Energy Economics 139 (2024) 107948

Contents lists available at ScienceDirect

Energy Economics

journal homepage: www.elsevier.com/locate/eneeco

Banks' fossil fuel divestment and corporate governance: The role of board gender diversity

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ARTICLE INFO

JEL classification:
G21
G30
Q54

Keywords:
Banks
Corporate governance
Board gender diversity
Fossil fuel
Climate change
Green transition

ABSTRACT

This study investigates the relationship between bank boards' characteristics and their commitment to divest from fossil fuels. Using data on worldwide listed banks from 2016 to 2022, the results show a positive influence of board gender diversity on bank divestment from fossil fuel companies. We find that this result holds even following numerous robustness tests. A sub-sample analysis reveals that the effect of board gender diversity is significant for laggards' countries in environmental performance. These results highlight that greater gender diversity in board composition promotes sustainability, facilitating a shift towards business models prioritizing environmental goals. Evidence also offers valuable insights for policymakers in their efforts to align financial activities with sustainability goals. By embracing these implications, banks can contribute to the global transition towards a more environmentally sustainable and socially responsible future.

1. Introduction

Climate change and its consequences for the global economy are at the centre of the agenda of policymakers seeking to redirect people and businesses towards greener behaviors through agreements, directives and regulations. Among the primary initiatives, September 15th, 2015, marked the day when the United Nations approved Agenda 2030, a call to action addressed without distinction to all sectors, which are required to make their contribution with proactive attitudes and concrete actions. Specifically, financial institutions can have a central role in sustainable development, given their dual role as companies and intermediaries of credit and financial services. Banks represent service companies (Sardianou et al., 2021) that increasingly pay attention to their sustainability profile, disclosing their green practices through communication channels to engage stakeholders (Cosma et al., 2020). Concurrently, through its intermediary function, the financial sector has the power to channel investments towards sustainable development goals (Polzin et al., 2021).

The role of the financial system is crucial in the transition towards a more sustainable future, which requires large amounts of capital and investments. In this context, the Net-Zero Banking Alliance is an initiative that well highlights the role of banks in the green transition, capturing the commitment of many banks to systematically reduce their operational emissions and incorporate ESG (environmental, social, and governance) criteria in the capital allocation process (Liu et al., 2024). This has led to numerous emerging themes regarding green investments and green finance (Nguyen et al., 2023). The "green" attribute describes the use of funds to provide financial support to green practices and sectors, such as green manufacturing and renewable energy (Nguyen et al., 2023; Li et al., 2021), and at the same time, divestment strategies from highly polluting sectors.

During the last summit of the 28th Conference of the Parties, the participating nations agreed on the transition from fossil fuels, marking the beginning of a phase-out stage from the oil sector.[1] The global reform of fossil-fuel consumption subsidies has been extensively debated as a fundamental policy in the fight against climate change (Chepeliev and van der Mensbrugghe, 2020). Climate activism puts much pressure on cutting the supply of financial capital to the fossil fuel industry (Cojoianu et al., 2021). However, there is still heated doubt about whether divestment or risk management/engagement is more effective

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[1] https://www.reuters.com/business/environment/countries-push-cop28-deal-fossil-fuels-talks-spill-into-overtime-2023-12-12/

https://doi.org/10.1016/j.eneco.2024.107948
Received 5 February 2024; Received in revised form 20 September 2024; Accepted 24 September 2024
Available online 1 October 2024

in combating climate change (Krueger et al., 2020). These misgivings stem from the fact that divestment can pose significant risks in terms of missed diversification and compliance costs (Krueger et al., 2020).

Despite the growing attention to these issues, and although several banks worldwide have launched many financing programs for typically green activities, fossil fuels persist as a dominant sector for investment in power generation and still constitute most commercial energy sources used (Bernardelli et al., 2022; Tumala et al., 2023). In 2011, banks provided 74 % of the coal industry's total financing, indirectly contributing to the sector's significant emissions (Schücking et al., 2011). Over the years, although attention to climate change and sustainability issues has increased significantly, the situation has not remarkably changed. In 2018, most global energy investments flowed into carbon-emitting energy sources. Financial and credit institutions maintain a notably higher interest in fossil fuel-based projects compared to green initiatives (Bernardelli et al., 2022), and this is driven by the fact that fossil fuel assets are historically considered an optimal asset from a portfolio management perspective because of their performance and from a diversification perspective (D'Ecclesia et al., 2024).

According to Elliott and Löfgren (2022), the banking sector seems to lack a critical reflection on the indirect negative effects generated by granting loans and financing. To date, many controversial sectors (arms, alcohol, fossil fuels) continue to rely on financing and investment from the financial sector. This relationship is usually overlooked in the sustainability reports of banks (Bonifácio Neto and Branco, 2019), which disclose vague commitments about the SDGs despite being among the leading lenders of fossil fuels (Elliott and Löfgren, 2022). Due to the absence of political accountability, weak enforcement of governance, and sometimes directors' greed, banks tend to demonstrate only a symbolic stance towards sustainability issues solely to respond to institutional pressures (Khan et al., 2021).

Although several studies often highlight symbolic, rather than substantial, commitments by banks in combating climate change (Heras-Saizarbitoria et al., 2022), evidence in the literature highlighted some organizational factors as possible catalysts for sustainable attitudes. Indeed, based on the upper echelon theory, the character traits of those who make up the board can impact the behavior of entire companies (Hambrick and Mason, 1984). This is particularly true for the environmental behavior of companies. Numerous studies have sought to establish the connection between board attributes and their focus on addressing climate change. Specifically, several scholars in business administration and banking and finance have focused their studies on gender issues within boards of directors. According to Liao et al. (2015), greater diversity in board gender composition positively correlates with an increased probability and comprehensiveness of disclosing greenhouse gas (GHG) emissions. Also, Yasser et al. (2017) show that board gender diversity guarantees better social responsibility performance within organisations. The presence of women can guarantee company boards of directors a more participatory, democratic and aware vision of CSR initiatives (Ray, 2005; Bear et al., 2010), as well as a more significant commitment to environmental issues (Fernandez-Feijoo et al., 2014; Williams, 2003; Cosma et al., 2021). Moreover, other studies looked for a link between the presence of women on executive committees and CO2 emission reduction practices. Reghezza et al. (2022) demonstrated that the presence of women in management ensures a reduction in CO2 emissions. Similarly, García Martín and Herrero (2020) determined that more diverse boards of directors lead to a decrease in emissions.

Given the growing interest in the relationship between gender and climate change, our research aims to investigate the relationship between corporate governance attributes of financial institutions and commitment to divestment from fossil fuels. In particular, based on the above-mentioned evidence, our intuition is that board gender diversity can promote the process of divestment from fossil fuels and, consequently, the transition to a greener economy. In order to test this intuition, we apply an econometric analysis with several model specifications on 360 bank-year observations from 2016 to 2022.

This research diverges from the current body of literature in numerous aspects. Firstly, our study focuses on the financial sector as, thanks to its intermediation function, it can facilitate the phase-out of fossil fuels and the transition towards a low-carbon economy. Secondly, our study does not analyse the impact of board characteristics on the reporting of green practices (e.g. Cosma et al., 2020) or on direct CO2 emissions (Reghezza et al., 2022; García Martín and Herrero, 2020), but instead on the indirect impact of banks on the green transition, deriving from the granting of loans to polluting sectors. In particular, our study focuses on the financing granted by banks to fossil fuel companies. Indeed, the transition from fossil fuels to renewable energy is a crucial step in combating climate change (Bolton and Kacperczyk, 2023).

The structure of the paper is outlined as follows. Section 2 is dedicated to the literature review and the main reference theories; Section 3 provides a description of the data, variables, and methodology; Section 4 provides the descriptive statistics; Section 5 reports the empirical findings; Section 6 performs several robustness tests; Section 7 provides the discussions. Then, we present the study's conclusions, implications, and limitations.

2. Literature review

2.1. Green transition and fossil fuels: The burden of being banks

Climate change risks have filled the agenda of policymakers and scientific community debates for several years (Venturini, 2022). The former, in particular, agree that the average global temperature increase caused by GHG emissions should not exceed the pre-industrial status by more than 2 °C (UNFCCC, 2010). The unanimous opinion of the scientific community is that to stabilise global warming, it is necessary to build a net-zero emission economy (Matthews and Caldeira, 2008). To achieve these goals, globally, “one-third of oil reserves, half of gas reserves, and more than 80 percent of current coal reserves would have to remain unused from 2010 to 2050” (McGlade and Ekins, 2015). Therefore, uninterrupted use of current fossil fuel reserves is incompatible with a warming limit of 2 °C (McGlade and Ekins, 2015).

These concerns have brought out the fossil fuel divestment campaign over the years, which advocates, among other things, cutting the supply of financial capital to the fossil fuel industry (Cojoianu et al., 2021). Cutting subsidies to the fossil fuel sector is now considered among the most important policies to combat climate change (Chepeliev and van der Mensbrugghe, 2020). Considering its influence in the capital allocation process, the financial sector assumes a relevant role in such debates (Iyke-Ofoedu et al., 2023). While it has embraced the challenges posed by climate change and policymakers' decisions, it is lagging in some respects (Venturini, 2022). Indeed, the green transition process has scrutinised bank lending and financing, highlighting the need for financial institutions to reassess their investments in environmentally harmful projects (Takahashi and Shino, 2023; Iyke-Ofoedu et al., 2023). Banking, by financing activities with high GHG emissions, has significant environmental impacts including pollution, biodiversity loss, and deforestation (Dogan et al., 2019). The motivations for such financing are easy to identify. Indeed, the choices and behaviors of investors (institutional and non-institutional) are anchored in the risk and return characteristics of individual investments (Dinica, 2006), and fossil fuel assets have historically been considered relevant from an optimal portfolio management perspective because of their profitability and from a diversification perspective (D'Ecclesia et al., 2024). However, the growing emphasis on sustainability is disrupting traditional investment paradigms (D'Ecclesia et al., 2024). Indeed, the risks posed by climate change are increasingly concrete (Ilhan et al., 2021), prompting debate about whether divestment or risk management/engagement is more effective in combating climate change (Krueger et al., 2020). Integrating climate risks into investment decisions is still particularly challenging and generates many issues in assessing and hedging these risks. Krueger

et al. (2020), through a survey, analyse whether and how institutional investors consider climate risks in their investment processes and find that only a small proportion (about 20 %) of respondents use the divestment approach, even though this approach is the subject of major activist initiatives. Although divestment comes with significant risks in terms of non-diversification and compliance costs (Krueger et al., 2020), not a few institutions are moving towards this approach (Takahashi and Shino, 2023; Mooney, 2017). Indeed, according to Herbohn et al. (2019), stakeholders expect banks to consider GHG emissions and carbon risk before lending. In light of these observations and considering the heated scholarly debate on the role of corporate governance in facilitating the green transition, we believe it is particularly interesting to investigate how corporate governance affects banks' decision to divest from fossil fuels.

2.2. Corporate governance and green transition

The issue of corporate governance, its structure and its influence on the sustainable orientation of companies is a much-debated topic in the literature (Kizys et al., 2023). Numerous scholars, in particular, have attempted to identify a link between the presence of women on boards of directors and the adoption of environmentally oriented practices by companies, relying on multiple theories that allow formalizing a connection between certain personality characteristics often linked to women, such as empathy and social awareness, and the attitude to take socially and environmentally responsible actions (Dietz et al., 2002).

According to the *Upper Echelon Theory* (Hambrick and Mason, 1984), the behaviors of firms turn out to be influenced by the characteristics of the individuals in the firm. Therefore, companies' strategic choices can be influenced by "the personal experiences, values, and attitudes as well as the knowledge and skills of board members" (Gangi et al., 2023). Consequently, board gender diversity will likely result in companies' higher commitment to environmental issues since female directors tend to be more inclined towards environmental consciousness (Ibrahim et al., 2009).

One of the well-established theories in the literature is the *Resource Dependence Theory*, which posits that a firm's management performance relies inherently on the human and social capital its board members provide (Pfeffer and Salancik, 1978; Lu and Herremans, 2019). The diversity within a board can significantly enhance a firm's ability to access a wide range of resources, encompassing knowledge, networks, reputation, and information. This amalgamation empowers directors to effectively fulfill their responsibilities by skillfully representing the interests of shareholders and other stakeholders (Burgess and Tharenou, 2002; Hillman et al., 2002). Gender diversity, in particular, plays a pivotal role in nurturing greater sensitivity towards environmental and social issues (Altunbas et al., 2022; Fernandez-Feijoo et al., 2014;).

Similar insights are derived from *Stakeholder Theory* (Freeman, 1984), according to which the presence of women on boards can improve the connection with stakeholders, especially in terms of social and environmental objectives (Hussain et al., 2018). However, this positive effect can be mitigated by the fact that women are often underrepresented on corporate boards. In accordance with *Token Theory* (Kanter, 1977a, 1977b), when a work group comprises less than 15 % representation from a specific social group, "underrepresented members are subject to three disadvantages: increased visibility, informal isolation, and role encapsulation" (Perez and Strizhko, 2018). A solution to this phenomenon is proposed with the *Critical Mass Theory* (Kanter, 1987), according to which elevates the number of women to a consistent minority presence. Ideally, at least three individuals enable this minority group to yield substantial and effective influence on strategic choices and decisions.

Several scholars analysed from an empirical point of view the influence of board gender diversity on companies' sustainability practices, such as CSR disclosure (Byron and Post, 2016), carbon disclosure (Liao et al., 2015; Ben-Amar et al., 2017), reduction of CO2 emissions (García Martín and Herrero, 2020; Haque, 2017), or more generally on ESG performance (Gillan et al., 2021). These studies, sometimes offering mixed results, generate the need for further research and the formulation of new research questions. Over the years, in particular, several studies have attempted more granular approaches, analysing such linkages within specific sectors, such as utilities (Nicolo et al., 2023), information technology (Simionescu et al., 2021), transportation (Kuzey et al., 2022) and banking (Gangi et al., 2023; Shakil et al., 2021).

The governance of the banking sector deserves further attention for several reasons. First, the bank board makes important decisions for the economic and financial domain and prevents systemic risks that could undermine the stability of the entire financial system. Secondly, bank boards are usually larger than those of nonfinancial firms and have a larger independent component (García-Meca et al., 2015). Furthermore, the complex banking structure and the need to protect savers and depositors make these directors subject to the supervision of banking regulators (García-Sánchez et al., 2018). Finally, the decisions of a bank's board impact financing decisions and the credit value chain (Faleye and Krishnan, 2017) and then the behavior of the industrial borrowers.

Several studies have shed light on the strong involvement of banks in the environmental aspect of sustainability, not only because of their direct and indirect emissions (Pucheta-Martínez and Gallego-Alvarez, 2020; Galletta et al., 2021; Venturelli et al., 2018), but also because of their lending to more or less polluting enterprises (Simpson and Kohers, 2002; Krasodomska, 2015). While the banking sector might not directly contribute to environmental impact, it is a facilitator and promoter of industrial activities that inherently lead to such impacts (Thompson and Cowton, 2004). Various authors in the literature explored the issue of board gender diversity in banking, specifically analysing its effects on different dimensions of sustainability. Kara et al. (2022), using data on European and U.S. banks, revealed that greater female presence on bank boards resulted in greater stakeholder support in socially responsible initiatives during the early stages of the COVID-19 pandemic. Shakil et al. (2021), analysing a sample of US banks between 2013 and 2017, highlighted the positive influence of board gender diversity on the ESG performance of banks. Al-Jaifi (2020) analysing the three pillars of ESG performance among a selection of ASEAN banks from 2011 to 2016 revealed that board gender diversity positively impacts corporate governance performance. However, no significant effects were observed on the environmental and social performance of the banks. Recently, Paolone et al. (2024), using a sample of 96 European-listed banks, highlighted a positive relationship between board gender diversity and ESG scores.

With specific reference to environmental performance, several authors investigated the impact of board gender diversity on various proxies of banks' environmental performance. Galletta et al. (2022), studying a sample of financial institutions over 2011–2019, showed that augmenting the proportion of female directors contributes to an enhancement in the environmental performance of banks, proxied by the probability of pursuing the emissions reduction policy. Birindelli et al. (2019), analysing the board characteristics of 96 listed banks in Europe, the Middle East and Africa from 2011 to 2019, showed a nonlinear relationship between women directors and the environmental performance of banks, proxied by the environmental score provided by Asset4. Similarly, Gangi et al. (2019), analysing 142 banks from 2011 to 2015, found that the frequency of female directors relative to the overall board membership positively predicts increased environmental involvement. Gangi et al. (2023) also found a positive influence of board gender diversity on banks' environmental responsibility regarding eco-innovation and emission management. García-Sánchez et al. (2018), using a sample of 159 banks in nine countries during 2004–2010, showed a significant impact of board gender diversity on a proxy of environment-related issues. Buallay and Alhalwachi (2022) investigated how board gender diversity influences environmental disclosure among listed banks from the top 100 oil-producing nations, examining data

from 2007 to 2016. Their findings demonstrated a substantial association between a board's 21 % to 50 % female representation and the disclosure of environmental and social issues.While many studies have explored the link between board gender diversity and banks' environmental performance, we believe it is imperative to have a more granular and sector-specific approach that considers several factors characterizing a bank's green approach. Among these, a key role is played by the financing policies put in place by banks, as these cover a pivotal role in the green transition process. In particular, given the increasing attention given by governments, companies, investors, and policymakers to the climate change issue, focal importance is assumed by the transition from fossil fuels to renewable energy (Bolton and Kacperczyk, 2023).

In our study, therefore, we adopt a different perspective of environmental performance than has been taken so far, considering the amount of financing banks issue to the fossil fuels sector. Considering the literature just outlined, we argue that an increased presence of women on boards of directors leads banks to accelerate the green transition process by reducing the amount of financing towards the fossil fuels sector.

We therefore formulate the following hypothesis:

H1. *There is a negative relationship between board gender diversity and the amount of bank financing to fossil fuel companies.*

3. Research design

3.1. Sample composition

Our starting sample included annual observations for the period from 2016 to 2022 for the world's 60 largest banks by the level of total assets reported in the 2023 Banking on Climate Chaos report, which annually reports the level of financing of banks towards fossil fuel companies since the entry into force of the Paris Agreement in 2016 (Reclaim Finance et al., 2023). Banks with absent or outdated governance data on Refinitiv (2023) were excluded from this initial sample. The final sample, therefore, comprises 360 annual observations relating to 54 global banks. As shown in Table 1, the banks in the sample operate in 16 different countries, and the country with the highest number of observations is China, followed by the United States, United Kingdom, Australia and Canada.

3.2. Model

To examine how board gender diversity influences the amount of bank financing to fossil fuel companies, we employ a panel fixed effects methodology as a baseline specification:

$$Log(Fossil\ Financing)_{it} = \alpha_i + \beta BoGenDiv_{it} + \theta X_{it} + \delta Z_{it} + \varepsilon_{it} \quad i = 1, 2, \ldots N; \; t = 1, 2, \ldots T \tag{1}$$

where i and t stand for bank and time.

Log(Fossil Financing) represents our main dependent variable. It is given by the logarithm of the amount of financing granted by bank i to companies belonging to the fossil sector. α indicates firm-fixed effects. We also used the variable FossilDivPolicy for a robustness check, which indicates (0/1) whether the bank claims to have a divestment policy from the fossil sector.

BoGenDiv represents our primary explanatory variable. It describes the Board Gender Diversity, computed as the fraction of female board members over the total number of members. For a robustness check, according to some recent literature (Kara et al., 2022; Venturelli et al., 2024) we also employed the variable *CriticalMass*, equals to 1 if the board has three or more women members and 0 otherwise.

Following Altunbas et al. (2022), we include a vector (X) of variables that describe the governance of banks and which could influence the decision to finance the fossil sector. We include the board size (*BoardSize*), i.e., the number of directors present on the board, independent board members (*IndepBoard*), computed as the percentage of independent board members in the bank, and CEO Charmain Duality (*CeoChDual*), which indicates whether a bank has a CEO duality situation (De Villiers et al., 2011). The inclusion of these variables serves to account for their effects while controlling for gender diversity.

Aware that the financing a bank grants does not depend only on corporate governance characteristics, we also included a vector (Z) of banks' financial characteristics. We included the logarithm of bank total assets (*LogTa*), which is a proxy of the bank size (La Torre et al., 2021; Reghezza et al., 2022), the cost-income ratio (*CostInc*), which describes the efficiency of the bank (Chiaramonte et al., 2022; Galletta et al., 2021), and the return on average equity (*ROAE*), which is a proxy of the performance (Reghezza et al., 2022; Chiaramonte et al., 2022). Finally, we introduced controls for the GDP growth rate (*gdpGrth*) within the models to examine the potential interdependence between the amount of bank financing to fossil fuel companies and the economic development status specific to each country (La Torre et al., 2021; Bătae et al., 2021). Table 2 describes the variables used in the analysis, their source and the expected sign of their influence on the dependent variable.

Data on board gender diversity and corporate governance characteristics were retrieved from Refinitiv database. Data on financial bank-specific variables were extracted from BankFocus. Finally, data on the GDP growth rate were extracted from the OECD database.

3.3. Fossil financing data

Data on bank fossil fuel financing was extracted from the 2023 Banking on Climate Chaos Report (Reclaim Finance et al., 2023), previously used in other research that analysed how the top 10 most active banks in financing the fossil fuel industry are contributing to the realization of the SDGs (Elliott and Löfgren, 2022) or that studied how the exposure of these banks to the fossil sector contributes to the determination of their ESG ratings (Bernardelli et al., 2022). This report uses data primarily sourced from Bloomberg Finance LP to examine the financing of the main commercial and investment banks for the fossil fuel industry in terms of lending and underwriting for bonds and equities. Our interest in this variable derives from the fact that policymakers are actively driving efforts to redirect capital allocation in response to the widespread and escalating concerns about climate change and its associated consequences. The Paris Agreement (COP21) signed in 2015, in particular, established the need to "make financial flows compatible with a path towards low GHG emissions and climate change resilient development" (Reghezza et al., 2022).

To this end, we decided to analyse how some characteristics of banks

Table 1
Sample composition by country.

Country	Freq.	Percent	Cum.
Australia	28	7.78	7.78
Canada	28	7.78	15.56
China	75	20.83	36.39
Denmark	7	1.94	38.33
Finland	7	1.94	40.28
France	21	5.83	46.11
Germany	14	3.89	50.00
India	7	1.94	51.94
Italy	14	3.89	55.83
Japan	21	5.83	61.67
Korea	7	1.94	63.61
Netherlands	7	1.94	65.56
Spain	21	5.83	71.39
Switzerland	12	3.33	74.72
United Kingdom	35	9.72	84.44
United States	56	15.56	100
Total	360	100	

Table 2
Description of variables.

Variables	Definitions	Sources	Expect sign
Dependent Variable			
LogFossil	Natural logarithm of total amount of bank financing to fossil fuel companies	Banking on climate chaos report (2023)	
FossilDivPolicy	Fossil divestment policy, indicates whether a bank claims to have a to have a divestment policy from the fossil sector	Refinitiv	
Independent Variables			
BoGendDiv	Board gender diversity, measured by as the ratio of female directors to the total number of board members	Refinitiv	–
CriticalMass	Critical mass of woman, equal to one if the board has three or more women members and zero otherwise	Refinitiv	–
Control Variables			
BoardSize	Board size, measured by the number of board members	Refinitiv	–/+
IndepBoard	Board independence proxied by the ratio of independent directors to the total number of board members.	Refinitiv	–/+
CeoChDual	Board CEO duality, indicates whether a bank has a CEO duality situation (0/1)	Refinitiv	–
LogTa	Logarithm of total assets	BankFocus	+
CostInc	Cost-income (efficiency) ratio	BankFocus	+
ROAE	Return on average equity	BankFocus	+
Macroeconomic Control Variable			
GDPgrth	Annual GDP growth rate	OECD Data	+

can impact their decision to invest or divest in the fossil sector. Fig. 1 depicts a situation in which, since the Paris Agreement entered into force, the world's largest banks by level of total assets have increased the amount of financing granted to the fossil sector. This is particularly true until 2019 when climate change began gaining media relevance following the 2018 Intergovernmental Panel on Climate Change (IPCC) report. This report issued numerous warnings on the need to initiate an immediate change, as well as the growing risk of incurring environmental disasters and economic losses from climate change. From 2019 onwards, the banks in the sample have substantially reduced the financing granted to fossil fuel companies. This could be seen as the starting process of awareness by the largest banking institutions of the role they can play in pursuing a low-carbon economy through their lending and financing operations.

Slight differences emerge when the sample is divided by geographical area to analyse the average amount of financing granted to fossil fuel companies (See Fig. 2). In this case, it can be seen that the country most exposed to this sector is America, which, from 2019 recorded a reduction in financing and a marked increase from 2020 to 2021. The average amount of fossil fuel funding fell again from 2021 to 2022. Other countries, on the other hand, recorded a less erratic increase, with a downward trend following 2020. This evidence makes it particularly interesting to investigate how specific characteristics of the banks in the sample influenced the decision to divest or not from the fossil sector.

4. Descriptive statistics

Table 3 reports a summary of descriptive statistics. The natural logarithm of the amount of funding in fossil fuels (LogFossil) is, on average, 22.78. The average value of the board gender diversity variable is equal to 28 %, meaning that females remain underrepresented in the board room. The presence of independent directors (IndepBoard) is, on average 66 %, and the size of the board (BoardSize) shows an average of 14 and a maximum value of 24. The summary statistics of the variable CEO Chairman Duality (CeoChDual) tells us that in a minority of banks (21.38 %) the CEO also serves as the chairman of the board of directors. Bank size computed as the natural logarithm of banks' total assets (LogTa), Efficiency ratio (CostInc) and profitability measure (ROAE) are balance sheet variables.

Table 4 displays the correlation matrix. We do not find a significantly high correlation across dependent, independent or control variables. Prior research indicates that the lack of correlations exceeding 0.8 rules out multicollinearity among variables (Li et al., 2008; Haniffa and Cooke, 2002).

5. Empirical results

Table 5 (columns 1–4) shows the baseline results considering various combinations of fixed effects. The preliminary findings support our hypothesis, allowing us to highlight a negative and statistically

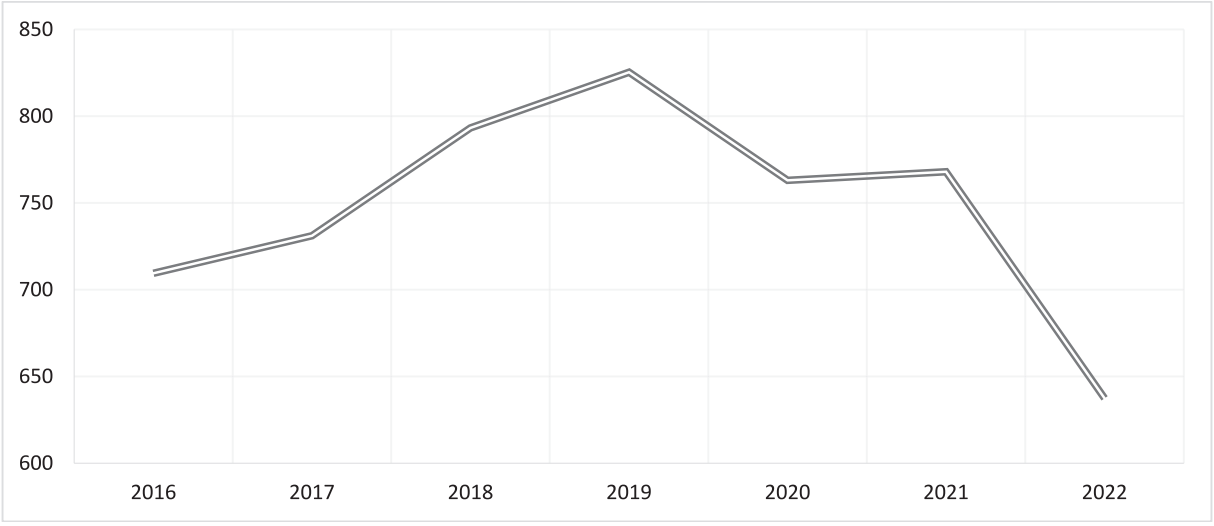

Fig. 1. Fossil fuel financing by year.
Notes: Financing (lending and underwriting for bonds and equities) granted by the sample banks to fossil fuel companies (in billions of dollars).

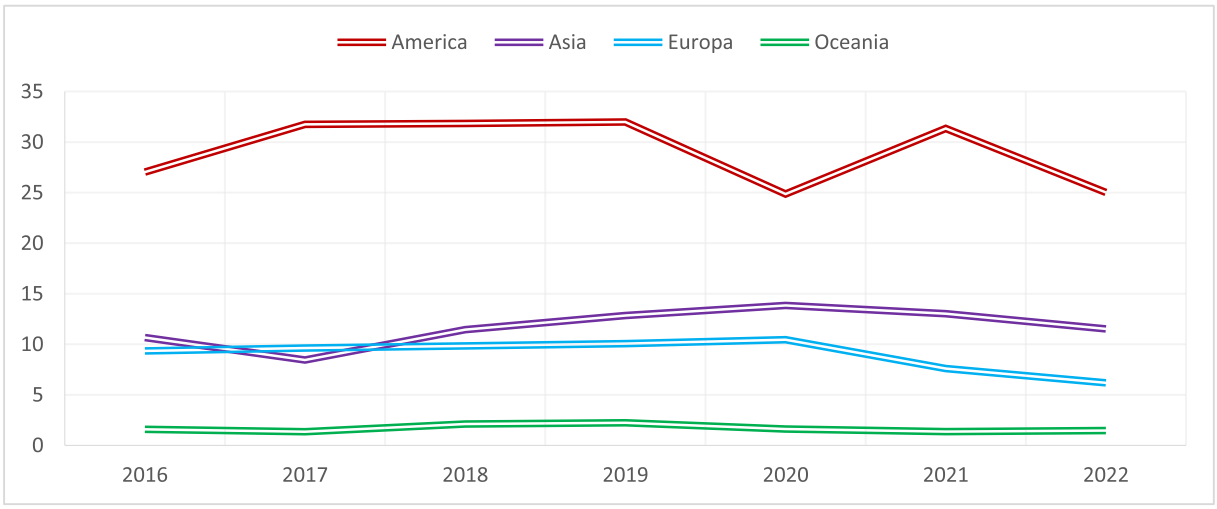

Fig. 2. Fossil Fuel financing by country.
Notes: This figure provides the average amount of financing to fossil fuel companies by geographic area (in billions of dollars).

Table 3
Descriptive statistics.

Variable	Obs	Mean	Std. Dev.	Min	Max
LogFossil	360	22.7899	1.1934	19.9824	25.0112
BoGendDiv	360	28.2850	13.1823	0	61.5385
IndepBoard	360	66.1202	23.3223	24	100
BoardSize	360	14.2472	3.2616	8	24
CeoChDual	360	0.2139	0.4106	0	1
LogTa	360	20.8781	0.6388	19.5555	22.4584
CostInc	360	58.6279	17.2807	25.8207	130.8125
ROAE	360	8.8665	5.2323	−24.5153	21.0583
GDPgrth	360	0.0556	0.0451	−0.1145	0.1650

Notes: This table shows the selected variables' descriptives.

significant relationship between board gender diversity and our dependent variable. A situation, therefore, emerges in which a more significant presence of women on boards leads to a lower level of financing towards the fossil fuel sector.

Specifically, in column 1, it is observed that the funding allocated to fossil fuel companies decreased by approximately 1 percentage point when the board gender diversity increased by 1 pp. In addition, by incorporating fixed effects for country, bank, and industry, we improved the econometric model even further (see Table 5, columns 2 to 4). All estimates support the idea that a greater board gender diversity leads to reduced financing granted by banks to fossil fuel companies. This aligns with prior research indicating that banks emphasizing sustainability tend to exhibit a greater representation of women on their boards (Birindelli et al., 2019). According to the existing literature, women on boards of directors can guarantee companies a more participatory vision, and greater awareness of the need to undertake social and environmental initiatives (Ray, 2005; Bear et al., 2010).

The subset of the control variables utilized shows a statistically significant association with fossil fuel financing (LogFossil). Contrary to our expectation, we find that the percentage of independent directors (IndepBoard) positively and statistically significantly influences the amount of financing to the fossil sector. The results also highlight that bigger banks with larger board sizes (BoardSize) and total assets (LogTa) tend to finance fossil fuel companies more, and therefore, be indirectly more polluting (Altunbas et al., 2022).

As expected, a significantly positive relationship emerges between fossil fuels financing and CEO Chairman duality (CeoChDual), confirming that a CEO also holding the position of the chairman causes information asymmetries and less attention to the environment (Mahran and Elamer, 2024). Consistent with prior studies linking socially responsible actions to financial indicators, we bolstered our analysis by integrating lagged variables (Pizzi et al., 2020). Incorporating lagged

Table 4
Pairwise correlations.

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) LogFossil	1.000								
(2) BoGendDiv	−0.054	1.000							
	(0.303)								
(3) IndepBoard	0.107*	0.563*	1.000						
	(0.043)	(0.000)							
(4) BoardSize	0.171*	−0.116*	−0.428*	1.000					
	(0.001)	(0.028)	(0.000)						
(5) CeoChDual	0.149*	−0.090	0.170*	−0.083	1.000				
	(0.004)	(0.087)	(0.001)	(0.115)					
(6) LogTa	0.593*	−0.174*	−0.297*	0.189*	−0.106*	1.000			
	(0.000)	(0.001)	(0.000)	(0.000)	(0.044)				
(7) CostInc	0.046	0.342*	0.335*	0.156*	0.079	−0.155*	1.000		
	(0.380)	(0.000)	(0.000)	(0.003)	(0.136)	(0.003)			
(8) ROAE	0.020	−0.086	0.042	−0.253*	0.079	0.012	−0.598*	1.000	
	(0.701)	(0.103)	(0.423)	(0.000)	(0.135)	(0.819)	(0.000)		
(9) GDPgrth	−0.128*	−0.013	−0.058	−0.115*	−0.048	0.019	−0.253*	0.278*	1.000
	(0.015)	(0.807)	(0.271)	(0.030)	(0.369)	(0.714)	(0.000)	(0.000)	

Notes: This table shows the selected variables correlation. The superscripts *, **, and *** represent statistical significance at the 10 %, 5 %, and 1 % level, respectively.

Table 5
Baseline and lagged results.

	Baseline				Lagged			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	LogFossil	LogFossil	LogFossil	LogFossil	LogFossil	LogFossil	LogFossil	LogFossil
BoGendDiv	−0.0115***	−0.0076**	−0.0124***	−0.0094**	−0.0116**	−0.0050	−0.0120***	−0.0094**
	(0.0043)	(0.0037)	(0.0037)	(0.0040)	(0.0048)	(0.0044)	(0.0043)	(0.0040)
IndepBoard	0.0234***	0.0118***	0.0226***	0.0016	0.0232***	0.0121***	0.0222***	−0.0028
	(0.0028)	(0.0033)	(0.0031)	(0.0047)	(0.0029)	(0.0033)	(0.0031)	(0.0030)
BoardSize	0.0829***	−0.0268*	0.0810***	−0.0224*	0.0977***	−0.0098	0.0951***	0.0057
	(0.0160)	(0.0145)	(0.0170)	(0.0110)	(0.0171)	(0.0150)	(0.0181)	(0.0180)
CeoChDual	0.4599***	0.0862	0.2370**	0.2625***	0.4597***	0.0566	0.2492**	0.3252**
	(0.1118)	(0.0943)	(0.1111)	(0.0573)	(0.1244)	(0.1037)	(0.1138)	(0.1287)
LogTa	1.3081***	1.0016***	1.2578***	0.9753***	1.3059***	0.9530***	1.2533***	1.2065***
	(0.0727)	(0.0618)	(0.0612)	(0.2573)	(0.0798)	(0.0638)	(0.0673)	(0.3046)
CostInc	0.0001	−0.0207***	0.0019	−0.0055	0.0015	−0.0181***	0.0030	0.0068
	(0.0038)	(0.0048)	(0.0043)	(0.0054)	(0.0042)	(0.0058)	(0.0043)	(0.0050)
ROAE	0.0109	−0.0502***	0.0132	−0.0215**	0.0241*	−0.0391***	0.0260**	0.0004
	(0.0114)	(0.0094)	(0.0134)	(0.0078)	(0.0125)	(0.0113)	(0.0129)	(0.0067)
GDPgrth	−1.9783	1.2054	−2.2113	1.2878	−0.1049	3.2163**	−0.4456	2.5984
	(1.6519)	(1.1530)	(1.6201)	(0.8001)	(1.7605)	(1.2727)	(1.7829)	(1.5620)
Observations	360	360	360	360	308	308	308	308
Sub-Industry FE	No	No	Yes	No	No	No	Yes	No
Country FE	No	Yes	No	No	No	Yes	No	No
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	No	No	No	Yes	No	No	No	Yes
R2_Adj.	0.53	0.80	0.56	0.17	0.53	0.80	0.55	0.21

Notes: This table reports the results of the OLS FE models during the period 2016–2022. The dependent variable is the natural logarithm of fossil fuels financing. The variable of interest is the percentage of gender diversity in the board (BoGendDiv). Bank-level clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1 %, 5 %, and 10 % levels, respectively, in two- tailed tests.

variables helps alleviate reverse causality issues (Godos-Díez et al., 2018; Bătae et al., 2021). Thus, we decide to re-estimate the various combinations of fixed effects regression models by adding the first lag of the explanatory variables. The main results hold for all several specifications of the model, confirming the positive and statistically significant influence of gender diversity on boards of directors on the reduction of fossil fuel financing by banks (Table 5, columns 5 to 8).

6. Robustness check

6.1. Changing dependent variable

As an initial step for robustness checking, we employed an alternative computation method for the dependent variable. Specifically, we first replace the natural logarithm of the total amount of bank financing to fossil fuel companies (LogFossil) with the fossil divestment policy (FossilDivPolicy), which is a dummy variable that takes the value of 1 if a bank claims to have a to have a divestment policy from the fossil sector and 0 otherwise. To consider FossilDivPolicy as our dependent variable, we apply the Probit estimation model. The results in Table 6 (column 1) highlight that a higher board gender diversity increases the banks' probability of having a divestment policy from the fossil sector. The results of other robustness tests are shown in columns (2) and (3). In column (2), we replace our main dependent variable (LogFossil) with the ratio of fossil fuel financing to total assets (FossilTA). In column (3), we replace the main dependent variable (LogFossil) with its winsorized version (LogFossil_W) at the 1st and 99th percentiles. This modification is intended to mitigate the influence of outliers, ensuring a more stable data analysis (Aslan et al., 2022). Overall, the findings in Table 6 are consistent with the leading results. We observe that the relationship between board gender diversity and the several dependent variables remains statistically significant confirming the main hypothesis that higher percentage of women on the board impact on the decision on the reduction of fossil fuels financing.

Table 6
Substitution of the dependent variable.

	(1) Probit	(2)	(3)
	FossilDivPolicy	FossilTA	LogFossil_W
L.BoGendDiv	0.0543***	−0.1053*	−0.0091**
	(0.0096)	(0.0513)	(0.0041)
L.IndepBoard	0.0116*	−0.0204	−0.0029
	(0.0063)	(0.0217)	(0.0030)
L.BoardSize	0.1090***	0.0674	0.0051
	(0.0339)	(0.1595)	(0.0178)
L.CeoChDual	−0.7707**	3.7133*	0.3216**
	(0.3294)	(1.8968)	(0.1282)
L.LogTa	0.2616	−3.3365	1.2092***
	(0.1712)	(5.4370)	(0.3082)
L.CostInc	0.0036	0.0494	0.0067
	(0.0090)	(0.0577)	(0.0049)
L.ROAE	−0.0661**	−0.1141	0.0001
	(0.0322)	(0.0830)	(0.0065)
L.GDPgrth	−6.8095*	13.7935	2.5403
	(3.5040)	(16.1351)	(1.5735)
Observations	308	308	308
Bank FE		Yes	Yes
Time FE	Yes	Yes	Yes
R2_Adj.		0.24	0.21
Pseudo R2_a	0.37		

Notes: This table reports the results of the different regression models during the period 2016–2022. The dependent variable is the dummy variable of the adoption of fossil fuel divestment policy (column 1), the ratio of fossil fuel financing on total assets (column 2) and the winsorised natural logarithm of the amount in USD of fossil fuel financing (column 3). The variable of interest is the percentage of gender diversity in the board (L.BoGendDiv). Bank-level clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1 %, 5 %, and 10 % levels, respectively, in two- tailed tests.

6.2. Critical mass

As second robustness check, we use an alternative independent variable to account for the presence of the women on the board. Building on the critical mass theory (Kanter, 1987), increasing the number of

women on boards from a mere "token" representation (one or two individuals) to a consistent minority presence (at least three) empowers this minority group to wield effective influence in decision-making processes. Then, following the best practices (Birindelli et al., 2019; Venturelli et al., 2024), we substitute the variable BoGendDiv with the dummy variable *CriticalMass*, which is equal to 1 if boards have at least three women and 0 otherwise. We then run a robustness check to ensure that the results also hold. Table 7 displays the findings of the fixed effects regression model using the log of fossil fuels (LogFossil) and the ratio of fossil fuel financing to total assets (FossilTA) as the main dependent variables. Consistent with the baseline specification, the coefficients associated with the critical mass are still negative and statistically significant (at a 1 % level) in decreasing fossil fuel financing, suggesting the validity of our main findings.

6.3. Removing China

As a third robustness check, we re-estimated the regression models by removing Chinese banks from the sample to avoid their presence (around 50 % of our sample) driving our results. The results for the smaller sample of banks are reported in Table 8. These confirm our previous findings; the lagged term of BoGendDiv remains negative and statistically significant in the regression for the LogFossil (columns 1 and 2).

Also, the results displayed in columns (3) and (4) for the specification with FossilTA as the dependent variable and for the Probit specification model -which considers the dummy variable of fossil fuel divestment policy- confirm previous findings. They are consistent with the basic model. This, therefore, confirms our research hypothesis.

6.4. Sub-sample analysis: Country heterogeneity

Byron and Post (2016) pointed out that the national context can determine the influence of female directors on firms' environmental performance. To provide more insights into the relationship between female presence on boards and divestment from fossil fuels, we perform a sub-sample analysis to account for the different levels of environmental commitment across countries (Garel et al., 2024). For this purpose, we use two different measures: the Environmental Performance Index (EPI) and country-level GHG emissions (Aresu et al., 2023). The EPI is an indicator calculated by the Yale Center for Environmental Law & Policy and Columbia University's Earth Institute in collaboration with the World Economic Forum and measures, in a range from 0 to 100, countries' attention to environmental protection and regulatory pressure from regulators on these issues (Wolf et al., 2022). GHG emissions, expressed in kilotonnes of CO2 equivalent, can be considered a proxy for transition risk (Mazzarano et al., 2024), and are retrieved from the World Bank portal.

According to recent studies, country-level emissions can substitute EPI because more environmentally conscious countries generally have lower emissions (Berry et al., 2021). Using the last year with available data for the two variables (2022 and 2020, respectively), we distinguish between more and less environmentally conscious countries using the median value of EPI and GHG emissions.

Table 9 shows that in countries with a Low EPI (column 1) (i.e., lower environmental attention), board gender diversity emerges as a factor that can statistically significantly influence divestment from fossil fuels. In contrast, in countries with a High EPI, board gender diversity does not emerge as a factor characterizing banks' decision to divest from fossil fuels. The results are also confirmed when we use GHG emissions in columns (3) and (4), proving that the role of women on boards is context-dependent. This evidence finds support in previous studies that women generally tend to take action to mitigate perceived environmental risks (Liao et al., 2015) or that the influence of female directors on environmental performance is significant only in countries that face considerable environmental risks (Hambali and Adhariani, 2024).

Table 7
Critical mass theory.

	(1)	(2)
	LogFossil	FossilTA
L.CriticalMass	−0.2021***	−1.9988***
	(0.0492)	(0.6503)
L.IndepBoard	−0.0021	−0.0126
	(0.0030)	(0.0210)
L.BoardSize	0.0163	0.1755
	(0.0177)	(0.1691)
L.CeoChDual	0.3004**	3.4169**
	(0.1184)	(1.5298)
L.LogTa	1.1056***	−4.3620
	(0.3286)	(5.5860)
L.CostInc	0.0070	0.0501
	(0.0047)	(0.0547)
L.ROAE	0.0006	−0.1140
	(0.0072)	(0.0936)
L.GDPgrth	2.5959	13.7863
	(1.5148)	(15.7489)
Observations	308	308
Bank FE	Yes	Yes
Time FE	Yes	Yes
R2_Adj.	0.20	0.24

Notes: This table reports the results of the OLS FE models during the period 2016–2022. The dependents variables are: the natural logarithm of fossil fuels financing (column 1) and the ratio of fossil fuel financing on total assets (column 2). The variable of interest is the lagged critical mass of women on the board (L. CriticalMass). Bank-level clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1 %, 5 %, and 10 % levels, respectively, in two- tailed tests.

Table 8
Exclusion of China from the sample.

	(1)	(2)	(3)	(4)Probit
	LogFossil	LogFossil	FossilTA	FossilDivPolicy
L.BoGendDiv	−0.0143**	−0.0112**	−0.1085**	0.0459***
	(0.0058)	(0.0053)	(0.0423)	(0.0104)
L.IndepBoard	0.0278***	0.0141***	0.2730***	0.0081
	(0.0032)	(0.0039)	(0.0312)	(0.0067)
L.BoardSize	0.1179***	0.0059	1.0298***	0.1012***
	(0.0187)	(0.0179)	(0.1797)	(0.0357)
L.CeoChDual	0.4322***	0.1115	−0.1287	−0.8991***
	(0.1310)	(0.1223)	(1.2470)	(0.3297)
L.LogTa	1.4732***	1.2371***	1.1773	0.3551*
	(0.0934)	(0.0796)	(0.8288)	(0.1854)
L.CostInc	0.0120**	−0.0066	0.1187**	−0.0066
	(0.0054)	(0.0051)	(0.0518)	(0.0106)
L.ROAE	0.0448***	−0.0294***	0.5788***	−0.0702**
	(0.0131)	(0.0093)	(0.1311)	(0.0317)
L.GDPgrth	−1.2139	2.1816	−23.4360	−4.1379
	(1.9393)	(1.3335)	(15.9379)	(3.7024)
Observations	244	244	244	244
Sub-Industry FE	No	No	Yes	
Time FE	Yes	Yes	Yes	Yes
Country FE	No	Yes	No	
R2_Adj.	0.63	0.85	0.38	
Pseudo_ R2				0.30

Notes: This table reports the results of the different regression models during the period 2016–2022 excluding the Chinese banks from the sample. The dependent variable is: the natural logarithm of fossil fuels financing (columns 1 and 2), the ratio of fossil fuel financing to total assets (column 3) and the dummy variable accounting for the involvement of fossil fuel divestment policy (column 4). The variable of interest the board gender diversity (L.BoGendDiv). Bank-level clustered standard errors (SE) are reported in parentheses. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1 %, 5 %, and 10 % levels, respectively, in two- tailed tests.

Table 9
Sub-sample analysis based on countries' environmental commitment.

	LogFossil			
	Environmental Performance Index (EPI)		GHG Emissions	
	(1)	(2)	(3)	(4)
	Low EPI	High EPI	High GHG	Low GHG
L.BoGendDiv	−0.0114*	−0.0006	−0.0120**	−0.0011
	(0.0048)	(0.0064)	(0.0032)	(0.0061)
L.IndepBoard	−0.0013	−0.0013	−0.0053	0.0010
	(0.0043)	(0.0040)	(0.0048)	(0.0056)
L.BoardSize	0.0187	0.0269	−0.0002	0.0351
	(0.0255)	(0.0194)	(0.0182)	(0.0340)
L.CeoChDual	0.3304	0.5847***	0.3156	0.5499***
	(0.3229)	(0.0644)	(0.1557)	(0.1322)
L.LogTa	0.3889	1.6145***	0.6477	1.1633***
	(0.8699)	(0.4408)	(0.5652)	(0.3443)
L.CostInc	−0.0000	0.0104**	0.0002	0.0110**
	(0.0218)	(0.0043)	(0.0189)	(0.0037)
L.ROAE	−0.0233*	0.0101	−0.0084	0.0107*
	(0.0098)	(0.0083)	(0.0181)	(0.0054)
L.Gdpgrth	8.9165**	0.3235	8.0018	0.6422
	(2.8006)	(0.9528)	(4.7320)	(1.4625)
Observations	148	160	148	160
Bank FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
R2_Adj.	0.19	0.35	0.23	0.23

Notes: This table reports the results of the sub-sample analysis during the period 2016–2022. The dependent variable is the natural logarithm of fossil fuels financing. The variable of interest is the percentage of gender diversity in the board (BoGendDiv). In columns 1 and 2, we distinguish between countries with an Environmental Performance Index above and below the median. In columns 3 and 4 we distinguish between countries with GHG emissions below or above the median. The superscripts *, **, and *** represent statistical significance at the 10 %, 5 %, and 1 % levels, respectively.

6.5. Two-stage Heckman test

The sample selection is contingent upon data about the board gender diversity (BoGendDiv). It follows that the banks analysed in this study are not chosen randomly. Sample-selection bias is highlighted as a notable factor contributing to endogeneity, potentially affecting coefficient estimates' accuracy. Therefore, to check and tackle this issue, we use the Heckman two-stage regression (Heckman, 1978) which is a commonly employed econometric methodology applied in banking, finance, and corporate governance literature (Chen et al., 2024; Perera et al., 2023; Shen et al., 2016; Wu and Shen, 2013). In the first stage, a probit model is performed with the dummy of board gender diversity (D_BoGendDiv) as the dependent variable. After estimating this probit regression for D_BoGendDiv, the Inverse Mills Ratio has been computed (IMR). In the second stage of the analysis, the specification model of Table 6 has been rerun, including the IMR as an additional explanatory variable (Song et al., 2024; Chen et al., 2024). Table 10 (columns 2 to 4) shows the results of the two-stage Heckman procedure, where the IMR coefficient is not statistically significant, which substantiates the absence of bias in the main model. Furthermore, the lagged coefficient of board gender diversity (L.BoGendDiv) displays a negative and statistically significant coefficient consistent with basic regression results presented in Table 10, confirming the relationship between board gender diversity and fossil fuels divestment strategies. This outcome validates that our findings are reliable even when considering potential biases in the selection process.

6.6. Instrumental variable approach

Following Altunbas et al. (2022), we perform a final robustness check to address the possible presence of a self-selection problem. Specifically, including female directors on boards might be susceptible to self-selection bias. The appointment of a woman could be contingent upon the board of directors' attributes and other distinct company characteristics (He and Jiang, 2019). Women may self-select to serve on boards of better-performing or lower-risk companies (Farrell and Hersch, 2005). To address this kind of problem, we apply the instrumental variable approach (IV) (Boulouta, 2013). In particular, we use an approach two-stage least squares (2SLS) to isolate the exogenous components from the proportion of female directors. A significant obstacle in this approach is determining which exogenous instrumental variables (IVs) exhibit no correlation with the dependent variable. Following Atif et al. (2021) and Altunbas et al. (2022), we use the ratio of female workforce participation to male workforce participation (LabPartecipFem) for the country in which the bank is headquartered. The decision to use this instrument stems from the fact that banks in states with higher female/male participation ratios have a larger pool of candidates to select good female directors (Chen et al., 2017). Consequently, such banks should be characterized by greater board gender diversity.

Column (1) of Table 11 illustrates the outcomes of the first-stage regression, wherein the variable BoGendDiv is regressed against our explanatory variables. In particular, when we enter the instrumental variable LabPartecipFem in the model, we find a positive and statistically significant relationship (1 % level) with BoGendDiv, highlighting the validity of our instrumental variable. The results are used to generate predicted values for the endogenous variable. Moreover, according to statistics from the Kleibergen-Paap and Cragg-Donald tests, the instrument is strong (Cragg and Donald, 1993; Stock and Yogo, 2002). The outcomes presented in Column (2) of Table 11 depict the results of the second-stage regression, where we replace the endogenous variable with its predicted value of the board gender diversity from the first-stage regression. The explanatory variable of interest is even stronger in its magnitude for reducing the amount of fossil fuel financing. Overall, the results corroborate previous evidence, confirming the positive influence of female directors on divestment from the fossil fuel sector.

7. Discussion

The need to reduce GHG emissions to contain climate change and divestment campaigns from the fossil fuel sector place under scrutiny loans and financing from the banking sector.

Our study aimed to investigate whether gender diversity on the boards of banks could act as a catalyst for divestment policies from fossil fuels. The study results highlight a negative relationship between gender diversity on the boards and the amount of bank financing to fossil fuel companies. This study aligns with research demonstrating a positive relationship between increased female representation on boards and companies' focus on environmental sustainability. This affirms well-established theories that traits typically associated with women, such as empathetic behavior and social sensitivity, can promote socially and environmentally responsible actions and good environmental performance by banks (Shakil et al., 2021; Birindelli et al., 2019; Gangi et al., 2019; García-Sánchez et al., 2018). Furthermore, in line with management theories such as Upper Echelon Theory or Resource Dependence Theory, our results highlight the role of individual characteristics of board members in shaping companies' commitment to environmental issues and improving the representation of shareholder and stakeholder interests.

To the best of our knowledge, this study represents the first attempt to examine the presence of women on bank boards as a driver of pro-environmental financing choices and, consequently, bank decisions towards the "decarbonization" of the economy. These results can strengthen managers' belief that higher gender diversity on boards can accelerate the transition to a business model prioritizing environmental goals.

Increasing the presence of women on bank boards could facilitate the energy transition. To discourage funding in brown sectors, policymakers might consider regulations encouraging gender diversity and other

Table 10
Two-stage Heckman test.

	(1)	(2)	(3)	(4)
	D_BoGendDiv	LogFossil	LogFossil	LogFossil
	Heckman phase 1	Heckman phase 2	Heckman phase 2	Heckman phase 2
L.BoGendDiv		−0.0117**	−0.0096**	−0.0099**
		(0.0048)	(0.0041)	(0.0040)
L.IndepBoard	0.0525***	−0.0053	−0.0029	−0.0004
	(0.0147)	(0.0052)	(0.0052)	(0.0045)
L.BoardSize	0.1240**	0.0070	0.0047	0.0045
	(0.0506)	(0.0148)	(0.0138)	(0.0138)
L.CeoChDual	0.5062	0.1917	0.3198**	0.5764***
	(0.4812)	(0.1492)	(0.1353)	(0.2175)
L.logTa		0.2797	1.1917***	0.7025
		(0.2199)	(0.2967)	(0.5485)
L.CostInc		0.0063	0.0074	0.0108*
		(0.0062)	(0.0057)	(0.0063)
L.ROAE		0.0005	0.0012	0.0073
		(0.0107)	(0.0096)	(0.0093)
L.Gdpgrth		0.1244	2.5561**	0.0000
		(0.6084)	(1.0934)	(.)
IMR		−0.2966	−0.4349	−0.1677
		(0.4872)	(0.4039)	(0.3280)
Observations		308	307	276
Bank FE		Yes	Yes	Yes
Time FE		No	Yes	Yes
Country FE		No	No	Yes
R2_Adj.		0.89	0.92	0.80
R2_Within		0.92	0.24	0.51
R2_Pseudo	0.28			

Notes: This table reports the results obtained from the Heckman two-step model over the period 2016–2022, with column 1 showing the first step and columns 2 to 4 the second one. The first step estimates the decision equation using a multinomial probit model, whose parameters are used to calculate the Inverse Mills Ratio (IMR). The second step estimates the stability regression with the Inverse Mills Ratio (IMR) generated by the first step. All the independent variables are lagged by one year concerning the dependent variable. Bank fixed-effects are included in all specifications. Specifically, Column 2 includes bank-fixed effects only; Column 3 includes bank and time-fixed effects; Column 4 includes bank and time*country fixed effects. Bank-clustered standard errors are reported in parentheses. The superscripts *, **, and *** represent statistical significance at the 10 %, 5 %, and 1 % levels, respectively.

professionalism, integrity, and competence requirements in the composition of bank boards. Our results are particularly interesting to ethical or socially responsible investors concerned about the financial risks associated with the fossil fuel sector. Given this type of investor's preference for socially responsible financial intermediaries (Cucinelli and Soana, 2023), they can use this information to make more informed investment decisions.

The dissemination of the results could also interest stakeholders, communities, environmentalists, and shareholders who are actively promoting pro-environmental strategies. They could pressure board composition choices in favor of greater female representation. Similarly, our findings give institutional investors significant insights to inform and guide their responsibilities in overseeing and managing investments.

Theoretically, the study enriches corporate governance and environmental management studies. Furthermore, our study fuels the debate about which strategy is most effective by financial institutions in combating climate change: divestment or risk management/engagement (Krueger et al., 2020). The fact that board gender diversity encourages divestment from the fossil fuel sector does not guarantee that this is the optimal strategy for banks, as it could bring greater risks from reduced portfolio diversification and higher compliance costs. Alongside active approaches such as divestment, there are passive approaches involving counterparty carbon footprint analysis or ESG integration into decision-making processes that could facilitate a more gradual and less risky transition (Krueger et al., 2020).

8. Conclusions

Financial institutions are pivotal in facilitating the shift towards a more sustainable tomorrow, influencing corporate behaviors by incorporating extra-financial considerations into financing and investment activities. Organizational factors, such as gender diversity on boards, have been identified as possible catalysts for sustainable behaviors and choices. This study analyses the relationship between the female presence on boards of directors and the amount of bank financing to the fossil fuel sector, which indicates the commitment to system decarbonization.

Through a panel data analysis of annual financing levels from 2016, when the Paris Agreement came into effect, to 2022, involving the world's 54 largest banks, we demonstrate a negative relationship between gender diversity on boards and the amount of banks' financing to fossil fuel companies. This finding holds even after conducting various robustness tests. Specifically, the result remains unchanged when addressing potential reverse causality issues by lagging independent and control variables, introducing the concept of critical mass, and excluding Chinese banks to eliminate the possibility of their significant influence on our sample. Simultaneously, the results hold when using the two-stage Heckman test and the instrumental variables approach to address potential selection bias. Additional results from robustness checks reveal that having at least three women on bank boards is associated with lower financing for the fossil fuel sector. Moreover, a higher percentage of women on the board makes adopting fossil divestment policies more likely, supporting the theory that gender diversity is crucial for fostering environmentally and socially responsible approaches. A sub-sample analysis that considers the heterogeneity of different countries also reveals that board gender diversity emerges as a factor that can significantly influence divestment from fossil fuels in those countries which still are far from the established environmental policy targets. When external and internal stakeholders' pressure towards adopting pro-environmental strategies is reduced due to country-specific factors, the importance and effect of women's greater environmental attitudes emerge with greater emphasis (Cosma et al., 2021).

Our research contributes to the existing literature on the link

Table 11
Instrumental variable approach.

	(1) FIRST STAGE IV	(2) SECOND STAGE IV
	BoGendDiv	LogFossil
LabPartecipFem	0.7405**	
	(0.1550)	
BoGendDiv-predicted		−0.0855***
		(0.0281)
L.IndepBoard	−0.1176	−0.0073**
	(0.0623)	(0.0032)
L.BoardSize	−0.0348	−0.0111
	(0.1679)	(0.0256)
L.CeoChDual	3.0422***	0.6422***
	(0.1503)	(0.0992)
L.LogTa	−5.8652	1.3703***
	(5.9680)	(0.2999)
L.CostInc	−0.0335	0.0132
	(0.0744)	(0.0082)
L.ROAE	0.2389	0.0117
	(0.2445)	(0.0173)
L.GDPgrth	−5.1709	2.4948***
	(9.4043)	(0.0299)
Observations	308	308
Bank FE	Yes	Yes
Time FE	Yes	Yes
Kleibergen-Paap LM stat	60.55***	
Cragg-Donald F-Stat	60.94	
Stock-Yogo (10 %)	19.93	

Notes: This table reports the results of the instrumental variables (IV) two-stage least squares (2SLS) estimator model. The results of the first stage of the IV 2SLS estimator are reported in column 1. The results of the second stage of the IV 2SLS where we replace the potentially endogenous interest variable with the results of the first stage are displayed in column 2; in this case the dependent variable is the Log Fossil, measured by the natural logarithm of fossil fuel financing. The variable of interest the board gender diversity (L.BoGendDiv). The Cragg-Donald F-Statistic and the most stringent Stock-Yogo critical value are reported. The superscripts ***, **, and * denote coefficients statistically different from zero at the 1 %, 5 %, and 10 % levels, respectively, in two- tailed tests.

between women on boards and environmental sustainability strategies, revealing the effects of governance and firm-specific attributes on an unexplored variable: fossil fuel financing. We acknowledge that our study is only one step towards understanding the impact of gender diversity on bank financing environmental choices, and we acknowledge its limitations that future research could address. These include a limited sample size. In addition, to avoid over-parametrization, we voluntarily limited the number of control variables to be included in the analysis. Considering the debate over the best strategies to combat climate change, future research could conduct comparative studies between divestment and passive approaches (carbon footprint assessment or ESG integration into decision-making processes). Analysing which management characteristics favor one approach over another or analysing the spillovers of these strategies on the financial performance of financial intermediaries can certainly be interesting and may provide additional insights for policymakers grappling with an increasingly troubling climate context.

Inclusion and diversity statement

While citing references scientifically relevant for this work, we also actively worked to promote gender balance in our reference list.

CRediT authorship contribution statement

Simona Cosma: Writing – original draft, Supervision, Methodology, Conceptualization. **Simona Galletta:** Writing – original draft, Supervision, Methodology, Conceptualization. **Sebastiano Mazzù:** Writing – original draft, Supervision, Methodology, Conceptualization. **Giuseppe Rimo:** Writing – original draft, Supervision, Methodology, Conceptualization.

Declaration of competing interest

None.

Acknowledgements

This study was funded by the European Union - NextGenerationEU, Mission 4, Component 2, in the framework of the GRINS -Growing Resilient, INclusive and Sustainable project (GRINS PE00000018 – CUP E63C22002120006). The views and opinions expressed are solely those of the authors and do not necessarily reflect those of the European Union, nor can the European Union be held responsible for them.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.eneco.2024.107948.

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