

Board of Directors Network Centrality and Environmental, Social and Governance (ESG) Performance

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Abstract

Purpose: Drawing from social capital, social network theory of stakeholder influence, and stakeholder management, this study examines the relationship between board network centrality and firms' environmental, social and governance (ESG) performance.

Design/methodology/approach: Using social network analysis, we construct five board network centrality, namely degree centrality (the number of connections), closeness centrality (distance among firms), eigenvector centrality (the quality of connections), betweenness centrality (how often a firm sits between two other firms), and the information centrality (the speed and reliability of information), as measures of board access for social capital and timely information.

Findings: Using a sample of non-financial firms listed in the UK FTSE 350 index from 2007 to 2018, we find that board networks, measured by degree, closeness, eigenvector, betweenness, and information centrality, have positive influence on firms' environmental, social and governance (ESG) performance. Furthermore, our findings show that there is a non-linear relationship between board networks and ESG performance and this relationship is stronger in the sectors where firms that have high product market concentration and high percentage of women board members.

Originality: This study unveils that strong board network centrality brings higher social (reputational) capital and information advantages to the firm to effectively, timely, and accurately deal with the pressures from stakeholders (stakeholder management), which leads to better environmental, social, and governance (ESG) performance.

Keywords: board network centrality; social network analysis; stakeholder management; ESG performance; non-linear

Introduction

In the digital and social media era where the speed and ease of connectivity are significantly faster, informal social and professional networks have become the essential part of corporate strategic operations (Collins and Clark, 2003; Zaheer and Bell, 2005). Extant studies have demonstrated that a firm's networks or often referred to a firm's "social capital" have been found to enhance innovation (Ahuja, 2000; Tsai and Ghoshal, 1998), knowledge transfer (Burt, 1992; 1997; Inkpen and Tsang, 2005; Koka and Prescott, 2002), intellectual capital (Nahapiet and Ghoshal, 1998), and efficiency (Baker, 1990; Burt, 2000). Adler and Kwon (2002) define social capital as "the goodwill (sympathy, trust, and forgiveness) that others have offered us is considered as a valuable resource" (pg. 18). Furthermore, a firm's social capital is largely facilitated by their direct and indirect links to other firms through director interlocks. Empirical studies also find that a firm's networks built from its board of directors contribute to the boards' ability to make more effective strategic decisions (Carpenter and Westphal, 2001; Thorgren, Wincent, and Anokhin, 2010). Our study extends this research stream by focusing on the board of directors' networks and the relationship between board networks and firms' environmental, social, and governance (ESG) performance.

Existing literature has examined the impact of social and professional networks of the top executives and board of directors on firms' financial performance and generally find that there is a positive relationship between them (e.g., Chahine and Goergen, 2013; Chuluun, Prevost, and Puthenpurackal, 2014; Horton, Millo, and Serafeim, 2012; Larcker, So, and Wang, 2013). Recent studies have also found that there is a positive relationship between US firms' alliance network centrality and corporate social performance (Macaulay et al., 2018; Vo, Le and Kim, 2020). Muthuri, Matten, and Moon (2009) also find a positive relation between the networks built from employees' volunteerism and firms' corporate social performance on three UK multinational firms. We extend this strand of literature and focus on the board of directors

for UK firms because of two reasons. First, the structure of board in the UK consists of executive and non-executive directors who work closely together and are collectively responsible for the firm performance (e.g., Conyon and Peck, 1998; Elmagrhi, Ntim, and Wang, 2016; Hopt and Leyens, 2004; Van Veen and Elbertsen, 2008). Bainbridge (2017) indicates that the collective responsibilities of the board in the UK has increased the importance and the influence of board of directors' monitoring and advising roles on firm performance. Second, the informal professional and social networks in the UK have been considered as deficient relative to other developed countries such as the US (e.g., Conyon and Muldoon, 2006; Letki, 2008; Pichler and Wallace, 2007; Useem, 1984). Thus, our study highlights the importance of board networks for the UK firms.

In the wake of corporate scandals and the 2007 global financial crisis, corporate social responsibility performance has drawn much attention among top executives, investors, and academics. The United Nations Global Compact (2017) indicates that there are over 9,000 companies and 4,000 non-businesses across 161 countries have taken serious commitments to address social issues, specifically actions to improve the environment, social, and governance (ESG) performance. More specifically, UK has considered corporate social responsibility or ESG performance seriously since UK was the first country in the world to appoint a Minister for Corporate Social Responsibility in March 2000. However, similar to most of other developed countries (e.g., United States), ESG activities in the UK are mostly practiced by large multinational corporations at which the power of shareholders' interests seems to dominate the interests of non-investing stakeholder (Brammer, Jackson, and Matten, 2012; Goergen et al., 2019; Kinderman, 2012; Wang et al., 2019). Thus, researchers have argued that the role of board of directors in the UK firms has become increasingly critical to represent the interests from the non-investing stakeholders along with the shareholders' interests (Aguilera,

2005; Aguilera et al., 2006; Elmagrhi, Ntim and Wang, 2016; Hillenbrand, Money, and Ghobadian, 2013; Money and Schepers, 2007).

Our study argues that having board of directors with strong networks would allow directors to draw the resources embedded within each director's social and professional networks, which are accessible through direct and indirect professional ties (Booth-Bell, 2018; Jang, Chung and Woo, 2019; Kacanski, 2019; Krenn, 2017). These resources increase firms' information advantages to satisfy the needs of and to address the pressures from non-investing stakeholders, thus leads to better ESG performance. Drawing from the social capital (Adler and Kwon, 2002) and social network theory of stakeholder influence (Rowley, 1997) and stakeholder management theory, we argue that board networks represents valuable social capital that can be mobilized to enhance firms' ability to gain faster and more accurate information to satisfy the needs of the stakeholders (Freeman, 1984; Donaldson and Preston, 1995; Rowley, 1997). We focus on board of directors because they have broader networks through their services on multiple companies (interlocking) and the board of directors have advising and monitoring roles, which lead to firms' tangible strategic actions (Forbes and Milliken, 1999). We argue that firms with stronger board networks have higher ability to tap information from their networks to understand recent developments to address the pressures from various stakeholders more quickly and more effectively and therefore leads to better ESG performance.

Literature Review and Hypotheses Development

Board networks and corporate social performance

The theory of social capital has been developed from sociology and psychology literature where researchers have recognized the value of networks as irreplaceable social capital (Bourdieu, 1972; 1985; Burt, 1987; Jacobs, 1961). Recently, management and business

literature have adopted social capital theory to explain the benefits of networks (Adler and Kwon, 2002; Seibert, Kraimer, and Liden, 2001; Woolcock and Narayanan, 2000). More specifically, the social capital theory has been used to explain the information channels among board of directors (Horton et al., 2012; Larcker et al., 2013; Chuluun et al., 2014) in relation to corporate financial performance.

The informal social and professional networks are usually built based on commonalities among the network participants (e.g., having similar careers, professions, etc.). Members of the networks can tap into the knowledge shared among members within the networks to advance their knowledge, know how, and more importantly critical and timely information that allow the members to make more effective decision-making (Carpenter and Westphal, 2001). Social and professional networks differ from others because they can maintain their power and can insulate themselves from traditional hierarchical organizational power. Within the management discipline, informal networks have been conceptualized using either a social capital or a social exchange that effective workplace relationships build mutual reciprocity that delivers benefits to all stakeholders (Adler and Kwon, 2002; Oh, Chung, and Labianca, 2004; Sparrowe et al., 2001).

Adler and Kwon (2002) define the “social capital” as resources available to actors that is a function of their “location” within the networks of their social relations. We argue that board members who hold multiple positions in other companies have advantageous location within their social and professional. Woolcock (1998) and Woolcock and Narayanan (2000) specifically define the “social capital” as having access to information that are available only if ones belong to the networks. Drawing from the resource theory of social exchange, Foa and Foa (1974; 1980) also indicate that the value of social capital specifically focuses on having access to critical information exchange within the social networks. Therefore, we argue that board with greater networks have greater information advantages than boards with less

networks. Therefore, the relative position of board in the network plays a critical role on their ability to gain access toward more accurate and timely information, especially with respect to addressing the stakeholders' needs. The firms' ability to effectively address the stakeholders' needs will result in higher ESG performance (Swanson and Orlitzky, 2018).

Extant literature has found that corporate governance effectiveness, monitoring, and corporate decision-making are influenced by board of directors' informal professional and social networks (Alipour et al., 2019; Cohen, Frazzini, and Malloy, 2008; Harjoto, Laksmana and Yang, 2019; Hochberg, Ljungqvist, and Lu, 2007; Kuhnen, 2009; Seidel, Polzer, and Stewart, 2000). For instance, Cohen et al. (2010) find that sell-side analysts who have educational connections with companies' board of directors tend to perform better in their stock recommendations. Renneboog and Zhao (2011) indicate that directors' networks are important to firms because through its directors a firm can "gain access to information, even prior to its public disclosures". Directors with stronger networks can also increase the firms' reputation in the society due to their close network relationships with key stakeholders (e.g., employees' organization, regulatory agencies, etc.). Macaulay et al. (2018) find a positive relationship of women boards and outside directors as proxies for board network alliance and firms' ESG performance. We extend the existing literature by examining the relationship between board network centrality and ESG performance.

Rowley (1997) develops the theory of stakeholder influence based on the social network structure and argues that network theory allows us to examine system of a dyadic (network or cobweb) of interactions, influences, and the interdependencies among stakeholders and the firm. More importantly, he argues that the centrality of firms' corporate actors (i.e., board of directors) in the network relative to others increases the firms' ability and effectiveness to accommodate and to respond to stakeholders' demands (stakeholder management).

Insert Figure 1 about here

We illustrate the interconnections between social capital and social network of stakeholder influence and stakeholder management in Figure 1. We argue that boards with higher networks can bring social capital to the firm. More specifically, board networks allow the firms to have access to high quality information (information advantage). Thus, firms with boards that are in a central position in the network may have better understanding of the stakeholders' needs that allow the firms to have closer connections to various stakeholder groups. As indicated by arrow A in Figure 1, the social capital theory (Adler and Kwon, 2002) and the social network of stakeholder influence theory (Rowley, 1997) both explain the importance of board networks for firms to manage the pressures from stakeholders. Furthermore, closer connections allow them to have a faster and more accurate understanding of the networks, coalitions, and complex interconnections of various stakes among stakeholders. Directors with higher (more essential) network centrality can bring greater insights for stakeholder management to the firms to construct a rational stakeholder map and are able to strategically, effectively, and more efficiently address the pressures and the interests of their stakeholders (arrow B of Figure 1). The firms' competitive advantages to effectively address their stakeholders' demands translates into higher ESG performance (arrow C of Figure 1). Firms with well-connected board of directors also have higher social and reputational capital at stake and they have stronger incentive to protect their social and reputational capital (Adler and Kwon, 2002; Seibert et al., 2001; Woolcock and Narayanan, 2000). Corporate social responsibility and philanthropic activities can generate positive moral capital that provides the "insurance like" to protect firms' reputational (social) capital (Godfrey, 2005; Godfrey, Merrill

and Hansen, 2009). Therefore, firms with well-connected boards also have stronger incentives to support firms' social responsibility activities to protect their own reputational capital and maintain their central positions in the network. Thus, we expect that board with stronger networks, which represents firms' reputational (social) capital, tend to have higher ESG performance. We formulate the following hypothesis:

Hypothesis: Firms that have board of directors with higher network centrality have higher ESG performance.

Research Design

Data and sample

Our sample composed of 203 non-financial firms listed on the London Stock Exchange FTSE 350 index from 2007 to 2018. Based on these 203 UK non-financial firms, we collect our data from multiple sources. First, we gather information on board of directors from the BoardEx database, which provides a comprehensive information on directors of public listed firms in the UK. We use this information to construct five measures of board networks, namely degree centrality, eigenvector centrality, closeness centrality, betweenness centrality and information centrality. Second, the data on board size, board independence, CEO tenure, CEO age, CEO education, CEO gender, the percentage of women board members and busy board are obtained from BoardEx. Third, environmental, social, and corporate governance (ESG) data is manually collected from the Bloomberg. Bloomberg started to report the ESG scores since 2007 (Grewal, Hauptmann, and Serafeim, 2017). Finally, we collect firms' financial information and institutional ownership data from the Bloomberg that provides definitive source of company information for the UK firms. After deleting missing observations, our final sample consists of 199 UK non-financial firms that are listed on the FTSE 350 index with 1,724 company-year observations for the period of 2007 to 2018.

Measurement of Variables and Empirical Models

Dependent Variable

We measure the overall ESG performance using the sum of environmental score (ENV), social score (SOC) and governance score (GOV) or ESG score. Each ENV, SOC and GOV score ranges from 0 to 100, depending on firms' performance on environmental, social, and corporate governance, which are updated annually and are constructed based on approximately 120 quantitative and qualitative measures by the Bloomberg analysts (Bloomberg, 2017). Grewal et al. (2017) indicate that the Bloomberg ESG data is constructed according to the standards developed by the Sustainability Accounting Standards Board (SASB) and therefore represents the most accurate measures of firms' sustainability practices.

The environmental score (ENV) contains data on aspects such as energy use, water consumption and waste generation. The social score (SOC) focuses on elements, such as employee turnover, number of accidents at work and the proportion of woman across the workforce. The governance score (GOV) includes data on aspects such as board structure and characteristics (Bloomberg, 2017; Giannarakis, Konteos, and Sariannidis, 2014). We also examine the impact of board networks on environmental (ENV), Social (SOC) and governance (GOV), performance separately.

Independent Variables

We follow existing literature (Chuluun et al., 2014; Houston, Lee, and Suntheim, 2018; Larcker et al., 2013; Renneboog and Zhao, 2011) to construct the board network centrality. Each firm is considered as a node in the network and two firms are connected if they share at least one interlocking director. Specifically, the degree centrality (DEG) measures the total number of direct connections to the other firms through interlocking directorates. Firms may be well connected if they have relatively more links than others can influence other firms or

use their links to access resources. The closeness centrality (CLOSE) measures how close it is to all other firms through the reachable shortest paths. Firms with higher closeness centrality can access resources or information faster than other firms. Unlike degree centrality, closeness is not just a local measure but also based on the distance between a firm to other firms. The eigenvector centrality (EIGEN) measures the quality or the power of the firm within a network. Firms with higher eigenvector centrality may have more power to influence other firms in terms of information dissemination and exchange. The betweenness centrality (BETW) measures how often a firm can sit between two other firms through director interlocks. If a firm sits between many other firms, it may act like a “gatekeeper” and control the flow of information through the network. The information centrality (INFO) captures its direct or indirect connections, not only through the shortest paths but also any other possible indirect paths to other firms that provide verifications on the accuracy of information. Stephenson and Zelen (1989) and Fitch and Leonard (2013) indicate that information centrality represents access to information with the least noise. Hence, firms with higher information centrality can gain more accurate information compared to closeness centrality, which only considers the shortest paths. To account for the lag effect of board networks on firms’ ESG performance, we use the one-year lag of these five measures in our regression models.

Control Variables

Following prior studies (Horton et al., 2012; Larcker et al., 2013; Money, and Schepers, 2007), we include a number of control variables while examining the relationship between board networks and ESG performance. Board size is the total number of executive and non-executive directors. Board independence is the number of independent non-executive directors divided by total number of board members. Tenure measures the number of years the current CEO has served as the CEO of the firm in year t . Age measures the CEO’s age. Education

measures the number of qualifications at undergraduate level and above the current CEO have in year t . Gender is a dummy variable, equals 1 if CEO is female and 0 otherwise. Busy board is a dummy variable, equals 1 if more than half of the directors hold three or more directorships and 0 otherwise. Institutional measures the percentage of shares held by institutional shareholders to total firm ordinary shareholdings. ROA is profit before tax as percentage of total asset. Leverage is the ratio of total debt to total assets. Detailed variable definitions, including dependent variables, independent variables and control variables are reported in the Appendix.

 Insert Table 1 about here

Empirical Model

To test our hypothesis, we use both univariate and multivariate analyses. More specifically, our initial empirical analyses consist of (i) summary statistics; (ii) bivariate analysis conducted by estimating Pearson correlation coefficients; and (iii) pooled ordinary least square is employed as baseline model to conduct multivariate regression analysis and the standard errors are clustered based on firm and year.

Our baseline model to examine the relationship between the impact of board networks and ESG is specified as follows:

$$ESG_{it} = \alpha_0 + \beta_1 Board_Networks_{it-1} + \sum_{i=1}^n \gamma_i CONTROLS_{it} + \delta_i + \varepsilon_{it}$$

where ESG is our dependent variables (ESG , ENV , SOC , AND GOV), the $Board_Networks_{t-1}$ is independent variable which refers to one-year lag of degree centrality, closeness centrality, eigenvector centrality, betweenness centrality and information centrality. $CONTROLS$ refers to a set of control variables, namely, board size (BSIZE), board independence (BINDEP), CEO

tenure, age, education, gender (TENURE, AGE, EDUC, WCEO), busy board (BBOARD), institutional ownership (INSTIT), return on assets (ROA), and financial leverage (LEV).

Insert Panel A of Table 1 about here

Summary Statistics and Regression Results

Descriptive Statistics

Table 1 presents the summary statistics for our sample. The average firms' ESG scores is 36 while the averages of ESG components: environmental (ENV), social (SOC), and governance (GOV) scores are 25.42, 38.73 and 57.66 respectively. The averages of degree centrality (DEG), closeness centrality (CLOSE), eigenvector centrality (EIGEN), betweenness centrality (BETW), and information centrality (INFO) (stated in %) are 1.3, 13.1, 4.3, 1.21, and 3.99 respectively. The average board size (BSIZE) in our sample is 9.03 and 61.01% directors are considered as independent (non-executives) directors (BINDEP). On average, CEO's tenure is 6.3 years (TENURE) and the average CEO's age is 54.15 years old (AGE). On average, CEOs hold two qualifications (EDUC). Approximately, 27% of the firms have more than a half of their boards with three or more directorships (BBOARD) and 5% of the CEOs are female (WCEO). These averages are similar with existing studies (e.g., Renneboog and Zhao, 2011). On average, 11.33% of the firms' shares in our sample are held by institutional investors (INSTIT). The average return on assets (ROA) and total debt-to-asset ratio (LEV) of our sample firms are 6.73% and 23.97%. On average, the firms in our sample has 26% industry concentration (HHI), which is consistent with Powell and Yawson (2005) that use the UK sample firms. Approximately, 3.5% of the board seats are held by women (WBOD).

Insert Panel B of Table 1 about here

Panel B of Table 1 displays the distribution of our sample across nine different sectors. We find that firms' ESG measures vary across different sectors. More importantly, we find that board networks measures are positively related to industry concentration (HHI) and the percentage of women boards (WBOD), which implies firms that operate in more concentrated industry and firms with higher percentage of women boards tend to have higher board networks.

Insert Table 2 about here

Table 2 presents the Pearson correlations between our dependent variables (ESG measures), board networks and control variables. Consistent with our hypothesis, we find that ESG measures are positively and significantly correlated with the board networks measures. We find that five board networks measures (DEG, EIGEN, CLOSE, BETW, INFO) are positively and highly correlated to one another. Therefore, we cannot include all five networks measures in the same regression equation due to a multicollinearity problem among five different board networks measures. We also find that the board size (BSIZE) and the percentage of independent boards (BINDEP) are also positively correlated with board network measures. We find that the correlations between the board network measures and control variables are less than 0.4. The correlations among control variables are generally less than 0.4, except for the percentage of independent board (BINDEP) and the percentage of women board (WBOD). Thus, we would not expect any serious multicollinearity problems in our multivariate regressions.

Insert Table 3 about here

Regression Results

We examine the relationship between board networks and firms' overall ESG performance. Table 3 presents the linear regression results between various measures of board networks and firms' ESG performance. We find that all of our five measures of board networks are positively related to firms' ESG performance. We find that one percent increase in boards' degree of centrality (DEG), board network closeness (CLOSE), and quality (EIGEN) increase the ESG score by 0.631, 0.237 and 0.04 respectively. One percent increase in board betweenness (BETW) and information network (INFO) increases the firms' ESG score by 0.311 and 0.115 respectively. These findings indicate that board networks are positively associated with ESG performance. Thus, we find empirical evidence to support our hypothesis that having boards with richer networks, measured by the total number of connections to other firms, shortest distance to other firms, the rank of importance from direct and indirect links, gatekeeper and control of information flow, and access to information with the least noise, can facilitate the firms' ability to better manage and meet the needs of multiple stakeholders (stakeholder management).

Second, we separately examine the relations between board networks with each of the three components of firms' overall ESG: environment (ENV), social (SOC), and governance (GOV) scores. Table 3 shows that the relationship between board networks measures and firms' environment (ENV), social (SOC), and governance (GOV) scores are generally positive and significant, except for information centrality (INFO) and social performance (SOC). Overall results from examining the components of ESG support our hypothesis that greater board networks is positively related with better environmental (ENV), social (SOC) and governance

(GOV) performance. We also use the two-year lag of board networks and the unreported results are consistent with our reported results.

Insert Table 4 about here

Extant literature has found that there is a non-linear relationship between board characteristics and firm performance (Coles, Daniel and Naveen, 2008; Chang et al., 2015). Therefore, we further explore whether there is a non-linear (curvilinear) relationship between board networks and firms' ESG performance. We regress the quadratic function of board networks (e.g., DEG_{t-1} and DEG_{t-1}^2) on firms' ESG and the results are presented in Table 4. We find that the coefficients of board networks remain positive and statistically significant. However, we find that the coefficients of the squared of board networks are negative and statistically significant. Thus, the relationship between board networks and firms' ESG performance is concave (non-linear), indicating there is a diminishing return of board networks on firms' ESG performance.

Additional Analysis

Recent studies have shown that there is a relationship between board diversity and board networks. Booth-Bell (2018) argues that more diverse boards tend to bring more diverse social capital that bridge the boards' networks and their tasks to advice, counsel, and monitor. Thus, board diversity enhances firms' corporate governance through their indirect link of boards' diverse networks. Ooi, Hooy, and Som (2017) also demonstrates that board diversity in human and social capital network ties significantly mitigates the negative effects of crises. Goyal (2017) and Basuony, Mohamed, and Samaha (2018) examine the positive impacts of

board diversity in the UK firms and find that board gender diversity influence the effectiveness of the board. Kim and Starks (2016) also document that women boards provide additional advisory skills and expertise such as risk management, sustainability and regulatory compliance. They argue that greater heterogeneity of expertise that women directors bring into the boardrooms come from their social networks that are significantly different from men. Based on existing literature, we conduct further empirical investigation whether board gender diversity influence the firms' board networks.

Insert Panel A of Table 5 about here

Furthermore, based on our descriptive statistics presented in Panel B of Table 1 indicates that firms that operate in more concentrated sectors (higher HHI) tend to have higher board networks. Therefore, we also examine whether the market concentration, measured by HHI, influence board networks. Essentially, our additional analysis here is to account for potential endogeneity issue of board networks. Thus, we conduct the two-stage regression (2SLS) analyses where in the first stage regression, we examine the impacts of board gender diversity and industry concentration on the board networks. In the second stage regression, we examine the impact of board networks on firms' ESG performance.

Insert Panels B and C of Table 5 about here

The results of the 2SLS regressions are presented in Table 5. The first stage regression results presented in panel A of Table 5 indicate that board gender diversity (WBOD) and

industry concentration (HHI) positively affect board networks. Thus, we find evidence that greater board gender diversity and firms that operate in sectors that are more concentrated tend to have higher board networks. The second stage regression results presented in both panel B (linear) and panel C (quadratic) are qualitatively similar to our baseline results presented in Tables 3 and 4 respectively, indicating our findings remain robust even after controlling for a potential endogeneity issue

Conclusions

Recent global financial crisis has made corporate social responsibility performance to become an increasingly critical aspect of firms' business strategic and stakeholder management. Firms are continuously receiving pressures from their stakeholders and must strategically address their environmental, social, and governance (ESG) concerns in order to manage the pressures from various stakeholders. Therefore, this study examines the monitoring and advising roles of board of directors and investigates the impact of board networks on firms' ESG performance.

Our findings indicate that having boards with greater social capital, measured by the board networks, is positively related with greater ESG performance. Our finding is consistent with the stakeholder theory (Donaldson and Preston, 1995) by identifying the connection between stakeholder management and the traditional corporate objectives to gain competitive advantage through having boards with higher networks. Furthermore, we find that board gender diversity and the industry characteristic, measured by the industry concentration, are positively related to board networks. Therefore, board networks are endogenously determined by board diversity and the industry concentration.

We also find a diminishing return on board networks on subsequent ESG performance indicating that a continuing increase in board networks does not always lead to higher ESG

performance in the subsequent period. Thus, we believe that our diminishing return of board networks on ESG performance result is also consistent with existing literature which indicate that there are potential downsides of having greater board networks that have been identified in the literature, such as the groupthink and less effective monitoring (Benabou, 2012; Coles, Daniels, and Naveen, 2015), lack of innovations (Aronson, Reilly and Lynn, 2019), and greater conflict of interests (Scharff, 2005).

Overall, our study extends the extant studies that examine the importance of board networks on firms' decision-making (Carpenter and Westphal, 2001; Thorgren, et al., 2010) and the relationship between board networks and firms' financial performance (Chahine and Goergen, 2013; Chuluun et al., 2014; Horton et al., 2012; Larcker et al., 2013). As illustrated in Figure 1, our study also extends the social capital (Adler and Kwon, 2002), the social network theory of stakeholder influence (Rowley, 1997; Neville and Menguc, 2006), and the stakeholder management (Freeman, 1984; Donaldson and Preston, 1995) by establishing the interconnections among these theories.

While our study is based on a sample of UK listed firms, future studies can extend our study by examining the nexus of board networks and ESG performance in different international environments, such as the emerging markets (Singh and Delios, 2017). Given the diminishing return of board networks on firms' ESG performance, we believe that future research could also examine whether and how increasing networks may lead to unethical behaviour (i.e., insider trading). Finally, although the results of this study are robust to alternative estimations, our study has some limitations including limiting the analysis only to the network of the firms' networks through their board of directors. Future studies can consider also examine the firms' social networks from outside of the firms such as industry alliance and joint ventures (Macaulay et al., 2018).

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APPENDIX

Definitions of Variables

Panel A: Dependent Variables (ESG)

ESG _{t-1}	One-year lag of environmental, social, and corporate governance score. It represents the firms' overall ESG score = ENV + SOC + GOV
ENV _{t-1}	One-year lag of environmental measures a company's impact on living and non-living natural systems, including the air, land and water, as well as complete ecosystems. It reflects how well a company uses best management practices to avoid environmental risks and capitalize on environmental opportunities in order to generate long-term shareholder value.
SOC _{t-1}	One-year lag of social measures a company's capacity to generate trust and loyalty with its workforce, customers and society, through its use of best management practices. It is a reflection of the company's reputation and the health of its license to operate, which are key factors in determining its ability to generate long term shareholder value.
GOV _{t-1}	One-year lag of corporate governance measures a company's systems and processes, which ensure that its board members and executives act in the best interests of its long-term shareholders. It reflects a company's capacity, through its use of best management practices, to direct and control its rights and responsibilities through the creation of incentives, as well as checks and balances in order to generate long-term shareholder value.

Panel B: Independent Variables (Board Networks)

DEG	The normalized degree centrality of a firm is the number of other firms it connects to through director interlocks (in %).
CLOSE	The normalized closeness centrality of a firm measures how close (shortest path) it is to all the other reachable firms (in %).
EIGEN	The eigenvector centrality of a firm measures, not only the number of other firms it connects to, but also the quality of the other firms it connects to (in %).
BETW	The normalized betweenness centrality of a firm measures how often a firm can sit between two other firms through director interlocks (in %).
INFO	The information centrality of a firm captures its direct or indirect connections, not only through the shortest paths but also any other possible paths to other firms with the least noise (in %).

Panel C: Control Variables

BSIZE	The total number of executive and non-executive directors.
BINDEP	Number of independent non-executive directors divided by total number of board members
TENURE	The number of years the current CEO has served as the CEO of the firm in year t.
AGE	CEO's age in year t.
EDUC	The number of qualifications at undergraduate level and above that current CEO has in year t.
WCEO	Dummy variable, 1 if CEO is female and 0 otherwise.
BBOARD	Dummy variable, 1 if more than half of the directors hold three or more directorships and 0 otherwise.
INSTIT	Percentage of shares held by institutional shareholders to total firm ordinary Shareholdings.
ROA	Profit before tax as percentage of total asset.
LEV	Ratio of total debt to total assets.
HHI	Industry concentration, measured by the Herfindahl index of firms' net revenue in each year across nine sectors based on the GICS classification
WBOD	Percentage of women board (board diversity)

Figure 1

Social Capital, Social Network of Stakeholder Influence, Stakeholder Management, and ESG Performance

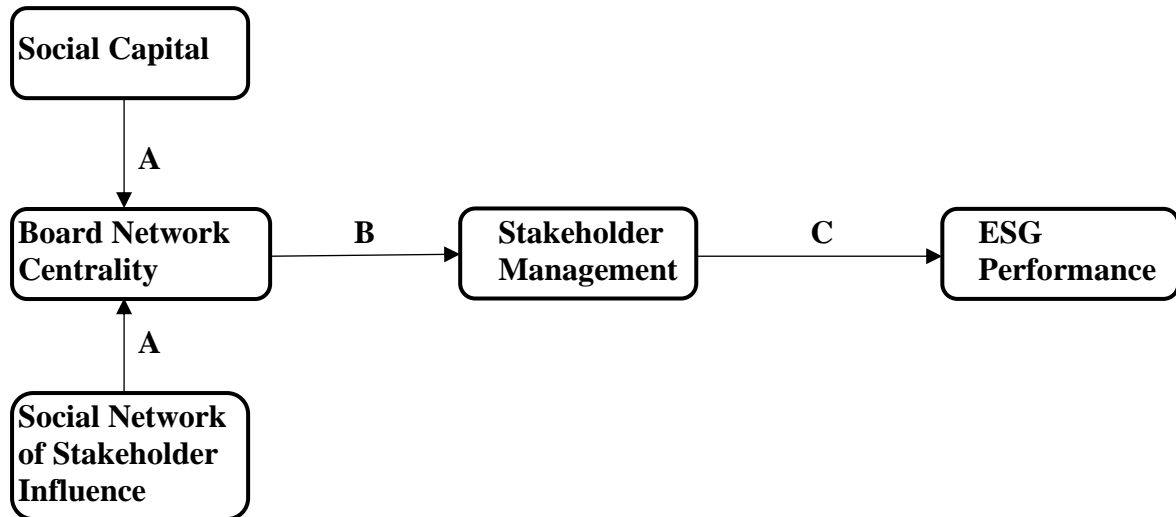


Figure 1 displays the interconnections among social capital, social networks of stakeholder influence, stakeholder management, and ESG performance

TABLE 1
Descriptive Statistics

Panel A. Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	25pctile	Median	75ptile	Max
ESG	1724	36.00	11.10	11.11	28.10	34.30	42.15	70.12
ENV	1724	25.42	13.98	1.55	15.50	22.48	34.11	68.60
SOC	1724	38.73	12.91	11.11	28.07	38.60	45.61	89.47
GOV	1724	57.66	7.06	41.07	53.57	57.14	62.5	82.14
DEG _{t-1}	1724	1.30	0.98	0	0.5	1.1	2	5.7
CLOSE _{t-1}	1724	13.10	3.41	6.3	10.83	13.8	15.7	20.2
EIGEN _{t-1}	1724	4.30	5.84	0	0.13	2.1	6	42.9
BETW _{t-1}	1724	1.21	1.71	0	0	0.5	1.9	11.6
INFO _{t-1}	1724	3.99	1.62	0.8	4	4.6	5.2	5.8
BSIZE	1724	9.03	2.13	4	8	9	10	19
BINDEP	1724	61.01	12.79	0	50	62.5	71.43	92.86
TENUR	1724	6.30	5.94	0.08	2.17	4.75	8.5	41.5
AGE	1724	54.15	5.50	35	51	54	57	77
EDUC	1724	1.86	1.10	0	1	2	3	6
WCEO	1724	0.05	0.22	0	0	0	0	1
BBOARD	1724	26.65	29.24	0	0	25	50	100
INSTIT	1724	11.33	3.34	0	9.63	11.27	12.66	46.06
ROA	1724	6.73	9.01	-68.95	3.06	6.07	10.34	70.25
LEV	1724	23.97	17.39	0	10.67	22.79	34.04	89.16
HHI	1724	0.26	0.06	0.12	0.22	0.25	0.31	0.52
WBOD	1724	3.49	2.44	0	2.08	3.16	5.27	12

Panel B. Descriptive Statistics across nine GICS sectors

Sector	Obs.	ESG	ENV	SOC	GOV	DEG	CLOSE	EIGEN	BETW	INFO	HHI	WBOD
Energy	92	41.76	31.53	46.26	60.60	0.98	12.02	2.40	0.74	3.69	0.24	3.68
Materials	231	42.40	32.86	45.09	61.63	1.30	12.42	3.69	1.27	3.71	0.25	2.64
Industrials	492	43.62	33.24	50.78	60.22	1.80	15.02	6.62	2.10	4.78	0.25	3.23
Con. Discr.	362	37.65	28.18	41.02	58.27	1.09	12.48	3.50	0.92	3.71	0.23	3.68
Con. Stap.	212	35.75	26.22	35.43	57.83	1.48	14.03	5.72	1.44	4.44	0.30	2.84
Healthcare	81	34.53	24.26	35.23	55.68	0.96	12.59	2.66	0.56	3.69	0.28	3.03
Info Tech	55	23.85	11.16	28.48	53.21	0.96	12.10	3.58	0.82	3.33	0.28	2.96
Communic.	138	37.27	26.63	39.70	59.23	1.06	12.66	3.81	0.73	3.73	0.25	3.84
Utilities	61	32.91	21.11	37.34	56.29	1.52	13.76	5.12	1.55	4.30	0.27	2.53

See Appendix for variables definitions.

TABLE 2
Pearson Correlations

No	Variables	1	2	3	4	5	6	7	8	9	10
1	ESG	1									
2	ENV	0.955*	1								
3	SOC	0.809*	0.653*	1							
4	GOV	0.761*	0.669*	0.556*	1						
5	DEG _{t-1}	0.199*	0.179*	0.154*	0.190*	1					
6	CLOSE _{t-1}	0.266*	0.225*	0.261*	0.211*	0.705*	1				
7	EIGEN _{t-1}	0.107*	0.094*	0.076*	0.116*	0.763*	0.556*	1			
8	BETW _{t-1}	0.156*	0.137*	0.131*	0.155*	0.821*	0.503*	0.702*	1		
9	INFO _{t-1}	0.239*	0.207*	0.219*	0.198*	0.635*	0.879*	0.421*	0.392*	1	
10	BSIZE	0.396*	0.364*	0.301*	0.399*	0.151*	0.162*	0.104*	0.157*	0.178*	1
11	BINDEP	0.357*	0.3366*	0.331*	0.249*	0.289*	0.404*	0.206*	0.183*	0.331*	0.157*
12	TENUR	-0.099*	-0.095*	-0.057	-0.092*	-0.147*	-0.142*	-0.092*	-0.123*	-0.154*	-0.005
13	AGE	0.105*	0.094*	0.097*	0.123*	0.008	-0.009	0.003	0.011	0.014	0.119*
14	EDUC	0.172*	0.156*	0.134*	0.192*	0.058	0.057	0.018	0.030	0.071*	0.193*
15	WCEO	0.072*	0.057	0.087*	0.036	0.048	0.109*	0.005	0.026	0.089*	0.004
16	BINTERL	0.145*	0.123*	0.156*	0.097*	0.227*	0.358*	0.114*	0.122*	0.291*	-0.049
17	PCTINSTI	-0.181*	-0.174*	-0.161*	-0.128*	-0.139*	-0.208*	-0.092*	-0.101*	-0.182*	-0.137*
18	ROA	-0.125*	-0.094*	-0.150*	-0.094*	0.015	-0.013	-0.007	0.044	0.0001	-0.014
19	LEV	0.073*	0.066*	0.039	0.060	0.008	0.017	0.025	-0.001	0.010	0.139*
20	HHI	-0.013	-0.005	-0.066*	0.010*	0.131*	0.060*	0.168*	0.128*	0.065*	0.061
21	WBOD	0.309*	0.268*	0.319*	0.164*	0.236*	0.441*	0.185*	0.171*	0.340*	0.193*

No	Variables	11	12	13	14	15	16	17	18	19	20	21
11	BINDEP	1										
12	TENUR	-0.205*	1									
13	AGE	0.049	0.280*	1								
14	EDUC	0.107*	0.080*	0.096*	1							
15	WCEO	0.079*	-0.054	-0.091*	0.076*	1						
16	BINTERL	0.231*	-0.059	-0.111*	0.007	0.034	1					
17	PCTINSTI	-0.213*	0.009	0.020	-0.069*	0.050	-0.079*	1				
18	ROA	-0.053	0.079*	0.015	-0.069*	-0.022	-0.067*	-0.073*	1			
19	LEV	-0.007	-0.124*	-0.052	0.061	-0.027	-0.020	-0.033	-0.205*	1		
20	HHI	0.025	-0.015	-0.051	-0.035	-0.019	0.003	-0.029	0.018	0.013	1	
21	WBOD	0.408*	-0.046	-0.047	0.028	0.224*	0.292*	-0.165*	0.015	0.062*	0.013	1

t statistics in parentheses and * $p < 0.01$. See Appendix for variables definitions.

TABLE 3
Linear Regression for Board Networks and ESG Performance

	ESG	ENV	SOC	GOV	ESG	ENV	SOC	GOV	ESG	ENV	SOC
DEGREEt-1	0.631 (2.72)***	0.677 (2.19)**	0.251 (1.88)*	0.537 (3.39)***							
CLOSEt-1					0.237 (2.94)***	0.239 (2.25)**	0.155 (1.69)*	0.204 (3.83)***			
EIGENT-1									0.040 (2.15)**	0.032 (1.70)*	0.016 (2.10)**
BSIZE	1.643 (15.14)***	1.841 (13.00)***	1.511 (11.38)***	1.095 (15.13)***	1.628 (15.02)***	1.829 (12.90)***	1.491 (11.26)***	1.082 (14.94)***	1.675 (15.57)***	1.877 (13.38)***	1.529 (11.62)***
BINDEP	0.176 (9.57)***	0.232 (9.61)***	0.182 (7.97)***	0.063 (4.82)***	0.174 (9.43)***	0.230 (9.56)***	0.178 (7.72)***	0.061 (4.63)***	0.184 (10.01)***	0.241 (10.04)***	0.187 (8.19)***
TENURE	-0.097 (2.61)***	-0.098 (2.01)**	-0.050 (1.05)	-0.100 (4.26)***	-0.093 (2.52)**	-0.095 (1.96)*	-0.046 (0.95)	-0.097 (4.16)***	-0.103 (2.81)***	-0.106 (2.19)**	-0.054 (1.12)
AGE	0.135 (3.15)***	0.141 (2.50)**	0.129 (2.56)**	0.121 (4.16)***	0.132 (3.08)***	0.138 (2.45)**	0.126 (2.51)**	0.118 (4.10)***	0.137 (3.19)***	0.143 (2.54)**	0.130 (2.58)***
EDUCATION	0.417 (2.01)**	0.491 (1.77)*	0.154 (0.62)	0.470 (3.33)***	0.403 (1.94)*	0.477 (1.72)*	0.144 (0.58)	0.458 (3.24)***	0.422 (2.02)**	0.496 (1.79)*	0.155 (0.63)
GENDER	1.955 (1.66)*	1.722 (1.16)	3.367 (2.25)**	0.669 (0.94)	1.843 (1.55)	1.616 (1.08)	3.267 (2.17)**	0.572 (0.80)	2.066 (1.74)*	1.838 (1.23)	3.406 (2.27)**
BBOARD	0.015 (1.83)*	0.026 (2.32)**	-0.003 (0.27)	0.009 (1.48)	0.015 (1.74)*	0.026 (2.27)**	-0.004 (0.41)	0.008 (1.38)	0.019 (2.29)**	0.030 (2.71)***	-0.001 (0.09)
INSTI	-0.323 (3.82)***	-0.409 (3.48)***	-0.365 (4.74)***	-0.104 (1.94)*	-0.312 (3.67)***	-0.398 (3.38)***	-0.355 (4.60)***	-0.095 (1.75)*	-0.331 (3.96)***	-0.418 (3.58)***	-0.369 (4.82)***
ROA	-0.087 (2.58)***	-0.078 (1.86)*	-0.126 (2.91)***	-0.045 (2.46)**	-0.088 (2.56)**	-0.078 (1.84)*	-0.126 (2.92)***	-0.046 (2.43)**	-0.085 (2.50)**	-0.075 (1.78)*	-0.124 (2.88)***
LEV	-0.006 (0.49)	-0.011 (0.63)	-0.013 (0.79)	0.005 (0.52)	-0.006 (0.50)	-0.011 (0.65)	-0.012 (0.78)	0.004 (0.50)	-0.007 (0.56)	-0.012 (0.69)	-0.013 (0.82)
Intercept	8.906 (2.51)**	-5.305 (1.15)	14.784 (3.60)***	38.098 (16.63)***	10.402 (2.94)***	-5.364 (1.17)	21.135 (5.07)***	37.585 (16.08)***	8.679 (2.44)**	-5.599 (1.21)	14.599 (3.55)***
Observations	1724	1724	1724	1724	1724	1724	1724	1724	1724	1724	1724
R-squared	0.404	0.337	0.366	0.323	0.405	0.337	0.367	0.325	0.402	0.335	0.366
# Firms	199	199	199	199	199	199	199	199	199	199	199

t statistics in parentheses and * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. See Appendix for variables definitions.

TABLE 3 (continued)
Linear Regression for Board Networks and ESG Performance

	ESG	ENV	SOC	GOV	ESG	ENV	SOC	GOV
BETWEENt-1	0.311 (2.41)**	0.283 (1.69)*	0.174 (1.91)*	0.266 (3.02)***				
INFOt-1					0.115 (2.17)**	0.144 (2.05)**	0.014 (0.90)	0.366 (3.71)***
BSIZE	1.643 (15.03)***	1.847 (12.96)***	0.422 (3.28)***	1.095 (15.02)***	0.445 (5.06)***	0.479 (3.89)***	0.428 (3.32)***	1.087 (15.19)***
BINDEP	0.181 (9.88)***	0.238 (9.95)***	0.045 (2.35)**	0.067 (5.15)***	0.018 (1.36)	0.028 (1.54)	0.047 (2.45)**	0.064 (4.88)***
TENURE	-0.099 (2.68)***	-0.101 (2.09)**	-0.011 (0.26)	-0.102 (4.34)***	-0.014 (0.49)	-0.003 (0.08)	-0.009 (0.21)	-0.097 (4.13)***
AGE	0.137 (3.19)***	0.143 (2.54)**	0.147 (3.38)***	0.122 (4.21)***	0.060 (2.04)**	0.021 (0.52)	0.149 (3.43)***	0.117 (4.05)***
EDUCATION	0.427 (2.04)**	0.500 (1.80)*	0.087 (0.38)	0.478 (3.37)***	0.192 (1.24)	0.110 (0.50)	0.073 (0.32)	0.457 (3.23)***
GENDER	1.992 (1.69)*	1.772 (1.19)	4.193 (4.13)***	0.700 (0.99)	0.507 (0.74)	-0.906 (0.94)	4.283 (4.22)***	0.595 (0.83)
BBOARD	0.017 (2.08)**	0.028 (2.57)**	-0.006 (0.82)	0.010 (1.78)*	-0.001 (0.17)	0.009 (1.27)	-0.005 (0.70)	0.009 (1.49)
INSTI	-0.326 (3.88)***	-0.412 (3.53)***	-0.145 (2.43)**	-0.107 (1.99)**	-0.107 (2.67)***	-0.137 (2.43)**	-0.142 (2.39)**	-0.098 (1.81)*
ROA	-0.088 (2.59)***	-0.078 (1.85)*	-0.068 (3.27)***	-0.046 (2.46)**	-0.022 (1.55)	-0.004 (0.19)	-0.067 (3.21)***	-0.045 (2.41)**
LEV	-0.006 (0.48)	-0.011 (0.64)	0.029 (1.48)	0.005 (0.53)	0.030 (2.16)**	0.043 (2.27)**	0.028 (1.43)	0.005 (0.52)
Intercept	8.875 (2.51)**	-5.400 (1.17)	38.263 (8.81)***	38.074 (16.69)***	36.538 (10.62)***	26.924 (5.82)***	38.146 (8.72)***	38.418 (16.58)***
Observations	1724	1724	1724	1724	1724	1724	1724	1724
R-squared	0.403	0.336	0.367	0.323	0.404	0.337	0.367	0.324
# Firms	199	199	199	199	199	199	199	199

t statistics in parentheses and * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. See Appendix for variables definitions.

TABLE 4
Quadratic Regression for Board Networks and ESG Performance

	ESG	ENV	SOC	GOV	ESG	ENV	SOC	GOV	ESG	ENV	SOC	GOV
DEGREE _{t-1}	2.310 (3.59)***	2.929 (3.59)***	1.695 (2.00)**	0.713 (1.76)*								
DEGREE _{t-1} ²	-0.504 (2.89)***	-0.676 (3.15)***	-0.434 (1.80)*	-0.053 (0.47)								
CLOSE _{t-1}					2.203 (4.54)***	2.685 (4.15)***	2.166 (3.84)***	0.467 (1.93)*				
CLOSE _{t-1} ²					-0.082 (4.16)***	-0.102 (3.86)***	-0.084 (3.70)***	-0.011 (0.80)				
EIGEN _{t-1}									0.325 (4.12)***	0.403 (3.80)***	0.163 (1.74)*	0.207 (3.65)***
EIGEN _{t-1} ²									-0.012 (4.60)***	-0.016 (4.58)***	-0.007 (2.24)**	-0.006 (3.11)***
BSIZE	1.635 (15.10)***	1.830 (12.97)***	1.504 (11.35)***	1.095 (15.09)***	1.612 (14.90)***	1.808 (12.78)***	1.474 (11.16)***	1.080 (14.92)***	1.651 (15.38)***	1.846 (13.20)***	1.515 (11.53)***	1.104 (15.34)***
BINDEP	0.171 (9.19)***	0.224 (9.21)***	0.178 (7.73)***	0.063 (4.75)***	0.178 (9.70)***	0.235 (9.79)***	0.182 (7.94)***	0.062 (4.68)***	0.174 (9.40)***	0.229 (9.44)***	0.182 (7.86)***	0.063 (4.77)***
TENURE	-0.087 (2.35)**	-0.086 (1.75)*	-0.042 (0.87)	-0.099 (4.19)***	-0.088 (2.39)**	-0.088 (1.83)*	-0.040 (0.84)	-0.096 (4.13)***	-0.092 (2.51)**	-0.091 (1.90)*	-0.047 (0.99)	-0.099 (4.24)***
AGE	0.135 (3.15)***	0.141 (2.50)**	0.129 (2.57)**	0.121 (4.15)***	0.133 (3.11)***	0.139 (2.47)**	0.127 (2.52)**	0.118 (4.10)***	0.136 (3.17)***	0.142 (2.52)**	0.129 (2.57)**	0.121 (4.19)***
EDUCATION	0.367 (1.75)*	0.423 (1.52)	0.111 (0.45)	0.465 (3.28)***	0.406 (1.95)*	0.481 (1.73)*	0.147 (0.60)	0.459 (3.24)***	0.424 (2.04)**	0.498 (1.80)*	0.156 (0.63)	0.477 (3.38)***
GENDER	1.752 (1.48)	1.450 (0.98)	3.193 (2.12)**	0.648 (0.91)	1.754 (1.47)	1.506 (1.00)	3.177 (2.12)**	0.560 (0.78)	1.875 (1.60)	1.590 (1.08)	3.295 (2.19)**	0.667 (0.94)
BBOARD	0.012 (1.45)	0.022 (1.94)*	-0.005 (0.53)	0.008 (1.41)	0.016 (1.94)*	0.028 (2.46)**	-0.002 (0.24)	0.008 (1.42)	0.015 (1.84)*	0.025 (2.28)**	-0.003 (0.31)	0.009 (1.62)
INSTI	-0.313 (3.67)***	-0.395 (3.33)***	-0.356 (4.60)***	-0.103 (1.92)*	-0.310 (3.63)***	-0.396 (3.34)***	-0.353 (4.51)***	-0.095 (1.74)*	-0.323 (3.85)***	-0.407 (3.48)***	-0.364 (4.75)***	-0.106 (1.98)**
ROA	-0.091 (2.69)***	-0.082 (1.97)**	-0.128 (2.98)***	-0.046 (2.48)**	-0.085 (2.50)**	-0.075 (1.78)*	-0.124 (2.88)***	-0.045 (2.41)**	-0.088 (2.61)***	-0.080 (1.90)*	-0.127 (2.93)***	-0.045 (2.44)**
LEV	-0.005 (0.41)	-0.010 (0.56)	-0.012 (0.74)	0.005 (0.53)	-0.005 (0.41)	-0.010 (0.57)	-0.011 (0.71)	0.005 (0.52)	-0.007 (0.51)	-0.011 (0.65)	-0.013 (0.79)	0.004 (0.47)
Intercept	8.284 (2.34)**	-6.139 (1.33)	14.249 (3.47)***	38.033 (16.61)***	0.118 (0.03)	-18.161 (3.18)***	10.617 (2.11)**	36.209 (12.66)***	9.051 (2.56)**	-5.117 (1.11)	14.816 (3.60)***	38.206 (16.71)***
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1724	1724	1724	1724	1724	1724	1724	1724	1724	1724	1724	1724
R-squared	0.407	0.340	0.368	0.324	0.410	0.343	0.371	0.325	0.407	0.340	0.367	0.324
# Firms	199	199	199	199	199	199	199	199	199	199	199	199

t statistics in parentheses and * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. See Appendix for variables definitions.

Table 4 (continued)
Quadratic Regression of Board Networks on ESG

	ESG	ENV	SOC	GOV	ESG	ENV	SOC	GOV
BETWEEN _{t-1}	0.774 (2.76)***	1.117 (3.01)***	-0.562 (2.24)**	0.501 (2.59)***				
BETWEEN _{t-1} ²	-0.074 (1.94)*	-0.133 (2.68)***	0.110 (3.37)***	-0.037 (1.44)				
INFO _{t-1}					1.433 (2.58)***	2.103 (2.69)***	0.966 (1.16)	1.687 (2.55)**
INFO _{t-1} ²					-0.224 (2.41)**	-0.333 (2.55)**	-0.167 (1.20)	-0.148 (1.03)
BSIZE	1.650 (15.11)***	1.860 (13.08)***	0.406 (3.17)***	1.099 (15.07)***	0.440 (5.00)***	0.472 (3.83)***	0.423 (3.29)***	1.095 (15.37)***
BINDEP	0.176 (9.46)***	0.229 (9.42)***	0.048 (2.49)**	0.065 (4.93)***	0.020 (1.50)	0.031 (1.70)*	0.049 (2.51)**	0.062 (4.72)***
TENURE	-0.096 (2.61)***	-0.097 (2.00)**	-0.002 (0.05)	-0.101 (4.28)***	-0.015 (0.51)	-0.004 (0.11)	-0.009 (0.22)	-0.097 (4.15)***
AGE	0.138 (3.20)***	0.144 (2.56)**	0.143 (3.30)***	0.122 (4.22)***	0.063 (2.13)**	0.025 (0.61)	0.151 (3.48)***	0.113 (3.92)***
EDUCATION	0.391 (1.87)*	0.436 (1.57)	0.137 (0.60)	0.460 (3.22)***	0.195 (1.25)	0.113 (0.52)	0.074 (0.32)	0.468 (3.31)***
GENDER	1.883 (1.60)	1.576 (1.06)	4.349 (4.29)***	0.645 (0.91)	0.567 (0.82)	-0.816 (0.85)	4.327 (4.26)***	0.534 (0.75)
BBOARD	0.015 (1.87)*	0.025 (2.28)**	-0.005 (0.63)	0.009 (1.61)	0.000 (0.01)	0.011 (1.46)	-0.005 (0.61)	0.008 (1.35)
INSTI	-0.324 (3.85)***	-0.410 (3.50)***	-0.146 (2.46)**	-0.106 (1.97)**	-0.110 (2.76)***	-0.142 (2.52)**	-0.145 (2.43)**	-0.096 (1.77)*
ROA	-0.090 (2.65)***	-0.082 (1.94)*	-0.067 (3.24)***	-0.047 (2.51)**	-0.022 (1.58)	-0.004 (0.22)	-0.067 (3.22)***	-0.047 (2.51)**
LEV	-0.006 (0.48)	-0.011 (0.64)	0.030 (1.54)	0.005 (0.54)	0.029 (2.09)**	0.042 (2.18)**	0.028 (1.40)	0.004 (0.42)
Intercept	9.015 (2.55)**	-5.149 (1.12)	38.546 (8.88)***	38.144 (16.74)***	35.730 (10.33)***	25.703 (5.53)***	37.557 (8.52)***	39.345 (15.99)***
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1724	1724	1724	1724	1724	1724	1724	1724
R-squared	0.405	0.339	0.368	0.323	0.404	0.337	0.367	0.327
# Firms	199	199	199	199	199	199	199	199

t statistics in parentheses and * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. See Appendix for variables definitions.

Table 5
Two-Stage Least Square (2SLS) Regression

Panel A. First Stage Regression: Determinants of Board Networks

	DEGREE	CLOSE	EIGEN	BETWEEN	INFO
DEGREE _{t-1}	0.008 (43.34)***				
CLOSE _{t-1}		0.007 (30.70)***			
EIGEN _{t-1}			0.006 (20.29)***		
BETWEEN _{t-1}				0.007 (20.97)***	
INFO _{t-1}					0.007 (23.32)***
HHI	0.018 (7.15)***	0.038 (4.68)***	0.254 (7.72)***	0.036 (6.40)***	0.009 (2.07)**
PCTWBOD	0.0002 (2.49)**	0.001 (2.21)**	0.002 (2.73)***	0.001 (3.42)***	0.0002 (1.77)*
BSIZE	0.000 (4.01)***	0.001 (4.42)***	0.002 (3.27)***	0.000 (3.04)***	0.001 (4.82)***
BINDEP	0.000 (2.12)**	0.000 (2.50)**	0.000 (1.35)	0.000 (1.71)*	0.000 (2.32)**
TENURE	0.000 (0.37)	-0.000 (1.47)	0.000 (0.36)	0.000 (0.01)	-0.000 (1.71)*
AGE	-0.000 (1.31)	0.000 (0.72)	-0.000 (0.42)	-0.000 (1.13)	0.000 (0.77)
EDUCATION	-0.000 (0.24)	-0.000 (0.45)	-0.001 (1.06)	-0.000 (0.30)	-0.000 (0.29)
GENDER	0.000 (0.47)	0.000 (0.24)	-0.003 (0.65)	-0.000 (0.09)	0.001 (0.70)
BBOARD	0.000 (3.66)***	0.000 (2.75)***	0.000 (1.46)	0.000 (2.96)***	0.000 (2.59)***
INSTI	-0.000 (0.50)	-0.000 (2.60)***	-0.000 (0.48)	-0.000 (0.16)	-0.000 (2.23)**
ROA	0.000 (0.16)	0.000 (0.22)	-0.000 (0.26)	-0.000 (0.11)	0.000 (0.30)
LEV	-0.000 (0.98)	-0.000 (1.45)	0.000 (0.49)	-0.000 (0.84)	-0.000 (1.85)*
Intercept	-0.005 (2.39)**	0.020 (2.97)***	-0.081 (5.57)***	-0.009 (2.26)**	0.019 (4.77)***
Year dummies	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes
Observations	1724	1724	1724	1724	1724
R-squared	0.710	0.703	0.521	0.560	0.651

HHI represents product market concentration and PCTWBOD represents the percentage of women boards.
t statistics in parentheses and * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. See Appendix for variables definitions.

Panel B

Second Stage Regression: Linear Regression of Board Networks on ESG

	ESG	ENV	SOC	GOV	ESG	ENV	SOC	GOV	ESG	ENV	SOC	GOV
DEGREE _{t-1}	0.642 (2.69)***	0.696 (2.20)**	0.241 (0.84)	0.535 (3.31)***								
CLOSE _{t-1}					0.242 (3.06)***	0.247 (2.35)**	0.152 (1.60)	0.202 (3.76)***				
EIGEN _{t-1}									0.043 (1.83)*	0.037 (1.74)*	0.006 (0.14)	0.056 (2.18)**
Intercept	7.480 (2.46)**	-6.428 (1.59)	12.987 (3.55)***	37.110 (17.98)***	5.865 (1.92)*	-8.107 (1.99)**	12.081 (3.28)***	35.762 (17.23)***	7.241 (2.37)**	-6.730 (1.66)*	12.794 (3.50)***	37.004 (17.89)***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1724	1724	1724	1724	1724	1724	1724	1724	1724	1724	1724	1724
R-squared	0.404	0.338	0.364	0.323	0.405	0.338	0.365	0.324	0.402	0.336	0.364	0.321
# Firms	199	199	199	199	199	199	199	199	199	199	199	199

t statistics in parentheses and * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. See Appendix for variables definitions.

Panel B (continued)

Second Stage Regression: Linear Regression of Board Networks on ESG

	ESG	ENV	SOC	GOV	ESG	ENV	SOC	GOV
BETWEEN _{t-1}	0.318 (2.42)**	0.292 (1.68)*	0.312 (1.99)**	0.271 (3.04)***				
INFO _{t-1}					0.451 (2.96)***	0.458 (2.26)**	0.324 (1.77)*	0.362 (3.50)***
Intercept	7.395 (2.43)**	-6.578 (1.63)	14.567 (4.13)***	37.045 (17.94)***	6.849 (2.25)**	-7.100 (1.76)*	12.683 (3.48)***	36.589 (17.75)***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1724	1724	1724	1724	1724	1724	1724	1724
R-squared	0.404	0.337	0.364	0.322	0.405	0.338	0.365	0.324
# Firms	199	199	199	199	199	199	199	199

t statistics in parentheses and * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. See Appendix for variables definitions.

Panel C

Second Stage Regression: Quadratic Regression of Board Networks on ESG

	ESG	ENV	SOC	GOV	ESG	ENV	SOC	GOV	ESG	ENV	SOC	GOV
DEGREE _{t-1}	2.310 (3.59)***	2.929 (3.59)***	1.695 (2.00)**	0.713 (1.76)*								
DEGREE _{t-1} ²	-0.504 (2.89)***	-0.676 (3.15)***	-0.434 (1.80)*	-0.053 (0.47)								
CLOSE _{t-1}					2.203 (4.54)***	2.685 (4.15)***	2.166 (3.84)***	0.467 (1.93)*				
CLOSE _{t-1} ²					-0.082 (4.16)***	-0.102 (3.86)***	-0.084 (3.70)***	-0.011 (0.80)				
EIGEN _{t-1}									0.325 (4.12)***	0.403 (3.80)***	0.163 (1.74)*	0.207 (3.65)***
EIGEN _{t-1} ²									-0.012 (4.60)***	-0.016 (4.58)***	-0.007 (2.24)**	-0.006 (3.11)***
Intercept	8.284 (2.34)**	-6.139 (1.33)	14.249 (3.47)***	38.033 (16.61)***	0.118 (0.03)	-18.161 (3.18)***	10.617 (2.11)**	36.209 (12.66)***	9.051 (2.56)**	-5.117 (1.11)	14.816 (3.60)***	38.206 (16.71)***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1724	1724	1724	1724	1724	1724	1724	1724	1724	1724	1724	1724
R-squared	0.407	0.340	0.368	0.324	0.410	0.343	0.371	0.325	0.407	0.340	0.367	0.324
# Firms	199	199	199	199	199	199	199	199	199	199	199	199

t statistics in parentheses and * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Appendix for variables definitions.

Panel C (continued)

Second Stage Regression: Quadratic Regression of Board Networks on ESG

	ESG	ENV	SOC	GOV	ESG	ENV	SOC	GOV
BETWEEN _{t-1}	0.774 (2.76)***	1.117 (3.01)***	-0.562 (2.24)**	0.501 (2.59)***				
BETWEEN _{t-1} ²	-0.074 (1.94)*	-0.133 (2.68)***	0.110 (3.37)***	-0.037 (1.44)				
INFO _{t-1}					1.433 (2.58)***	2.103 (2.69)***	0.966 (1.16)	1.687 (2.55)**
INFO _{t-1} ²					-0.224 (2.41)**	-0.333 (2.55)**	-0.167 (1.20)	-0.148 (1.03)
Intercept	9.015 (2.55)**	-5.149 (1.12)	38.546 (8.88)***	38.144 (16.74)***	35.730 (10.33)***	25.703 (5.53)***	37.557 (8.52)***	39.345 (15.99)***
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1724	1724	1724	1724	1724	1724	1724	1724
R-squared	0.405	0.339	0.368	0.323	0.404	0.337	0.367	0.327
# Firms	199	199	199	199	199	199	199	199

t statistics in parentheses and * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Appendix for variables definitions.