04***	-0.04***
		9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
9	ROA	1							
10	WC	0.00	1						
11	Div	0.01***	0.01	1					
12	Invest	0.01	0.19***	0.02***	1				
13	InstInv	0.00	0.00	-0.01	-0.01**	1			
14	Bact	-0.03***	0.01*	-0.01**	0.05***	-0.01*	1		
15	Bindep	0.01	-0.03***	0.01**	-0.03***	-0.07***	-0.07***	1	
16	Duality	0.00	0.04***	0.03***	0.10***	-0.03***	-0.11***	0.14***	1
17	CSRComm	0.01**	0.08***	0.02***	0.32***	0.01**	0.06***	-0.06***	-0.07***
18	EU	0.00	-0.02***	0.00	0.07***	0.04***	0.08***	-0.05***	-0.08***
19	Shock	0.00	0.01	-0.01	-0.05***	0.01***	0.07***	0.01**	-0.03***
		17	**18**	**19**					
17	CSRComm	1							
18	EU	0.11***	1						
19	Shock	0.13***	0.04***	1					

Table 5 reflects the basic and robust models proposed in equations 1 to 3. In particular, Table 5 comprises nine columns. The first three columns present the results of the estimation of equation 1 with Tobit methodologies and fixed and random effects linear regressions, respectively. The next three columns reflect the results relative to equation 2 for the same methodological specifications. The last three columns reflect those related to equation 3. As

we previously mentioned, the Tobit approach is the most appropriate due to the censure nature of the dependent variable. Additionally, the results of the Hausman test indicate that fixed effects in linear models are preferable to random effect specifications.

Table 5 also include the global fit of the models: Log likelihood for Tobit regression and R-square for linear regression. The Log likelihood of the fitted model is used in the Likelihood Ratio Chi-Square (LR chi2) test to determine whether all predictors' regression coefficients in the model are simultaneously zero. The significance (p-value) of the LR chi2 test allows us to conclude that at least one of the regression coefficients in the model is not equal to zero, thus explaining the dependent variable and assessing how well each Tobit model fits the data. The coefficient of determination R-square indicates the proportion of variation in the dependent variable that is explained by the independent or control variables in the estimated linear regression model. The higher the R-square, the greater the explanatory power of the model.

Focusing on the first column of equation 3, which is Tobit specification, we observe that the impact of the EFW and WonB variables on the dependent variable ESD is positive and significant at a 99% confidence level. Specifically, the impact of EFW is $\delta_1 = 1.349$ and that of WonB is $\delta_2 = 0.00923$. In the case of the first column of equation 2, a model in which only the effect of EFW is analyzed, we also observe that it is positive and significant at a 99% confidence level. Furthermore, if we compare the impact of the EFW variable in equations 2 and 3, we verify that $\alpha_1 = 2.218 > \delta_1 = 1.349 > 0$. Additionally, analyzing the first column of equation 1 we can identify that the EFW variable has an impact of $\beta_1 = 93.80$ on the dependent variable WonB, which is a significant result at a 99% confidence level.

The empirical testing confirms the conditions specified by Baron & Kenny (1986) to determine the existence of an indirect effect: (1) EFW variable has a significant positive impact on WonB mediator variable $(\beta_1 > 0)$; (2) the coefficient of WonB mediator is significant and positive $(\delta_2 > 0)$ and (3) the effect of the EFW is lower in the third equation than in the second equation $(\alpha_1 > \delta_1 > 0)$. Additionally, we observe a direct effect of EFW variable, as indicated by $\delta_1 > 0$ and its significance. Please refer to Figure 2 for further details.

Thus, the evidence obtained allows us to accept the two proposed research hypotheses, confirming the existence of the direct and indirect effects of equal opportunities between men and women in society on the dissemination of information on energy transition reported by companies.

More specifically, the results of the effect of EFW on ESD confirm that gender equality promotes greater disclosure of energy-related information. This direct effect is linked to the fact that the essential pillars are strongly associated with social recognition and the promotion of environmental care and protection as fundamental axes to achieve human well-being. This evidence would complement the findings of Miska et al. (2018), Mohamed Adnan et al. (2018), Vitolla et al. (2019b) and Boura et al. (2020), specifically regarding business commitment to decarbonization through information disclosure that facilitates the assessment of their energy efforts. Thus, we confirm the importance of companies responding to the information demands of their stakeholders, facilitating interaction and feedback between both parties to establish effective strategies to combat climate change. Furthermore, we contradict the findings of Baldini et al. (2018), reaffirming that communities with high levels of well-being demand greater corporation disclosure. This is consistent with theoretical approaches regarding stakeholders' demands and the social legitimacy pursued by corporations.

In addition, the data show that the presence of women on the board is determined by the level of gender equality in societies and is associated with disclosure of energy-related information, as evidenced by the positive and significant coefficient of WonB on ESD. This indirect effect suggests that gender equality in society enables girls and women to acquire a foundation of professional and scientific knowledge, allowing them to hold influential positions in business decision-making processes. Together with the traits of female leadership, this facilitates women directors within organizations actively promoting information dissemination on energy transition, aligning with theoretical perspectives on enhanced boardroom oversight and providing new decision-making perspectives. Our findings are in line with previous literature demonstrating the positive and significant impact of WonB on various environmental sustainability reporting issues (i.e., Liao et al., 2015; Ben-Amar et al., 2017; Haque & Jones, 2020; Raimo et al., 2021. However, this evidence contradicts that of Kouloukoui et al. (2020), Cucari et al. (2018) and Amran et al. (2014), thereby encouraging greater participation of women in boardrooms in any case.

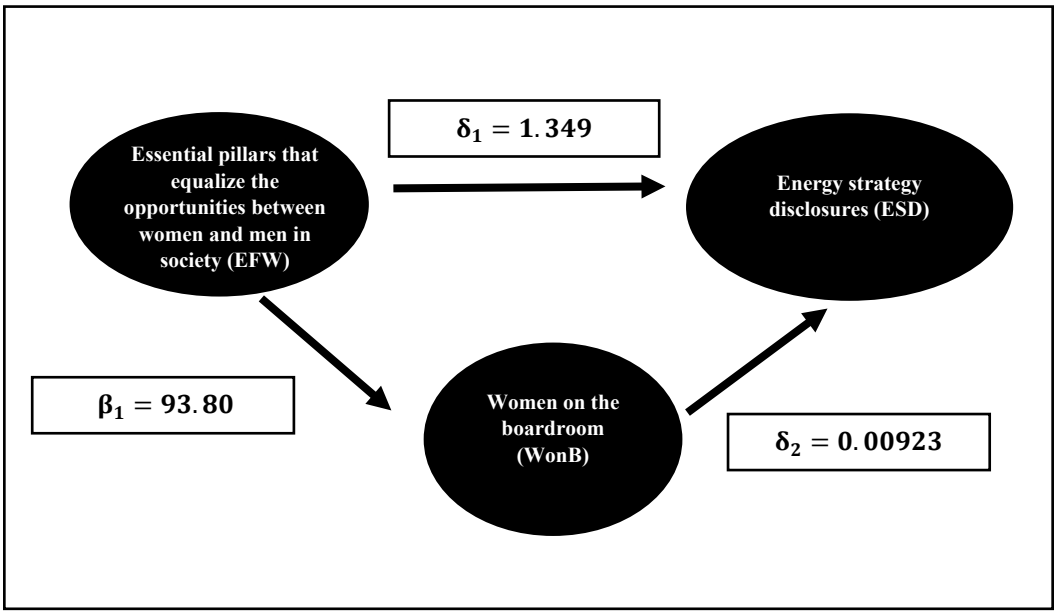


Figure 2. Direct and indirect effects

Table 5. Basic and robust results: different specification methodologies

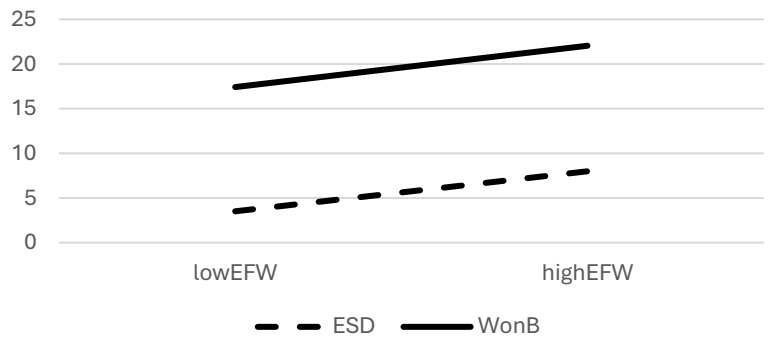
	Equation 1			Equation 2			Equation 3		
	Tobit	**Lineal FE**	**Lineal RE**	**Tobit**	**Lineal FE**	**Lineal RE**	**Tobit**	**Lineal FE**	**Lineal RE**
					Coeff. (Std. dv.)				
EFW	93.80***	78.54***	93.75***	2.218***	5.569***	2.035***	1.349***	5.037***	1.137***
	(2.614)	(3.565)	(2.618)	(0.421)	(0.576)	(0.414)	(0.432)	(0.584)	(0.425)
WonB							0.00923***	0.00644***	0.00955***
							(0.00107)	(0.00124)	(0.00107)
Social	0.0595***	0.0402***	0.0593***						
	(0.00469)	(0.00555)	(0.00468)						
GRI				0.316***	0.233***	0.328***	0.322***	0.236***	0.334***
				(0.0262)	(0.0279)	(0.0263)	(0.0262)	(0.0279)	(0.0263)
Assurance				-0.223***	-0.324***	-0.210***	-0.221***	-0.321***	-0.209***
				(0.0269)	(0.0288)	(0.0271)	(0.0269)	(0.0288)	(0.0271)
Fsize	0.0282	1.527***	0.0217	0.451***	0.390***	0.447***	0.449***	0.381***	0.446***
	(0.113)	(0.200)	(0.113)	(0.0178)	(0.0320)	(0.0172)	(0.0177)	(0.0320)	(0.0172)
Leverage	-0.0776	-0.00571	-0.0777	-0.235***	-0.120	-0.249***	-0.234***	-0.119	-0.247***
	(0.509)	(0.608)	(0.509)	(0.0817)	(0.0979)	(0.0812)	(0.0815)	(0.0978)	(0.0810)
ROA	2.190***	0.610	2.176***	0.189**	-0.0531	0.218**	0.173*	-0.0542	0.199**
	(0.563)	(0.639)	(0.563)	(0.0905)	(0.103)	(0.0905)	(0.0904)	(0.103)	(0.0904)
WC	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Div	-0.0103	0.0352	-0.0103	0.000975	-0.0349*	0.000991	0.00107	-0.0348*	0.00109
	(0.00664)	(0.112)	(0.00668)	(0.00105)	(0.0180)	(0.000997)	(0.00105)	(0.0180)	(0.000994)
Invest	0.608***	0.779***	0.607***	0.202***	0.130***	0.202***	0.194***	0.124***	0.194***
	(0.104)	(0.185)	(0.104)	(0.0165)	(0.0298)	(0.0160)	(0.0165)	(0.0298)	(0.0160)
InstInv	-0.136**	-32.71*	-0.137**	-0.0123	-0.338	-0.0127	-0.0117	-0.311	-0.0120
	(0.0583)	(18.76)	(0.0587)	(0.00924)	-3.023	(0.00873)	(0.00919)	-3.021	(0.00870)
Bact	0.0278**	0.0165	0.0276**	0.000108	0.00121	-3.39e-05	-0.000170	0.00108	-0.000327
	(0.0125)	(0.0136)	(0.0125)	(0.00202)	(0.00219)	(0.00203)	(0.00202)	(0.00219)	(0.00203)
Bindep	0.0786***	0.0505***	0.0783***	0.00141*	0.00159	0.00163**	0.00244***	0.000922	-0.00269***

	(0.00486)	(0.00627)	(0.00486)	(0.000776)	(0.00101)	(0.000765)	(0.000783)	(0.00102)	(0.000773)
Duality	0.286	0.311	0.287	-0.0233	0.000916	-0.0246	-0.0253	-0.00106	-0.0266
	(0.189)	(0.224)	(0.190)	(0.0304)	(0.0360)	(0.0303)	(0.0304)	(0.0360)	(0.0302)
CSRcomm	0.301*	0.147	0.299*	0.983***	0.672***	1.019***	0.972***	0.667***	1.006***
	(0.172)	(0.190)	(0.172)	(0.0271)	(0.0297)	(0.0266)	(0.0270)	(0.0297)	(0.0266)
EU	4.841***		4.850***	1.105***		1.111***	1.051***		1.055***
	(0.431)		(0.433)	(0.0687)		(0.0655)	(0.0687)		(0.0656)
Shock	3.297***	3.350***	3.300***	0.433***	0.444***	0.433***	0.403***	0.423***	0.402***
	(0.0993)	(0.111)	(0.0993)	(0.0160)	(0.0175)	(0.0161)	(0.0163)	(0.0179)	(0.0165)
Region	Yes		Yes	Yes		Yes	Yes		Yes
Country	Yes		Yes	Yes		Yes	Yes		Yes
Industry	Yes		Yes	Yes		Yes	Yes		Yes
Year	Yes		Yes	Yes		Yes	Yes		Yes
Constant	-68.33***	-67.24***	-68.41***	-9.673***	-9.159***	-9.488***	-8.946***	-8.552***	-8.746***
	(2.730)	(14.60)	(2.735)	(0.429)	(2.358)	(0.419)	(0.436)	(2.359)	(0.426)
Log likelihood	-80855.71***			-38631.52***			-38591.83***		
R-squared (overall)		0.203***	0.476***		0.202***	0.471***		0.217***	0.336***
Haussman test (chi2)		226.33***			1726.86***			1683.72***	

Note: *** p<0.01; ** p<0.05; * p<0.1
Sample = 8,757 firms (49,826 observations) Period: 2016-2022

The analysis of the coefficient results from the estimates using linear regressions, both with fixed and random effects, across the three equations (Table 5) confirms the robustness of the findings to variations in methodological specifications. At the bottom of the table, model fits and the Haussmann test are presented to asess the preference between fixed effects and random effects. Additionally, according to Panwar et al. (2015), Marquis et al. (2016) and Oh et al. (2018), among others, Figure 3 reflects the relationships analyzed using an interaction plot. This graph visually demonstrates a direct correlation between the number of female directors and the level of information disclosed by companies regarding energy transition. Importantly, this relationship is notably higher in societies characterised by greater gender equality.

Figure 3. Interaction plot for the relationships



Additionally, Table 6 shows robust results for various measurements of the ESD, EFW and WonB variables. Specifically, in the case of ESD it has been decided to divide it by the total value that the aggregate score would take, 13 points. The EFW variable is disaggregated into individual scores that measure the level achieved for each of the essential pillars: survival (Score_S), educational achievements (Score_EA), economic empowerment (Score_EEmp) and political empowerment (Score_PEmp). The WonB variable has been replaced by the Blau diversity index, calculated as $BI = 1 - \sum(Pi)^2$. The results confirm previous evidence, guaranteeing the robustness of the direct and indirect effects associated with closing the gender gap in opportunities at the country level concerning information disclosure on the energy transition.

From the econometric point of view, it is important to highlight that all the components of the EFW score positively impact the WonB and ESD variables at 99% confidence levels. However, an exception is observed for Score_S, which represents survival and lacks a statistically significant impact on gender diversity within the board of directors (WonB). This pillar represents food security and access to health services for girls and women, crucial for understanding business commitment to combat climate change but not directly affecting inclusivity in organizational leadership roles. The rest of the pillars are essential in promoting inclusivity and commitment to ecosystems in the business field.

Regarding the findings on control variables, we observe that larger companies, which make greater investments and have boards featuring independent directors and specialized sustainability subcommittees, demonstrate higher transparency. This aligns with previous research by Ben-Amar et al. (2017), who maintain that companies with greater financial resources are more inclined to disclose information regarding CO_2 emissions, to maintain a

positive reputation and ensure the operational continuity. Similarly, in agreement with Cucari et al. (2018), we confirm that a greater presence of independent directors on the boardrooms encourages the disclosure of environmental sustainability information to meet stakeholders' demands. Additionally, according to Haque & Jones (2020), we hire companies with specialized sustainability committees to reinforce greater disclosure of information related to climate change.

We also observe that the shocks that have characterized the 2020-2022 period (COVID-19 pandemic and Ukraine war), and the initiatives launched within the EU positively affect both decisions, results that are aligned with the evidence of Ali et al. (2023) and García-Sánchez et al. (2023d). These results indicate that business efforts for post-pandemic recovery and the energy problems caused by the war in Ukraine are important drivers of the energy transition and the information that companies issue abroad so that their stakeholders know their commitments. In this sense, it can be stated that the uncertainty associated with the aforementioned context has revealed the insecurity of the production and consumption model, which is highly delocalized, based on fossil energies and with growing needs for materials and energy. COVID-19 has also made clear that there are close interrelationships between environmental protection, health and the survival of humanity. On the other hand, the institutional effect of the regulatory frameworks and initiatives that are being developed in Europe confirms the evidence obtained by García-Sánchez et al. (2023c). In this regard, the Green Deal and other developments that the EU has been making in terms of sustainability are clearly promoting a responsible business model.

Additionally, the use of the international GRI standard promotes the availability of more complete public information on the corporate energy strategy, being in line with the findings of Ali et al. (2023) and Haque & Jones (2020). However, we show the opposite effect for hiring a service to verify the sustainability information reported by companies. A finding that, according to Haque & Jones (2020), is a consequence of the fact that companies may be more reluctant to implement, at the same time, different mechanisms related to information quality standards. This decision would be motivated by the expenses that they entail and that would lead them to adopt a single mechanism, betting on GRI standards.

Table 6. Robust results: changes in the measures

	Equation 1	**Equation 2**	**Equation 3**
		Coeff. (Std. dv.)	
Score_S	0.0748	1.528***	1.511***
	(0.0944)	(0.103)	(0.102)
Score_EA	0.354***	1.242***	1.233***
	(0.0630)	(0.0684)	(0.0683)
Score_EEmp	0.258***	0.160***	0.179***
	(0.0180)	(0.0196)	(0.0195)
Score_PEmp	0.236***	0.111***	0.0931***
	(0.00835)	(0.00908)	(0.00922)
BlauIndex			0.0715***
			(0.00703)
GRI	0.00636***	0.0242***	0.0246***
	(0.00183)	(0.00200)	(0.00200)
Assurance	-0.0101***	-0.0153***	-0.0147***

	(0.00188)	(0.00205)	(0.00205)
Fsize	0.00260**	0.0338***	0.0336***
	(0.00125)	(0.00136)	(0.00135)
Leverage	0.00200	-0.0142**	-0.0143**
	(0.00572)	(0.00623)	(0.00622)
ROA	0.0346***	0.0112	0.00916
	(0.00632)	(0.00689)	(0.00688)
WC	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)
Div	-8.35e-05	6.64e-05	7.30e-05
	(7.40e-05)	(8.01e-05)	(7.96e-05)
Invest	0.00862***	0.0139***	0.0132***
	(0.00116)	(0.00126)	(0.00126)
InstInv	-0.00181***	-0.00149**	-0.00142**
	(0.000651)	(0.000704)	(0.000699)
Bact	9.84e-05	-4.37e-05	-5.48e-05
	(0.000141)	(0.000154)	(0.000154)
Bindep	0.000976***	5.89e-05	-3.79e-05
	(5.53e-05)	(5.99e-05)	(6.05e-05)
Duality	0.00257	0.000979	0.000936
	(0.00214)	(0.00232)	(0.00232)
CSRcomm	0.0129***	0.0705***	0.0695***
	(0.00188)	(0.00207)	(0.00207)
EU	0.0599***	0.0771***	0.0726***
	(0.00492)	(0.00533)	(0.00531)
Shock	0.0362***	0.0326***	0.0301***
	(0.00112)	(0.00123)	(0.00125)
Region	Yes	Yes	Yes
Country	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
Constant	-0.558***	-0.735***	-0.710***
	(0.105)	(0.114)	(0.113)
Log likelihood	22857.60***	20903.46***	20953.22***

Note: *** p<0.01; ** p<0.05; * p<0.1
Sample = 8,757 firms (49,826 observations) Period: 2016-2022

Finally, to ensure that our results are not subject to sample selection bias, we estimate a two-step analysis proposed by Heckman (1979). This involves first estimating a function that considers all firms, including those with and without female directors, and a second model that explains the presence of WonB. From the residuals of this estimation, we compute the Inverse Mills Ratio (IMR). Later, we estimate the initial Tobit model incorporating the IMR as an additional regressor. If it is significant, it indicates the presence of selection bias; otherwise, our evidence would suggest no selection bias.

In this vein, it is evident from the third column of Table 7 that the coefficient of the IMR is not statistically significant. These results confirm that our evidence does not suffer from sample selection bias.

Table 7. Robust model: Heckman procedure

	Heckman		
	First step	**Second step**	**Tobit**
	Equation 2	**Equation 1**	**Equation 3**
	Coeff. (Std.dv)		
IMR			-0,937
			(0.932)
EFW	7.435***	6.678***	1.289***
	(1.002)	(0.350)	(0.445)
Social		0.00850***	
		(0.000661)	
GRI	0.634***		0.254***
	(0.0681)		(0.0260)
Assurance	-0.133*		-0.211***
	(0.0701)		(0.0267)
Fsize	0.366***	-0.0115	0.468***
	(0.0283)	(0.0118)	(0.0175)
Leverage	-0.675***	0.198**	-0.393***
	(0.166)	(0.0771)	(0.0810)
ROA	0.219	0.526***	-0.256***
	(0.217)	(0.0847)	(0.0916)
WC	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Div	0.00135	-0.000380	0.00103
	(0.00149)	(0.000915)	(0.00103)
Invest	0.0832***	0.0805***	0.125***
	(0.0262)	(0.0106)	(0.0166)
InstInv	0.0110	-0.0162***	0.00452
	(0.0118)	(0.00398)	(0.00908)
Bact	-0.00645	0.00626***	-0.00289
	(0.00560)	(0.00239)	(0.00200)
Bindep	-0.0168***	0.0111***	-0.0120***
	(0.00181)	(0.000630)	(0.000892)
Duality	0.0795	-0.0641**	0.0153
	(0.0637)	(0.0268)	(0.0301)
CSRcomm	1.358***	0.0931***	0.830***
	(0.0697)	(0.0292)	(0.0276)
Shock	0.813***	0.131***	0.759***
	(0.0983)	(0.0504)	(0.0690)
EU	0.164**	0.282***	0.172***
	(0.0647)	(0.0245)	(0.0194)
Region	Yes	Yes	Yes
Country	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
Constant	3.538***	-6.447***	-3.857***

	(1.079)	(0.357)	(0.493)
Log likelihood	-7021.8986***		-38352.533***
Pseudo R-squared	0.205***		

Note: *** p<0.01; ** p<0.05; * p<0.1
Sample = 8,757 firms (49,826 observations) Period: 2016-2022

5. COMPLEMENTARY RESULTS

In order to complement the previous evidence, Table 8 presents the results of three equations for different subsamples created for the 8 geographic regions that make up the sample used. On the one hand, in the case of companies located in societies within Eurasia and Central Asia, we observe that the direct and indirect effects of the essential pillars that equalize the opportunities between women and men in society disappear. Furthermore, the impact of the presence of women on the board of directors negatively and marginally affects this business practice, which is consistent with the findings of Almaqtari et al. (2023), confirming the existence of a negative relationship between the participation of women directors on the boardroom (WonB) and the disclosure of ESG information of Asian companies due to the lack of coercive stimuli.

On the other hand, the results obtained in the previous section are confirmed in the case of companies located in 7 of the 8 regions analysed: East Asia and the Pacific, Europe, Middle East and North Africa, Latin America and the Caribbean, North America, Southern Asia and Sub-Saharan Africa. However, the level of confidence in the significance of the effects differs between them, being marginally relevant from the econometric point of view in the case of the first three regions.

These findings are in accordance with those of Miska et al. (2018), who posit that countries with analogous beliefs exhibit a comparable degree of isomorphism. Similarly, Wang et al. (2021) suggest that a group of countries where cultural knowledge is similar exhibits a soft and implicit institution that is supported across physical boundaries and exerts a high influence on corporate response to environmental climate action, with the aim of maintaining their common natural resources in an optimal state.

Additionally, it is confirmed that a high score on the essential pillars that equalize the opportunities between women and men in society (EWF), affects positively and significantly for confidence levels at 95% and 99% in all the geographic regions analysed.

Table 8. Complementary results by geographic region

	Eurasia and Central Asia			**Latin America and the Caribbean**		
WonB			-0.026*			0.005
EFW	456.524***	17.701	29.922	93.186***	8.359***	7.974***
	East Asia and the Pacific			**North America**		
WonB			0.005***			0.001***
EFW	96.671***	1.294*	1.760*	12.732*	4.463***	4.109***
	Europe			**Southern Asia**		
WonB			0.009***			0.011
EFW	45.752***	1.283*	0.856*	57.598**	10.506**	9.865*
	Middle East and North Africa			**Sub-Saharan Africa**		

WonB			0.001			0.001**
EFW	95.024***	6.343*	4.427*	113.774***	19.366***	17.609***

Note: *** p<0.01; ** p<0.05; * p<0.1
Sample = 8,757 firms (49,826 observations) Period: 2016-2022

6. CONCLUSIONS AND IMPLICATIONS

This study makes a significant contribution to the literature by empirically demonstrating the relationship between gender equality and energy transition disclosure practices. Due to the requirements of institutions, academics and other parties interested in understanding the socio-cultural mechanisms that increase the dissemination of business strategies for energy transformation, this research aimed to analyse the role that equality has played in the opportunities between women and men in society. This was done through the essential pillars in terms of health, education, economic and political empowerment, serving as a direct and mediating mechanism. Furthermore, we propose a novel measure that identifies the information disclosed by companies about their commitment, actions and performance in energy efficiency policy. The findings obtained support a multi-theoretical perspective, that societies striving for gender equality benefit from the feminine perspective of environmental care, both in the internal processes of cultural communication, and in organizational leadership roles. These situations enrich business literature by encouraging real, active participation of women in greater proportions in business management positions. Additionally, it calls on government institutions to continue guaranteeing opportunities for girls and women to achieve full human development.

6.1. Theoretical, practical and social implications

The findings we have obtained in this research have important theoretical, practical and social implications. From a theoretical perspective, we demonstrate the existence of direct and indirect effects, which are positive and significant, between the establishment and protection of essential pillars that correct inequalities between men and women, and the dissemination of transparent information on energy transition.

In this sense, we expand the proposals of stakeholder and institutional theories for a broader consideration of values and social knowledge oriented towards the protection of the disadvantaged. Confirming that when different social groups recognize and demand with greater emphasis the change in the conditions that cause the state of lack of protection and vulnerability of ecosystems, companies meet their demands. In this regard, the pressures and demands of a gender-inclusive society encourage companies to disclose more information about the environmental contingencies derived from their activities and the strategies, policies and initiatives they implement to correct negative environmental externalities.

Likewise, this research confirms and expands the assumptions of the agency and upper echelons theories, under which the greater presence of women directors in the boardrooms provides a range of perspectives that improve corporate dialogue with stakeholders. This engagement is carried out on a basis of transparent information that facilitates the evaluation of the business effort to mitigate the underlying effects of the use of polluting energy sources,

as well as the redirection towards the use of alternative sources compatible with the maintenance of ecosystem conditions suitable for the continuation of humankind on the Earth.

From a practical and business approach, our research has implications for climate stability and greater participation of women in business management. Firstly, companies must persist in energy transformation and seek greater investment in the development of solutions that promote climate resilience and contribute to the well-being of communities. Secondly, our results show that access to opportunities under equal conditions for men and women generates a favourable work scenario where women can add value to companies, combining their protectionist traits with their technical, professional and scientific knowledge. All of this translates into the benefit of greater dissemination of business information compatible with the urgent environmental need to monitor and contain the increase in global temperature and the ecosystem alterations derived from a high concentration of CO_2. In this vein, companies can use these findings to justify implementing gender diversity policies on their boards and to communicate their equality practices, thereby promoting workplace inclusivity and raising awareness in society.

In addition, our evidence supports the reasonableness of the policies being promoted regarding gender, particularly those focused on incorporating women onto boards and ensuring balanced representation in these bodies. However, our findings show that the success of these initiatives is closely linked to equitable societies, characterized by the integration of women across all dimensions of society. In this regard, politicians and regulators must commit to the comprehensive inclusion of gender parity in various educational, health, political and economic policies. This integrated approach will favour a comprehensive social change regarding parity and reinforce global responsibility toward environmental issues.

Regarding the social implications, the positive impact of the essential pillars that equalize the opportunities between women and men in society, demonstrates the importance of social and intergenerational feedback on the recognition and promotion of full equality of capabilities and abilities between men and women to develop professional and leadership roles in different economic, political and social spheres. This equality benefits the symmetry of business information disclosed and aligns with social requirements for preserving natural resources.

6.2. Limitations and future research line

Finally, this research has shown important implications: however, it is necessary to indicate limitations that can be addressed in subsequent work. We have focused on the presence of women directors in the boardroom as a mediating mechanism, which can be combined with the analysis of situations that give them greater power, such as the occupation of positions like chair of the board or CEO. From these positions, women could have greater power to promote organizational changes in energy strategy and greater participation of women directors in the decision-making process.

Additionally, our evidence is typical of large companies that have extensive resources and capabilities, a situation that favours alignment and commitment to sustainability. In this sense, future studies should observe whether the effects identified in large corporations are extensible to small and medium-sized companies. In this vein, future research can explore the relationship between gender diversity and sustainability in specific sectors to better understand industry dynamics.

We also acknowledge that a limitation of this study is its reliance on secondary data, which may not capture all nuances of business practices. In future research, academics could employ complementary methodological analysis based on original data collected themselves, such as conducting interviews with board members, particularly female directors, and society in general, to determine their perceptions of equality and the reasons behind their decision.

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