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RESEARCH ARTICLE

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Gender spillovers from supervisory boards to management boards

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This study investigates gender spillovers from women on supervisory boards to women on management boards in a two-tier system with employee codetermination. The supervisory board consists of a nominating committee mainly responsible for the appointment of directors in the management board. By combining similarity attraction theory with power theory, we predict that only female shareholder representatives who serve on the nominating committee drive the positive effect on the presence of women on management boards. The results of the correlated random effects models in a sample of 95 German codetermined and publicly listed companies (2009–2016) confirm the predicted relationship.

1 | INTRODUCTION

In recent years, scientific interest in investigating the determinants of woman reaching board positions in the corporate sector has been growing (Doldor et al., 2016; Gabaldon et al., 2016; Galia et al., 2017; Hillman et al., 2007; Joecks et al., 2019; Mensi-Klarbach et al., 2019; Seierstad et al., 2017). These studies show that firms feel an increasing outside pressure because of political regulations or increasing inside pressure by, for example, female employees. However, after decades of women in the corporate sector, we observe “some progress in the boardroom, little change at the top” (Mitchell et al., 2016, p. 1). Despite the increasing prevalence of women on boards (e.g., Abdullah et al., 2016; Buchwald & Hottenrott, 2019; Chen et al., 2016) and growing research about the determinants of female presence in top positions (e.g., Duguid et al., 2012), sparse evidence about the spillover effects of women in the boardroom to women in the top management exists. Previous research establishes a significant positive correlation between the presence of women directors and

the presence of women in the top management for US firms in a one-tier system (Bilimoria & Piderit, 1994; Matsa & Miller, 2011; Wang & Kelan, 2013). A recent German study shows that there is tentative evidence that the gender quota for supervisory boards positively affects the percentage of women on management boards (Kirsch & Wrohlich, 2020).

In this study, we also focus on spillover effects in a two-tier corporate governance system, as present in Germany, and explore the effects of women on supervisory boards to the presence of women on the management board. The one-tier system differs from the two-tier system in the civil law versus common law regulations. In a two-tier corporate governance system, there are a management board and a supervisory board. In many civil law countries (e.g., France and the Nordic countries), the management board consists of one person that puts together a management team (for a detailed description, see the next chapter on the German corporate governance system). In this paper, we dig deeper into the effects of the board structure and the presence of women on the nominating committee (Guldiken et al., 2018).

Knowledge about the existence of gender spillovers from supervisory boards to management boards is highly relevant for countries with separate board structures and especially for those with a two-tier system, such as in Europe—Poland or Austria—or with an optional choice: Portugal, France, and Italy.¹ The relevance for at least these

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The data that support the findings of this study are based on own data collection and on the Bureau van Dijk's ORBIS DACH database. Restrictions apply to the availability of these data, which were used under license for this study. The data are not publicly available due to privacy.

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countries is twofold: (1) the institutional dependencies between these two corporate bodies and (2) the recently introduced legal regulations of the supervisory board gender composition in many countries. In Germany, as a country with a two-tier system, for example, it is one of the supervisory board's duties to appoint and monitor the members of the management board (e.g., German Stock Corporation Law [AktG, §84]). Thus, the directors of the supervisory board are the sole decision makers when it comes to the question of whom will be running the company.

By drawing on similarity attraction theory (Byrne, 1971) in combination with structural and ownership power (e.g., Finkelstein, 1992), we argue that only female shareholder representatives (compared with female employee representatives) who serve on the nominating committee of the supervisory board have a positive effect on the presence of women directors on the company's management board. By using a sample of 95 German codetermined and publicly quoted companies from 2009 to 2016 that consider time constant and unobservable characteristics, we find a positive effect of female shareholder representatives, who serve on the nominating committee of supervisory boards, on the presence of women in management boards. This result stresses the importance of structural and ownership power in gender diverse boards.

Our study contributes to the literature twofold. First, and in contrast to prior studies establishing spillover effects of women on supervisory boards to women on management boards (e.g., Bilimoria, 2006; Matsa & Miller, 2011 for common law countries like Great Britain or the United States; Wang & Kelan, 2013 for civil law countries like Norway), we contribute to previous inconclusive studies on gender spillovers by outlining that it is necessary to combine similarity attraction theory (Byrne, 1971) with managerial power theory (Finkelstein, 1992) to dig deeper into the board structure and to analyze how women directors' prestige power (their presence on the nominating committee) (Guldiken et al., 2018) as well as their potential ownership power (their representation of shareholders on the board) influence separately but also jointly the presence of women on the management board. More precisely, we take into account that the nomination of management board members is typically delegated to the nominating committee of supervisory boards and argue that being a member in this committee is linked to power, more precisely to structural power (Bacon & Brown, 1973; Guldiken et al., 2018; Kesner, 1988). We refer to the seminal study of Kesner (1988), which indicates that the nominating committee is one of the most powerful board committees. This leads to an increase in women directors' structural power (Finkelstein, 1992) who are members of the nominating committee when compared with those who serve on the residual supervisory board (Guldiken et al., 2018). Hence, our study is related to a number of studies considering the spillover effects of women directors found on supervisory boards or those in committees on the management board (e.g., Bugeja et al., 2016; Kaczmarek et al., 2012; Oliver et al., 2018; Strobl et al., 2016 for common law countries). Moreover, we contribute to previous studies on the effects of directors' power on strategic decisions in companies (Åberg et al., 2019; Combs et al., 2007; Finkelstein, 1992; Oehmichen et al., 2017;

Triana et al., 2014; Udueni, 1999; Veltrop et al., 2017) by being the first to investigate potential gender spillover effects due to the ownership power and structural power of women directors on boards.

Second, we contribute methodologically to previous literature by employing a correlated random effects (CRE) logit model with lagged independent variables and test if correlation of time-constant unobserved firm heterogeneity with time-varying control variables must be accounted for in this setting. To the best of our knowledge, previous studies do not address this issue. Hence, we correct a potential source of estimation bias in the literature (i.e., Wang & Kelan, 2013).

2 | GERMAN CORPORATE GOVERNANCE SYSTEM

The corporate governance literature typically distinguishes between one-tier or two-tier systems when categorizing a company's management structure (Adams, 2017; Gerner-Beuerle & Schuster, 2013). In one-tier systems, the corporate board typically consists of both executive and nonexecutive directors. Executive directors are responsible for the strategic day-to-day business, whereas nonexecutive directors have monitoring and advising responsibilities. These systems are mostly spread in the Anglo-American sphere but also in southern Europe, for example, Spain or Greece. In two-tier systems, the corporate board consists of a management board and a supervisory board that are mutually exclusive, meaning that members of one board are usually not allowed as a member of the other. Although the management board runs the daily business, that is, has executive responsibilities, members of the supervisory board are responsible for the appointment, monitoring, and advisement of the management board. Two-tier systems are often present in continental Europe, for example, Germany, Poland, or Austria. In Germany, the members of the supervisory board are explicitly asked to appoint and dismiss the management board members and to monitor its work by law (Stock Corporation Act [AktG] §84 and §111). In consequence, the management board is highly dependent on the supervisory board regarding its constitution but also when it comes to having long-term strategic decision approved (Stock Corporation Act §111). Finally, a third group of countries allow companies to choose between one-tier and two-tier systems, for example, Portugal, France, and Italy (Gerner-Beuerle & Schuster, 2013).

The difference between one-tier and two-tier systems refers to the division of labor between directors. Corporate boards may also differ referring to their composition due to employee codetermination. Although in some countries, boards consist solely of directors representing the shareholders and are thus not formally company employees, a significant number of countries have regulations according to which the board must consist of shareholder representatives who are appointed by the Annual General Meeting (AGM) and employee representatives who are elected by the employees of the company. Typical examples of companies without employee codetermination are the United States but also the United Kingdom and Italy.

Examples of companies with codetermined boards are the Nordic countries, but also about one-third of the countries in the European Union as well as China. In Germany, employee codetermination has a long-lasting tradition and is legally binding for public limited and private companies and companies with one or more partners but limited by shares as well as cooperatives with at least 500 employees by three laws: Thirdly Co-Determination Act (DrittelbG), the Parity Co-Determination Act (MitbestG), and the Coal, Mining, and Steel Industry Co-Determination Act (MontanMitbestG). According to the Thirdly Co-Determination Act, the supervisory board of companies with at least 500 and up to 2000 employees must consist of one-third employee representatives, that is, employee-elected members. In consequence, the size of the supervisory board for these companies is restricted to being divisible by three. If the number of a German company's employees exceeds 2000, half of the supervisory board must consist of employee representatives and, depending on the actual number of employees two to three trade union officials who are all elected by the employees of the company. However, even in the case of parity codetermination, when it comes to a tie, the chair of the board, who is usually a shareholder representative (Parity Co-Determination Act §29 and §27), has an additional vote. In consequence, the shareholder representatives have the final say. Finally, companies of the coal, mining, and steel industry with at least 1000 employees must also establish a supervisory board with 50% employee-elected members.

Similar to the work of the corporate board in one-tier systems, the supervisory board's work in two-tier systems is usually organized along its responsibilities, and for each specific task, a standing committee is established (Bacon & Brown, 1973; Bilimoria & Piderit, 1994; Bozhinov et al., 2019; Braiotta & Sommer, 1987; Kesner, 1988). The German legislation actively supports the establishment of committees in supervisory boards to ensure work effectiveness and to enforce a better utilization of the expertise of the single directors (see Stock Corporation Act §107). Most supervisory boards typically establish a nominating committee. The nominating committee's responsibility is to identify potential candidates for vacant executive board positions and to propose these candidates to the supervisory board as a whole in order to appoint them to the management board (Bozhinov et al., 2019; Walther et al., 2017). Thus, in practice, the appointment of the executive board is typically prepared by a small circle of directors representing shareholders and employees and resolved by the supervisory board. It is important to note that this contrasts one-tier systems, where executive and nonexecutive directors jointly serve on the same board and executive directors have a strong say on the appointment of their colleagues due to the monistic structure of the board.

3 | LITERATURE REVIEW

Previous studies intensely discuss the direction of gender spillovers with mixed and inconclusive results. On the one hand, studies show a significant negative gender spillover effect, meaning that women at higher job levels hinder women at lower job levels to get promoted

rather than supporting them (Bagues & Esteve-Volart, 2010). This is also known as the Queen Bee phenomenon among women (Arvate et al., 2018; Derks et al., 2016; Merluzzi, 2017; Staines et al., 1974). Likewise, the value threat approach (Duguid et al., 2012) predicts negative gender spillovers if women have the individual concern of not being perceived as a valuable member of a group. Because women are numeric minorities in high-prestige work groups, women and men might have different motivations to support each other in a competitive setting due to a value threat, the concern of not being of value for the other group members (Duguid et al., 2012). Accordingly, previous empirical research finds that there is a significantly higher probability for women to cite a woman as a negative network tie (Merluzzi, 2017). Moreover, a higher share of women creates significant negative spillover effects on a possible promotion of female peers (other female workers within one rank) (Duguid et al., 2012; Kunze & Miller, 2017). Further empirical evidence for this phenomenon is provided by Bagues et al. (2017), who find that female evaluators do not significantly prefer female candidates in scientific committees. Finally, Smith and Parrotta (2018) show that companies with a female chairperson on the board have a significantly lower probability of having shareholder-elected female board members. On the other hand, and in contrast to the Queen Bee phenomenon and the value threat approach, the similarity attraction paradigm by Byrne (1971) proposes positive spillover effects from women on supervisory boards to women on management boards. Thus, interpersonal liking and therefore interpersonal interaction increase with demographic similarity. More precisely, salient individual characteristics such as race, age, or gender provide a basis for group interactions (e.g., Tsui et al., 1992). Experiments and field studies on hiring decisions find a positive relationship between applicant-rater similarity and the perceived performance of the applicant and provide support for the existence of the similarity attraction paradigm (e.g., Baskett, 1973; Zajac & Westphal, 1996). What follows is that members of a group may favor demographically similar individuals. Hence, directors might prefer directors of the same gender not just because of gender but because of similar behavior. Thus, an all-male supervisory board may tend to hire male managers because previous research provides empirical evidence for all-male boards in one-tier systems to treat male ingroup members more favorably than women representing an outgroup member (Bodenhause et al., 2012; Hewstone et al., 2002; Knippen et al., 2019; Westphal & Stern, 2006, 2007).

When women act as role models or mentors and actively support the promotion of women, these gender spillovers might be positive (Athey et al., 2000). Ng and Sears (2017) show that having a female CEO in a company is associated with a higher percentage of female managers. Whereas Bilimoria (2006) and Matsa and Miller (2011) find a significant positive correlation between the presence of women directors and the presence of women in the top management for US companies with a one-tier system, Wang and Kelan (2013) and Matsa and Miller (2011) also show that a higher percentage of women directors has a significant positive spillover effect on the probability of a woman being CEO. Moreover, Guldiken et al. (2018) show that boards with one woman on the nominating committee and an increasing

number of women top managers significantly increase the probability for additional appointments of women directors. Goldeng et al. (2019) stress in their study how important the institutional framework for the recent changes of the elected female directors is and find that the gender quota changes the average age, composition of present nationalities on board, and the average number of multiple directorships of board directors in Norwegian public limited companies. Moreover, Rigolini and Huse (2019) show for Italy that women being appointed on a board (due to a gender quota) differ in their social capital characteristics.

Because previous theories propose diverging impact directions of women directors in higher ranks when related to women in lower ranks, the question which theoretical argument is empirically evident can only be answered by (1) intertwining multiple theoretical approaches in order to learn more about the underlying mechanisms of the appointment of women managers and (2) providing additional empirical evidence about the combination of theoretical approaches to contribute to previous inconclusive findings.

4 | THEORETICAL BACKGROUND AND HYPOTHESES

The similarity attraction paradigm by Byrne (1971) is our leading theoretical approach when analyzing spillover effects caused by women on supervisory boards onto women on management boards. According to this paradigm, interpersonal interaction increases with demographic similarity. Individual characteristics provide a salient basis for group interactions (e.g., Tsui et al., 1992). Many experiments and field studies on hiring decisions find a positive influence between the applicant-rater similarity and the perceived similar applicant performance (e.g., Baskett, 1973; Contreras Krueger et al., 2014; McFarland et al., 2004). In general, members of a group may favor demographically similar individuals. Thus, according to the similarity attraction paradigm, incumbent supervisory board members might prefer demographically similar individuals for positions on the management board, for example, a supervisory board with only male board members may tend to hire male managers. On the contrary, a supervisory board consisting of men and women may more likely prefer hiring men and women managers.

Further, theoretical work on the impact of gender on strategic decisions stresses the importance of power and uses different definitions for women directors' power (Finkelstein, 1992; Ragins & Sundstrom, 1989; Triana et al., 2014). Child (1972) stresses that power is essential when individuals are making choices. Previous research distinguishes four different power dimensions (Finkelstein, 1992; Triana et al., 2014): (1) expert power, (2) structural power, (3) prestige power, and (4) ownership power. In our setting, two of these dimensions are of particular interest: structural power and ownership power.

We argue that if women directors have (sufficient) power on the board, there might be more prevalence of the similarity attraction theory (Byrne, 1971). In such a case, women directors with power might prefer to work with additional women because of gender and

behavioral similarities and thus act positively in supporting other women, which generates positive gender spillover effects from supervisory boards to management boards. Simultaneously, men directors who agreed to appoint powerful women directors to the supervisory board might also be open to appoint women to the management board.

Ownership power in the supervisory board's strategic decision making about the composition of the management board is of particular relevance for our study because it captures a great influence in the decision-making process (Rediker & Seth, 1995; Udueni, 1999). This power dimension describes the capacity to represent the will of the shareholders (Triana et al., 2014). From an institutional perspective, the consideration of ownership power is important for our study because we analyze gender spillover effects in two-tier systems where the shareholders are only represented in the supervisory board but not in the management board, so their power is mostly exercised in monitoring tasks.

Hence, the presence of women directors on the management board could be significantly determined by the representative function, implying possible ownership power of women directors on the supervisory board. We hypothesize:

Hypothesis 1. Female shareholder representatives on the supervisory board will have a stronger positive effect on the presence of female directors on the management board than female employee representatives on supervisory board.

Structural power might be measured, for example, by the director's assignment to a board committee (Finkelstein, 1992; Triana et al., 2014). The director's committee assignment is of particular relevance for spillover effects from the supervisory board on the management board because past research emphasizes the importance of committees for effective board decision making (e.g., Bilimoria & Piderit, 1994; Carter et al., 2010; Jiraporn et al., 2009; Kesner, 1988; Klein, 1998). Delegating decisions into committees has advantages in terms of specialization, resulting in higher efficiency, flexibility, or expediency (Bacon & Brown, 1973; Braiotta & Sommer, 1987; Brown, 1976; Kesner, 1988). Consequently, most decisions made by supervisory boards are prepared in the supervisory boards' committees (Bacon & Brown, 1973; Kesner, 1988). According to the delegated task, four committees with the comparably highest impact on company decisions are the audit, compensation, executive, and nominating committee (e.g., Adams & Ferreira, 2009; Kesner, 1988). Because the nomination of new management board members is initiated within the nominating committee and then discussed with the residual supervisory board, we expect that supervisory board members have more influence on the composition of the company's management board if they serve on the nominating committee. Thus, being member of the nominating committee means having structural power over the management board's composition, reflecting social capital and habitus. Having female directors on the residual supervisory board may not significantly matter for decisions about the (gender) composition of the management board members unless the nominating committee also contains women directors who have

the structural power to influence the committee's and further supervisory board decisions in favor of women to be appointed to the firm's management board.

When it comes to strategic decisions about the composition of the management board, both power types—structural power and ownership power—might be of equal relevance because both types of representatives (shareholder elected vs. employee elected) might be either member of the nominating committee or the residual supervisory board. In our research context, we assume women who are representing shareholders to have a higher power due to their representative function and the support of the shareholders for gender diversity on the supervisory board compared with women directors representing employees on a board.

Following this argument, it is likely that the spillover effect of women on supervisory boards on women on management boards will depend on the presence of both structural power and ownership power. Thus, it might not be enough for a woman to solely serve on a nominating committee, that is, to have structural power, or represent shareholders, and therefore have ownership power. Rather the combination of both power dimensions might generate gender spillover effects from the supervisory board onto the management board. Combining the arguments of structural power and ownership power (Finkelstein, 1992) yields the following hypothesis:

Hypothesis 2. Female shareholder representatives on the nominating committee of the supervisory board will have a stronger positive effect on the presence of female directors on the management board than female employee representatives on the supervisory board.

5 | DATA AND ESTIMATION METHOD

5.1 | Sample and data sources

The basic sample of the present analysis consists of all 160 companies listed in the German DAX, MDAX, SDAX, and TecDAX for the key date 31 December 2009. The first three indices account for the 130 largest companies in Germany in terms of market capitalization and trading volume. The TecDAX additionally accounts for the 30 largest companies in the technology sector.

We restrict the basic sample threefold. First, we exclude all non-German companies because these companies are not subject to German legislation. This step reduces the sample to 149 companies. Second, we restrict the sample to companies subject to employee codetermination. This means that our sample consists of companies subject to at least one-third employee codetermination. Thus, the supervisory boards of interest are characterized by the collaboration between shareholder and employee representatives. We are explicitly investigating women directors who only represent shareholders on the supervisory board. In the German institutional context, only management board members might hold shares of the firm as a performance incentive. By contrast, shareholder-elected directors on boards

are not per se shareholders of the firm. This restriction reduces the sample to 107 companies. Third, we exclude all companies of the legal form KGaA (i.e., companies with one or more partners but limited by shares) because the supervisory boards of these companies are not obliged to appoint the management board members (Allen & Overy, 2017). This step reduces the sample by additional five companies.

We gather data on the management and supervisory boards' gender composition and the boards' structure in terms of codetermination as well as the information on the nominating committee membership of each director from publicly available annual reports of each firm for the key date December 31 of each year between 2009 and 2017. In addition, we include information on the firm's age and total assets from the *Bureau van Dijk's ORBIS DACH* database. The data collection procedure reduces the sample by additional six companies for which information was not available. We end up with a final unbalanced panel of 775 firm-year observations of 96 companies for the present analysis. For our estimation strategy (see below for more details), we lag the independent variables by 1 year, which reduces the estimation sample to 673 observations.

5.2 | Variable definitions

5.2.1 | Dependent variable: Presence of at least one woman on the management board

We employ the dichotomous variable *woman manager* as dependent variable in our analysis. Using a continuous measure for the extent to which women are included in management boards is barely possible because the number of firm-year observations where more than one woman serves on the management board is less than 10. Thus, our sample is in line with the findings of Farrell and Hersch (2005) and Hillman et al. (2007), showing that numerous companies have only one woman on serving on the management board. The variable equals 1 for a firm in a particular year when at least one woman occupied a position on the management board and 0 otherwise. In about 21% of the observations, at least one member of the management board is a woman. In only one firm in our sample, a woman acts as CEO. In consequence and in contrast to Wang and Kelan (2013), it seems that there is no relationship between women on the supervisory board and the presence of a female CEO.

5.2.2 | Independent variables

We define the variables *number of women on supervisory board (shareholder representatives)* as a proxy for women directors with ownership power and *number of women on supervisory board (employee representatives)* as a proxy for women directors without ownership power by splitting the number of women by their representative function. In order to measure the combined effects of structural and ownership power, we distinguish between the *number of women on nominating committee (shareholder representatives)* measuring both power

dimensions and the *number of women on nominating committee (employee representatives)* measuring only structural power of female employee representatives. In addition, we split the residual number of women on the supervisory board by their representation status (*number of residual women on supervisory board [shareholder representatives]* and *number of residual women on supervisory board [employee representatives]*). The summary statistics unveil that the number of female shareholder representatives is lower compared with the number of female employee representatives (0.99 vs. 1.4) and confirms the finding that relatively few women serve on the nominating committee of the board compared with the residual board for both groups.

5.2.3 | Controls

We include two groups of control variables in our model. The first group accounts for structural differences in the supervisory board and the management board. The second group captures firm-specific factors. We control for the *average tenure in the supervisory board* in years. According to the literature, this variable has a negative impact on the presence of women on the management board (Oehmichen et al., 2012). The *size of the supervisory board in seats* and the *size of the nominating committee in seats* are also included in the model to account for the fact that the total number of women must be set in relation to the size of the respective body. For instance, Strobl

et al. (2016) find these two controls to be correlated with the presence of women on committees. Finally, we control for the size of the management board because it has been shown to be a (positive) predictor of women on management boards (Hillman et al., 2007; Oehmichen et al., 2012).

The second group of control variables consists of the *logarithm of total assets*, the *firm age*, and the *free float* share in percent. By controlling for firm size in terms of total assets, we consider that large organizations are more exposed to public pressure and might therefore include more women on the supervisory board as well as on the management board (DiMaggio & Powell, 1983; Nekhili & Gatfaoui, 2013). Firm age in years is included to account for differences in factors shaping acceptance of women in leadership. Finally, Oehmichen et al. (2012) give some indication that the ownership structure of companies is related to the presence of female managers. The descriptive statistics of all variables included in the analysis are summarized in Table 1.

5.2.4 | Estimation strategy

To account for the panel structure of the used data, we employ a standard random effects (RE) logit model to estimate the probability of at least one woman serving on the management board of company i in year t according to Equation 1.

TABLE 1 Summary statistics

	N	Mean	Std. dev.	Min	Max
Woman manager (dummy)	673	0.21		0	1
Number of women on supervisory board $t-1$	673	2.36	1.84	0	8
Number of women on nominating committee $t-1$	673	0.47	0.74	0	7
Number of residual women on supervisory board $t-1$	673	1.89	1.69	0	7
Number of women on supervisory board (shareholder representatives) $t-1$	673	0.99	0.94	0	5
Number of women on supervisory board (employee representatives) $t-1$	673	1.37	1.33	0	8
Number of women on nominating committee (shareholder representatives) $t-1$	673	0.17	0.44	0	5
Number of women on nominating committee (employee representatives) $t-1$	673	0.31	0.54	0	2
Number of residual women on supervisory board (shareholder representatives) $t-1$	673	0.82	0.88	0	4
Number of residual women on supervisory board (employee representatives) $t-1$	673	1.07	1.17	0	7
Average tenure in supervisory board (in years) $t-1$	673	5.90	1.97	1.56	13.03
Supervisory board size (in seats) $t-1$	673	13.48	4.73	6	21
Nominating committee (in seats) $t-1$	673	4.24	1.62	1	20
Management board size (in seats) $t-1$	673	4.55	1.94	2	12
Log. of total assets $t-1$	673	22.61	2.01	18.87	28.40
Firm age (in years) $t-1$	673	86.12	58.38	4	268
Free float (in percent) $t-1$	673	66.61	25.75	0	100

Note: All variables except woman manager (dummy) lagged by 1 year.

$$\Pr(\text{Woman manager}_{it} = 1 | \mathbf{x}_{it-1}) = \Lambda(\alpha_i + \beta \mathbf{x}_{it-1}) \quad (1)$$

Λ is the logistic distribution function, \mathbf{x}_{it-1} contains the full set of lagged control variables discussed in the previous section. Additionally, we control for industries and include year dummies in all models to account for industry-specific differences in the number of women on supervisory boards and a time trend in our variables. α_i captures the time-constant unobservable heterogeneity. To account for autocorrelation in the error term, standard errors are clustered on firm level.

We lag all independent variables by 1 year due to two reasons. First, it is unlikely that the changes on the supervisory board composition have an immediate effect on the gender composition of the management board. New supervisory board members need time to evaluate incumbent managers before taking actions to replace them. Furthermore, ongoing contracts might hinder an immediate replacement. Second, managers might maintain relations to block shareholders, which in turn can influence the supervisory board's decision. However, from an institutional perspective, reverse causality might not be a problem in the present study because the supervisory board members are elected by shareholders and employees and are obliged to select the management board by law. Therefore, it is very unlikely that female management board members influence the number of women on the supervisory board (Plessis et al., 2012). Nevertheless, we reduce the likelihood to run into such a problem by lagging the independent variables.

The model assumes that the time-constant unobserved heterogeneity α_i is unrelated to all other time-varying controls, that is, it imposes that unobserved firm attributes, such as firm culture, are unrelated to time-varying covariates. Because this assumption can be questioned, our results may be inconsistent. Therefore, in additional regressions, we relax the assumption on the relationship between α_i and the covariates by employing a CRE logit model, also known as the Mundlak extension (Greene, 2012; Mundlak, 1978). Thus, we extend Equation 1 by including time-averaged equivalents of all covariates, yielding Equation 2.

$$\Pr(\text{Woman manager}_{it} = 1 | \mathbf{x}_{it-1}) = \Lambda(\alpha_i + \beta \mathbf{x}_{it-1} + \delta \bar{\mathbf{x}}_i) \quad (2)$$

Therefore, we allow the time-variant controls to be correlated with the time-constant unobserved heterogeneity, which is to some extent similar to a fixed effects framework. This re-specification of the model is furthermore advantageous because we can test the RE assumption by employing a Wald test on the δ vector. Note that this model is still estimated in an RE framework, that is, the model relaxes the RE assumption by allowing the RE to be dependent on the time-averaged covariates.

6 | FINDINGS

6.1 | Main empirical results

Table 2 summarizes the results of models digging deeper into the board structure. Hypothesis 1 was that female shareholder

representatives on the supervisory board have a stronger positive effect on the presence of women directors on the firm's management board due to ownership power. To test this, we split the number of women by their representative function, that is, we distinguish between female shareholder representatives and female employee representatives.

According to the results, an additional woman representing the shareholders increases the probability of at least one woman on the management board in the next year by 7.5 percentage points when holding all other variables constant (Specification 1). The effect increases furthermore to 9.4 percentage points in the CRE model. The corresponding effect for employee-elected women is statistically insignificant at the conventional thresholds. Moreover, the difference between both estimates is significant at the 1% level. The results provide empirical support for a positive effect of female shareholder representatives on the supervisory board on the presence of female directors on the company's management board.

According to Hypothesis 2, a stronger positive effect is expected of female shareholder representatives on the nominating committee of the supervisory board on female directors on the firm's management board. This effect is justified with the combination of structural power and ownership power. To test this hypothesis, we split the number of women not only by their representative function but also by their membership on the nominating committee in Specifications 2 and 4. The point estimate of female shareholder representatives on the nominating committee is 0.199 and statistically significant at the 1% level (Specification 4). Female shareholder representatives serving on the residual supervisory board increase the probability of having at least one woman on the management board in the subsequent year too, but the size of the point estimate is about 8.3 percentage points and thus half the size. Again, female employee representatives do not have any effect on the gender composition of the management board. Given these results, we find support for the line of argumentation that female shareholder representatives on the nominating committee in turn have a positive effect on the presence of women on the firm's management board.

In addition to statistical significance, these results reveal economic significance. According to Model 3, adding one additional female shareholder representative to the supervisory board increases the probability of a women manager on average by 7.5 percentage points. Compared with an overall share of 21% of management boards with at least one woman in the sample, this effect implies an increase of roughly 37% in probability. If this woman is serving on the nominating committee of the board, then the corresponding probability increases up to 76% showing an even higher effect.

Regarding the control variables in all models, we establish robust evidence that the larger the management board, the higher the probability for having at least one woman present on the management board, which is in line with previous results established by Oehmichen et al. (2012). The point estimate of increasing the board size by one seat is about 7 percentage points. In addition, the estimates reveal that the size of the nominating committee has no effect on the presence of women on the management board. The Wald test rejects the

TABLE 2 Effect of women on the supervisory board on the probability of having at least one female manager

Dependent variable: Woman manager (yes = 1)	RE logit		Correlated RE logit	
	(1)	(2)	(3)	(4)
Number of women on supervisory board (shareholder representatives) $t-1$	0.075*** (0.0247)		0.094*** (0.0272)	
Number of women on supervisory board (employee representatives) $t-1$	–0.010 (0.0163)		–0.010 (0.0210)	
Number of women on nominating committee (shareholder representatives) $t-1$		0.159*** (0.0405)		0.199*** (0.0544)
Number of women on nominating committee (employee representatives) $t-1$		–0.011 (0.0288)		–0.031 (0.0365)
Number of residual women on supervisory board (shareholder representatives) $t-1$		0.060** (0.0248)		0.083*** (0.0274)
Number of residual women on supervisory board (employee representatives) $t-1$		–0.010 (0.0171)		–0.000 (0.0210)
Average tenure in supervisory board (in years) $t-1$	0.017* (0.0102)	0.015* (0.0090)	0.029** (0.0117)	0.026*** (0.0100)
Supervisory board size (in seats) $t-1$	0.001 (0.0105)	0.004 (0.0099)	0.013 (0.0157)	0.018 (0.0132)
Nominating committee size (in seats) $t-1$	–0.016 (0.0107)	–0.034** (0.0147)	–0.015 (0.0142)	–0.034 (0.0238)
Management board size (in seats) $t-1$	0.072*** (0.0124)	0.070*** (0.0120)	0.079*** (0.0146)	0.076*** (0.0141)
Log. of total assets $t-1$	–0.032 (0.0219)	–0.030 (0.0203)	–0.049 (0.1050)	–0.058 (0.0847)
Firm age (in years) $t-1$	–0.000 (0.0004)	–0.000 (0.0004)	–0.015 (0.0305)	–0.027 (0.0320)
Free float (in percent) $t-1$	0.001 (0.0009)	0.001 (0.0009)	0.001 (0.0018)	0.001 (0.0016)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
McFadden R^2	0.26	0.28	0.28	0.32
Observations	673	673	673	673
Wald test of correlated RE				
F-statistic			12.33	16.65
p-value ($F > F^{crit}$)			0.200	0.120

Notes: Separate effects for shareholder and employee representing women. All independent variables lagged by 1 year. Average marginal effects reported. Standard errors clustered on firm level in parentheses.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

CRE model in favor of the RE model again. Thus, across all models, it does not seem to be important to use a framework accounting for the correlation of firm heterogeneity and time-variant controls.

6.2 | Robustness checks

To strengthen our results, we change our main specifications fourfold. First, we test if the representative function of women directors in terms of ownership power is crucial for the significant impact of women shareholder representatives on the probability for at least one female director on the management board. Table A1 contains the average marginal effects of the RE logit models and the CRE logit models testing the impact of women directors on supervisory boards influencing the presence of at least one woman on the management

board. The estimates of these logit models show that the effect of the number of women present on supervisory board does not significantly influence the probability of having at least one woman on the management board though it prove positive (Specifications 1 and 3). According to the influence of structural power, we expect a positive relationship between women directors present on the nominating committees of the supervisory board and women directors on the firm's management board. Specifications 2 and 4 test this proposition by splitting the total number of women into women serving on the nominating committee and the residual number of women on supervisory boards. In accordance with our expectation that power dimensions are necessary, the point estimate of the number of women serving on nominating committees is negative in sign and statistically insignificant in both specifications. In consequence, we reject the proposition that the mere presence of women directors (without

ownership power) has a significant positive impact on the presence of women on management boards. Furthermore, the comparison of the RE and CRE models reveals that the existence of a correlation between the time-constant firm characteristics and the control variables can be rejected. In both specifications, the Wald test for the significance of the time-averaged variables rejects the CRE models in favor of the RE models.

Second, we reestimate the specifications testing the importance in the nominating committee using only the subsample of companies that established a nominating committee according to the annual report. The estimates are summarized in Table A2 in the Appendix. The results of these models confirm our main findings. The number of women serving on nominating committees has no significant effect on the presence of women on management boards. On the other hand, female shareholder representatives, particularly women directors, have a positive effect on the presence of women on the management board. Thus, our main findings are supported again.

Third, we collected data on the membership in the audit committee of the board and include the number of women in the audit committee as a placebo. We do this in order to identify if the nominating committee is really the channel of the women's structural power on supervisory boards in order to have influence the presence of women on management boards. We choose the audit committee in our analysis as an alternative committee because it is one of the most powerful committees other than the nominating committee (e.g., Adams & Ferreira, 2009; Kesner, 1988). Furthermore, the German Corporate Governance Codex recommends that supervisory boards establish—among other committees—an audit committee, which underlines its importance. However, the structural power stemming from this committee is different than the structural power arising from membership on the nominating committee because the different responsibilities connected audit committee membership. Therefore, we expect the effect of women in the audit committee influencing the probability of having at least one woman serving on the supervisory board in the subsequent year to be lower when compared with the effect of women on nominating committees. Table A3 in the Appendix contains the estimates of these models. Interestingly, we do find a small effect of women serving on nominating committees on the outcome variable of interest (Models 1 and 3, Table A3). Supportive of our expectation, women in the audit committee do not have any effect on the presence of female managers, which supports our overall finding. When splitting up the number of women between shareholder and employee representatives, we can confirm the importance of female shareholder representatives in the nominating committee. The percentage of female shareholder representatives in the audit committee is small in comparison with the effect of the corresponding coefficient for the nominating committee, which is positive and highly significant (14.6 percentage points). Finally, female shareholder representatives who do not serve on any of these committees increase the likelihood of one woman on the management board by 5 percentage points. The difference between these coefficients is significant at the 1% level. These findings emphasize the importance of the membership of

female shareholder representatives in the nominating committee. In consequence, this robustness check supports our main finding.

Fourth, we consider the percentage of women working in the industry as an additional control variable to rule out the possibility that our results are driven by an increasing aggregate supply of women in some industries, which might have had effects on both the presence of women on management boards and the number of women on supervisory boards in the sample period. However, it turns out that the year dummies and industry dummies are almost perfectly collinear with the percentage of women in the industry. The adjusted R^2 in a multiple regression employing the percentage of women in the industry as dependent variable and industry and year dummies as independent variables equals 0.998. In consequence, we can rule out that our results are biased due to omitting the percentage of women in the industry as a controlling variable.

7 | DISCUSSION

Whereas in recent years the number of women on German supervisory boards has increased rapidly in anticipation of the upcoming quota law, the corresponding number of women on management boards is still limited (Holst & Wrohlich, 2018). Even though the knowledge about potential spillover effects from the supervisory board's gender composition on the makeup of the management board is highly relevant for the introduction of a gender quota, no empirical evidence has been provided for two-tier systems yet.

The present study investigates supervisory boards in two-tier systems that are responsible for the appointment of management board members (like in other European countries such as Poland or Austria). The distinction between shareholder-elected women and employee-elected women directors is hereby crucial. On the one hand, one might argue that women directors elected by employees raise their voices to a higher extent for gender equality and the presence of women on the management board when compared with shareholder-elected women directors. Overall, they might have a stronger feminist agenda than the shareholder-elected women due to a stronger interest of unions in gender equality by, for example, lowering the gender pay gap (Blau & Kahn, 2003). Furthermore, Huse et al. (2009) show an impact of employee-elected board member on board effectiveness of supervisory boards in Norwegian companies (for German boards see Joecks et al., 2019). On the other hand, contrary reasoning could be drawn based on ownership power (Finkelstein, 1992): Due to social capital and habitus, we predict that especially female shareholder representatives serving on the supervisory board positively affect the presence of women on the management board due to their representation of the shareholders on board. Furthermore, and in an attempt to clarify the influence of the appointment of women managers, the study investigates the effects of women directors' structural power (Finkelstein, 1992) by distinguishing between women serving on the nominating committee of the supervisory board and women serving on the supervisory board but not being a member of this committee (so-called residual board members).

The results of an analysis of 95 German listed and codetermined companies (2009–2016) provide empirical support for the proposition that women shareholder representatives serving on the supervisory board, who have ownership power, significantly increase the probability for the presence of at least one woman on the management board. Thus, a positive gender spillover effect of women shareholder representatives either on the supervisory board (with ownership power) or on the nominating committee (with both ownership power and structural power) positively influences the presence of at least one woman on the management board. Therefore, our results stress not only the importance of ownership power of women directors but also the combination of women directors' ownership power and structural power (Finkelstein, 1992).

Hence, the results emphasize that *not the mere presence* of women on the supervisory board affects the presence of women on the management board. More precisely, the presence of women shareholder representatives that we assume to have (at least) ownership power drives the spillover effect.

Our study has practical implications for policy decision makers and shareholders. Although Germany has a two-tier system, these implications may also apply to one-tier systems because the function of shareholder representatives in two-tier systems is formally comparable with the special governance function of outside directors in one-tier systems (Fauver & Fuerst, 2006, p. 675). The first implication addresses policy decision makers. Although very recently policy decision makers in Germany have decided the need for the regulation of the number of women on management boards in 2021 (Busse et al., 2020), our findings indicate that it might not be necessary to introduce additional quotas for management boards. We find positive gender spillover effects from the supervisory board on the management board for women who represent shareholders and also have structural power on the boards. In this respect, the German board gender quota targeting the share of women on the overall supervisory board is a first step in the right direction to increase the presence of women in the top management of German listed companies. However, our data also show that most women on German supervisory boards (between 2009 and 2016) were elected by employees (see, e.g., Bozhinov et al., 2019) so that the structural power of minor shareholder-elected women directors might not be sufficient to generate spillover effects, resulting in more than one woman on management boards. Thus, the recent decision of the German Parliament to introduce a gender quota for management boards of codetermined listed companies (Busse et al., 2020) may be a fortuitous additional initiative toward more women in leadership positions.

Our study is not without limitations. First, though we rely on demographic similarity and the existence of two power dimensions to explain the spillover effect of women on the supervisory boards on the presence of women on the management boards, we cannot control for a director's structural power, such as formal titles, and expert power (competence and expertise) because our dataset contains (1) only few observations concerning women directors and (2) very incomplete information on the directors' qualifications and careers (at most for employee representatives). Second, our dataset

ends 1 year after the implementation of the gender quota for German supervisory boards. Therefore, even though the number of women on supervisory boards increased in anticipation of the upcoming legislation, we cannot rule out that the effect changes in the presence of the quota regime. For example, if the talent pool of qualified women is scarce, as employer organizations sometimes argue, it might be that women managers are absorbed to the supervisory boards to comply with the mandatory quota for these boards. This would imply a reversal of the positive spillover effect found by the present study.

The limitations of this present study are at the same time opportunities for future research. First, it would be interesting to analyze the similarity beyond gender and the power of women shareholder representatives and to pin down the processes and paths leading to the formation of other power dimensions. Second, future research might test the robustness of our findings before and after the introduction of the gender quota.

8 | CONCLUSION

Spillover effects from women on supervisory boards to women on management boards are of theoretical and of practical relevance. We find a strong positive effect of women shareholder representatives either on the supervisory board or on the nominating committee on the presence of women directors on a company's management board, stressing the importance of combining two power dimensions of women directors.

These findings imply that the *mere presence of women directors* on the supervisory board is not sufficient for implementing spillover effects but that (1) ownership power (the women directors' representation of shareholders) and (2) additional structural power (their presence on the nominating committee) play an important role in influencing the presence of women on the management board.

ENDNOTE

- ¹ Our study might be also of relevance for those countries where the management board consists of one person because there are also institutional dependencies to the supervisory board.

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APPENDIX A.

TABLE A1 Effect of women on the supervisory board on the probability of having at least one female manager

Dependent variable: Woman manager (yes = 1)	RE logit		Correlated RE logit	
	(1)	(2)	(3)	(4)
Number of women on supervisory board $t-1$	0.018 (0.0152)		0.024 (0.0192)	
Number of women on nominating committee $t-1$		0.041 (0.0250)		0.023 (0.0331)
Number of residual women on supervisory board $t-1$		0.011 (0.0167)		0.026 (0.0205)
Average tenure in supervisory board (in years) $t-1$	0.015 (0.0116)	0.014 (0.0119)	0.025* (0.0131)	0.026* (0.0131)
Supervisory board size (in seats) $t-1$	−0.001 (0.0106)	0.000 (0.0104)	0.015 (0.0149)	0.015 (0.0148)
Nominating committee size (in seats) $t-1$	−0.011 (0.0107)	−0.021 (0.0131)	−0.009 (0.0121)	−0.009 (0.0169)
Management board size (in seats) $t-1$	0.070*** (0.0132)	0.072*** (0.0132)	0.073*** (0.0152)	0.073*** (0.0149)
Log. of total assets $t-1$	−0.022 (0.0208)	−0.022 (0.0207)	−0.095 (0.1025)	−0.093 (0.1054)
Firm age (in years) $t-1$	−0.000 (0.0004)	−0.000 (0.0004)	−0.069 (0.0547)	−0.071 (0.0573)
Free float (in percent) $t-1$	0.001 (0.0010)	0.001 (0.0010)	0.001 (0.0018)	0.001 (0.0018)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
McFadden R^2	0.28	0.28	0.32	0.32
Observations	673	673	673	673
Wald test of correlated RE				
F-Statistic			7.44	10.47
p-Value ($F > F^{crit}$)			0.600	0.400

Notes: All independent variables lagged by 1 year. Average marginal effects reported. Standard errors clustered on firm level in parentheses.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

TABLE A2 Effect of women on the supervisory board by representation on the probability of having at least one female manager

Dependent variable: Woman manager (yes = 1)	RE logit		Correlated RE logit	
	(1)	(2)	(3)	(4)
Number of women on nominating committee $t-1$	0.005 (0.0261)		-0.005 (0.0350)	
Number of residual women on supervisory board $t-1$	0.012 (0.0166)		0.036 (0.0224)	
Number of women on nominating committee (shareholder representatives) $t-1$		0.122*** (0.0410)		0.164*** (0.0576)
Number of women on nominating committee (employee representatives) $t-1$		-0.024 (0.0272)		-0.042 (0.0372)
Number of residual women on supervisory board (shareholder representatives) $t-1$		0.051** (0.0230)		0.084*** (0.0281)
Number of residual women on supervisory board (employee representatives) $t-1$		-0.013 (0.0169)		-0.002 (0.0230)
Average tenure in supervisory board (in years) $t-1$	0.011 (0.0120)	0.014 (0.0097)	0.029** (0.0124)	0.027** (0.0116)
Supervisory board size (in seats) $t-1$	0.017* (0.0093)	0.009 (0.0095)	0.032* (0.0170)	0.029** (0.0148)
Nominating committee size (in seats) $t-1$	-0.036* (0.0193)	-0.038** (0.0181)	-0.033 (0.0286)	-0.035 (0.0316)
Management board size (in seats) $t-1$	0.068*** (0.0137)	0.068*** (0.0135)	0.072*** (0.0170)	0.078*** (0.0165)
Log. of total assets $t-1$	-0.023 (0.0188)	-0.031 (0.0196)	-0.064 (0.1037)	-0.042 (0.1001)
Firm age (in years) $t-1$	0.000 (0.0004)	-0.000 (0.0004)	-0.030 (0.0336)	-0.036 (0.0326)
Free float (in percent) $t-1$	0.001 (0.0010)	0.001 (0.0009)	0.002 (0.0021)	0.002 (0.0018)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
McFadden R^2	0.28	0.30	0.32	0.34
Observations	657	657	657	657
Wald test of correlated RE				
F-statistic			23.46	25.95
p-value ($F > F^{crit}$)			0.000	0.000

Notes: Subsample of firms that established nominating committees. Average marginal effects displayed. Standard errors clustered on firm level in parentheses. Time-averaged coefficients in Models 3 and 4 not reported.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

TABLE A3 Effect of women on the supervisory board and women serving in the audit and nominating committee by representation on the probability of having at least one female manager

Dependent variable: Woman manager (yes = 1)	RE logit		Correlated RE logit	
	(1)	(2)	(3)	(4)
Number of women on nominating committee $t-1$	0.053 [*] (0.0274)		0.055 (0.0356)	
Number of women on audit committee $t-1$	0.023 (0.0228)		0.036 (0.0266)	
Number of residual women on supervisory board $t-1$	0.012 (0.0131)		0.029 [*] (0.0160)	
Number of women on nominating committee (shareholder representatives) $t-1$		0.137 ^{***} (0.0449)		0.146 ^{**} (0.0578)
Number of women on nominating committee (employee representatives) $t-1$		0.006 (0.0305)		0.002 (0.0401)
Number of women on audit committee (shareholder representatives) $t-1$		0.052 [*] (0.0294)		0.078 ^{**} (0.0319)
Number of women on audit committee (employee representatives) $t-1$		0.003 (0.0220)		0.011 (0.0270)
Number of residual women on supervisory board (shareholder representatives) $t-1$		0.034 [*] (0.0196)		0.050 ^{**} (0.0231)
Number of residual women on supervisory board (employee representatives) $t-1$		0.001 (0.0150)		0.010 (0.0177)
Average tenure in supervisory board (in years) $t-1$	0.015 (0.0117)	0.010 (0.0110)	0.026 ^{**} (0.0128)	0.017 (0.0117)
Supervisory board size (in seats) $t-1$	0.007 (0.0102)	0.015 ^{**} (0.0071)	0.030 [*] (0.0160)	0.043 ^{***} (0.0138)
Nominating committee size (in seats) $t-1$	-0.054 ^{***} (0.0188)	-0.043 ^{**} (0.0188)	-0.054 ^{**} (0.0262)	-0.045 (0.0287)
Audit committee size (in seats) $t-1$	0.005 (0.0169)	-0.001 (0.0156)	0.011 (0.0209)	0.005 (0.0197)
Management board size (in seats) $t-1$	0.071 ^{***} (0.0144)	0.061 ^{***} (0.0158)	0.076 ^{***} (0.0162)	0.069 ^{***} (0.0152)
Log. of total assets $t-1$	-0.029 (0.0192)	-0.034 [*] (0.0174)	-0.071 (0.0994)	-0.091 (0.0871)
Firm age (in years) $t-1$	-0.000 (0.0004)	-0.000 (0.0004)	-0.073 (0.0714)	-0.045 (0.0596)
Free float (in percent) $t-1$	0.001 (0.0011)	0.002 [*] (0.0009)	0.001 (0.0020)	0.002 (0.0016)
Industry dummies	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
McFadden R^2	0.30	0.34	0.34	0.38
Observations	613	558	613	558
Wald test of correlated RE				
F-statistic			16.95	23.43
p-value ($F > F^{crit}$)			.12	.04

Notes: Average marginal effects displayed. Standard errors clustered on firm level in parentheses. Time-averaged coefficients in Models 3 and 4 not reported.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.