Toward an alternative measure of board diversity: an exploratory study on board polarization in German stock exchange-listed companies

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Abstract

Purpose – The effects of board composition on performance have long been discussed in management research using fractionalization measures. In this study, we propose an alternative measurement approach based on board polarization.

Design/methodology/approach – Using an exploratory analysis and applying the polarization measure to German Deutscher Aktienindex (DAX)-, Midcap-DAX (MDAX)- and Small Cap-Index (SDAX)-listed companies, this paper applies the polarization index to examine the relationship between board diversity and performance.

Findings – The results show that the polarization concept is well suited to measure principal-agent problems between the members of the management and supervisory boards. We reveal that board polarization is negatively associated with firm performance, as measured by return on investment (ROI).

Originality/value – This exploratory study shows that the measurement of board polarization can be linked to performance differences between companies, which offers promising starting points for further research.

Keywords Supervisory board, Management board, Board composition, Polarization, German firms, Agency theory

Paper type Research paper

Introduction

Board composition is a fundamental topic in the field of management research (Gardiner, 2022; Ren and Zeng, 2022; Porcena *et al.*, 2021; Tyrowicz *et al.*, 2020; Li and Huang, 2019). In particular, the question of how board diversity can be increased is becoming a growing priority in the ongoing political and academic debate (Dodd and Zheng, 2022; An *et al.*, 2021; Brahma *et al.*, 2020; Braendle *et al.*, 2020; Aggarwal *et al.*, 2019). On the one hand, this is related to the increasing social awareness of diversity and equality issues (Fleischer, 2022; Kirsch *et al.*, 2022; Huang *et al.*, 2020). On the other hand, there is also growing empirical evidence suggesting that heterogeneous groups can achieve performance advantages over homogeneous groups (Zhou *et al.*, 2023; Vafaei *et al.*, 2021; He and Jiang, 2019; Kirsch, 2018; Aluchna and Kaminski, 2017). However, the literature focuses mainly on single-tier board systems, as they are common in many countries and especially in the Anglo-American world (Hossain and Oon, 2022). In this article, we will instead look at two-tier systems, which are common in many European countries (Fitzner, 2022). The two-tier system is characterized by an organizational separation between managerial and supervisory functions (Hopt, 2016).

While the management board is responsible for running the company, the supervisory board appoints, supervises and advises the members of the management board on important decisions (Dienes and Velte, 2016). Thus, the supervisory board has a monitoring and control function that can decisively influence the decision-making of the management board (Velte, 2020). However, the effects of supervisory board monitoring on corporate performance are controversially discussed in research (Fitzner, 2022). Studies either come to contradictory results or fail to prove a significant impact of the supervisory board (Handschumacher and Ceschinski, 2020; Kirsch, 2018; Schulten, 2013).

Nevertheless, board composition has been identified by many authors as a critical success factor for companies (Dobija *et al.*, 2022; Huang *et al.*, 2020; Tyrowicz *et al.*, 2020; Krause *et al.*, 2019; Johansen *et al.*, 2017). Thus, many studies have examined gender, age, educational, functional and ethnical board members diversity for their impact on communication (Tuggle *et al.*, 2010; Gillette *et al.*, 2003), decision-making (Thompson and Adasi Manu, 2021; Rao and Tilt, 2015), risk-taking (Díez-Esteban *et al.*, 2022; Adelopo *et al.*, 2021; Noja *et al.*, 2021), strategy formulation (Valls Martínez *et al.*, 2019; Baysinger and Hoskisson, 1990), accounting quality (Schumann *et al.*, 2023), financial performance (Hosny and Elgharbawy, 2022) and business performance (Brahma *et al.*, 2020; Fleischer, 2022). Methodologically, most studies rely on the concept of fractionalization. In doing so, they measure board diversity using concentration ratios or measures of inequality. In this study, we propose a different measurement approach based on polarization between supervisory and executive board members (Przeworski, 2022; Esteban *et al.*, 2012; Duclos *et al.*, 2004). Referring to principal-agent theory and based on an extensive literature, we hypothesize that board polarization impedes communication between supervisory and executive board members and thus intensifies potential principal-agent problems within governing committees. To the best of our knowledge, such a measurement approach has not yet been used in business research. We assume that the new approach can help resolve the conflicting findings of empirical research and provide a conceptually different understanding of the interaction between the management and supervisory boards.

Our study makes several important contributions to the literature on board composition. First, we offer a possible explanation for why previous empirical studies have produced inconsistent results. We argue that diversity studies have so far paid too little attention to the different functions of executive and supervisory boards and that these differences can be well captured empirically by the polarization index. Second, we use the polarization index to offer a new perspective on the phenomenon of supervisory board composition. In doing so, we provide an alternative way to evaluate the problems in research on board composition. Third, we use the polarization approach to understand how dynamics in board composition are reflected in management performance measures. In this way, we not only illustrate the potential application of the polarization index, but also identify entry points for future research to conduct quantitative studies.

The rest of the paper is organized as follows. We first provide an overview of the empirical literature, which so far has not provided clear evidence of performance effects with respect to the diversity parameters usually considered. We then shed light on the conceptual foundations of our analysis by first distinguishing the German two-tier board system from the Anglo-American one-tier system. We then address the conceptual differences between the measurement of fractionalization and polarization. In particular, we highlight the different premises underlying the two measurement approaches and explain why we believe the polarization approach is better suited to measure board diversity. At this point, we argue in particular in light of the principal-agent theory, which provides a good rationale for the polarization approach. Building on this, we conclude by applying the polarization framework to the management and supervisory boards of German DAX, MDAX and SDAX companies in order to demonstrate its applicability and to explore the performance implications of board polarization.

Literature review on board composition and performance

The impact of board composition on firm performance has been extensively discussed in the management literature (Chindasombatcharoen *et al.*, 2022; Thompson and Adasi Manu, 2021; Manna *et al.*, 2020; Boivie *et al.*, 2016; Ararat *et al.*, 2015). In this regard, two opposing opinions can be identified in the literature. The first strand of literature considers board heterogeneity positively, as greater board diversity leads to a larger pool of resources and capabilities, which should improve strategic decision-making (Zhou *et al.*, 2023; Ararat *et al.*, 2015; FitzRoy and Kraft, 2005) and innovation (Vafaei *et al.*, 2021; He and Jiang, 2019) and increase firms' responsiveness to crises and other challenges (Harjoto *et al.*, 2019). The second strand of research, on the other hand, considers homogeneous boards to be beneficial (Hosny and Elgharbawy, 2022; Frijns *et al.*, 2016; Tekleab *et al.*, 2016; Torchia *et al.*, 2015). This line of research argues that homogeneous boards develop better groupthink and cohesion (Anderson *et al.*, 2011), which is associated with shorter decision times (Bernile *et al.*, 2018) and more effective communication (Erhardt *et al.*, 2003; Yermack, 1996).

The contradictory research findings can be attributed in part to different approaches of measurement, as the composition of the board is understood differently in many studies (Gardiner, 2022; Makkonen, 2022; Reddy and Jadhav, 2019). For example, different criteria such as gender, age, education, or functional background of the decision makers are used to determine the degree of diversity on the board (Hosny and Elgharbawy, 2022; Tuggle *et al.*, 2010; Gillette *et al.*, 2003).

The most extensive part of the relevant literature deals with the board composition in terms of gender. One reason for the great research interest in gender diversity is due to the legal regulations that impose mandatory quotas for women on boards in many countries (Huang *et al.*, 2020; Valls Martínez *et al.*, 2019; Bøhren and Strøm, 2010). Although a quota regulation for DAX40 companies has also been introduced in Germany, companies are still far from implementing it (Fleischer, 2022). For example, only about 18% of executive board positions in DAX40 companies are held by women (Holst and Wrohlich, 2019). Interestingly, the proportion of women on supervisory boards is significantly higher at almost 35% (Kirsch *et al.*, 2022). However, the question of how a higher proportion of women in boards affects corporate performance is controversial and the empirical evidence is inconclusive (Reddy and Jadhav, 2019). While some authors find positive effects on firm performance (Schumann *et al.*, 2023; Brahma *et al.*, 2020; Adams and Ferreira, 2016; Joecks *et al.*, 2013), others report negative (Hosny and Elgharbawy, 2022) or non-significant results (Fleischer, 2022; Rose, 2007).

Board member age is another commonly used indicator to measure board diversity (Xu *et al.*, 2022; Sutarti *et al.*, 2021). Higher age is traditionally associated with greater life experience of board members, which is thought to improve decision-making (Ararat *et al.*, 2015; Platt and Platt, 2012; Sundaram and Yermack, 2007). At the same time, increased age is assumed to reduce the willingness to take risks (Johnson *et al.*, 2013) and to initiate organizational change (Ahn and Walker, 2007; Wieserma and Bantel, 1992). For this reason, two fundamentally different expectations exist in the literature regarding the performance effects associated with board member age. Because empirical research has been able to find evidence to support both opposing positions, the debate about the effects of board age diversity on firm performance remains controversial to this day (Gardiner, 2022).

Besides the demographic characteristics of age and gender, recent studies on board composition increasingly take into account the ethnic and cultural background of board members. In multinational companies, for example, it is common practice to fill board positions with people of different nationalities (Schumann *et al.*, 2023; Harjoto *et al.*, 2019). Cultural diversity created in this way is assumed to open up different ways of solving problems and break down rigid ways of thinking that can occur in culturally homogeneous boards (Nederveen *et al.*, 2013). It is also supposed that board members with different cultural backgrounds help multinational companies better assess foreign markets and better engage in

cross-border networks (Masulis *et al.*, 2012). On the other hand, cultural heterogeneity also increases the risk of the formation of subgroups within the board, which can limit communication and lead to tensions within the group (Frijns *et al.*, 2016). Whether greater cultural board diversity leads to better corporate performance is therefore also a matter of controversy (Dodd and Zheng, 2022; Hosny and Elgharbawy, 2022; Braendle *et al.*, 2020).

Since diversity is a multifaceted phenomenon, it is important to consider how many of its dimensions should be included in the measurement. Some studies choose a very broad strategy by attempting to capture as many facets as possible (An *et al.*, 2021; Bernile *et al.*, 2018; Tuggle *et al.*, 2010). In these studies, the operationalization of diversity often includes aspects such as the functional or educational background of board members, in addition to basic demographic and cultural characteristics (Hosny and Elgharbawy, 2022; Anderson *et al.*, 2011). However, the demographic characteristics of age and gender along with ethnic background are the dimensions most often incorporated in research, at least for practical reasons (Gardiner, 2022; Braendle *et al.*, 2020; Reddy and Jadhav, 2019; Kirsch, 2018). Therefore, we limit our consideration to these dimensions as well.

Conceptual framework
The German two-tier board system
In comparison with the Anglo-American one-tier system, the companies listed on the German Stock Index DAX have a two-tier system in which there is a separate supervisory board in addition to the executive board (Fitzner, 2022). The supervisory board is responsible for appointing and dismissing members of the management board, setting long-term goals and reviewing the performance of the managing directors (Velte, 2020). In addition, specific rules apply to the structural separation of the executive and supervisory boards (Heyden *et al.*, 2015). A special feature in Germany is that, due to the Codetermination Act, employees are assigned a quota on the supervisory board depending on the size of the company (Denis and McConnell, 2003). As a rule, the supervisory board consists of three to twenty-one members, depending on the share capital, the number of employees in the company and the applicable codetermination law (Fauver and Fuerst, 2006). For companies employing more than two thousand people, the number of employee and owner representatives must be equal (Lin *et al.*, 2018). The involvement of employee representatives is based on the premise that the flow of information from employees to management positively influences decision-making (FitzRoy and Kraft, 2005). This is said to be particularly beneficial in industries that require intensive coordination, integration of activities and exchange of information. However, this type of multi-stakeholder system also results in conflicts between the two groups. In this sense, Fauver and Fuerst (2006) find an inverted U-shaped relationship between firm value and the number of employee representatives.

One important task of the supervisory board is to monitor the managing directors (Dienes and Velte, 2016). Empirical research has provided some evidence that monitoring can have a strong impact on managerial and organizational performance. For instance, studies show that independent supervisory boards increase management turnover (Buchwald, 2017), reduce risk-taking (Eling and Marek, 2014) and exercise better capital control in the company (Balsmeier *et al.*, 2015). However, research has also shown that the extent of monitoring varies greatly across companies (Van den Berghe and Baelden, 2005). Stricter monitoring is practiced by supervisory boards primarily in those companies with poorer managerial performance (Tuggle *et al.*, 2010). Some authors have also argued that imbalances in knowledge about the company between the supervisory and management boards make monitoring more difficult as managing directors usually have better insight into operational and strategic processes (Boivie *et al.*, 2016; Stevenson and Radin, 2009). Information asymmetries lead to classic agency problems and promote opportunistic behavior by

managers (Lopatta *et al.*, 2020; Adams and Ferreira, 2007). Further, study results show that the quality of monitoring increases when board members serve on two or more monitoring committees of different firms (Faleye *et al.*, 2011). However, empirical results are not consistent. Many authors also find no significant impact of supervisory board monitoring on managerial performance (Hossain and Oon, 2022; Handschumacher and Ceschinski, 2020; Kirsch, 2018; Schulten, 2013; Bermig and Frick, 2010).

Polarization

In diversity research, much attention has been paid to the question of when conflict increases in groups, organizations, or societies as a whole (Huber and Mayoral, 2019; Esteban *et al.*, 2012; Easterly and Levine, 1997). In this regard, there are two competing schools of thought based on different assumptions and beliefs (Arbatlı *et al.*, 2020). The first line of reasoning assumes that the potential for social conflict must increase as heterogeneity increases (Wegenast and Basedau, 2014). For example, the more people belong to different social, ethnic, religious, or cultural categories, the more likely they are to experience social stereotypes or misunderstandings (Easterly and Levine, 1997). Accordingly, in this view, the greatest potential for social conflict is expected in a state of highest fractionalization (Alesina *et al.*, 2003). Polarization theory, on the other hand, offers a conceptually different perspective (Przeworski, 2022; Esteban *et al.*, 2012; Montalvo and Reynal-Querol, 2005; Duclos *et al.*, 2004; Esteban and Ray, 1994). Authors of the polarization school argue that social conflict increases when two different poles emerge (Montalvo and Reynal-Querol, 2003). Thus, polarization is conceptually distinct from inequality because increasing heterogeneity does not *per se* increase the potential for social conflict (Park and Shin, 2012). Rather, social tensions increase when groups of the same size form because their members share common identifying characteristics among themselves that are opposite to the identifying characteristics of the other group (Esteban and Ray, 1994). This is because the relative size of the two groups favors the formation of a common group identity and leads to group-based competition (Duclos *et al.*, 2004).

The concept of polarization has been taken up in the literature by various academic disciplines. In political science, for example, it has been argued that party polarization can have an impact on political decision-making (Lindqvist and Ostling, 2010; Alesina *et al.*, 1999). Some authors have argued that the bipolar two-party system in the United States prevents the assertion of a one-sided, extreme political position (Lee, 2015). Polarization thus seems to favor two main effects. On the one hand, it makes decision-making more difficult because more varying interests have to be weighed (Murse, 2019). But on the other hand, polarization can also help stabilize political arrangements because the different poles of interest balance each other out, which can prevent the political system from tilting in one extreme direction (Dulio and Thurber, 2000).

The concept of polarization has also been addressed in the economic literature. In particular, polarization has been studied in relation to income and wealth inequality (Brzezinski, 2013; Biancotti, 2006; Keefer and Knack, 2000). The growing gap between rich and poor has been identified in economic studies as a major source of social conflict and political instability (Chakravarty, 2015; Akdede, 2012), as well as an impediment to growth and innovation (Caiani *et al.*, 2016; Jacobs, 2016; Thorbecke and Charumilind, 2002).

Moreover, the concept of polarization has received particular attention in research on creative cities (Ottaviano and Peri, 2005, 2013; Florida, 2010; Walks and Maaranen, 2008). Relevant studies have focused on whether culturally, ethnically and religiously homogeneous cities achieve better economic outcomes than cities with a high proportion of immigrants (Ottaviano and Peri, 2006; Montalvo and Reynal-Querol, 2003). While population diversity has in many cases been associated in these studies with positive aspects such as a larger pool

of ideas and creativity, higher wages and greater productivity (Olney, 2013; Card and Shleifer, 2009), other authors have also pointed to the negative effects of cultural polarization, which can result, for example, from a growing potential for conflict or greater language barriers (Field *et al.*, 2008; Montalvo and Reynal-Querol, 2003).

The concept of polarization has also been widely used in organizational research. Crucial contributions came from organizational psychology and team management studies (Jung *et al.*, 2019; Rodríguez-Ruiz *et al.*, 2016; Iyengar and Westwood, 2015; Croson *et al.*, 2008; Maddock, 2002). Central to this research has been the question of optimal group composition. Studies in this area show that polarized group composition can improve productivity and quality of work outcomes (Xie *et al.*, 2020; Opstrup and Villadsen, 2015; Bogan *et al.*, 2013; Díaz-García *et al.*, 2013). Authors attribute this finding to the fact that polarized work teams require more discussion and need to consider more alternative opinions due to differing viewpoints, which can lead to better decision-making (DeBode *et al.*, 2024; Shi *et al.*, 2019). At the same time, however, a high degree of group polarization can make communication and mutual understanding more difficult. Principal-agent problems can also be intensified if the polarization leads to information gaps and conflicting opportunistic motivations. We will discuss this point in more detail below.

A principal-agent theory perspective

The effectiveness of communication between the management and supervisory boards is often analyzed using the principal-agent theory (Ross, 1973; Jensen and Meckling, 1976). This theory also offers a good starting point for analysis, particularly with regard to the polarization problem described above. As an economic concept, principal-agent theory deals with moral hazards in contractual relationships in which one party (the agent) acts on behalf of another party (the principal). The principal-agent problem emerges when there are different objectives or different levels of information between the principal and the agent.

In the context of companies, the principal-agent problem can arise between the management board (agent) and the supervisory board (principal). The management board is the authorized representative of the supervisory board and acts on behalf of the company. The supervisory board has the task of monitoring the management board and supervising the executive directors of the company. The principal-agent problem can occur in this context if the management board places its own interests above those of the company or if the supervisory board is unable to fully assess the management board's activities and performance (Schöndube-Pirchegger and Schöndube, 2010).

Researchers often argue that the one-tier board system used in the USA and UK does not provide sufficient control mechanisms to prevent opportunistic behavior by board members (Block and Gerstner, 2016; Dienes and Velte, 2016). The two-tier board system, on the other hand, is designed to provide a strong supervisory board as a counterweight to the management board, which is intended to limit opportunistic behavior and align the actions of the management board with the objectives of the company. Accordingly, some authors have suggested that the two-tier board system should be better suited for imposing discipline on corporate governance and preventing malpractice (Hossain and Oon, 2022; Velte, 2020). Thus, in terms of principal-agent theory, the two-tier system will reduce principal-agent problems and increase the quality of corporate governance.

The polarization index introduced in this study can be understood in terms of principal-agent theory as a measure of how easily the management board can communicate with the supervisory board. A high degree of polarization indicates differences in the composition of the members of the two boards and therefore means that it becomes more difficult to find a common language (DeBode *et al.*, 2024). Accordingly, it can be assumed that polarization also leads to an information gap between the management board and the supervisory board,

which can intensify principal-agent problems and reduce the quality of corporate governance. Against this background, we hypothesize that polarization between the two boards should be negatively related to corporate performance.

Data and methodology

To measure board composition diversity, we use the polarization index originally proposed by Esteban and Ray (1994). The index can be formulated as follows:

$$POL = 1 - \sum_{i=1}^{N} \left(\frac{0.5 - s_i}{0.5} \right)^2 s_i$$

where s_i denotes the proportion of a group i in the population. The polarization index reaches a maximum when two groups of equal size face each other and decreases when the configuration of the groups deviates from this bipolar distribution (Alesina and La Ferrara, 2005). Although the methodology is similar in many respects to the widely used fractionalization approach, the measurement results differ decisively in one respect. This is because while the common fractionalization measures consistently show a higher degree of diversity as the number of different characteristics increases, the polarization index shows lower values as the deviation from bipolarity increases. Thus, in the extreme case where all board members differ in the relevant characteristics, the fractionalization approach would measure maximum diversity, while the polarization approach would indicate very low polarity.

In order to investigate whether the polarization index we propose as a measure of communication ease in governance boards is related to the company performance, we took a closer look at German companies listed in the DAX, MDAX and SDAX for an exploratory regression analysis. A total of 160 companies are listed in the three stock indices. For these companies, we first calculated the polarization index based on the gender, age and nationality of the board members. We then collected a number of company-related control variables that are often used in studies focusing on performance measures. Specifically, the age of the company, revenue per employee, revenue growth, profit per employee, debt-to-equity ratio and labor intensity were recorded. In addition, the industry classification of the companies in the sample was measured in terms of dummy variables. We chose the year 2022 as the reference year for the analysis.

We use return on investment (ROI) as a performance indicator for our exploratory study. ROI is a financial indicator that measures the profitability of an investment (Braendle *et al.*, 2020; Hinterhuber and Liozu, 2015). It is calculated by dividing the net profit of an investment by the cost of the investment. The outcome is expressed as a percentage or ratio. ROI is a widely accepted metric in the financial and corporate world (Ichsani and Suhardi, 2015). It is used to evaluate the performance of an investment and to compare the profitability of different investments. A positive ROI means that an investment is profitable, while a negative ROI means that an investment is unprofitable. ROI is therefore a useful tool for evaluating the cost-effectiveness of investments and drawing conclusions about company performance (Porcena *et al.*, 2021).

Due to missing observations in the data, the sample size varies between 156 and 118 observations. The descriptive statistics of the sample are summarized in Table 1. Please note that some control variables have a skewed distribution. As is common in econometric practice, we have therefore performed a logarithmic transformation of the variables.

Table 1 also shows the correlations between the variables included in the sample. Particularly striking here are the statistically significant correlations between the polarization measurements and the target variable ROI. The negative sign of the

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1) Return on investment	1.000											
(2) Polarization (gender)	−0.204**	1.000										
(3) Polarization (age)	−0.229***	−0.049	1.000									
(4) Polarization (nationality)	−0.234***	0.143*	0.067	1.000								
(5) Firm Age	0.061	0.117	0.054	−0.129	1.000							
(6) Sales per Employee	0.037	−0.012	0.016	−0.009	0.021	1.000						
(7) Sales growth	0.177**	−0.067	−0.194	−0.135*	−0.049	0.058	1.000					
(8) Profit per employee	0.044	−0.140*	−0.042	0.059	−0.073	0.279****	−0.03	1.000				
(9) Debt ratio	−0.254***	0.198**	0.042	0.119	−0.018	0.069	0.088	−0.203**	1.000			
(10) Labor intensity	0.181**	−0.149*	−0.027	−0.005	0.050	−0.075	0.179**	−0.172**	0.158*	1.000		
(11) DAX	−0.064	0.220***	0.081	0.161**	0.201**	0.251	−0.042	0.147*	0.110	−0.083	1.000	
(12) MDAX	0.009	0.115	−0.050	0.009	−0.111	−0.067	0.193**	−0.03	−0.004	−0.036	−0.389****	1.000
Min	−23.13	0.000	0.395	0.000	2.000	−603281	−124.06	−1100000	9.170	2.000	0.000	0.000
Max	27.98	1.000	0.992	1.000	355.0	12,000,000	372.22	130,310,000	110.5	92.00	1.000	1.000
Mean	4.603	0.746	0.823	0.491	67.91	668,622	18.578	875,901	59.28	43.38	0.250	0.313
Median	4.100	0.850	0.824	0.495	40.00	389,415	14.585	22,199	60.27	45.00	0.000	0.000
SD	6.855	0.272	0.087	0.312	57.03	1,247,666	35.469	10,431,167	18.39	19.912	0.434	0.465
Variance inflation factors	–	1.39	1.14	1.19	1.26	1.96	1.34	2.56	1.18	1.43	1.48	1.40

Note(s): Significance Levels: (*) $p < 0.1$, (**) $p < 0.05$, (***) $p < 0.01$ and (****) $p < 0.001$

Source(s): Calculation and presentation by the authors

correlations initially indicates that the direction of the examined correlation supports our hypothesis formulated at the beginning. The polarization between the management and supervisory boards does therefore seem to be negatively associated with company performance.

Exploratory regression analysis

The results of the regression analysis are shown in Table 2. We begin the exploratory approach with simple bivariate regressions in which the polarization measurements are individually regressed on the target variable. The estimates each have a negative sign and are statistically significant at the 5 and 1% level. In the next step, we combine all three polarization measurements in one model. There is little change in the statistical significance and the estimated variable signs. Moreover, the adjusted R-squared increases. The polarization measurements alone are therefore already able to explain around 12% of the data variance, which is a comparatively high value.

In the next steps, we add the control variables and the industry dummies to the regression models. The R-squared initially rises to almost 52% and later increases to around 57%. The estimate can therefore explain a good part of the data variance overall. With regard to the control variables, except for company age and sales growth as well as the DAX and MDAX

Models	OLS (1)	OLS (2)	OLS (3)	OLS (4)	OLS (5)	OLS (6)
Intercept	8.465****	19.064****	7.203****	24.643****	19.638**	16.107**
	(1.549)	(4.995)	(0.993)	(5.134)	(7.992)	(7.685)
Polarization (gender)	−5.034**	–	–	−5.043***	−1.567	−0.596
	(1.947)	–	–	(1.915)	(1.381)	(1.331)
Polarization (age)	–	−17.208***	–	−17.250***	−8.680**	−10.787***
	–	(6.031)	–	(5.866)	(3.872)	(3.748)
Polarization (nationality)	–	–	−4.978***	−3.604**	−2.012*	−2.235**
	–	–	(1.710)	(1.664)	(1.166)	(1.11)
Ln (firm age)	–	–	–	–	−0.618	−0.337
	–	–	–	–	(0.379)	(0.367)
Ln (sales per employee)	–	–	–	–	−2.851****	−2.568****
	–	–	–	–	(0.588)	(0.564)
Ln (sales growth)	–	–	–	–	0.206	0.172
	–	–	–	–	(0.309)	(0.305)
Ln (profit per employee)	–	–	–	–	3.016****	2.968****
	–	–	–	–	(0.431)	(0.410)
Ln (debt ratio)	–	–	–	–	−2.631**	−2.673***
	–	–	–	–	(1.013)	(0.976)
Ln (labor intensity)	–	–	–	–	4.007****	4.184****
	–	–	–	–	(0.716)	(0.679)
DAX	–	–	–	–	−0.517	−0.759
	–	–	–	–	(0.954)	(0.904)
MDAX	–	–	–	–	−0.167	−0.597
	–	–	–	–	(0.814)	(0.779)
Industry dummies	no	no	no	no	no	yes
Observations	156	149	148	147	118	118
R-squared	0.035	0.046	0.048	0.117	0.516	0.567
F-test	6.683**	8.142***	8.476***	7.436****	12.33****	12.78****

Table 2.
Exploratory regression analysis

Note(s): Significance Levels: (*) $p < 0.1$, (**) $p < 0.05$, (***) $p < 0.01$ and (****) $p < 0.001$
Source(s): Calculation and presentation by the authors

dummies, all other variables are estimated significantly and with a plausible direction. Please note that due to the logarithmic transformation of the controls, the estimates of the regression coefficients cannot be interpreted as simple slope parameters.

Moreover, it is noteworthy that the polarization measurement based on gender loses its statistical significance when we add control variables. However, the measurements based on age and nationality remain significant. The small fluctuations in the estimation results for the polarization index also indicate a robust finding.

The model specification used in this study was evaluated diagnostically. In order to rule out problems with multicollinearity, the variance inflation factors (VIFs) were examined (see Table 1). All VIFs listed are at a low level and far below the critical threshold specified in literature (Neter *et al.*, 1990). Therefore, we conclude that our estimates are not subject to multicollinearity problems. In addition, the residuals of the model were tested for normal distribution using the Kolmogorov–Smirnov test (Massey, 1951). The test result Komogorov-Smirnov (KS)= 0.1047 (p = 0.1501) indicates that the normal distribution assumption is satisfied. In addition, the assumed variance homogeneity was tested using the Goldfeld–Quandt test (Quandt and Goldfeld, 1965). The test statistic GQ = 1.583 (p = 0.0636) also indicates that there is no heteroscedasticity in the model.

Discussion

With regard to board composition, two main questions are of crucial importance for management research (Dobija *et al.*, 2022; Ren and Zeng, 2022; Porcena *et al.*, 2021; Krause *et al.*, 2019; Li and Huang, 2019; Aluchna and Kaminski, 2017). The first question concerns the impact of board diversity on company performance. And the second one relates to measurement of board composition. Addressing these fundamental issues, we have presented the polarization index as an alternative measure of board composition in this article. The polarization measure basically reflects the quality of communication between the management and supervisory boards. Based on principal-agent theory, we formulated the hypothesis that a high degree of polarization impedes communication and thus negatively affects the quality of corporate governance. To test our hypothesis, we measured polarization by gender, age and nationality of board members and compared this measure with ROI as a performance indicator in an exploratory regression analysis. The results of our estimates confirm the initial hypothesis. Board polarization is indeed negatively and statistically significantly related to ROI. This suggests that board polarization increases principal-agent problems and has a negative impact on firm performance.

Our results provide interesting implications for management research. First, we show that board polarization can worsen principal-agent problems between the management and supervisory boards. Thus, we confirm the strand of research that critically examines board composition and raises concerns regarding negative effects of group conflicts and ineffective communication between governing committees in companies (Huang *et al.*, 2020; Johansen *et al.*, 2017; Dienes and Velte, 2016; Walther and Morner, 2014). On the other hand, our findings also contribute to a better understanding of how board composition in a two-tier system affects corporate governance performance. Researchers have long puzzled over why there is no clear evidence of positive performance effects in two-tier board systems compared to single-tier systems (Fitzner, 2022; Handschumacher and Ceschinski, 2020; Kirsch, 2018; Schulten, 2013). Theoretically, a two-tier system should have an advantage over a single-tier system because the supervisory board acts as a monitoring counterpart to the management and thus has a disciplinary effect on executive management. However, empirical studies provide no clear evidence of this positive effect. One possible reason for this, as our results show, could stem from the composition of the two boards. To ensure that the supervisory board can perform its control function for the benefit of the company,

communication between the two boards must function well. However, an improper composition of board members can lead to strong polarization, which hinders mutual understanding and thus counteracts productive cooperation between the two corporate governing entities. When appointing board members, companies must therefore ensure that there are no major differences between their members. This implication is also important for policymakers, as many legal regulations such as the women's quota can intensify polarization problems. Politicians must therefore take this point into account when setting rules on the composition of supervisory boards.

However, the results of our study must also be considered against the background of their limitations. An important limitation arises, for example, with regard to the measurement of polarization. We have limited our analysis to the easily observable parameters of gender, age and nationality. However, there are a variety of other issues that may be relevant to board composition that we have not included in our analysis. Furthermore, we have limited our scope of research to German companies only. We therefore cannot exclude that we have captured country-specific characteristics that prevent generalization. With regard to performance measurement, it should also be noted that we have limited the analysis to ROI as a performance indicator. Other studies might therefore try to transfer our approach to other performance measures and replicate our results. Finally, it should be kept in mind that our analysis was only a cross-section and did not capture the dynamics of board evolution and interaction over time. Further research could address this limitation and examine the effects of board polarization in more detail in a panel study.

Conclusions

Board composition is an important issue in debates about corporate performance in the modern world. For this reason, it is important to know how board diversity affects corporate performance. So far, the effects of board composition have generally been studied using the fractionalization approach. This neglects the interaction between the board of directors and the supervisory board. In this study, we proposed an alternative approach, the polarization index, which can help to better account for the emerging group effects. We have also discussed that the polarization index can be used as a measure of how well the management and supervisory boards communicate with each other and thus serve as an indicator of principal-agent problems. Based on principal-agent theory, we have argued that increasing polarization between board members intensifies principal-agent problems, which translates into lower firm performance. We draw this conclusion from an exploratory analysis of DAX-, MDAX- and SDAX-listed companies from Germany. In particular, we showed through a regression analysis that return on investment is negatively related to various measures of polarization, which confirms our theoretical expectation. Given these results, we found that the polarization index can contribute to a better understanding of the impact of board composition on firm performance. However, our study has a number of methodological limitations, and further research is needed to better validate the relationship between the polarization approach and firm performance.

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