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Examining the effect of female directors on US firm ESG performance

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Abstract: This study revisits the effects of gender and racial board diversity on firms' corporate social responsibility measured using environmental, social, and governance (ESG) scores. We contribute to the corporate governance literature by using a panel of director-level data to conduct our analysis and by accounting for endogeneity using an instrumental variables (2SLS) approach when assessing the link between female board members and ESG scores. We find that women serve on boards with higher ESG scores when compared with similar men. Meanwhile, board members who identify as racial minorities serve on boards with higher ESG scores than their white counterparts. Gender does not moderate the minority effect as we find no significant difference in scores reported between minority men and women.

Keywords: environmental, social and governance score; ESG score; female directors; corporate governance.

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1 Introduction

Though a large body of research outlines the potential benefits of increasing board gender diversity, women are heavily underrepresented on boards globally. In the USA, the pace to increase female representation in the boardrooms lags behind that of other developed countries. As of 2021, female representation on US boards averaged 29% overall and 30% in S&P 500 corporations (Stuart, 2021). This compares with other developed countries like France, which reports 44%, the UK, which reports 36.3%, and Canada, which reports 31% female participation (see Sutton and Architektonidis, 2021).[1]

Notwithstanding the relatively low representation of females on US boards, board diversity is important for several reasons. The composition of the board of directors may influence a firm's market strategy, and a diversity of people generates a diverse set of opinions that impacts and improves the decision-making process (Bernardi and Threadgill, 2010). Against this background, several papers use firm-level data to assess the effect of female board members on firms' corporate social responsibility (CSR) defined using several statistics, including firms' ESG scores. However, the estimated impact of gender diversity on CSR can be described as mixed, at best (Dawar and Singh 2016). Using firm-level data and the percentage of female board members to capture board diversity, many researchers like Valls Matinez et al. (2020) and Xie et al. (2020) report that gender diversity has a positive and statistically significant impact on a firm's CSR. Others like Walls et al. (2012) and Cucari et al. (2017) find no effect, while a few, like Fauzi and Locke (2012), report that an increase in gender diversity results in a significant decline in a firm's CSR using data on firms operating in New Zealand and India, respectively. Given the lack of consensus in the literature, we contribute to the ongoing discussion by using micro-level data from 2011 to 2021 to re-estimate the relationship between board gender diversity and US firms' ESG outcomes.

Adams (2016) outlined and emphasised the potential for invalid estimates in research addressing the effects of board gender diversity due to endogeneity. One source of endogeneity is selection bias. For example, women may be more interested than men in serving as directors on the boards of progressive firms, which in turn have better ESG records, and hence self-select themselves into these companies. It is also possible that more progressive firms, which in turn have better ESG records, actively seek out (select) female board members. In both cases, there would be a 'selection' of women into boards of firms with better ESG records insofar as these more progressive firms have better ESG records. Thus, in addition to using micro-level and more recent data to carry out our analysis, we execute an instrumental variables (IV) approach, which controls for potential endogeneity issues when investigating the effect of board gender diversity on ESG outcomes.

Using a panel of 8,350 directorships, we show that female directors have a positive, meaningful (0.4 standard deviation), and statistically significant impact on board ESG scores, especially environmental scores. Our paper adds to the corporate governance literature by providing additional evidence of a positive impact of gender on firms' ESG outcomes while using individual (director) level data and a unique combination of instruments to address selection bias.

The remainder of the paper is organised as follows: Section 2 discusses other papers which utilise the IV approach to address potential endogeneity in board gender diversity research. Section 3 describes the data. Section 4 provides an overview of the methodology used in this paper and discusses the potential bias in results due to

endogeneity (including self-selection and reverse causality/simultaneity/simultaneous equations) in board gender diversity ESG research. Section 5 provides a discussion of the results. And section 6 concludes the paper.

2 Literature review

Adams (2016) and Adams and Ferreira (2009) outlined and emphasised the potential for invalid estimates in research addressing the effects of board gender diversity due to 'endogeneity'. Endogeneity refers to a correlation between one or more of the independent variables in a regression and the error term in the regression – and when there is endogeneity, the ordinary least squares (OLS) estimator is inconsistent (Stock and Watson, 2007). Adams (2016) invited future researchers studying the effects of board gender diversity on ESG outcomes to employ state-of-the-art econometric techniques that can address endogeneity. The emerging body of research addressing endogeneity complements the prior body of research that measured the impact of gender on ESG outcomes using OLS-based regression methods, including OLS and fixed effects. In a meta-analysis of 87 studies examining this prior body of research, Byron and Post (2016) find the effect of female board representation on firm social performance is largely mixed, but generally positive.

The IV technique has become an increasing popular approach to addressing potential endogeneity in the wider literature addressing different aspects of corporate governance (Dupatti et. al, 2022; Kumar and Sujit, 2022; Belgacem et al., 2022; Balachandran et al., 2021; Rahman et al., 2021; Geeta and Prasanna, 2016; Elston and Zhang, 2016; Klai and Omri, 2013). The following review of literature will focus on papers which use the IV approach utilised in this paper to address endogeneity when trying to assess the impact of board gender diversity on company ESG outcomes. The reviewed papers can generally be divided into two broad categories – the impact of board gender diversity on environmental outcomes and initiatives, and the impact of board gender diversity on various measures of social responsibility.

In the analysis of the effects of board gender diversity on ESG outcomes, the reviewed papers run the gamut, analysing: voluntary climate change disclosure, renewable energy consumption, environmental innovation (measured as process innovation and product innovation), general corporate environmental responsibility, securities fraud litigation, obfuscation in 10-K reports, capital disclosure in initial public offering prospectuses, and product recalls (how often and quickly firms implement FDA class 3 recalls). In every case of this not-all-inclusive review, board gender diversity has a statistically significant positive effect on environmental or social-responsibility outcomes.

A popular instrument, for board gender diversity suggested by Adams and Ferreira (2009) is the proportion of males on the board who sit on other boards with at least one female member. Wang et al. (2021) utilise this instrument on a panel of Chinese firms covering the 2010–2016 period (2,215 firm year observations). They posit that women will seek out boards with connections to other women board members to improve their 'informal social network linking directors'. They find a significant positive effect of board gender diversity on corporate environmental responsibility, but that the effect is attenuated in provinces with a higher population ratio of males to females. Joo et al.

(2021) employed this instrument in their study of a panel of S&P 1500 firms covering the 1998–2017 period (13,479 firm year observations).[2] They argue it "is a suitable instrument since the connection of male directors to women directors on other boards can increase the visibility of female directors as potential candidates for director appointments on additional company boards". They find a significant negative effect of the proportion of female independent directors on the probability of a securities lawsuit being filed against a firm. Wowak et al. (2021) employed this instrument given the proportion 'implies enhanced networking and board opportunities for female directors'. In their analysis of 4,270 medical product recalls using a panel of 92 publicly traded and FDA regulated companies covering the 2002–2013 period, they find that boardroom gender diversity has a significant positive effect on the number of product recalls and a significant negative effect on the time to recall.

Another commonly appearing instrument in board gender diversity research is industry average board gender diversity. Nadeem (2022) uses the instrument in a panel of Russell 3,000 firms covering the 2002–2018 period (6,268 firm year observations) to investigate the impact of board gender diversity on obfuscation in 10-K reports – specifically readability in terms of linguistic complexity. He argues that the proportion of female directors in any particular firm is likely to be affected by proportion of female directors in the firm's industry due to peer pressure. He finds a significant positive effect of boardroom gender diversity on the readability of 10-K reports and that his results are driven by female independent directors and by their representation on audit and compensation committees. Nadeem (2020) uses the instrument in a panel of 107 Chinese firms that went pubic over the 2009–2017 period to examine the impact of board gender diversity on voluntary intellectual capital disclosure in initial public offering prospectuses. He finds a significant positive effect of boardroom gender diversity on intellectual capital disclosure. Nadeem et al. (2020) use the instrument in a panel of US firms covering the 2002–2018 period (10,344 firm year observations) to examine the relationship between board gender diversity and environmental innovation (measured as process innovation and product innovation). They find a significant positive effect of board gender diversity on both environmental process innovation and environmental product innovation.

In studying the effects of board gender diversity on environmental outcomes, Ben-Amar et al. (2017) use an IV Probit model and panel of Canadian firms over the 2008–2014 period to measure the effect of women board members on voluntary climate change disclosure. They instrument for the percentage of women directors using the number of board members and the existence of a mandatory retirement policy for board members. They find a significant positive effect of the percentage of female board members on voluntary climate change disclosure.

Atif et al. (2021) use a panel of 1,500 US firms covering the 2008–2016 period (11,677 firm year observations) to examine the effect of board gender diversity on renewable energy consumption. They instrument for the percentage of women on the board using the female-to-male workforce participation ratio for the state of the firm's headquarters. Their rationale is that firms in states with higher female-to-male participation ratios should have a higher percentage of female directors due to the greater likelihood of finding good ones due to the larger pool of candidates. They find a significant positive effect of percentage of women on the board on renewable energy consumption and that this effect comes from female independent rather than female executive directors.

It's still early, but this emerging body of causal inference-based research on the effects of board gender diversity on firm ESG outcomes increasingly offers convincing support of the conclusion that women have a positive effect on firm ESG outcomes. Our results are consistent with this emerging consensus but offer a unique approach to answering the question which contributes to the existing body of research on causal inference-based research on the effects of board gender diversity.

3 Data

Several datasets were utilised for this paper. Firm ESG ratings were obtained from Institutional Shareholder Services Inc. (ISS). The ESG score is a weighted sum of firm environmental, social, and governance (ESG) rating indices. The 'E' or environmental aspect of the ESG score accounts for firms' attempts to address the climate crisis and environmental sustainability. The 'S' or social aspect of the score captures firms' performance on issues such as diversity, human rights, and consumer protection. Meanwhile, the 'G' or governance aspect of the score captures firms' performance on issues such as management structure, employee relations, and executive compensation. Note that there is no universally accepted definition for an ESG score. Each rating agency determines the attributes accounted for and their relative weights when creating scores. As a result, ESG scores have received criticism for their divergence across rating agencies (Berg et al., 2022). Yet ESG scores remain a crucial indicator for measuring firms' CSR by regulators and stakeholders. The performance ratings scores published by ISS are analysed using a twelve-point rating scale from 1 (poor performance, which corresponds to a letter grade of D-) to 4 (excellent performance, which corresponds to a letter grade of A+) in increments of 0.25. Each score is a weighted sum, combining data from more than 30 industry-specific ESG topics and applying approximately 100 social, environmental, and governance-related indicators per score (ISS, 2020).[3]

The ISS Governance Director database which was used to collect director characteristics such as an individual's age, gender, and race allows us to examine the difference in firms' ESG scores across demographic groups. We also obtain a measure of board independence, calculated as the proportion of non-executive directors on the board of directors. Consistent with existing research on CSR (Ben-Amar et al., 2022; Fisher et al., 2019; García-Sánchez et al., 2019; Melloni et al., 2017), our analysis accounts for firm financial market performance by incorporating firm-specific data such as return on assets (ROA), firm size (defined as the natural log of annual sales), firm leverage (defined as the ratio of total debt to total assets), and capital intensity (defined as the ratio of capital expenditures to total sales). We collected this data from COMPUSTAT database via Wharton Research Data Services (WRDS).

After we drop directorships (firm-director position) with missing information, our final sample consists of 17,615 observations from 1,576 unique US firms from 2011 to 2021. We utilise these data to investigate the average difference in firm ESG rating scores associated with directors of different genders and races. Given that the indicators used to create a firm's ESG score are industry-specific, we seek to control for differences across industries by creating industry-standardised ESG scores. Specifically, we create ESG z-scores by subtracting the mean industry ESG score from each individual value and then dividing that result by the standard deviation of the ESG score for the industry

(Giese et al., 2021; Bennani et al., 2018). For the calculation of industry-standardised ESG scores (z-scores) and the development of industry indicators to include as fixed effects in our regressions, industries were grouped into the following major SEC code categories: manufacturing, finance and real estate, services, and other, which combined all remaining major SEC code categories (agriculture, mining, construction, transport, wholesale trade, retail trade, and public administration).

In addition to reporting differences in the aggregate ESG score, we also separately assess the differences in firms' environmental ratings and combined social and governance ratings associated with directors of different genders and races. Though aggregate ESG scores represent the main ESG performance score provided by rating agencies, by incorporating an analysis of the underlying pillars of the ESG score – ESG scores. By including this analysis, we can identify which dimension of ESG overall score has a stronger relationship with board diversity. Across all directors in our data set, the average overall ESG score is 1.7, the average environmental score is 1.6 and the average social and governance score is 1.8.

Our primary independent variables of interest are gender and race. We use three different variables to measure female board gender diversity. First, we employ a binary variable, female director, which takes a value of one if the board member identifies as female and zero otherwise. Our second measure of board gender diversity is the proportion of directors who identify as female. Regarding our third measure of board gender diversity: some empirical papers promote the significance of a critical mass of female board members to influence CSR. They largely find that at least three female board members are necessary to have a lasting impact on board decisions and hence firms' performance (Bernardi and Threadgill, 2010; Jia and Zhang, 2013; Liao et al., 2018). Often these papers report an average board size of nine or more members; as a result, three largely represents 33% or more. Given that three or more females may not be reflected on smaller boards, authors like Buallay et al. (2022) move away from a critical mass definition in terms of the number of females to one based on the proportion of females. They find that when females account for 21% to 50% of board members, firms report significantly higher ESG scores. Meanwhile, focusing on firms' idiosyncratic volatility, Lin and Poon (2019) report an optimal female board ratio of 24%, which translates to 2–3 female directors on a typical board of ten members. As a result, our third measure of board gender diversity follows the approach of Buallay et al. (2022), who account for a critical mass of female directors by incorporating an indicator variable that takes a value of one if the percentage of female directors exceeds 20% and zero otherwise.

To control for race, we use a binary variable, minority, which takes a value of zero if the director is white and one otherwise. Each model reported on below includes firm and director level controls such as firm size, leverage, ROA, capital intensity, board independence, and age. We also include industry and year fixed effects. Table 1 provides a detailed description of the variables utilised in our regressions.

Table 2 displays the summary statistics. In columns 1 through 3, we present mean characteristics for the full sample and sub-samples of male directors and female directors, respectively. In columns 4 and 5, we display the average characteristics for firms with no female board members and firms with at least one female board member, respectively. In column 6, we present p-values from the test of differences in mean characteristics for firms without female directors versus the mean for firms with at least one female board member.

Table 1 Variable descriptions

Name of variable (acronym)	*Measurement*
Dependent variables	
Standardised ESG score (ESG)	This represents the combination of a firm's environmental, CSR, and corporate governance disclosure indexes
Standardised environmental score (E)	An index that measures the rating a firm's energy use, waste, pollution, natural resource conservation, and animal treatment.
Standardised CSR and governance score (SG)	An index that measures the rating of a firm's business relationships, bank donation, volunteer work, employees' health, and safety
Key independent variables	
Female	Indicator variable that takes a value of one if the director identifies as female and zero otherwise
Fraction of female directors	The proportion of female directors
Critical mass of women on the board of directors (critical mass)	Indicator variable equal to one if the percentage of female Board members is greater than or equal to 20% and zero otherwise
Minority	The proportion of the board that identifies as racial minority
Controls	
Board independence	The proportion of independent non-executive directors
Firm size	Natural log of total asset
Firm leverage	Total debt as a proportion of total assets
Return on assets (ROA)	Net income divided by total assets
Capital Intensity	Capital expenditure as a proportion of total sales
Age	Age
Industry fixed effects	Manufacturing, finance, and real estate, services, and other
Year fixed effects	2012–2021 with 2011 as the reference year
Instruments	
Female president	Indicator variable that takes a value of one if the president identifies as female and zero otherwise
Female CEO	Indicator variable that takes a value of one if the CEO identifies as female and zero otherwise
Board size	Natural log of the number of directors sitting on the board

We present data for 6,639 unique directors holding a total of 8,350 directorships (firm-director position) at 1,576 unique US firms over the 2011–2021 period for a total sample of 17,615 (firm-director position-year) observations. Females represent 1,305 or 19.7% of directors, and hold 18.2% of directorships over time. Approximately 71.2% of females are independent board members, while only 67.3% of male directors are independent. Women are associated with larger boards and are more likely to identify as a minority – 25.2% relative to 16.9% of male directors. Male board members are older on average – 62 years relative to 59 years for female directors. Sixty-three percent of our

sample firms have appointed at least one woman on their board, while only 5.7% have appointed at least three female directors.

Table 2 Summary statistics

	All	*Male*	*Female*	*No female*	*At least one female*	*P-value (4)–(5)*
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*
ESG overall score	1.707	1.696	1.759	1.638	1.748	0.000
ESG social score	1.807	1.797	1.854	1.762	1.834	0.000
ESG environmental score	1.578	1.566	1.631	1.489	1.631	0.000
Female	0.182	0.000	1.000	0.000	0.289	
Gender diversity	0.182	0.144	0.350	0.000	0.289	
Critical mass	0.411	0.324	0.804	0.000	0.654	
Minority	0.184	0.169	0.252	0.159	0.200	0.000
Age	61.373	61.963	58.719	61.704	61.177	0.000
Firm leverage	0.280	0.277	0.291	0.274	0.283	0.012
Firm size	8.533	8.493	8.715	8.135	8.769	0.000
Board independence	0.680	0.673	0.712	0.603	0.726	0.000
ROA	0.058	0.057	0.063	0.049	0.063	0.000
Capital Intensity	0.067	0.069	0.061	0.074	0.063	0.000
Female president	0.049	0.036	0.108	0.000	0.078	0.000
Female CEO	0.067	0.050	0.145	0.000	0.107	0.000
Board size	5.035	4.994	5.217	3.765	5.785	0.000
Manufacturing	0.419	0.417	0.427	0.421	0.417	0.640
Finance and real estate	0.175	0.178	0.164	0.182	0.171	0.056
Service	0.133	0.134	0.128	0.152	0.122	0.000
Other	0.273	0.271	0.280	0.245	0.290	0.000
At least one female	0.628	0.546	1.000	0.000	1.000	
At least three females	0.057	0.041	0.129	0.000	0.091	
Observations	17,615	14,410	3,205	6,544	11,071	17,615

Notes: Numbers are the mean of the variable. In column 6, we present p-values from the test of differences in mean characteristics reported by boards with no female members and those with at least one female board member.

Source: ISS ESG and Directors Databases

When we compare boards without female members to those with at least one female director (columns 4 through 6), we find that firms with at least one female director report higher ESG scores, on average. In our regression analysis, we test if the significant difference in scores remains once we account for the firm-and director-specific characteristics. Overall, Table 2 shows that boards with at least one female director are

bigger, more racially diverse, and largely report stronger average financial performance relative to those with no female directors.

Because firms with at least one female director report stronger financial performance (in terms of total assets-firm size and ROA) and have larger boards than firms without female directors, it is possible that a firm's choice to nominate female board members could be influenced by firm characteristics. As a result, we include these variables as controls in our regression analysis.

Table A1 in Appendix displays the correlation analysis. As expected, ESG is positively related to our measures of board gender diversity (the female indicator variables, the proportion of female directors, and the critical mass indicator variable). There is also a positive correlation between ESG scores and firm size, the percentage of independent directors on a board (board independence), return on assets (ROA), the percentage of the board who identify as racial minority, and spending on capital resources. In contrast, the correlation between the dependent variables and firm leverage or directors' age can be described as mixed or negative.

Except for the association among our different measures of board gender diversity, the largest correlation among explanatory variables involves firm size and board independence (a correlation coefficient of 0.28). As a result, the relatively low correlation coefficients presented here provide evidence that multicollinearity may not be an issue in our analysis.

4 Methodology

We utilise an IV regression to correct for potential endogeneity problems. Endogeneity problems arise when there is a correlation between one or more of the independent variables in a regression and the error term in the regression (Stock and Watson, 2007). When there is endogeneity, OLS-based regression estimates (including fixed effects) are inconsistent since 'changes in [the endogenous independent variable] are associated not only with changes in [the dependent variable] but also changes in the error [Cameron and Trividi, (2005), p.96].

There are three common sources of endogeneity – omitted variable bias, simultaneous equation bias, and measurement error [Wooldridge, (2002), pp.50–51]. Two of these are key potential sources of endogeneity in studies analysing the impact of board gender diversity on corporate ESG outcomes.

The first key potential source of endogeneity is omitted variable bias caused by selection (Adams, 2016). Here, an 'omitted variable' is one not included in the regression, but which is a determinant of the dependent variable and correlated with one or more of the independent variables [Stock and Watson, (2007), p.237]. In discussing omitted variable bias in his book *Econometric Analysis of Cross Section and Panel Data* (2002, p.51), Wooldridge states that "the correlation of explanatory variables with unobservables is often due to self-selection". Meanwhile, Antonakis et al. (2010, p.1094), model selection as a special case of omitted variable bias. And Angrist and Pischke (2009, p.59) discuss omitted variable bias in the context of selection. Note that selection can occur due to observational units self-selecting into 'treatment' or by otherwise being selected into 'treatment' [Antonakis et al., (2010), p.1094], or due to 'sample selection decisions by analysts or data processors' [Heckman, (1979), p.153]. Selection is such an

important issue that Angrist and Pischke (2009, p.15) claim "the goal of most empirical economic research is to overcome selection bias, and therefore to say something about the causal effect of a variable..."

Selection, and the resultant omitted variable bias, may impact studies analysing the effect of board gender diversity on company ESG outcomes. For example, it is possible that women are more interested than men in serving as directors on boards of firms that are more progressive, which in turn have better ESG outcomes (i.e., assume firm-progressiveness is a determinant of firm-ESG-outcomes), and hence self-select into higher ESG companies. Or it is possible that more progressive firms, which in turn have better ESG outcomes, actively seek out ('select') female board members.

In both examples, there would be a 'selection' of women into boards of more progressive firms, creating correlation between firm board gender diversity and firm progressiveness [Antonakis et al., (2010), p.1094, discuss a conceptually similar example]. And, if firm-progressiveness is not included in a regression measuring the impact of firm board gender diversity on firm ESG outcomes, it will be included in the error term (since in the examples, firm-progressiveness is assumed to be a determinant of firm ESG outcomes). And since the error term (which includes firm-progressiveness) is then correlated with one or more of the independent variables (firm-board-gender-diversity), there is endogeneity, and the OLS-based regression estimate of the impact of firm-board-gender-diversity on firm ESG outcomes will be inconsistent.

Using the language of omitted variable bias: there is a variable omitted from the regression (firm progressiveness), which is a determinant of the dependent variable (firm ESG outcome) and correlated with one of the independent variables (firm board gender diversity), resulting in an omitted variable bias. In our specific examples, an OLS-based regression estimate of the effect of firm board gender diversity on the firm ESG outcome being analysed would 'combine these two effects' [Cameron and Trividi, (2005), p.96] of firm board gender diversity and firm-progressiveness, and the estimated effect of firm board gender diversity would be biased upwards.

The second key potential source of endogeneity affecting OLS-based regression estimates of the impact of board gender diversity on ESG outcomes is simultaneous equation bias, also referred to as simultaneity or reverse causality bias (Adams, 2016). For example, it is possible that while women are more interested than men in serving on boards of firms with better ESG records, it is also the case that firms with better ESG records have a greater preference for hiring female board members. Thus, while firm-ESG-outcomes are a function firm board gender diversity, firm board gender diversity is simultaneously a function of firm ESG outcomes. In this case, there are two separate but simultaneous equations explaining the relationship between firm ESG outcomes and firm board gender diversity.

By substituting the firm board gender diversity equation into the firm ESG outcome equation, and making a relatively benign assumption about the parameters, it can be shown that the error term in the firm ESG outcome equation is correlated with the independent variable, firm board gender diversity [Wooldridge, (2013), p.559]. So, with simultaneity, endogeneity again occurs in OLS-based regressions of firm ESG outcomes on firm board gender diversity, and estimates again will be inconsistent.

Successful IV regression relies on finding an IV(s), or instrument(s), that meet two conditions – instrument relevance and instrument exogeneity [Stock and Watson, (2007), p.423]. With a single endogenous variable, these conditions are somewhat straightforward – instrumental relevance is when the partial correlation between the

instrument and the endogenous variable (firm board gender diversity), controlling for the other independent variables from the regression, is non-zero; while instrument exogeneity is when the correlation between the instrument and unobservables in the error term of the regression is zero [Stock, (2002), p.7578].[4] A related exogeneity condition is that the instrument has no partial effect on the dependent variable after the independent variables and omitted variables have been controlled for [Wooldridge, (2013), p.514].

An IV regression typically takes the form of a two-stage regression (2SLS) (Stock and Watson, 2007). In the first stage, the potentially endogenous independent variable (female, in our below model utilising individual level data) is regressed on the instruments and the additional independent variables. Then, in the second stage regression, the fitted values from the first stage regression are used in place of the endogenous independent variable (female) in our below model.

The intuition behind this approach is that the fitted values from the first stage regression are effectively stripped of their correlation with the error term [Wooldridge, (2013), p.529]. These fitted values can then be viewed as a problem free (exogenous) component of the endogenous independent variable (female), and when used in the second stage OLS regression, permit consistent estimation of the effect of the independent variable (female) on the dependent variable (ESG score) [Stock and Watson, (2007), p.421, p.424]. The interpretation of the estimated coefficient on the fitted values from the second stage regression is then analogous to the interpretation of the coefficients on independent variables in OLS based regressions.

We estimate a random effects panel regression model to analyse the determinants of director ESG performance. To analyse differences in the average ESG scores reported by directors of different gender and race, we estimate the following model:

$$\begin{aligned} Y_{ijt} = {} & \beta_f Female_i + \beta_A Age_{it} + \beta_{AA} Age_{it}^2 + \beta_M Minority_i \\ & + \beta_5 Firmsize_{jt} + \beta_L Firmleverage_{jt} + \beta_{ROA} ROA_{jt} \\ & + \beta_{Indep} Boardindependence_{jt} + \beta_{CI} Capitalinbntensity_{jt} \\ & + \delta_I + \lambda_t + \epsilon i_{jt} \end{aligned} \tag{1}$$

where Y_{ijt} is the industry-standardised ESG score of interest for board member i, at company j, in year t. We estimate equation (1) for overall standardised ESG score, as well as standardised social and governance, and standardised environmental scores. Our key coefficient of interest is β_f which captures the difference in average standardised scores for female directors relative to males. In subsequent specifications we replace this definition of board gender diversity with our other two measures: fraction of female directors and critical mass. We are also interested in the link between race and ESG scores. This is captured by the coefficient β_M which estimates the difference in average standardised ESG scores associated with minority directors relative to their white counterparts. All other controls are standard in the corporate social governance literature; δ_I and λ_t represent industry and year fixed effects, respectively.

As discussed above in this section, results from equation (1) may suffer from endogeneity due to self-selection or simultaneity. To reduce potential bias due to endogeneity, we complement our random effects model estimates of the effect of board gender diversity on standardised ESG score with two-stage least square regression models. To additionally minimise potential bias due to omitted variables, we control for firm and director-level characteristics in all models. As in Ben-Amar et al. (2017) and

Campbell and Minguez-Vera (2008), we use board size as an instrument for our measure of board gender diversity, female. As a board of directors gets larger, the absence of a woman on it gets more scrutiny and so should affect the likelihood of hiring a woman board member. Table 2 also shows that female directors in our sample are associated with large boards. Meanwhile, there is no obvious reason why board size would cause increased ESG outcomes.

In addition to board size, we use an indicator variable for female CEO (Aabo and Giorici, 2023; Borghesi et al., 2014) and an indicator variable for female president as instruments for the female director variable. The CEO variable and the president variable take a value of one if the CEO or president, respectively, is female, and zero otherwise. A female CEO or President may prioritise women directors and give them greater influence in corporate decision-making (Jia and Zhang, 2013; Torchia et al., 2011), in which case it would affect the likelihood of hiring a woman board member. Meanwhile, Aabo and Giorici (2023) report mixed results, null or positive effects, insofar as the effect of female CEOs on ESG outcomes. Furthermore, they show that whether a female CEO matters for a firm's ESG profile depends crucially on the rating agency or ESG data provider. To support our choice of IV regression methodology and associated instruments we employ standard endogeneity and over-identification tests which are discussed in the Section 5 immediately below.

5 Results

In Table 3, we present baseline results from regression where we examine the impact of gender and race on firm standardised EGS scores, without addressing endogeneity explicitly. Using three distinct measures of gender diversity in columns 1 through 4, we show that board gender diversity is positively related to overall standardised ESG scores. The coefficient on the main variable of interest, female, is positive and statistically significant at the 5% level. This suggests that female directors are associated with firms that report higher ESG scores. Specifically, the coefficient on the female indicator variable is 0.06, implying that female directors are associated with firms reporting average ESG scores which are 0.06 standard deviations higher than the average score reported by male directors.

Because some existing research highlights that the fraction of female board members matters when considering CSR (Birindelli et al., 2018; Valls Martínez et al., 2020), we examine the link between ESG scores and the fraction of female directors in column 2 of Table 3. Our results suggest that a 1% increase in the percentage of female directors is associated with an increase of 0.22 standard deviations, on average, in the overall ESG score. This positive link is in line with existing work by Birindelli et al. (2018) and Valls Martínez et al. (2020). We also examine the presence of a nonlinear association between board gender diversity and ESG (Ben-Amar et al., 2017; Birindelli et al., 2018; Valls Martínez et al., 2020), by adding the fraction of female directors as a quadratic term. The coefficient on the fraction of female directors, displayed in column 3 of Table 3, is positive and statistically significant, while the coefficient on the squared term is negative and statistically insignificant. Valls Martínez et al. (2020) also report a negative coefficient on the squared term. However, their results suggest a negative and statistically significant effect, though modest in magnitude. Overall, the results presented in column 3 of Table 3 imply that a nonlinear relationship does not exist between the fraction of

female board members and ESG scores in our data set of US firms. This insignificant effect is in line with Ben-Amar et al. (2017), though they examined the relationship between board gender diversity and firms' climate change disclosures in Canada.

Table 3 Random effects models, ESG z-score

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Female	0.057*				0.073**
	(0.0224)				(0.0256)
Minority	0.102***	0.104***	0.104***	0.105***	0.118***
	(0.0223)	(0.0222)	(0.0222)	(0.0222)	(0.0255)
Age	0.023*	0.023*	0.023*	0.023*	0.023*
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Firm leverage	0.071*	0.065+	0.065+	0.066+	0.071*
	(0.0342)	(0.0342)	(0.0342)	(0.0341)	(0.0342)
Firm size	0.258***	0.256***	0.256***	0.257***	0.258***
	(0.0062)	(0.0062)	(0.0062)	(0.0062)	(0.0062)
Board independence	0.279***	0.249***	0.243***	0.255***	0.278***
	(0.0339)	(0.0343)	(0.0346)	(0.0342)	(0.0339)
ROA	–0.051	–0.058	–0.057	–0.057	–0.051
	(0.0717)	(0.0717)	(0.0717)	(0.0717)	(0.0717)
Fraction of female directors		0.220***	0.344***		
		(0.0378)	(0.0907)		
Fraction of female directors^2		–0.257			
			(0.1701)		
Critical mass				0.071***	
				(0.0122)	
Female × Minority					–0.067
					(0.0519)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	17,615	17,615	17,615	17,615	17,615
Overall R^2	0.218	0.22	0.221	0.221	0.218

Notes: Dependent variables is the industry-neutral overall ESG score (ESG z-score), which was created to raise awareness of factors related to the sustainability of businesses in terms of their long-term performance. This index represents the combination of a firm's environmental, CSR, and corporate governance scores. We create z-scores by first subtracting the industry mean from each index value and dividing by the standard deviation. Standard errors are in parentheses and clustered at the director-firm level. $+p < 0.1$, $*p < 0.05$, $**p < 0.01$, $***(p < 0.001)$.

Source: ISS ESG and Director Databases

Table 4 Random effects models, CSR z-score

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Female	0.046*				0.057*
	(0.0228)				(0.026)
Minority	0.091***	0.092***	0.092***	0.093***	0.103***
	(0.0226)	(0.0225)	(0.0225)	(0.0225)	(0.0259)
Age	0.044***	0.043***	0.043***	0.044***	0.044***
	(0.0092)	(0.0092)	(0.0092)	(0.0092)	(0.0092)
Firm leverage	–0.180***	–0.186***	–0.186***	–0.184***	–0.180***
	(0.0353)	(0.0353)	(0.0353)	(0.0353)	(0.0353)
Firm size	0.229***	0.226***	0.226***	0.228***	0.229***
	(0.0063)	(0.0063)	(0.0063)	(0.0063)	(0.0063)
Board independence	0.431***	0.401***	0.400***	0.406***	0.431***
	(0.0374)	(0.0378)	(0.0378)	(0.0377)	(0.0374)
ROA	0.039	0.03	0.031	0.032	0.039
	(0.0766)	(0.0766)	(0.0766)	(0.0766)	(0.0766)
Fraction of female directors		0.237***	0.302**		
		(0.0399)	(0.1008)		
Fraction of female directors^2			–0.133		
			(0.1895)		
Critical mass				0.070***	
				(0.013)	
Female × Minority					–0.048
					(0.0528)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	17,615	17,615	17,615	17,615	17,615
Overall R^2	0.238	0.24	0.24	0.241	0.238

Notes: Dependent variable is the industry-neutral CSR score (z-score). Social and governance aspects include human rights, labour practices, corruption, bribery, reputation, and management effectiveness. This is an index that measures the rating of a firm's business relationships, bank donations, volunteer work, and employees' health and safety. We create z-scores by first subtracting the industry mean from each index value and dividing by the standard deviation. Standard errors are in parentheses and clustered at the director-firm level. $+p < 0.1$, $*p < 0.05$, $**p < 0.01$, $***(p < 0.001)$.

Source: ISS ESG and Director Databases

Prior researchers provide evidence that female board members promote CSR reporting, especially when there are three or more female directors (Bear et al., 2010; Jia and Zhang, 2013; Amorelli and García-Sánchez, 2020). In column 4 of Table 3, we examine how ESG scores differ across firms with and without a critical mass of females. Only 5.7% of our sample represents boards with three or more female directors (Table 2). Thus, we adopt Buallay et al.'s (2022) approach and define the critical mass of females as

an indicator variable equal to one if a firm has at least 20% female board members and zero otherwise. We find that boards with 20% or more females report average standardised ESG scores that are 0.07 standard deviations higher than the average reported by similar firms with a smaller proportion of female board members. This estimate of the effect of board gender diversity is similar in magnitude to the estimate reported in column 1 of Table 3.

Regarding racial diversity, the coefficient associated with the minority variable in columns 1 through 4 of Table 3 indicates that a 1% increase in racial diversity (the proportion of directors who identify as non-white) raises a firm's overall ESG score by 0.10 standard deviations, on average. Given that the estimated coefficients on the minority variable in columns 1 through 4 are large and highly significant, we use an interaction term to test if the estimated effect differs by gender in column 5. That is, we attempt to ascertain whether female directors on racially diverse boards report higher ESG scores than male directors on similar boards. The results in column 5 of Table 3 indicate that white females report average ESG scores that are 0.07 standard deviations higher than white males, and a 1% increase in racial diversity on boards increases ESG scores by 0.12 standard deviations. The interaction term between female and minority director variables is statistically insignificant, indicating no significant differences between female minority and male minority directors.

Tables 4 and 5 reproduce the above discussed regression models reported in Table 3, except that the dependent variable, firm standardised ESG score, is replaced by standardised measures of the two components of a firm's ESG score – its environmental score (Table 4) and its social and governance score (Table 5). Columns 1 through 4 of Tables 4 and 5 show that previous results persist when we examine social and governance scores and environmental scores, separately. That is, the impact of female board members on both the standardised social and governance score and on the standardised environmental score suggests a positive and statistically significant relationship. Specifically, the results for the regressions in Tables 4 and 5 are largely consistent with our Table 3 ESG score regression results for all three measures of female board representation (female director, fraction of female directors, and critical mass of female directors) insofar as sign, magnitude, and significance of the coefficients. Insofar as the minority variable coefficient in Table 4's social and governance score regression, the results are also similar in sign, magnitude, and significance to the coefficient estimates in Table 3's ESG regressions. However, the coefficient estimates for the minority variable in Table 5's environmental score regressions are about the half the magnitude (though the same sign) and with lower significance compared to Table 3's ESG regression results.

Our previous results in Tables 3, 4 and 5 suggest that female directors are associated with firms reporting higher ESG scores, on average. However, we cannot say much regarding causation since the relationship between ESG score and director's gender suffers from endogeneity. The reason is that the presence of a female director may impact a firm's decisions in a way that improves ESG scores, but firms with higher ESG scores may attract or select female directors. To address the possibility that board gender diversity is endogenous in the random effects specification, we re-estimate the model in equation (1) using the IV (2SLS) approach. Table 6 displays the IV regression results. Column 1 displays the first-stage results, and the second-stage results are outlined in columns 2 through 4. The results in column 1 support the relevance of our instruments. The coefficient associated with all three instruments is positive and statistically different

from zero, suggesting that the presence of a female president, female CEO, and board size increase the probability that a director identifies as female. Additionally, the Hansen Sargan J statistic of 3.689 (p = 0.1581) suggests that we fail to reject the null that our instruments are exogenous.

Table 5 Random effects models, environmental Z-score

	(1)	*(2)*	*(3)*	*(4)*	*(5)*
Female	0.039+				0.043+
	(0.0229)				(0.0262)
Minority	0.059**	0.060**	0.061**	0.061**	0.063*
	(0.0228)	(0.0227)	(0.0227)	(0.0227)	(0.0261)
Age	0.019*	0.019*	0.019*	0.019*	0.019*
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)
Firm leverage	0.176***	0.171***	0.171***	0.173***	0.176***
	(0.0335)	(0.0335)	(0.0335)	(0.0335)	(0.0335)
Firm size	0.279***	0.278***	0.278***	0.278***	0.279***
	(0.0063)	(0.0063)	(0.0063)	(0.0063)	(0.0063)
Board independence	0.218***	0.198***	0.195***	0.198***	0.218***
	(0.0331)	(0.0335)	(0.0335)	(0.0334)	(0.0331)
ROA	–0.121+	–0.125+	–0.124+	–0.126+	–0.121+
	(0.0653)	(0.0653)	(0.0653)	(0.0653)	(0.0653)
Fraction of female directors		0.159***	0.336***		
		(0.0353)	(0.0863)		
Fraction of female directors^2			–0.364*		
			(0.1616)		
Critical mass				0.054***	
				(0.0112)	
Female × Minority					–0.016
					(0.0531)
Industry fixed effects	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	17,615	17,615	17,615	17,615	17,615
Overall R^2	0.164	0.166	0.166	0.166	0.164

Notes: Dependent variable is the industry-neutral environmental score (z-score). The environmental aspect of the ESG score may include gas emissions, carbon regulation exposure and pollution and contamination. This is an index which measure the rating a firm's energy use, waste, pollution, natural resource conservation and animal treatment. We create z-scores by first subtracting the industry mean from each index value and dividing by the standard deviation. Standard errors are in parentheses and clustered at the director-firm level. +$p < 0.1$, *$p < 0.05$, **$p < 0.01$, ***($p < 0.001$).

Source: ISS ESG and Director Databases

Table 6 Two-stage least squares

	Female	*ESG Z-score*	*Social Z-score*	*Environmental Z-score*
	(1)	*(2)*	*(3)*	*(4)*
	First stage	*Second stage*	*Second stage*	*Second stage*
Female		0.386*	0.221	0.367*
		(0.1655)	(0.1624)	(0.1765)
Minority	0.068***	0.036	0.073**	–0.01
	(0.0138)	(0.0287)	(0.0276)	(0.0301)
Age	–0.004	0.028*	0.051***	0.019
	(0.0049)	(0.0114)	(0.0100)	(0.012)
Firm leverage	0.019	–0.058	–0.293***	0.179***
	(0.0218)	(0.0417)	(0.0356)	(0.0473)
Firm size	0.008*	0.231***	0.224***	0.239***
	(0.0035)	(0.0094)	(0.0086)	(0.0096)
Board independence	0.114***	0.463***	0.508***	0.350***
	(0.0214)	(0.0485)	(0.0506)	(0.0511)
ROA	0.064	0.165	0.178+	0.203+
	(0.0484)	(0.1057)	(0.1056)	(0.1069)
Female president	0.0812*			
	(0.0398)			
Female CEO	0.150***			
	(0.0364)			
Board size	0.0290*			
	(0.0123)			
Industry fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Observations	17,615	17,615	17,615	17,615
F-test of excluded instrument	34.25 (0.000)			
Adjusted R^2		0.238	0.252	0.211
Test of endogeneity $X^2(1)$		4.746	1.387	3.804
p-value		0.029	0.239	0.051

Notes: Dependent variables are the probability that a director identifies as female (column 1), firms' overall ESG z-score (column 2), and the social and environmental z-scores (columns 3 and 4, respectively). All models include industry and year fixed effects. In columns 2 to 4, we report the 2SLS results. In these models, we use the indicator variable, female president, female CEO, and the log of board size as instruments for the endogenous variable, female. We present the results from the endogeneity tests with the null hypothesis that the indicator variable female is exogenous. Standard errors are in parentheses and clustered at the director-firm level. $+p < 0.1$, $*p < 0.05$, $**p < 0.01$, $***(p < 0.001)$.

Source: ISS ESG and Director Databases

The estimated effect of female directors on firm ESG scores can be seen in column 2 of Table 6 and are consistent with the previous results in Table 3. That is, female directors are associated with firms reporting higher ESG scores, on average. The Hausman test statistic for the null hypothesis that the female indicator variable is exogenous in the ESG regression in column 2 of Table 6 is 4.746 (p-value = 0.029). Thus, we reject the null hypothesis that the specified endogenous regressor, female, can actually be treated as exogenous, and conclude that the IV results are consistent.

Relative to the estimated coefficient on the female director indicator variable in column 1 of Table 3, the IV estimate for the effect of female directors on ESG score is larger while remaining statistically significant at the 5% level. Specifically, the coefficient associated with female is 0.39, implying that females are associated with firms reporting ESG scores are 0.39 standard deviations higher than the average score reported by male directors. However, there is no statistically significant impact of minority directors on the standardised ESG score. We tested the minority variable for endogeneity using the same procedures as for female directors above but found no evidence.

Columns 3 and 4 of Table 6 report the IV estimates when we consider standardised social and governance scores and standardised environmental scores, separately. No significant difference was identified across female and male directors when social and governance scores are considered in column 3. However, minority directors are more likely than their white counterparts to increase a firms' social and governance score, to the order of 0.07 standard deviations. Our results also reveal that female directors are associated with significantly higher environmental scores relative to similar male directors. The coefficient on the female director variable in column 4 of Table 6 is 0.37, which suggests that female directors are associated with environmental scores that are 0.37 standard deviations higher than the scores reported by male directors. The impact of minority directors on environmental score is statistically insignificant.

6 Conclusions

In the USA, and more generally in developing countries across the world, women continue to be underrepresented on corporate boards. Board gender diversity research has sought to determine whether the low number of women board members negatively impacts corporate ESG outcomes due to a positive effect of women board members on firms ESG outcomes. In a meta-analysis of 87 studies examining this body of research, Byron and Post (2016) find the effect of female board representation on firm social performance is largely mixed, but generally positive.

Our initial regression results employed a random effects panel regression model utilising individual (board director) level data but without any attempt to correct for potential endogeneity, as in much of the research covered by Byron and Post's (2016) review. We utilised three different measures of female board membership across various regressions and found significant positive effects in each. In our initial regressions, we found a modest, yet significant, positive impact of a female director on a firm's standardised ESG score.

Unfortunately, disentangling the effect of board gender diversity on ESG outcomes is a challenging task due to the potential endogeneity of the gender diversity variable in ESG regressions (Adams, 2015; Adams and Ferreira, 2009). The two main sources of

endogeneity in board gender diversity research are omitted variable bias caused by self-selection and reverse causality.

Due to potential endogeneity of the gender diversity variable in ESG regressions and any resultant bias in estimates of the effect of board gender diversity on ESG outcomes, a body of research has emerged which complements OLS-based existing research by utilising IV regression. We use an IV (2SLS) regression approach to measure the unbiased impact of female board members on firms' ESG outcomes. We instrumented for the female director variable in our regression using three variables – board size, a female CEO indicator variable, and a female president indicator variable.

Our IV results indicate that the impact of a female board member on the standardised ESG score is positive, significant, and meaningful in magnitude. These results are largely consistent with the new generation of board gender diversity studies addressing endogeneity through the IV (2SLS) regression approach which were discussed in the literature review in Section 2. These results offer further evidence in support of the conclusion that female board members have positive effects on the ESG outcomes of their firms.

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Notes

1 In the USA, unlike several European countries, there is no national mandate regarding the representation of female board members. However, California is an exception, as it mandates that publicly traded companies have at least one female board member. In contrast, France requires a 40% female board representation, Norway also mandates 40%, and the UK sets it at 25%, as noted by Valls Martinez et al. (2020).

2 They also use the proportion of female directors in the county where a firm is headquartered as an instrument arguing that "a higher supply of female directors in the county may be positive correlated with the proportion of female independent directors in the firm".

3 The indicators used to create each score are drawn from a pool of more than 700 indicators and account for international norms and conventions, social debate, regulatory changes, and technological progress (see ISS ESG 2020 for details). ISS uses a set of about 100 criteria for each industry in developing the ESG rating. Of these 100 criteria, approximately 30 are standard across all industries.

4 Testing for instrument relevance can and should be done using a simple regression of the endogenous variable on the instrument [Wooldridge, (2013), p.514]. This test is critical because 'when instruments are weakly correlated with endogenous regressors, conventional methods for IV estimation and inference become unreliable' [Andrews et al., (2019), p.1]. Unfortunately, we cannot generally hope to test for instrument exogeneity, and in many cases we must simply maintain it by appealing to economic behaviour and or introspection (Wooldridge, 2013).

Appendix

Table A1 Correlation matrix

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1	ESG Score													
2	Social score	0.772	1.000											
3	Environmental score	0.847	0.597	1.000										
4	Female	0.061	0.060	0.052	1.000									
5	Gender diversity	0.133	0.132	0.114	0.454	1.000								
6	Critical mass	0.126	0.136	0.096	0.377	0.831	1.000							
7	Age	–0.085	–0.112	–0.043	–0.148	–0.111	–0.109	1.000						
8	Minority	0.063	0.068	0.045	0.081	0.043	0.031	–0.038	1.000					
9	Firm leverage	0.002	–0.023	0.030	0.024	0.053	0.064	–0.069	–0.021	1.000				
10	Firm size	0.361	0.296	0.404	0.057	0.125	0.081	0.042	0.065	0.003	1.000			
11	Board independence	0.148	0.088	0.184	0.064	0.140	0.114	0.099	0.070	0.012	0.280	1.000		
12	ROA	0.097	0.072	0.111	0.028	0.061	0.050	0.008	0.038	–0.022	0.209	0.082	1.000	
13	Capital intensity								07	–0.058	0.008	0.049	–0.127	1.000