If and where: Environmental antecedents of CDO adoption

Verena Hossnofsky [1], Sebastian Junge [2], Lorenz Graf-Vlachy [3]

Abstract: The opportunities and challenges of digital transformation lead many firms to adopt the position of a chief digital officer (CDO). Prior studies have started investigating the antecedents of CDO presence. However, they do not directly distinguish between CDOs positioned at the top management team level and CDOs located at lower levels of the organizational hierarchy. Additionally, pressures arising from a firm's external environment have not been considered comprehensively and in detail from a theoretical as well as an empirical point of view. Our study addresses these points by performing panel data regression analyses on publicly listed German firms between 2016 and 2019. Our results indicate that the effects of environmental antecedents vary significantly for CDOs at different hierarchical levels.

Keywords: Chief Digital Officer, digital transformation, antecedents, TMT.

1 Introduction

The increasing importance of digital technologies and the corresponding ongoing digital transformation creates substantial challenges and opportunities alike for firms across all industries [FDZ14, Hu17, Lu13]. Leadership plays a crucial role in addressing and exploiting these, since organizational leaders ultimately decide on the level of attention and the resources allocated towards new digital technologies [AS99, HM84]. As such, many firms have started to adopt a new position, namely the chief digital officer (CDO) [SH17, TBB18], signaling strong commitment to digitalization [SKH20]. A recent study highlights that in 2018 21 percent of the global 2500 largest public firms had established a CDO position, compared to just 6 percent in 2015 [Pw19]. In addition, Drechsler et al. [DWR19] show that stock markets tend to react positively to the announcement of CDO appointments. Due to this increasing prevalence and apparent importance of the role,

[1] Friedrich-Alexander-University Erlangen-Nuremberg, Chair of Strategic Management, Lange Gasse 20, 90403, Nuremberg, Germany, verena.hossnofsky@fau.de
https://orcid.org/0000-0002-3591-5206

[2] Friedrich-Alexander-University Erlangen-Nuremberg, Chair of Strategic Management, Lange Gasse 20, 90403, Nuremberg, Germany, sebastian.junge@fau.de
https://orcid.org/0000-0002-0939-6393

[3] TU Dortmund University, Professorship of Strategic Management and Leadership, Otto-Hahn-Str. 4, 44227, Dortmund, Germany, lorenz.graf-vlachy@tu-dortmund.de
https://orcid.org/0000-0002-0545-6643

interest in CDOs among practitioners and researchers in strategic management and information systems (IS) has risen in the last years.

CDOs are senior executives who are explicitly responsible for a firm's overarching digital strategy and the accompanying change management efforts to prepare the business for the digital era [HKB16]. Of course, one might argue that these tasks could also fall under the responsibility of the well-established position of a Chief Information Officer (CIO). And indeed, ambidextrous CIOs, mastering both the information technology (IT) supply-side (i.e., traditional tasks around IT exploitation) and the demand-side (i.e., IT exploration for business innovation and transformation), are often considered desirable [CPX10]. Because it is, however, often difficult to meet the increasing demands of both types of leadership in practice, the roles are split increasingly frequently. In such cases, the CDO becomes tasked with demand-side leadership [CM09, PEL11]. Thus, the CDO role is largely viewed as complementary to the CIO position [HKB16].

Recent research on CDOs mostly focuses on the CDO role itself and its consequences [e.g., HKB16, SH17, TBB17, TBB18]. This research tends to take on an explorative perspective and draw upon case studies. Only two quantitative studies have started investigating the antecedents of CDO presence. The initial explorative study by Kunisch et al. [KML20] tests "several factors related to firm performance, strategic leadership, task demands, task environments, and mimicry behavior that influence the likelihood of CDO presence." Firk et al. [Fi21] add to these findings by theorizing and testing novel factors, which specifically apply to the digital age, e.g., the urgency to transform.

However, a very recent literature review on CDOs calls for further studies to gain a more nuanced picture and a better understanding of the complex interactions between antecedents of CDO presence on the individual, firm, and environment levels [KG21]. Specifically, previous studies do not directly distinguish between CDO positions implemented at the top management team (TMT) level and CDOs located at lower levels of the organizational hierarchy. Also, pressures arising from a firm's external environment have not been considered comprehensively and in detail in at least three ways. First, financial analysts' assessments have not yet been taken into account as a predicting factor. Second, while the study by Firk et al. [Fi21] considers the degree of institutional ownership, no research thus far has distinguished between transient and dedicated institutional owners [Bu01]. Third, although prior work has studied various individual aspects of environmental uncertainty [Fi21, KML20], no study has used all three measures of environmental uncertainty that are typically used in the field [KH88].

Our study specifically addresses these points by performing panel data regression analyses on listed German firms between 2016 and 2019. We find that firms are more likely to have a non-TMT CDO when they received positive analyst recommendations. Also, dedicated institutional owners seem to positively influence non-TMT CDO adoption. With regards to the implementation of TMT CDO positions, our data suggests that the ownership share of transient institutional owners is negatively related to CDO adoption. We find that environmental uncertainty largely negatively impacts non-TMT

CDO appointments. Overall, our results indicate that the effects of these environmental antecedents vary significantly for CDO adoption at different hierarchical levels.

Overall, we contribute to a better understanding of IS-related senior management positions and the management of IT and digitalization within firms in general. We add to the knowledge on how incumbent firms react to major technological changes through adapting their organizational structures. By testing novel factors, we complement extant research on CDO antecedents [Fi21, KML20]. Moreover, our study is the first to offer extensive empirical evidence from Germany. Also, our results indicate that the factors associated with CDO adoption vary significantly for CDO positions within and outside the TMT.

2 Theoretical background

2.1 Digital strategy and the rise of TMT and non-TMT CDOs

For a long time, IT strategy has been viewed as a merely functional-level strategy, which is aligned with—but generally subordinate to—business strategy [Bh13]. However, with the increasing availability of digital technologies and their substantial performance implications, boundaries between IT and business strategy began to blur. Digital technologies increasingly influence firms' strategic approaches, affecting future survival and success by driving competitive advantage and strategic differentiation [Bh13, Pa13]. As such, managerial attention to digitalization increased in firms across all industries.

Leading a firm through this digital transformation represents an exceptional managerial challenge, since digital transformation comprises a wide range of tasks and activities that are increasingly complex, cross-functional, and interdependent [Ho16]. The allocation of corresponding responsibilities within a firm's TMT is vital because the structural design of the TMT impacts the prominence and salience of issues within the whole organization [Ha07]. The more attention a strategic issue receives, the more support (e.g., investments) will be provided and the more likely desired outcomes can be achieved [Oc97]. Following this logic, firms often want to ensure that the issue of digitalization is addressed in an appropriate manner, e.g., through the appointment of a CDO who oversees a firm's overarching digital strategy [HKB16].

At the same time, firms may decide against a new centralized role at the apex of the firm and rather opt for non-TMT CDOs, e.g., CDOs located inside of business units. Among other reasons, this might be due to a desire to prevent an increase in complexity within the TMT and to avoid power struggles at this level [MS14, TBB18]. Also, the implementation of a central role may lead to losses of hidden knowledge within business units [Fi21]. Additionally, having solely one person in charge of digitalization might be viewed as insufficient [Bh13]. Hence, a non-TMT CDO might be preferable.

2.2 Environmental antecedents of CDO adoption

There may be many causes that make firms adopt the role of a CDO within their TMT or at a lower hierarchical level within the firm. Previous studies have started to shed light on the importance of pressures arising from a firm's external environment [Fi21, KML20]. We refine these observations by considering key stakeholders as well as environmental uncertainty, which we deem potentially particularly important factors triggering CDO appointments for listed firms.

First, we consider assessments from financial analysts as a predicting factor of CDO adoption. Financial analysts are information intermediaries who significantly affect investors' expectations about a firm's ability to create future value and thus their investment decisions [Wo96, Zu99]. This in turn enables them to also influence firms' decisions, such as leadership choices [BR12, Zu00]. For example, Wiersema and Zhang [WZ11] show that analyst recommendations affect the probability of CEO dismissal. Consequently, analysts may also influence the decision to appoint a CDO. Specifically, we propose that firms who received favorable assessments (perceive to) have the license to make changes to their leadership structure that may bring novel sources of income and cost reductions in the future, but that might initially create uncertainty and likely additional cost [SLD81]. We thus formalize:

Hypothesis 1 (H1): Analysts' recent assessments are positively related to CDO adoption.

Second, we argue that the presence of dedicated and transient institutional owners might be a determinant of CDO adoption. Institutional investors have become particularly powerful shareholders over the past decades [SSJ08, Sm96]. Previous studies show that they not only own high equity stakes, but also influence strategic decisions such as risk-taking [Wr96] or diversification [HJM94] to align firm behavior with their interests. These investment preferences may vary substantially by type of institutional owner [Bu01, ZG16]. Dedicated, i.e., long-term-oriented investors, may look past the additional immediate costs arising from a CDO position, but rather focus on the upsides that may come with it. In contrast, transient investors, i.e., investors who are sensitive to firms' short-term earnings, may not want to endure these additional costs. We thus hypothesize:

Hypothesis 2 (H2): The presence of dedicated institutional owners is positively related to CDO adoption, whereas the presence of transient institutional owners is negatively related to CDO adoption.

Third, we argue that environmental uncertainty explains whether firms choose to implement a CDO position. Generally speaking, the organizational environment has long been thought of as a crucial factor that influences firms' strategic decisions and structural choices [MJW18]. Typically, (objective) environmental uncertainty is conceptualized as comprising three dimensions, namely complexity (i.e., number and heterogeneity of, e.g., customers, suppliers, and competitors that a focal firm deals with), instability (i.e., the rate, intensity, and predictability of change in the environment), and

munificence (i.e., the capacity for growth that the environment supports) [DB84, KH88]. On the one hand, when a firm perceives its environment increasingly as uncertain, one might expect a swift reaction, such as the implementation of a role in charge of the changes arising from novel digital technologies. However, research and practice have shown time and time again that established firms may consider uncertainty a threat [SLD81] and find it extremely difficult to adapt to a discontinuous change such as digitalization, often failing to overcome organizational inertia [e.g., EF18, HR03, KGS21, UMK09, We19]. Therefore, we expect firms operating in a more uncertain environment to be less likely to react and adopt a CDO position. Put formally:

Hypothesis 3 (H3): Environmental uncertainty is negatively related to CDO adoption.

3 Method

3.1 Sample

Our empirical setting covers firms that were listed on the main German stock indices (DAX, MDAX, and SDAX) between 2016 and 2019. We excluded financial institutions, real estate firms, and purely financial holdings since accounting data cannot readily be compared between these and other industries [MP97]. This led to a sample of 151 companies. Since not all companies existed over the whole time period and due to missing data, our final sample contains 126 companies and 494 company years.

3.2 Dependent variables

Our dependent variable is the adoption of a CDO position. We distinguish between CDOs within the TMT and non-TMT CDOs. The German governance system is two-tiered, with a management board and a separate supervisory board. Members of the management board act as representatives of the firm and are legally and collectively responsible for managing the firm. We thus consider the management board the TMT [HH13]. To determine CDO adoption within the TMT, we followed a comprehensive approach [FTC20, MS14]. First, we manually searched firms' annual reports for the members of the management board at the end of the respective financial year. Second, we analyzed their titles and responsibilities and specifically searched for TMT CDOs. Third, we coded a binary variable to indicate TMT CDO adoption, taking a value of 1 if a TMT CDO was introduced in a given year and a value of zero otherwise. The coding was straightforward and was carried out by trained graduate research assistants. Interrater reliability was nearly perfect from the beginning. Disagreements were resolved through discussion. For the adoption of non-TMT CDOs, e.g., CDOs located at lower levels of the hierarchy, we also manually searched firms' annual reports, websites, as well as press releases. We further conducted individual firm level searches on the internet and used newspaper websites, business portals, and social networks as additional

sources [see e.g., Fi21, WLL17]. We then applied the same coding as described above. Again, interrater agreement was quasi-perfect.

3.3 Independent variables

Our independent variables are various environmental factors. First, we operationalized analysts' assessments as the mean investment recommendation for each firm, which we obtained from I/B/E/S. The variable is coded on a five-point scale from "1", indicating a strong buy recommendation to "5", which indicates a strong sell recommendation. We inverted the scale for a more intuitive interpretation. Second, we include institutional owners with at least 1% ownership, since those are assumed to have sufficient holdings to be able and incentivized to influence their investee [Co10, NZ06]. We downloaded reports from Capital IQ which list the institutional owners for each firm within our sample at each financial year-end within our sampling frame. To measure the influence of transient and dedicated institutional owners, we followed the procedure of Bushee [BU98], which is well-established in the literature [ARZ13]. Using a factor analysis, we classified institutional owners based on their prior investment behavior (e.g., portfolio concentration, turnover, or trading sensitivity to current earnings) [BU98]. Subsequently, we calculated the proportions of ownership of dedicated and transient owners for each firm-year [BU98]. Third, we measured the three notions of environmental uncertainty based on accounting data by industry (two-digit GICS codes) [KH88, MJW18]. Complexity refers to the increase or decrease in market concentration and is measured through regressing the market share in the initial year over the market share in the terminal year. Instability captures the volatility of net sales and operating income growth. Munificence is measured as the regression slope coefficient of net sales and operating income growth [KH88].

3.4 Control variables

We controlled for a host of potentially confounding variables at the individual and organizational level, as well as further environment variables [Fi21, KG21, KML20]. We considered firms' financial performance measured as their yearly Return on Assets (RoA) [Fi21]. We also included Tobin's Q, which is calculated as the ratio between market values and book values of equity and liabilities [TB77], as well as a firm's sales growth from t-2 to t-1 [KML20]. We also controlled for the average RoA and market-to-book value in each industry [KML20]. We controlled for firm age and size, measured as the natural logarithm of the firm's total assets [e.g., KML20]. Furthermore, we included asset intensity (i.e., assets over sales) as an industry-specific control. We accounted for TMT size by counting the number of members listed in the annual report. We also calculated the average age of the TMT members [Fi21]. Moreover, we controlled for CDO adoption by industry peers [Fi21, KML20]. We considered the number of a firm's existing technology-related TMT members by counting the number of present alternative relevant functions, such as CIO, Chief Technology Officer, and Chief Innovation Officer. In line with the procedure outlined above, we identified these positions by

searching and coding firms' annual reports. We consider a firm's diversification by using Palepu's [Pa85] entropy measure based on the dispersion of sales across different business lines [HC04, MS14]. We considered the number of institutional owners and further accounted for the number of analysts covering the firm in the focal year. All variables were lagged by one year to address issues of reverse causality. We obtained the data from Standard & Poor's Capital IQ if not stated otherwise. Finally, we included year dummies to control for time-specific factors.

3.5 Empirical strategy

To account for the binary dependent variables, and in line with previous research on the subject, we employed a general estimating equations (GEE) regression model with a logit link function [Fi21, KML20].

4 Results

Table 1 presents means, standard deviations, and pairwise correlations of all variables used in the study. Some correlations are substantial but not unexpected. We believe that each of the variables has its own explanatory power, and the high correlations are not driven by a shared omitted variable [Ka18]. Consequently, we retained the variables in our models. Nevertheless, we ran additional models, testing every one of the variables on its own. With one exception, the impact of the independent variables on the adoption of a CDO did not change substantially, which makes it unlikely that multicollinearity distorts our results [Ka18]. The sole exception is the number of institutional owners. This variable is substantially correlated with transient institutional ownership ($\beta = 0.7542$) and the results for the effects of transient institutional ownership on non-TMT CDO adoption (Model 7) are not robust to its exclusion.

Table 2 shows the results of our regression analyses. Models 1 and 2 contain only the control variables. Models 3 and 4 address H1, which is partially supported since analysts' assessments show a significant ($\beta = 0.462$; $p < 0.05$) positive effect on non-TMT CDO adoption, but no statistically significant effect ($\beta = 0.179$; $p > 0.1$) for CDOs within the TMT. Hence, firms appear to take positive assessments as a license to make adjustments to their organizational structure, albeit not as extensively as we had hypothesized. This could be explained by prior research that characterizes analysts as generally status-quo oriented [BW18]. Firms might be concerned that too extensive adjustments, i.e., changing the TMT composition, might be viewed as excessive and thus create negative backlash. Changes at lower levels, however, such as implementing a non-TMT CDO position, might be deemed acceptable to analysts.

Variable	Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
(1) TMT CDO adoption	0.02	0.12	0.00	1.00	1.00																						
(2) Lower level CDO adoption	0.04	0.21	0.00	1.00	0.06	1.00																					
(3) RoA	0.04	0.07	-0.27	0.32	-0.11*	-0.05	1.00																				
(4) Tobin's Q	2.02	1.63	0.65	15.66	-0.05	-0.05	0.25*	1.00																			
(5) Sales growth	1.08	0.16	0.32	1.90	0.01	-0.01	0.01	0.27*	1.00																		
(6) Industry RoA	0.04	0.06	-0.27	0.29	-0.12*	-0.04	0.83*	0.16*	0.01	1.00																	
(7) Industry MTB	1.97	1.34	0.65	15.66	-0.07	-0.05	0.18*	0.83*	0.24*	0.21*	1.00																
(8) Firm size	8.17	1.77	4.36	13.1	0.01	0.10*	-0.12*	-0.35*	-0.22*	-0.09	-0.33*	1.00															
(9) Firm age	85.35	66.72	1.00	450.0	-0.01	0.08	-0.04	-0.26*	-0.18*	-0.05	-0.27*	0.22*	1.00														
(10) Asset intensity	0.55	0.19	0.03	0.95	0.08	0.07	-0.11*	-0.16*	-0.09	-0.09	-0.13*	0.37*	-0.01	1.00													
(11) TMT size	4.20	1.89	2.00	12.00	0.01	0.06	0.02	-0.11*	0.05	0.05	-0.10*	0.55*	0.07	0.19*	1.00												
(12) Average board age	52.6	4.32	34.67	72.00	-0.04	0.02	-0.09	-0.23*	-0.17*	-0.05	-0.20*	0.13*	0.18*	0.06	0.09	1.00											
(13) Industry CDO adoptions	0.65	0.95	0.00	4.00	0.12*	0.20*	0.03	-0.12*	0.07	0.07	-0.17*	0.38*	0.09	0.19*	0.35*	0.04	1.00										
(14) Technology-related TMT members	1.02	0.89	0.00	5.00	0.04	0.04	-0.02	-0.11*	-0.04	-0.04	-0.13*	0.31*	0.01	0.12*	0.23*	0.03	0.15*	1.00									
(15) Degree of diversification	0.36	0.20	0.00	0.90	0.02	0.10*	-0.02	-0.11*	-0.15*	0.00	-0.14*	0.37*	0.22*	0.15*	0.20*	0.09	0.19*	0.04	1.00								
(16) Number institutional owners	5.38	4.97	0.00	21.00	0.02	0.04	-0.08	0.06	-0.04	-0.04	0.08	0.21*	0.04	0.03	0.14*	-0.03	0.08	0.10*	0.02	1.00							
(17) Analyst coverage	13.10	9.72	0.00	45.00	0.02	0.07	-0.01	-0.14*	-0.14*	0.04	-0.12*	0.58*	0.17*	0.28*	0.27*	0.07	0.26*	0.22*	0.24*	0.30*	1.00						
(18) Analyst assessments	3.14	0.98	0.00	5.00	-0.06	0.05	-0.03	0.03	0.13*	-0.02	-0.01	0.03	-0.03	0.05	0.04	0.07	0.08	0.01	0.03	0.14*	0.23*	1.00					
(19) Transient institutional ownership	0.02	0.03	0.00	0.24	0.02	0.05	-0.14*	0.05	0.12*	-0.10*	0.06	-0.05	0.06	-0.08	-0.08	-0.01	0.04	-0.04	-0.03	0.75*	0.07	0.11*	1.00				
(20) Dedicated institutional ownership	0.07	0.09	0.00	0.71	0.01	0.07	-0.05	0.05	-0.01	-0.01	0.07	0.22*	-0.06	0.12*	0.12*	-0.05	0.15*	0.15*	0.11*	0.56*	0.23*	0.09	0.28*	1.00			
(21) Complexity	0.18	0.10	0.08	0.51	-0.02	-0.05	0.01	0.09	0.01	0.01	0.11*	0.03	-0.25*	0.29*	0.01	-0.12*	-0.05	0.06	-0.02	-0.03	0.00	0.02	-0.09	0.03	1.00		
(22) Instability	1.12	0.06	1.07	1.40	-0.02	-0.03	-0.04	-0.04	-0.05	-0.05	-0.05	0.25*	-0.05	0.33*	-0.02	0.06	-0.02	-0.04	0.16*	-0.01	0.17*	-0.07	-0.08	0.08	0.47*	1.00	
(23) Munificence	1.08	0.06	0.94	1.28	0.02	0.12*	0.00	-0.06	0.03	0.03	-0.07	0.18*	-0.02	0.28*	-0.01	0.08	-0.02	0.08	0.11*	0.08	0.05	-0.05	0.01	0.15*	0.17*	0.36*	1.00

* $p < 0.05$

Tab. 1: Descriptive Statistics and Pairwise Correlations

Models 5 through 8 address H2. With regard to TMT CDOs, we find that, largely as we hypothesized, the presence of transient (i.e., short-term oriented) institutional owners is marginally significantly negatively ($\beta = -31.44$; $p < 0.1$) related to TMT CDO adoption, whereas the presence of dedicated institutional owners has no significant effect on TMT CDO adoption. Dedicated institutional owners do, however, have a significantly positive effect on non-TMT CDO adoption ($\beta = 4.457$; $p < 0.001$). The presence of transient institutional owners is only marginally significantly related to non-TMT CDO adoption ($\beta = 17.32$; $p < 0.1$). Hence, we can only partially support H2. On the one hand, dedicated institutional owners appear to increase the likelihood of CDO adoption on a non-TMT level. Dedicated institutional owners have extended investment horizons within few firms [Co10] and may thus be willing to endure additional costs in the short-term to ensure firm survival and success in the long run. Our findings suggest that firms are inclined to cater to these preferences by implementing non-TMT CDOs. On the other hand, our findings for transient institutional owners are only marginally significant and partially unexpected. Transient owners do not adopt a long-term perspective. In line with this, our data show that firms with more transient institutional owners are hesitant to adopt TMT CDOs, likely because they are more sensitive to additional short-term costs arising from additional TMT appointments. Surprisingly, such firms at the same time appear open to non-TMT adoption.

Models 9 and 10 address H3, which states that environmental uncertainty is negatively related to CDO adoption. This can only be supported for non-TMT CDOs and for the dimensions complexity ($\beta = -5.211$; $p < 0.1$) and instability ($\beta = -9.012$; $p < 0.05$). The coefficient for the munificence dimension is highly significant, but positive ($\beta = 10.87$; $p < 0.001$). We hence only partially support H3. Interestingly, but perhaps not completely surprisingly, we find the three dimensions to impact CDO adoption at a lower hierarchical level in different directions. As described above, munificence describes the capacity for growth within an environment [DB84, KH88]. Higher levels of munificence might be less likely to be perceived as a threat, and rather, indicate the necessary resources given in an industry, which are needed for growth [e.g., HKG06]. Hence, firms might implement CDOs as a means to reap such growth potential.

5 Discussion and conclusion

The purpose of our study was to gain a better understanding of specific environmental factors that are associated with CDO adoption within and outside of TMTs. Our results indicate that the effects of these antecedents vary by the hierarchical level of CDO implementation. Specifically, analysts' assessments and dedicated institutional owners seem to positively influence the likelihood of non-TMT adoption. In contrast, we find that environmental uncertainty largely negatively impacts non-TMT CDO appointments, which might be an indication for firm inertia in the face of the challenges of digital transformation. Regarding the implementation of TMT CDOs, our data suggest that ownership by transient institutional owners may be negatively related to CDO adoption.

	Control models		Analyst Models		IO Models				Environment Models	
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*
	TMT	Lower level	TMT	Lower level	TMT	TMT	Lower level	Lower level	TMT	Lower level
Variables	CDO	CDO	CDO	CDO	CDO	CDO	CDO	CDO	CDO	CDO
RoA $_{t-1}$	-16.52***	0.264	-16.14***	-0.037	-17.42***	-16.46***	-0.136	-0.245	-19.89***	-2.322
	(3.05)	(3.86)	(3.05)	(3.75)	(2.70)	(3.27)	(4.34)	(3.39)	(5.18)	(5.46)
Tobin's Q $_{t-1}$	0.147	0.068	0.055	0.046	0.132	0.150	0.003	0.090	0.333	0.116
	(0.41)	(0.31)	(0.46)	(0.32)	(0.45)	(0.37)	(0.39)	(0.31)	(0.33)	(0.33)
Sales Growth $_{t-1}$	2.471*	-0.625	2.477+	-0.968	3.136**	2.459+	-0.762	-0.435	2.170	-1.013
	(1.23)	(1.17)	(1.27)	(1.25)	(1.19)	(1.28)	(1.18)	(1.20)	(1.89)	(1.40)
Industry RoA $_{t-1}$	12.62*	2.208	12.96*	2.88	13.14***	12.57**	3.344	3.326	11.61*	4.013
	(5.30)	(6.66)	(5.24)	(6.60)	(3.22)	(4.75)	(7.37)	(6.41)	(5.88)	(8.33)
Industry MTB $_{t-1}$	-2.170*	-0.124	-2.208*	-0.121	-2.354**	-2.169*	-0.084	-0.177	-2.319*	-0.186
	(0.85)	(0.32)	(0.94)	(0.31)	(0.75)	(0.86)	(0.38)	(0.31)	(0.99)	(0.33)
Firm size $_{t-1}$	-0.432	0.035	-0.458	0.031	-0.554+	-0.432	0.055	0.013	-0.301	0.141
	(0.31)	(0.15)	(0.33)	(0.16)	(0.31)	(0.31)	(0.14)	(0.15)	(0.30)	(0.15)
Firm age $_{t-1}$	-0.000	0.001	-0.000	0.001	0.001	-0.000	-0.000	0.001	0.001	0.000
	(0.005)	(0.002)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Asset intensity $_{t-1}$	2.022	1.763	2.058	1.677	1.619	2.034	1.889+	2.029+	3.159+	1.842
	(1.77)	(1.18)	(1.82)	(1.11)	(1.68)	(1.70)	(1.12)	(1.22)	(1.86)	(1.14)
TMT size $_{t-1}$	0.151	0.045	0.142	0.028	0.096	0.151	0.106	0.084	0.249	0.061
	(0.223)	(0.11)	(0.22)	(0.11)	(0.21)	(0.21)	(0.11)	(0.09)	(0.24)	(0.11)
Average board age $_{t-1}$	-0.114	-0.028	-0.119	-0.039	-0.115+	-0.114	-0.032	-0.025	-0.145+	-0.035
	(0.08)	(0.05)	(0.08)	(0.05)	(0.07)	(0.08)	(0.05)	(0.05)	(0.09)	(0.05)
Industry CDO adoptions $_{t-1}$	-0.294	-0.414	-0.315	-0.406	-0.294	-0.291	-0.486	-0.579	-0.388	-0.548
	(0.38)	(0.38)	(0.40)	(0.38)	(0.45)	(0.41)	(0.38)	(0.37)	(0.36)	(0.38)
Technology-related TMT members $_{t-1}$	0.034	-0.048	0.062	-0.044	0.017	0.036	-0.023	-0.105	0.076	-0.043
	(0.48)	(0.23)	(0.46)	(0.23)	(0.42)	(0.50)	(0.22)	(0.19)	(0.45)	(0.22)
Degree of diversification $_{t-1}$	2.636	0.653	2.686	0.745	3.268	2.639	0.644	0.337	1.954	0.196
	(2.02)	(1.29)	(2.06)	(1.25)	(1.20)	(1.97)	(1.23)	(1.38)	(1.86)	(1.19)
Number institutional owners $_{t-1}$	0.108	-0.004	0.108	-0.006	0.279**	0.109	-0.119	-0.056	0.109	-0.016
	(0.07)	(0.04)	(0.07)	(0.04)	(0.11)	(0.08)	(0.09)	(0.05)	(0.08)	(0.05)
Analyst coverage $_{t-1}$	0.038	0.017	0.037	0.012	0.032	0.038	0.025	0.020	0.036	0.012
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)	(0.03)
Analyst assessment $_{t-1}$			0.179	0.462*						
			(0.18)	(0.21)						
Transient institutional ownership $_{t-1}$					-31.44+		17.32+			
					(18.12)		(9.74)			
Dedicated institutional ownership $_{t-1}$						-0.225		4.457***		
						(4.39)		(1.05)		
Complexity $_{t-1}$									-9.957	-5.211+
									(8.28)	(2.90)
Instability $_{t-1}$									-11.36	-9.012*
									(8.93)	(4.54)
Munificence $_{t-1}$									5.320	10.87***
									(4.12)	(2.91)
Constant	0.994	-3.322	1.085	-3.615	1.580	0.997	-3.269	-3.762	8.903	-4.417
	(6.14)	(3.27)	(6.25)	(3.27)	(5.04)	(6.12)	(3.34)	(3.40)	(10.35)	(5.40)
Wald chi2	179.72	34.26	182.52	50.64	184.65	183.16	72.52	196.26	278.86	57.89
Prob > chi2	0.0000	0.0117	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: n = 494, Standard errors in parentheses, + p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001

Tab. 2: Analysis of TMT CDO Adoption

Our research identifies several factors that are predictive of the choice to implement CDO positions and thereby contributes to a better understanding of IS-related senior management positions and the management of IT and digitalization within firms in general. What is more, we add to the knowledge on how incumbent firms react to major technological changes by adapting their organizational structures. By testing novel factors, we complement extant research on CDO antecedents [Fi21, KML20]. Moreover, our study is the first to offer extensive empirical evidence from Germany. Our novel distinction between CDOs within and outside TMTs may add to the strategic centralization literature [e.g., MKC15]. At the very least, our study may initiate

meaningful discussions in academia and the C-suite by showing how firms' characteristics lead them to choices about CDO adoption within and outside of the TMT.

We acknowledge the limitations of this study, which may inspire future research. We focused squarely on CDO adoption decisions because none of the firms in our sample that introduced TMT-level CDO positions reversed this decision within our sampling timeframe. Future researchers might wish to use specific econometric techniques to account for the fact that once a firm adopted a CDO position, an additional adoption (at the TMT-level) is thus effectively impossible. Alternatively, but likely even more interestingly, future researchers might wish to study samples in which firms decided to remove CDO positions again, possibly creating valuable insights into the obsolescence of executive positions. Related to this idea of studying extended time frames, it may be particularly interesting to see how CDO adoption evolved recently, e.g., whether changing perceptions during the Covid-19 pandemic have also altered expectations towards CDOs and the role's future [KG21]. Further, although we did not experience specific problems, the identification of non-TMT CDOs is not trivial since firms are not obliged to report such positions and there is no database providing this information. Identifying such CDOs hence requires a manual search, which ultimately might be subject to biases. Thus, we encourage future studies that further validate this data, e.g., through questionnaires. Generally, further robustness checks and replication studies might be valuable. Insights from qualitative studies might additionally help to further illuminate the reasons for the observed differences between TMT CDO adoption and non-TMT CDO adoption.

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