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## ARTICLE

# Ownership concentration, ownership identity and seasoned equity offerings probabilities: Evidence from Germany

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**Abstract**

This study analyzes the effect of ownership concentration and ownership identity on the probability of seasoned equity offerings (SEOs) in the German stock market. In Germany, equity issues require shareholder approval by a supermajority vote of 75% at shareholder meetings. This study contributes to the literature by testing the non-monotonic effect of ownership concentration on the SEO probability. While low levels of ownership concentration can be expected to increase SEO probabilities, for example, through signaling effects, high levels of ownership concentration beyond the 25% blocking minority imply a negative effect, likely driven by the largest shareholder's willingness to maintain control. After constructing a control group using propensity score matching, we find that SEO likelihood is positively affected by the ownership concentration of the largest shareholder, as long as the 25% blocking threshold is not reached, regardless of the largest shareholder's identity. However, once this threshold is exceeded, the SEO likelihood decreases significantly as the equity stake of the largest shareholder increases. Nonetheless, when we control for the identity of the owners with equity stakes above the 25% threshold, the negative effects are predominantly not statistically significant at common levels.

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**KEYWORDS**

blocking minority, endogeneity, German stock market, investor identity, largest shareholder, logistic regression, non-monotonic relationship, propensity score matching, seasoned equity offering, shareholder approval

**JEL CLASSIFICATION**

G30, G32

## 1 | INTRODUCTION

Seasoned equity offerings (SEOs) are popular among companies wishing to raise capital. While some companies frequently return to the equity market and issue additional shares, others do so sporadically or not at all (Qian, 2014). What are the factors that promote or hinder the issuance of additional shares? A growing body of literature provides empirical evidence to answer this question. Most studies focus on the US market (Cheung et al., 2016; Hao, 2014; Howe & Zhang, 2010).

However, the United States is one of only a few countries where managers may issue additional stocks without shareholder approval (Holderness, 2018). On the one hand, shareholder approval is considered an effective way to mitigate agency conflicts between managers and shareholders (Holderness, 2018). On the other hand, principal-principal conflicts may emerge when shareholder approval is necessary, especially if corporate laws or by-laws require that shareholders approve an equity issue by a supermajority vote. Under such settings, shareholders who hold a blocking minority can prevent an SEO, either by voting or by a hidden intervention, if they fear dilution and a loss of control over the company.

Prior studies have revealed that investors' willingness to maintain control over a company is reflected in issuers' financing decisions. For instance, family owners prefer non-control-diluting debt financing (De la Bruslerie & Latrous, 2012; Croci et al., 2011). Such studies usually regress variables that capture issuers' capital structures on ownership variables and a set of controlling variables. Others conduct surveys of either the issuers' managers (e.g., Graham & Harvey, 2001) or investors, providing insights into the effects of shareholders' preferences on capital structure decisions. A recent survey demonstrates that financial investors are also concerned about the dilution in control caused by equity offerings (Brown et al., 2019).

Likewise, some studies have analyzed the determinants of equity issuance control for ownership concentration. Such studies focus on the impact of specific investor types on the probability of equity issues, such as institutional investors (e.g., Hao, 2014) or family ownership (e.g., Croci et al., 2011) and/or concentrated ownership in general (e.g., Bessler et al., 2016). Nevertheless, these studies have in common the fact that they assume a monotonic relationship between concentrated shareholdings and SEO probability.

Our analysis seeks to add to the aforementioned strands in the literature. In particular, we test for the non-monotonic impact of ownership concentration on the SEO probability. To illustrate, the SEO probability can be expected to rise at low levels of ownership concentration, as the largest investors are likely to oversee the issuer's management (Shleifer & Vishny, 1986). Hence, potential investors' willingness to invest in newly issued shares can be assumed to increase. Conversely, at high levels of ownership concentration, the largest shareholder's willingness to maintain control may reduce SEO probabilities. When SEOs require shareholder approval, the cut-off can naturally be derived from the level of the blocking minority. Based on our literature analysis, this is the first study to account for shareholder approval of equity issues by supermajority votes. Moreover, we control for the largest shareholder's identity because the capabilities and incentives to monitor managers may vary with ownership identity (e.g., Boone et al., 2011), and maintaining control over the company is not necessarily a motive exclusive to family

blockholders. Thus, instead of focusing on specific investor types, we follow a holistic approach by investigating the joint impact of different shareholder types on the SEO probability.

We choose to analyze the German market for two reasons. First, under German institutional settings, SEOs require a supermajority vote of 75% of the shares present at the time of adoption during the shareholder meeting. Ownership tends to be highly concentrated in Germany (e.g., Kuhlmann & Rojahn, 2017), which means that the largest shareholders frequently hold sufficient fractions of shares outstanding to block shareholder approval. Hence, the conditions for a quasi-natural experiment are met. Because the equity fractions in the hands of the second- and third-largest investors are considerably lower, we follow Thomsen and Pedersen (2000) and consider only the largest equity stake in our analysis. Second, ownership is diverse in terms of identity. The largest shareholders that hold blocking minorities primarily include corporate investors or families, but financial investors occasionally exceed the 25% threshold.

Because SEOs are rare in the dataset and to account for potential self-selection based on observables, our findings rely on a sample of SEOs in the German market constructed by propensity score matching. On this dataset, we run logistic regressions to test for the non-monotonic impact of ownership concentration on the SEO probability. The results of our logistic regressions reveal that the SEO probability significantly rises (falls) with ownership concentration below (above) 25% of all shares outstanding. Moreover, we control for ownership identity. In particular, we seek to determine whether the negative impact of ownership concentration above the 25% threshold is attributable to a specific owner identity by distinguishing between ownership by corporations, family ownership and holdings of financial investors. While the signs and marginal effects of such ownership variables correspond to our previous findings, they are predominantly not statistically significant. Our findings remain robust against alternative matching procedures, variations in ownership boundaries, another classification technique and when applying instrumental variable (IV) regression to deal with the endogeneity that arises from unobservable variables that affect both self-selection and the outcome.

The remainder of this paper is organized as follows. Section 2 presents a brief legal background of SEOs in the German market and develops our hypotheses. Section 3 describes the data, methodology and regression model. Section 4 presents the results of our analysis and several robustness checks. Finally, Section 5 concludes the paper.

## 2 | THEORETICAL FRAMEWORK AND EMPIRICAL PREDICTIONS

### 2.1 | Legal framework for equity issues in Germany

Under the German Stock Corporation Act (Aktengesetz, AktG), any equity issue requires shareholder approval of 75% of the voting shares present at the time of adoption during the shareholder meeting (Section 182 AktG). As is common in other continental European countries (Cohen et al., 2007; Ginglinger et al., 2013), existing shareholders have pre-emptive subscription rights to prevent any dilution (Section 186 AktG). These preemptive rights can be waived (Holderness, 2018) but only with a voting share exceeding the 75% threshold. The individual companies' by-laws may define a different majority ratio, but any amendments to the by-laws require a 75% majority vote.

Equity issues can be undertaken in four different ways: ordinary capital increases (Section 182 and following AktG), authorized capital increases (Section 202 and following AktG), conditional capital increases (Section 192 and following AktG) and capital increases using retained earnings (Section 207 and following AktG). The fourth option changes only the composition of the company's equity, and, thus, is comparable to a share split. In addition to preparing for a merger, the purpose of the conditional equity increase is limited to granting conversion and subscription rights to creditors of convertible bonds or employees and members of the management board. Therefore, this study analyzes only right issues as cash offers, that is, ordinary capital increases (according to Section 182 and following AktG) or authorized capital increases (according to Section 202 and following AktG). In contrast to an ordinary capital increase, an authorized capital increase offers more flexibility to the issuer's management. Within a maximum period of 5 years,

equity capital can increase by up to 50%. However, new shares may only be issued with the approval of the supervisory board.

This legal framework illustrates that there are several ways in which shareholders with a blocking minority can prevent SEOs. If such blockholders are not willing to participate in an equity issue and seek to avoid dilution, they will likely vote against an SEO at an annual shareholder meeting. Alternatively, they can intervene privately to ensure that SEO proposals do not appear on the shareholder meeting's agenda. Even if an equity issue has already been approved in accordance with Section 202 and following AktG, the transaction can still be prevented by the supervisory board in which major shareholders are frequently represented.

## 2.2 | Hypotheses

Agency considerations imply an initially positive effect of ownership concentration on the decision to issue additional shares. A large shareholder's incentive to monitor management is positively related to the size of its equity stake and its investment horizon (Shleifer & Vishny, 1986). As such, the presence of such shareholders is expected to increase potential investors' willingness to invest in newly issued shares. Moreover, ownership concentration may signal the issuer's quality, assuming that the largest shareholder has superior skills related to detecting well-managed firms (e.g., Gaspar et al., 2005). Because the institutional framework in Germany allows shareholders to prevent capital increases only if they hold a blocking position of the shares at the general meeting, we hypothesize the following:

*H1: At ownership concentration levels below 25% of all shares outstanding, SEO probability is positively affected by ownership concentration in the hands of the largest shareholder.*

In contrast, SEO probabilities are assumed to decrease with an increase in ownership concentration in the hands of the largest shareholder beyond the 25% threshold. In addition to SEOs, this level of ownership allows shareholders to block other important corporate decisions in German settings, such as major restructuring operations (Ringe, 2015). Accordingly, shareholders with equity stakes above 25% may avoid dilution effects in order to maintain control over the company, for instance, if portfolio considerations discourage additional investments in an issuer. Moreover, principal–principal conflicts are common when ownership is highly concentrated (e.g., Renders & Gaeremynck, 2012). Thus, the SEOs of firms with a blocking owner may be less attractive to potential investors, resulting in insufficient demand for newly issued shares. In particular, institutional investors are expected to refrain from investments in the presence of principal–principal conflicts (Fernando et al., 2014). Therefore, we hypothesize the following:

*H2: Once a blocking minority is reached, SEO probabilities decrease with an increase in the largest shareholder's ownership concentration.*

The group of largest shareholders cannot be considered a homogeneous class, as their investments are based on different motives, which in turn can affect the likelihood of SEOs. Because these motives are not directly observable by nature, they are proxied by investors' identities. In our sample, those holding equity stakes exceeding 25% of all shares outstanding are usually corporate investors or families, as well as institutional financial investors sporadically. Even though their investment motives differ significantly, there are reasons to expect that all of these investor types strive to retain control over the firm when already holding a blocking minority.

Common reasons for corporate investments are to realize synergies or to gain access to the target's technology (Drees et al., 2013). For example, previous studies find that corporate blockholders are common when the target company invests in research and development (Fee et al., 2006) and when the products of the blockholder and the target company are complementary (Clayton & Jorgensen, 2011). Such arguments lead to the conclusion that

corporate blockholders may seek to maintain control over the target company to realize their strategic investment goals.

An argument that can be put forth against substantial equity holdings of a corporate investor, however, is that it may mitigate incentives on the level of the target firm's managers and the remaining target's owners, as these shareholders may fear an expropriation by the corporate investor (e.g., Ouimet, 2013). Consequently, the optimal ownership stake held by corporate investors is expected to be limited (Fee et al., 2006, among others). However, in German settings, many important corporate decisions, besides SEOs, can be blocked with a 25% equity position, some of which may be of particular concern to corporate investors, such as changes in the company's purpose (Section 23 AktG). Therefore, we propose the following hypothesis:

*H3a: When corporate investors hold a blocking minority, SEO probabilities decrease with an increase in corporate blockholders' ownership concentration.*

Listed firms in which an individual, their descendants, or their families possess 25% of the decision-making rights are usually identified as family firms (e.g., European Commission, 2009). Family owners are likely to avoid dilution effects for at least two reasons. First, a primary goal of family owners is to retain control over the company for future generations (Miller et al., 2010). Second, family owners are concerned with their socioemotional wealth (SEW), that is, the noneconomic utility derived from ownership (Gómez-Mejía et al., 2007). If family owners are loss-averse with regard to SEW, they avoid corporate strategies that allow their control over the firm to erode and are even willing to accept higher levels of risk to preserve their ability to affect the firm (Gomez-Mejia et al., 2010). Prior research on German IPO firms implies that family firms seek to preserve SEW because they accept higher IPO underpricing than non-family firms do in order to protect the firm's reputation and avoid non-family ownership concentration (Leitterstorf & Rau, 2014). Hence, the following hypothesis is derived:

*H3b: Once the blocking minority is reached, SEO probabilities decrease with an increase in the family ownership concentration.*

Financial institutions include a wide range of organizations, such as insurance companies, pension funds, or private equity funds. Many financial institutions are subject to investment constraints, such as issuer limits. As a consequence, on average, they usually hold considerably smaller equity stakes than corporate investors (Barclay et al., 2009); therefore, they rarely attain the status of blocking minorities. The survey by Brown et al. (2019), however, shows that institutional financial investors not only perceive to play a vital role in issuers' capital structure decisions but are also concerned about any dilution of voting rights that comes along with equity issues. Such concerns may be expected to rise with the investment horizon and the size of the equity stake. Private equity companies are prominent among the few financial investor types that hold equity stakes beyond the 25% threshold. A common motive for private equity companies to invest in listed equity is to prepare for public-to-private transactions (e.g., Weir et al., 2005). Under such a scenario, a negative impact on SEO probabilities can be assumed. Conversely, in cases where private equity companies have not fully exited through an initial public offering (IPO), an SEO may be an option for a post-IPO exit, with shares trading as a part of a public offer to avoid an inverse price impact on the open market. However, prior studies have revealed an increasing number of public-to-private transactions in continental Europe in recent years (Martinez & Serve, 2017), which indicates a decreasing SEO probability in the presence of private equity companies holding a blocking position. Overall, these arguments support H3c.

*H3c: When financial investors hold a blocking minority, SEO probabilities decrease with an increase in the ownership concentration of financial investors.*

**TABLE 1** Number of seasoned equity offerings (SEOs) in the German Prime Standard between 2007 and 2017 (rights issues as cash offers)

Year	Number of sample firms	Number of sample SEOs	Fraction of SEOs (%)
2007	271	16	5.90
2008	296	11	3.72
2009	290	9	3.10
2010	274	13	4.74
2011	267	12	4.49
2012	269	13	4.83
2013	242	20	8.26
2014	222	19	8.56
2015	212	15	7.08
2016	215	9	4.19
2017	206	17	8.25
Total	2764	154	5.57

Note: The table provides yearly information on the frequency of SEOs in the German stock market during the sample period. Only rights issues as cash offers are included.

### 3 | DATA AND METHODOLOGY

#### 3.1 | Basic sample definition and dependent variable

The data collection process starts with all companies that have listed common stocks on the German Prime Standard for at least 1 year during the sample period 2007–2017. Because the analysis requires detailed firm-specific information and reliable ownership data, the sample period covers the most recent years of Prime Standard issuers. These issuers must fulfill more rigid information disclosure requirements than those in other segments of the German stock market. Unless otherwise stated, all data are collected from Refinitiv Eikon.

The initial sample includes 3770 yearly observations. To reduce the danger of endogeneity, we follow Laeven and Levine (2008) and compute all continuous explanatory variables as of the end of the fiscal year before the SEO announcement. This procedure requires firm-specific data for 2 consecutive years. As a result, 142 yearly observations are dropped owing to missing observations in the previous period. In the second step, we eliminate 510 financial firms according to the GICS (Global Industry Classification Standard) classification. When controlling for total assets and debt, the results are likely to be distorted if financial firms are included in the data sample. In the third step, 314 yearly observations are removed owing to missing information on at least one independent variable, mainly because of a lack of data on ownership structure. Finally, 40 outliers are eliminated. An observation is defined as an outlier if it deviates from the population mean by more than five standard deviations in at least one explanatory variable before eliminating the outliers. Such observations are particularly evident in the debt ratio or market-to-book ratio, indicating severe financial distress. The basic sample is an unbalanced panel dataset comprising 2764 yearly firm observations for 379 issuers over an 11-year period.

Table 1 provides descriptive information on the frequency of SEOs in the German stock market during the sample period. Only rights issues as cash offers are included. Overall, we observe 154 yearly firm observations with at least one SEO per year in the sample period. This finding adds to the conventional wisdom that the number of SEOs in Germany is rather low (Bessler et al., 2016; Stehle et al., 2000). Although the majority of issuers do not attempt an SEO during the sample period, 94 firms return to the capital market at least once during this period, with 39 returning more than once. Overall, the decision to issue new shares in the German stock market can be characterized as

heterogeneous. For the empirical analysis, we employ a dummy variable  $SEO_{i,t}$  that takes the value one if firm  $i$  issues additional shares in fiscal year  $t$  and zero otherwise.

### 3.2 | Methodology

We estimate logistic regressions using the dummy variable  $SEO_{i,t}$  as the dependent variable. Because we analyze a non-random sample, the results may be affected by self-selection bias. For example, it is challenging to determine whether the effect of the largest shareholder on the SEO probability is causal or whether the largest shareholders select companies with SEO probabilities that meet their preferences. Common methods of controlling for self-selection include using a fixed-effects regression, propensity score matching (e.g., Mackey et al., 2017) or the IV method (Bascle, 2008; Clougherty et al., 2016). Fixed-effects regressions require sufficient variation within units (e.g., Hill et al., 2019). However, prior research reveals that our key variables of interest (i.e., the ownership variables) remain stable over time (e.g., Faccio & Lang, 2002; Maury & Pajuste, 2005). Moreover, four of our sample firms perform SEOs in each sample year, which would leave us with only 90 issuers in a fixed-effects logistic regression. The IV method allows us to deal with the endogeneity that arises from unobservable variables that affect both self-selection and outcome (Clougherty et al., 2016). However, it requires valid instruments, which are often difficult to detect, and is less efficient in the absence of endogeneity (Ebbes et al., 2016). Therefore, our basic findings are based on a sample constructed using propensity score matching, which removes selection bias based on observables (Villalonga, 2004, among others). The results of the IV method are discussed in the robustness check section. Fixed-effects regressions are not applied because there is insufficient variation in the dependent and potentially endogenous variables.

Another reason for applying propensity score matching is that conventional classification techniques, such as logistic regressions, can underestimate the likelihood of rare events (King & Zeng, 2001), which are also present in our sample, as shown in Table 1. We choose the propensity score matching developed by Rosenbaum and Rubin (1983) to construct a sample of matched firm-year observations. This offers an advantage over traditional covariates in that it summarizes multiple covariates to a single score (Olmos & Govindasamy, 2015). The goal is to find a group of yearly firm observations that do not undertake an SEO but that are comparable to those that issue additional shares in terms of relevant pre-treatment characteristics. Pre-treatment covariates are supposed to be highly correlated with the treatment and outcome (Steiner et al., 2010). CAPEX, that is, the ratio of capital expenditure scaled by total assets, and SIZE, measured by the natural logarithm of the firm's total assets, meet these requirements. Ownership concentration is expected to increase with CAPEX to reduce the danger of misallocating funds (e.g., Pindado & de la Torre, 2008). Concurrently, investment financing is a typical motive for both initial and SEOs (Kim & Weisbach, 2008). Hence, CAPEX can be assumed to increase the probability of an SEO. The negative effect of SIZE on ownership concentration follows from shareholders' wealth or legal investment constraints (Holderness, 2017). Moreover, several studies find a significant positive effect of firm size on SEO probability (e.g., Alti & Sulaeman, 2012). In our basic sample, both CAPEX and SIZE affect ownership concentration and SEO probability as predicted (not reported here). Moreover, we match using industry and yearly dummy variables to control for macroeconomic, potential regulatory and/or industry effects. We generate four industry dummies: *CONSUMER*, *HEALTHCARE*, *INDUSTRIALS* and *TECHNOLOGY*. All observations not assigned to one of these industries are aggregated in a reference category. Time effects are captured by yearly dummy variables (Y2008 to Y2017), with observations in 2007 serving as a reference category.

Several matching algorithms can be employed, but nearest-neighbor matching is widely used (Olmos & Govindasamy, 2015). Nearest-neighbor matching without replacement is applied here to ensure that we consider a match only once. Furthermore, the literature suggests using more than one nearest neighbor (Caliendo & Kopeinig, 2008), especially if the control group is as large as it is in the current dataset. Here, 2:1 matching is used, which results in a matched data sample of 462 observations, with 154 yearly firm observations of at least one SEO per year.

Table 2 reports the means of the variables selected to identify matched observations for the control group based on the basic sample, for the SEO observations and for the matches. For the dummy variables, the mean value displays the



**TABLE 2** Propensity score matching: Summary statistics

	Mean control group	Mean SEO	Mean matched firms
	sample	undertaking firms	
CAPEX <sub>i,t-1</sub>	0.0414	0.0514	0.0533
SIZE <sub>i,t-1</sub>	13.016	14.4259	14.3907
CONSUMER <sub>i</sub>	0.2322	0.3896	0.3929
HEALTHCARE <sub>i</sub>	0.1092	0.0714	0.0649
INDUSTRIALS <sub>i</sub>	0.2889	0.2273	0.2500
TECHNOLOGY <sub>i</sub>	0.2180	0.1104	0.1234
Y2008 <sub>i</sub>	0.1092	0.0714	0.0487
Y2009 <sub>i</sub>	0.1077	0.0584	0.0455
Y2010 <sub>i</sub>	0.1000	0.0844	0.1006
Y2011 <sub>i</sub>	0.0977	0.0779	0.0909
Y2012 <sub>i</sub>	0.0981	0.0844	0.0974
Y2013 <sub>i</sub>	0.0851	0.1299	0.1461
Y2014 <sub>i</sub>	0.0778	0.1234	0.0909
Y2015 <sub>i</sub>	0.0755	0.0974	0.0877
Y2016 <sub>i</sub>	0.0789	0.0584	0.0617
Y2017 <sub>i</sub>	0.0724	0.1104	0.1071
Number of obs.	2610	154	308
Imbalance before matching $\chi^2$	92.8 ( $p = 0.000$ )		
Imbalance after matching $\chi^2$			5.04 ( $p = 0.996$ )

Note: The columns report the means of the variables selected to identify matched observations for the control group based on the basic sample ( $n = 2610$ ), SEO undertaking firms ( $n = 154$ ) and matches ( $n = 308$ ) identified by 2:1 nearest neighbor matching. For the industry dummy variables, that is, CONSUMER, HEALTHCARE, INDUSTRIALS, TECHNOLOGY and the yearly dummy variables (Y2008 to Y2017), the mean value shows the relative proportion of observations in the respective sample. Imbalance between the groups is measured using a  $\chi^2$ -test. All variables are defined in the Appendix.

relative proportion of observations in the respective sample. Before matching, there is a significant imbalance in the data, which is eliminated using nearest-neighbor matching. Unless otherwise stated, all subsequently reported results are based on this matched data sample. Because we match using CAPEX, SIZE, industry dummies and the yearly dummy variables, these variables no longer contribute to explaining the decision to conduct SEOs and, therefore, do not serve as controlling variables.

### 3.3 | Ownership variables

Following Thomsen and Pedersen (2000), we measure ownership structure in terms of the equity fraction held by the largest shareholder, as well as its identity. The equity stake of the largest shareholder is denoted as LARGEST. To test H1 and H2, LARGEST is subdivided as follows:

$$LARGEST - 0.25 = LARGEST \text{ if } LARGEST < 0.25, = 0.25 \text{ if } LARGEST \geq 0.25 \quad (1)$$

$$LARGEST - 0.25 = 0 \text{ if } LARGEST \leq 0.25, = LARGEST - 0.25 \text{ if } LARGEST > 0.25 \quad (2)$$

**TABLE 3** Summary statistics on ownership variables in the matched data sample

Panel A: Ownership concentration						
Explanatory variable	No. of observations > 0	Mean	Median	Std. dev.	Min.	Max.
LARGEST-025	454	0.1890	0.25	0.0822	0.0	0.25
LARGEST-25	249	0.1181	0.0033	0.1702	0.0	0.7193
Panel B: Ownership identity						
Explanatory variable	No. of observations > 0	Mean	Median	Std. dev.	Min.	Max.
CORPORATION-025	66	0.0327	0.0	0.0825	0.0	0.25
CORPORATION-25	50	0.0279	0.0	0.0987	0.0	0.63
FAMILY-025	166	0.0766	0.0	0.1097	0.0	0.25
FAMILY-25	113	0.0529	0.0	0.1190	0.0	0.549
FINANCIAL-025	141	0.0421	0.0	0.0786	0.0	0.25
FINANCIAL-25	36	0.0139	0.0	0.0681	0.0	0.6449
OTHER-025	81	0.0376	0.0	0.0859	0.0	0.25
OTHER-25	50	0.0234	0.0	0.1003	0.0	0.7193

Note: The table provides details on ownership concentration in the matched data sample. Panel A reports the descriptive statistics for the fraction of shares held by the largest shareholder (*LARGEST*). Panel B displays details on the holdings of the largest shareholder sorted by identity and distinguishes between corporate ownership (*CORPORATION*), family ownership (*FAMILY*), financial ownership (*FINANCIAL*) and others (*OTHER*). All the variables are defined in the Appendix.

Panel A of Table 3 provides the descriptive statistics for *LARGEST-025* and *LARGEST-25* in the matched data sample. The median holding of the largest shareholder is 25.33% of all shares outstanding, indicating substantial ownership concentration in German issuers. In 249 firm-year observations, the largest shareholder holds more than 25% of all shares. As such, SEOs can only be resolved at shareholder meetings with the approval of this shareholder. In contrast, eight of our 462 firm-year observations have no identifiable largest shareholder. The median holdings of the second and third largest shareholders are considerably lower (5.33% and 3.39%, respectively; not reported in Table 3). Hence, with the exception of the largest shareholder, all remaining equity positions (and coalitions between them) are usually too small to prevent an SEO. An additional t-test (not reported in Table 3) reveals that the firms included in the matched data sample are not significantly different from the remaining companies in the basic sample in terms of ownership concentration ( $p = 0.5861$ ). Model 1 is specified in equation (3).

$$SEO_{i,t} = f(\text{controlling variables}_{i,t-1}, LARGEST - 025_{i,t-1}, LARGEST - 25_{i,t-1}) \quad (3)$$

We specify a further model to test H1, H3a, H3b and H3c by considering the largest owner's identity (Model 2). To proxy the largest shareholders' investment motives, we categorize the fraction of shares held by the firm's largest owners into corporate ownership (*CORPORATION*), family ownership (*FAMILY*), financial ownership (*FINANCIAL*) and others (*OTHER*) by hand-collecting details on ownership identities from the issuers' annual reports. Any investor who reaches a minimum threshold of 3% of the voting rights of an issuer is obliged to notify the German Federal Financial Supervisory Authority and the issuer (Section 33 German Securities Trading Act). Such notifications are disseminated in the issuers' annual reports.

For an observation to be sorted into the category *CORPORATION*, we require the strategic nature of the relationship between the issuer and corporate investor to be revealed in the issuer's annual statements, for example, as the issuer's supplier or customer or because of R&D (research and development) alliances or joint ventures. We cross-check the strategic link for such observations in corporate investors' financial statements. Any observation in which individuals or families are the largest shareholder, either directly or indirectly, for example, through family

trusts or pools, and in which at least one family member serves as a member of the executive board or supervisory board is assigned to the category *FAMILY*. In the vast majority of such observations, a family member either chairs the management or supervisory board. If the largest shareholders are, by direct or indirect ownership through subsidiaries, either banks, hedge funds, insurance companies, investment funds, pension funds, private equity investors, or venture capitalists, such observations are classified as *FINANCIAL*. The *OTHER* category includes the fraction of shares held by government agencies, individual investors who are neither directly nor indirectly represented on the management board or supervisory board, corporate investors that have explicitly declared an investment as non-strategic, for example, in cases where only minority positions are still held subsequent to a spin-off, or in a few cases where no large shareholder is identifiable. Again, we subdivide the equity stakes in these categories at the 25% threshold in line with equations (1) and (2). Model 2 is specified in equation (4).

$$\begin{aligned}
 \text{SEO}_{i,t} = f(\text{controlling variables}_{i,t-1}, & \text{CORPORATION} - 0.25_{i,t-1}, \text{CORPORATION} - 0.25_{i,t-1}, \\
 & \text{FAMILY} - 0.25_{i,t-1}, \text{FAMILY} - 0.25_{i,t-1}, \text{FINANCIAL} - 0.25_{i,t-1}, \text{FINANCIAL} - 0.25_{i,t-1}, \\
 & \text{OTHER} - 0.25_{i,t-1}, \text{OTHER} - 0.25_{i,t-1}) \quad (4)
 \end{aligned}$$

Panel B of Table 3 reveals that in 307 of 462 observations, the largest equity stake is held either by a family or by a financial investor. By contrast, corporate ownership is rarely identified. If companies make up the largest shareholder, however, they often have an equity stake of more than 25%, analogous to family ownership. Corporations and families account for 163 of the 249 firm-year observations in which the 25% cut-off is passed. For financial institutional investors, regulatory constraints, such as issuer limits, mean that equity positions beyond the 25% blocking position are seldom reached. With only a few exceptions, financial investors holding blocking minorities are private equity funds. These findings add to the conventional wisdom that strategic investors, such as corporations, tend to hold larger stakes, on average, than financial institutions (Barclay et al., 2009). With regard to the category *OTHER*, equity positions above 25% are homogeneously distributed among the shareholder identities assigned to this class. Overall, the findings shown in panels A and B of Table 3 demonstrate that the ownership structure of German issuers in the matched data sample can be characterized as rather complex with regard to concentration and identity, thereby supporting previous findings (Laeven & Levine, 2008).

### 3.4 | Controlling variables

The set of controlling variables is based on the literature on firm-specific determinants of capital structure and SEO probabilities. *ANALYST*, measured by the natural logarithm of the number of a firm's security analysts + 1, is used as a proxy for information asymmetry between managers and investors. Information asymmetry decreases with an increase in the number of analysts covering an issuer (Chang et al., 2006). Therefore, its effect on SEO likelihood is assumed to be positive. We include the relative bid-ask-spread (*BAS*), averaged daily and over the last month before the financial year-end, as a proxy for the stock's liquidity. A more liquid stock fosters SEO probability because it creates a more informative stock price (Cheung et al., 2016). *CASH* is measured as the ratio of cash plus short-term investments to total assets. Low cash reserves can indicate a need for cash, implying a higher likelihood of issuing additional shares (Bessler et al., 2016). Operating cash flow (*CF*), that is, net income plus depreciation minus dividends paid, scaled by total assets, serves as a measure of a firm's internal financing capacity. For firms with low internally generated funds, external equity financing via SEOs is predicted to be more likely (DeAngelo et al., 2010). The debt ratio (*DEBT*) is defined as the total financial debt scaled by total assets. Because financial leverage reduces managerial discretion and agency costs (Stulz, 1990), investors might be more willing to invest in newly issued shares, making SEOs more likely. The findings of Altı and Sulaeman (2012) and Hao (2014) are consistent with this implication. Additionally, high levels

**TABLE 4** Descriptive statistics on the firm-specific control variables in the matched data sample

Controlling variable	Mean	Median	Std. dev.	Min	Max
ANALYST	2.2532	2.5249	1.1199	0.0	3.7377
BAS	0.0110	0.0072	0.0124	0.0005	0.1172
CASH	0.1404	0.1075	0.1250	0.0014	0.7230
CF	0.0599	0.0693	0.1010	-1.0177	0.4064
DEBT	0.3635	0.3687	0.2268	0.0	1.2164
MBR	1.2588	0.9460	1.0150	0.0949	6.9228
TANGIBLES	0.2383	0.2278	0.1528	0.0007	0.7266

Note: The table provides descriptive statistics for continuous firm-specific control variables in the matched data sample. All variables are defined in the Appendix.

**TABLE 5** Correlations between controlling variables and ownership concentration

	(1) LARGEST	(2) CORPORATION	(3) FAMILY	(4) FINANCIAL	(5) OTHER
ANALYST	-0.2964***	-0.1020**	-0.1262***	-0.0732	-0.0788*
BAS	0.1635***	-0.0078	0.0045	0.0767*	0.1125**
CASH	-0.1143**	-0.0653	0.0042	-0.0162	-0.0805*
CF	-0.0420	-0.0400	0.1337***	-0.1439***	-0.0747
DEBT	-0.0121	0.1104**	-0.2034***	0.0923**	0.0583
MBR	0.0689	-0.1058**	0.1150**	0.2060***	-0.1055**
TANGIBLES	0.0633	-0.0112	0.0748	-0.0472	0.0385

Note: Column 1 reports the correlation coefficients between ownership concentration (*LARGEST*) and the controlling variables. Columns 2 to 5 report the correlation coefficients by ownership category. All variables are defined in the Appendix.

\*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% level (two-tailed), respectively.

of debt may call for SEOs to establish an optimal capital structure. *MBR* (market-to-book ratio) is defined as the market value of equity to the book value of equity and is included to capture the stock's valuation level. The general finding in the literature is that companies time the market (Baker & Wurgler, 2002; Dong et al., 2012), such that a positive effect of *MBR* on the SEO probability is expected. Alternatively, *MBR* can be understood as a proxy for an issuer's growth options (Dong et al., 2012), again implying an increase in SEO probability. The tangible assets ratio (*TANGIBLES*) is defined as property, plant and equipment over total assets. Tangible assets frequently serve as collateral, which means that debt-related agency costs decrease. Consequently, a high tangible asset ratio should make an SEO less likely to occur.

All explanatory variables (i.e., ownership variables and controlling variables) are calculated as of the fiscal year-end before the SEO announcement. Table 4 provides descriptive statistics for the control variables. Because the sample period includes both economic upturns and downturns, considerable fluctuations in the controlling variables are observed. From further *t*-tests (not reported here), we find that the observations included in the matched data sample differ from the remaining observations in the basic sample with regard to the control variables at the 5% significance level, except for *MBR*. On average, the observations in the matched data sample have higher numbers of analysts, lower cash reserves, higher operating *CF* ratios, higher debt ratios and higher tangible asset ratios.

Table 5 presents the correlation coefficients between the controlling variables and ownership concentration, that is, *LARGEST*, as well as breakdowns for ownership categories. In general, the signs of the correlation coefficients correspond to earlier findings, such as the negative correlation between *LARGEST* and *ANALYST* (Hope, 2003, among

others) or the positive correlation between *LARGEST* and *BAS* (e.g., Heflin & Shaw, 2000). However, the signs of the correlations are occasionally found to vary with ownership identity. For instance, the correlation between *CF* and *FAMILY* is significantly positive, while the correlation between *CF* and *FINANCIAL* is significantly negative.

We calculate the variance inflation factor (VIF) for all explanatory variables. Multicollinearity is not an issue because the VIF values in all subsequent analyses are below five unless otherwise stated. Moreover, Box-Tidwell transformations do not indicate nonlinearities, given the model specifications and variable definitions discussed in Sections 3.3 and 3.4.

## 4 | RESULTS

### 4.1 | Basic findings

Table 6 displays the results of the logistic regressions for Models 1 and 2 based on the matched data sample. The table reports both regression coefficients and average marginal effects. These represent the change in the SEO probability for a one-unit change in each continuous independent variable, holding all other regressors at their mean values. Despite applying nearest-neighbor matching before performing the logistic regressions, the goodness of the regressions is rather low as indicated by the pseudo- $R^2$  values and the confusion matrices. The signs of all regression coefficients of the controlling variables included in Models 1 and 2 meet the expectations outlined in Section 3.4. In both regressions, the coefficients and average marginal effects of *BAS*, *DEBT*, *MBR* and *TANGIBLES* are statistically significant at least at the 10% level.

For the variables of interest, the results from Model 1 support H1 and H2. The coefficient and average marginal effect for *LARGEST-025* indicate a strong positive effect on SEO likelihood, which is likely driven by signaling. By contrast, the SEO probability decreases significantly when the largest shareholder owns more than 25% of the shares, regardless of its identity. If we instead test for a monotonic relationship between *LARGEST* and SEO probability, that is, we waive the subdivision of *LARGEST* at the 25% cut-off, we find a positive but non-significant effect of *LARGEST*, and the goodness of the regression decreases (not reported here in detail).

The findings of Model 2 support H1. The SEO probabilities increase significantly with increases in *CORPORATION-025*, *FAMILY-025*, *FINANCIAL-025* and *OTHER-025*. Although the signs of *CORPORATION-25* and *FAMILY-25* are as expected, they are not statistically significant at common levels. Thus, H3a and H3b are rejected. A potential explanation is that the shareholder's identity may not be sufficient to capture investment motives. Corresponding to H3c, we find that SEO probabilities significantly decrease with rising equity stakes beyond the 25% threshold in the hands of financial investors. As mentioned in Section 3.3, in the category *FINANCIALS*, equity positions above 25% are mostly held by private equity investors. If private equity companies prepare for public-to-private transactions, they may be expected to prevent SEOs. Consistently, we find such de-listings for about a third of the observations where financial investors possess more than 25% of the shares in subsequent years. However, the number of observations in the category *FINANCIALS-25* is insufficient to perform additional tests that would allow for more advanced conclusions.

### 4.2 | Interaction effects between ownership variables and the market-to-book ratio

Section 2.2 argues that blockholders' attitudes toward SEOs may be driven by their willingness to maintain control, which may, in turn, lead to endowment effects (Gomez-Mejia et al., 2010). Conversely, investors that do not hold a blocking minority pursue financial goals and are able to detect mispriced stocks may urge issuers' managers to exploit high stock valuation levels by issuing additional stocks. Therefore, the interaction terms between the stock's valuation level and the ownership variables employed in Models 1 and 2 seem to be natural candidates for testing the effects of the owners' investment goals. Significantly negative interaction terms may indicate a desire to maintain control.

**TABLE 6** Logistic regressions of ownership variables on SEO probabilities

Variable	Model 1		Model 2	
	Coefficient	Average marginal effect	Coefficient	Average marginal effect
Intercept	-1.478**		-1.826**	
(z-value)	(-2.538)		(-3.007)	
ANALYST <sub>it-1</sub>	0.037	0.008	0.084	0.018
(z-value)	(0.357)	(0.356)	(0.787)	(0.786)
BAS <sub>it-1</sub>	-0.448***	-0.096***	-0.423***	-0.090***
(z-value)	(-2.690)	(-2.776)	(-2.694)	(-2.767)
CASH <sub>it-1</sub>	-0.431	-0.092	-0.355	-0.076
(z-value)	(-0.471)	(-0.470)	(-0.374)	(-0.373)
CF <sub>it-1</sub>	-1.417	-0.303	-1.198	-0.255
(z-value)	(-1.585)	(-1.598)	(-1.204)	(-1.209)
DEBT <sub>it-1</sub>	1.188**	0.254**	1.132 <sup>†</sup>	0.241 <sup>†</sup>
(z-value)	(2.220)	(2.222)	(1.927)	(1.936)
MBR <sub>it-1</sub>	0.406***	0.087***	0.376***	0.080***
(z-value)	(3.763)	(3.763)	(3.126)	(3.119)
TANGIBLES <sub>it-1</sub>	(-1.570)**	-0.336**	-1.527 <sup>†</sup>	-0.325 <sup>†</sup>
(z-value)	(-1.963)	(-1.968)	(-1.816)	(-1.823)
LARGEST-025 <sub>it-1</sub>	4.516***	0.966***		
(z-value)	(2.809)	(2.862)		
LARGEST-25 <sub>it-1</sub>	-1.608**	-0.344**		
(z-value)	(-2.096)	(-2.108)		
CORPORATION-025 <sub>it-1</sub>			5.758**	1.226***
(z-value)			(2.576)	(2.604)
CORPORATION-25 <sub>it-1</sub>			-1.152	-0.245
(z-value)			(-0.758)	(-0.758)
FAMILY-025 <sub>it-1</sub>			3.840 <sup>†</sup>	0.818 <sup>†</sup>
(z-value)			(1.929)	(1.951)
FAMILY-25 <sub>it-1</sub>			-0.074	-0.016
(z-value)			(-0.056)	(-0.056)
FINANCIAL-025 <sub>it-1</sub>			9.800***	2.087***
(z-value)			(4.264)	(4.345)
FINANCIAL-25 <sub>it-1</sub>			-4.646***	-0.989***
(z-value)			(-3.008)	(-2.997)
OTHER-025 <sub>it-1</sub>			3.753 <sup>†</sup>	0.799 <sup>†</sup>
(z-value)			(1.833)	(1.848)
OTHER-25 <sub>it-1</sub>			-1.852	-0.394
(z-value)			(-1.051)	(-1.053)

(Continues)

**TABLE 6** (Continued)

Variable	Model 1		Model 2	
	Coefficient	Average marginal effect	Coefficient	Average marginal effect
Number of obs.		462		462
Pseudo McFadden $R^2$		0.090		0.113
Adj. pseudo McFadden $R^2$		0.053		0.055
Area under curve		0.684		0.699
Accuracy		0.710		0.721
True positive rate		0.247		0.292
True negative rate		0.942		0.935

Note: The table reports the results of logistic regression estimates for equations (3) and (4). The z-values of the coefficients are based on robust standard errors (sandwich estimators). The calculation of the marginal effect standard errors is corrected for heteroskedasticity. All variables are defined in the Appendix.

\*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% level (two-tailed), respectively.

The regression results for these adjusted models are largely comparable to the findings shown in Table 6, even though the inclusion of interaction terms results in multicollinearity. Because interpreting interaction effects in logit models is not straightforward, owing to its nonlinear specification, we apply the procedure outlined by Ai and Norton (2003) to calculate the marginal effects. Panel A of Table 7 reports the descriptive statistics of the marginal effects of the interaction terms. Panel B of Table 7 shows the corresponding z-statistics.

For the interaction terms in Model 1, the following findings emerge. For most observations, the interaction terms between *MBR* and *LARGEST-025* are positive. When we plot interaction effects against predicted probabilities (not reported in Table 7), we observe statistically significant marginal effects at rather low predicted SEO probabilities of up to 0.3. Conversely, the marginal effects of the interaction terms between *MBR* and *LARGEST-25* are negative for almost all observations and are significant at conventional levels for observations with predicted SEO probabilities up to 0.6 (not reported in Table 7). These findings indicate that shareholders with blocking positions are reluctant to lose control. Alternatively, investors with substantial stakes may suffer from overconfidence. From behavioral finance research, it is known that companies are financed according to the implications of the pecking order if managers are overconfident (Hackbarth, 2009). Similarly, the largest shareholders may assume that shares are undervalued, thus preventing an SEO.

Comparable results emerge with regard to the interaction effects added to Model 2. In general, the majority of the interaction terms with the variables that capture an ownership concentration below (above) 25% are positive (negative), except for the interaction terms between *MBR* and *CORPORATION*. However, most observations in Model 2 are non-significant. Accordingly, the negative interaction between *MBR* and ownership concentration beyond the 25% threshold effect cannot be attributed to a particular shareholder type.

### 4.3 | Robustness checks

First, we test whether our results are robust against alternative matching procedures, that is, different matching ratios and/or pretreatment characteristics, to create a matched data sample. Although not reported in detail here, the results for Models 1 and 2 remain stable with regard to the signs of the regression coefficients, marginal effects and their significance levels for both the ownership and the controlling variables. Overall, the results are consistent with H1 and

**TABLE 7** Descriptive statistics on the marginal effects of the interaction terms between MBR and ownership variables

Panel A: Interaction effects					
Model	Interaction between $MBR_{i,t-1}$ and...	Mean	Median	Min.	Max.
1	LARGEST-025 $_{i,t-1}$	0.342	0.383	-0.401	0.632
1	LARGEST-25 $_{i,t-1}$	-0.263	-0.294	-0.399	0.039
2	CORPORATION-025 $_{i,t-1}$	-0.233	-0.225	-0.560	0.034
2	CORPORATION-25 $_{i,t-1}$	0.547	0.597	-0.080	0.974
2	FAMILY-025 $_{i,t-1}$	0.236	0.262	-0.282	0.489
2	FAMILY-25 $_{i,t-1}$	-0.369	-0.405	-0.564	0.031
2	FINANCIAL-025 $_{i,t-1}$	0.543	0.639	-1.186	1.244
2	FINANCIAL-25 $_{i,t-1}$	-0.327	-0.365	-0.551	0.143
2	OTHER-025 $_{i,t-1}$	-0.257	-0.271	-0.472	-0.002
2	OTHER-25 $_{i,t-1}$	-0.011	-0.020	-0.041	0.066
Panel B: z-statistics					
Model	Interaction between $MBR_{i,t-1}$ and...	Mean	Median	Min.	Max.
1	LARGEST-025 $_{i,t-1}$	1.013	1.061	-1.831	2.255
1	LARGEST-25 $_{i,t-1}$	-1.593	-1.678	-2.915	0.373
2	CORPORATION-025 $_{i,t-1}$	-0.248	-0.239	-1.451	0.219
2	CORPORATION-25 $_{i,t-1}$	0.767	0.805	-0.312	1.134
2	FAMILY-025 $_{i,t-1}$	0.632	0.645	-0.699	1.418
2	FAMILY-25 $_{i,t-1}$	-1.140	-1.195	-2.469	0.247
2	FINANCIAL-025 $_{i,t-1}$	1.442	1.639	-4.246	3.036
2	FINANCIAL-25 $_{i,t-1}$	-1.074	-1.174	-1.793	0.578
2	OTHER-025 $_{i,t-1}$	-0.360	-0.349	-1.052	-0.030
2	OTHER-25 $_{i,t-1}$	-0.022	-0.030	-0.741	0.686

Note: Panel A displays descriptive statistics on the marginal effects of interaction terms between the MBR and the ownership variables employed in Models 1 and 2. Panel B reports the corresponding z-values. All variables are defined in the Appendix.

H2. However, as shown in Section 4.1, the regression coefficients for ownership variables capturing equity positions of specific owner categories beyond the 25% threshold remain predominantly non-significant. Moreover, all results for the subsequently reported robustness checks remain substantially unchanged when alternative matched datasets are applied.

As a second robustness test to check the validity of our results, we assume the blocking minority at the general meeting to be 20% of all shares outstanding, instead of 25%. Through this, we account for the lower attendance rates at these meetings. Again, the results (not reported here) do not deviate substantially from the findings discussed in Section 4.1; that is, an ownership concentration below (over) 20% increases (decreases) the SEO probability. In addition, we differentiate between ownership concentrations between 25% and 50% and above 50% of the outstanding shares. This adjustment is motivated by previous findings that the largest shareholder faces a trade-off between maintaining control over the firm and reducing risk (De la Bruslerie & Latrous, 2012). In contrast to the implications of this trade-off, we find a non-significant negative effect of ownership concentration above 50% on SEO probabilities, irrespective of ownership identity.



Third, we include additional controlling variables in Models (1) and (2) that have been omitted before because of limited data availability. Corresponding to the investment financing motive of equity issues (Kim & Weisbach, 2008), we add R&D expenses relative to total assets. Moreover, we extend the analysis by using a proxy for corporate governance. We choose the Refinitiv Eikon ESG management score to capture governance at the board level. This management score reflects the issuer's commitment to corporate governance principles and includes corporate governance indicators, such as the skills and experiences of members of the supervisory board or the independence of an audit committee. The higher the score, the greater the effectiveness of applying the best practices of corporate governance. We follow prior studies and set missing values to zero (Fee et al., 2006; Bessler et al., 2016), that is, about 20% (25%) of the observations on R&D (on the corporate governance score). When we include R&D and the score for corporate governance and re-estimate the regressions, as presented in Table 6, we find no substantial changes in terms of the signs of the regression coefficients for both the ownership variables and the controlling variables, their marginal effects and their significance levels, so we refrain from additional reporting. Contrary to theoretical predictions, we obtain a non-significant negative impact of R&D and a significant negative influence of the corporate governance score ( $p < 0.05$  in Models 1 and 2, respectively) on SEO probabilities. Such findings may be attributable to limited data availability and prior matching, among other covariates, via industry dummies.

Fourth, we apply Newey's two-step endogenous probit estimator (Newey, 1987) to account for the endogeneity arising from unobservable variables as outlined in Section 3.2. The natural instruments for *LARGEST-25* are included in our one-step regression model. Therefore, we choose potential IVs from the firm-specific pre-treatment characteristics to create the matched data sample, that is, *CAPEX* and *SIZE*. Only *SIZE* is found to be significant when testing the strength of the IVs. Thus, *CAPEX* is dropped from the first-stage regression. The results of the first-stage regression are shown in column 1 of Table 8. We estimate an incremental *F*-statistic for *SIZE*, as recommended by Stock et al. (2002), to check for weak instruments because the reduced form in Newey's two-step endogenous probit estimator is linear as well. The *F*-statistic is 10.24, and thus slightly exceeds the threshold of 10 for weak instruments based on Stock et al. (2002). The Wald statistic of exogeneity of the instrumented variable is 8.75 ( $p = 0.0031$ ). Therefore, the null hypothesis of "no endogeneity" is rejected. Column 2 of Table 8 reports the estimates of the second stage. The estimates of the two-step probit estimators cannot be compared directly with those of a traditional probit analysis because the two-step error terms are assumed to be multivariate normal (Newey, 1987). The signs of the coefficients of the second-stage regression correspond to our previous findings, with the exception of the coefficients for *ANALYST* and *TANGIBLES*. Similar to the results reported in Table 6, we find a significantly negative effect of *BAS* on SEO probability, while SEO probability significantly increases with *MBR* and *LARGEST-025*. Consistent with our basic findings discussed in Section 4.1, the SEO probability decreases significantly with *LARGEST-25* when accounting for endogeneity. In Model 2, four ownership variables are potentially endogenous. Hence, we lack a sufficient number of valid instruments to apply the two-step endogenous probit estimator.

Finally, we perform a random forest analysis for two reasons. First, we seek to validate the causal effects of ownership concentration and identity on SEO probability, because different classification techniques may lead to diverse predictions of a class. Second, none of the results of the logistic regressions discussed above predict SEOs well (the true positive rates are only between 0.25 and 0.3). Compared with conventional classification techniques, such as logistic regressions, some studies find that random forests tend to perform better in terms of prediction (e.g., Ballings et al., 2015). The random forest is generated from a bootstrapped sample for which a full tree is built. The training dataset contains 70% of the observations in the matched data sample. Randomly chosen explanatory variables are used to split the sample. Three variables are tested at each split. Observations are allocated by a majority vote of 5000 classification trees. To detect which explanatory variables are most informative (i.e., contribute most to the prediction accuracy), the mean decrease in accuracy is applied. Panel A of Table 9 reports these results. The findings for both Models 1 and 2 reveal the high importance of *BAS* and *ANALYST* in the decision to conduct an SEO. Overall, the results for Model 1 emphasize the effect of *LARGEST-25* on SEO probability and essentially support our previous findings. For Model 2, the random forest documents the high importance of *FINANCIAL-025*. However, when accounting for ownership identity, all variables capturing ownership concentration beyond the 25% threshold turn out to be less important,

**TABLE 8** Two-step endogenous probit estimator with *LARGEST-25* as endogenous variable

Dependent variable	(1)	(2)
	<i>LARGEST-25</i> <sub><i>i,t-1</i></sub>	<i>SEO</i> <sub><i>i,t</i></sub>
	Estimates (t-values)	Estimates (z-values)
Intercept	-0.234** (-3.076)	-1.181** (-2.189)
<i>ANALYST</i> <sub><i>i,t-1</i></sub>	-0.038** (-4.611)	-0.263 (-1.561)
<i>BAS</i> <sub><i>i,t-1</i></sub>	0.013 (1.264)	-0.290** (-2.639)
<i>CASH</i> <sub><i>i,t-1</i></sub>	-0.058 (-0.967)	-0.996 (-1.057)
<i>CF</i> <sub><i>i,t-1</i></sub>	-0.074 (-0.741)	-1.632 (-1.539)
<i>DEBT</i> <sub><i>i,t-1</i></sub>	-0.062* (-1.719)	0.475 (0.986)
<i>MBR</i> <sub><i>i,t-1</i></sub>	0.024** (3.031)	0.433** (3.174)
<i>TANGIBLES</i> <sub><i>i,t-1</i></sub>	0.115** (2.274)	0.338 (0.377)
<i>LARGEST-025</i> <sub><i>i,t-1</i></sub>	0.950** (15.936)	12.469** (2.567)
<i>LARGEST-25</i> <sub><i>i,t-1</i></sub>		-11.204** (-2.283)
<i>SIZE</i> <sub><i>i,t-1</i></sub>	0.0154*** (3.200)	
Number of obs.	462	462
F-test of excluded instruments	10.241	
Wald test of exogeneity ( <i>p</i> -value)		8.75 (0.003)

Note: Column 1 shows the first-stage regression results for *LARGEST-25* as the endogenous variable. *SIZE* is used as the instrument. The corresponding *t*-values are based on robust standard errors (sandwich estimators) and are displayed in brackets. Column 2 reports the second-stage regression results (z-values in brackets). In the second stage, we include the fitted values for *LARGEST-25* from the first-stage regression as a regressor. All variables are defined in the Appendix.

\*, \*\* and \*\*\* indicate statistical significance at the 10%, 5% and 1% level (two-tailed), respectively.

compared to the results for Model 1. Hence, with regard to the variables of interest in this study, the findings correspond with the results of our logistic regressions. Shareholdings above 25% of the shares outstanding reduce the SEO probability. However, the analyses fail to attribute this negative relationship to specific owner identities. Panel B of Table 9 shows that when generalizing the results of the random forests to the test dataset, that is, 30% of the observations in the matched data sample, the true positive rates of both models are higher than those of the logistic regressions; however, they can still be improved.

**TABLE 9** Random forest variable importance for SEOs

Panel A: Variable importance based on the training dataset				
Rank	Model 1		Model 2	
	Variable	Mean decrease in accuracy	Variable	Mean decrease in accuracy
1	$BAS_{i,t-1}$	56.448	$BAS_{i,t-1}$	51.488
2	$ANALYST_{i,t-1}$	47.378	$ANALYST_{i,t-1}$	42.492
3	$LARGEST-25_{i,t-1}$	36.232	$FINANCIAL-025_{i,t-1}$	29.207
4	$TANGIBLES_{i,t-1}$	29.247	$TANGIBLES_{i,t-1}$	28.491
5	$LARGEST-025_{i,t-1}$	28.771	$OTHER-25_{i,t-1}$	22.505
6	$CF_{i,t-1}$	14.406	$FAMILY-25_{i,t-1}$	21.375
7	$MBR_{i,t-1}$	10.299	$OTHER-025_{i,t-1}$	14.210
8	$CASH_{i,t-1}$	5.432	$CF_{i,t-1}$	13.437
9	$DEBT_{i,t-1}$	4.367	$CORPORATION-025_{i,t-1}$	11.958
10			$DEBT_{i,t-1}$	11.749
11			$FAMILY-025_{i,t-1}$	11.641
12			$MBR_{i,t-1}$	11.636
13			$FINANCIAL-25_{i,t-1}$	9.665
14			$CORPORATION-25_{i,t-1}$	6.155
15			$CASH_{i,t-1}$	3.269
Panel B: Prediction accuracy based on the test dataset				
	Model 1		Model 2	
Accuracy	0.731		0.731	
True positive rate	0.455		0.432	
True negative rate	0.856		0.866	

Note: Panel A reports the variable importance for SEO probabilities measured by the mean decrease in accuracy for the variables applied in Models 1 and 2. Panel B shows the prediction accuracy of the random forests based on the test dataset (30% of the observations in the matched data sample). All variables are defined in the Appendix.

## 5 | CONCLUSION

This study examines the effect of ownership concentration and ownership identity on SEO probability in the German stock market. At low levels of ownership concentration, agency theory implies a positive effect of ownership concentration on SEO probabilities, while at high levels of ownership concentration, SEO probabilities may be reduced by the largest shareholder's willingness to maintain control over the firm. Thus, we test for the non-monotonic impact of ownership concentration on the SEO probability. Under German law, SEOs require shareholder approval, and so the cut-off is derived from the level of the equity stake of 25% of the shares outstanding, which allows shareholders to block important decisions (e.g., SEOs) at general meetings.

Because SEOs are rare in the basic data sample and to control for self-selection based on the observables, a matched data sample is created using propensity score matching. Once the matched data sample is determined, a set of different ownership variables is tested. Overall, the logistic regression results reveal that an ownership concentration below 25% of all shares outstanding significantly and positively affects SEO probability. In contrast, the SEO probability decreases significantly with an increase in the equity stake of the largest shareholder if this shareholder possesses more than 25% of the shares outstanding.

When including variables in our model that capture the identity of owners with equity stakes above the 25% threshold, the signs and marginal effects of the ownership variables correspond to our hypotheses and previous findings but are predominantly not statistically significant at common levels. Apparently, the willingness to maintain control over the company cannot be allocated to a specific identity. Only if financial investors hold more than 25% of the shares, which, however, rarely applies to our sample, the negative influence on the SEO probability is statistically significant. Further analysis reveals that among the category of financial investors, equity positions above 25% are mostly held by private equity investors that may prepare for subsequent public-to-private transactions.

Moreover, we add the interaction terms between the market-to-book ratio and ownership variables to our regression models. For most observations, the interaction terms between the market-to-book ratio and ownership concentration above 25% are negative. Such negative interactions indicate that shareholders with blocking positions are reluctant to lose control.

Our findings are robust against alternative matching procedures, variations in ownership boundaries and another classification technique. Compared with the logistic regressions, the prediction accuracy of our random forests is higher but can still be improved. To reduce the danger of an omitted variable bias, we additionally control for R&D expenses and corporate governance that have not been captured in the main analysis due to data limitations. Taken together, our findings consistently reveal that the presence of the largest shareholder with a blocking minority reduces the probability of an SEO. Moreover, our findings remain essentially unchanged when we control for the endogeneity of ownership concentration beyond the 25% threshold by applying Newey's two-step endogenous probit estimator.

Our results are based on a relatively small sample of German SEOs and, therefore, cannot be generalized. Subsequent studies may investigate whether a non-monotonic effect of ownership concentration on SEO probabilities can also be identified under institutional settings different from the German stock market or whether potential influences can be distinctively attributed to specific shareholder identities. Moreover, an analysis of other markets that require shareholder approval for SEOs, possibly with differing blocking minorities, could help to verify whether the importance of the blocking minority threshold is specific to the German market. While our analysis focuses on the largest shareholder's motive to maintain control, subsequent surveys may also provide further insights as to whether the presence of a blocking shareholder discourages current and potential minority shareholders from participating in SEOs.

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## DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from Thomson Reuters Eikon. Restrictions apply to the availability of these data, which were used under license for this study.

## CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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## APPENDIX

## Variable definition

Variable	Definition
<i>Ownership variables</i>	
LARGEST	Fraction of shares held by the largest shareholder
LARGEST-025	= LARGEST if LARGEST < 0.25, = 0.25 if LARGEST ≥ 0.25
LARGEST-25	= 0 if LARGEST ≤ 0.25, = LARGEST - 0.25 if LARGEST > 0.25
CORPORATION	Fraction of shares held directly or indirectly by the largest shareholder if it is a strategic corporate investor. The strategic nature of the relationship between the investee firm and corporate investor has to be revealed in the investee's firm annual statements, for example, as the issuer's supplier or customer or because of R&D alliances or joint ventures.
CORPORATION-025	= CORPORATION if CORPORATION < 0.25, = 0.25 if CORPORATION ≥ 0.25
CORPORATION-25	= 0 if CORPORATION ≤ 0.25, = CORPORATION - 0.25 if CORPORATION > 0.25
FAMILY	Fraction of shares held directly or indirectly by the largest shareholder in the case of family ownership. To be sorted into the category FAMILY at least one family member has to serve as member of the executive board or supervisory board.
FAMILY-025	= FAMILY if FAMILY < 0.25, = 0.25 if FAMILY ≥ 0.25
FAMILY-25	= 0 if FAMILY ≤ 0.25, = FAMILY - 0.25 if FAMILY > 0.25
FINANCIAL	Fraction of shares held directly or indirectly by the largest shareholder if it is either a bank, hedge fund, insurance company, investment fund, pension fund, private equity investor, or venture capitalist.
FINANCIAL-025	= FINANCIAL if FINANCIAL < 0.25, = 0.25 if FINANCIAL ≥ 0.25
FINANCIAL-25	= 0 if FINANCIAL ≤ 0.25, = FINANCIAL - 0.25 if FINANCIAL > 0.25
OTHER	Fraction of shares held directly or indirectly by the largest shareholder who is not sorted into the categories CORPORATION, or FAMILY, or FINANCIAL.
OTHER-025	= OTHER if OTHER < 0.25, = 0.25 if OTHER ≥ 0.25
OTHER-25	= 0 if OTHER ≤ 0.25, = OTHER - 0.25 if OTHER > 0.25
<i>Propensity score matching pre-treatment covariates</i>	
CAPEX	Capital expenditures scaled by total assets
SIZE	Natural logarithm of the firm's total assets
<i>Controlling variables</i>	
ANALYST	Natural logarithm (number of a firm's security analysts + 1)
BAS	Relative bid-ask spread of the issuer's stocks
CASH	Cash plus short-term investments to total assets
CF	Net income plus depreciation minus dividends paid, scaled by total assets
DEBT	Total financial debt scaled by total assets
MBR	Market value of equity to the book value of equity
TANGIBLES	Property, plant and equipment over total assets