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Short Paper

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Abstract

The role of the top management team (TMT) and IT executives in organizing and leading digital innovation are increasingly recognized. However, past studies often focus on the role of IT expertise of TMT members. Relative power and interactions of the elite members remain under-researched. In this study, we draw on the literature on power distribution in the TMT to investigate the impact of power dispersion between IT executives and the TMT on digital innovation. We theorize that power dispersion has a non-linear, inverted U-shaped relation to digital innovation. Further, we introduce the moderating role of two relevant expertise of the IT executives, technological expertise and firm-specific expertise. Using panel data from US firms belonging to the list of top innovators, we find support for our theory. Our study offers potential contributions to the digital innovation literature as well as to research in IS leadership.

Keywords: Power distribution, power dispersion, IT executives, top management team, technological expertise, firm-specific expertise, digital innovation

Introduction

Under the increasing pressure of digitalization, innovating with digital technologies is considered a strategic imperative for most firms. The literature shows that digital innovations are beneficial for firms in terms of increasing performance as well as contributing to overall innovation productivity (Dong and Yang 2019; Hanelt et al. 2021). Consequently, there has been special attention toward digital innovation, including its drivers, processes, and outcomes (Kohli and Melville 2019).

Research on the role of the top management team (TMT) in driving digital innovation is increasing (Chen et al. 2021; Choi et al. 2021; Firk et al. 2021) because support from the top managers has been shown as a vital condition in different stages of initiating, developing, and implementing digital innovation (Kohli and Melville 2019). IT executives[1] are obviously important members when it comes to digital innovation (Chen et al. 2021). However, within the top team, IT executives do not operate separately. Rather, the collaboration between the IT executives and the TMT is crucial to driving strategic outcomes. These collaborations are particularly pertinent to digital innovation as it is a complex and interdisciplinary type of innovation. Cross-functional collaborations are often the main predictor of a successful digital innovation project (Nambisan et al. 2017; Yoo et al. 2012). Interestingly, however, past research on digital innovation primarily focuses on the role of IT (or digital) knowledge of the TMT members as the driver of digital innovation (Choi et al. 2021; Firk et al. 2021) although digital knowledge alone does not guarantee a fruitful

[1] While CIO is the most common title for IT executives, research and industry reports have shown that not all highest IT executives are titled CIO. In this study, we use IT executives to be inclusive.

collaboration within the TMT. The literature on behavioral integration of the TMT has emphasized that power distribution in the TMT plays a major role in group interactions, dynamics, and joint outcomes, yet it has remarkably received little attention in explaining digital innovation (Patel and Cooper 2014; Siegel and Hambrick 2005).

In the context of innovation, this line of research shows that power dispersion – defined as the differences in power markers such as status and compensation of a single team member relative to the TMT (Greer and van Kleef 2010; Tarakci et al. 2016) has curvilinear effects on strategic outcomes. Moderately unequal distribution of power creates incentives for the TMT members to participate and contribute to the productivity and effectiveness of innovation (Amore and Failla 2020; Wang et al. 2015). Reasonable power inequality also drives executives' motivation to engage in risky, innovative activities, an effect resonating with tournament strategies (Kale et al. 2009; Ridge et al. 2015). However, an extreme level of dispersion (also known as the disparity in power markers such as compensation, status, and prestige) may hamper innovation (Yanadori and Cui 2013). Innovation, and specifically digital innovation, requires a high level of collaboration among members, but power disparity creates hierarchical barriers and negative comparison that is detrimental to knowledge sharing and collaboration (Siegel and Hambrick 2005). The information processing effectiveness and the behavioral integration of the TMT for collaboration will suffer. To sum up, this literature signifies that power dispersion initially increases and then decreases with the firm's strategic innovation.

In this study, we aim to illuminate the curvilinear impact of power dispersion on digital innovations. Contextualizing this construct, we examine the power dispersion of IT executives and other members of the top team. Drawing on past research on TMT power, we argue that power dispersion at the low to moderate level is a motivation for IT executives to engage in, support, and contribute efforts to digital innovation. With increasing incentives and attribution to personal gains, the IT executive will champion the potential of digital technologies in the top team (Chen et al. 2021). Further, IT executives may act as an evangelist and diffuse digital innovation in the firms, facilitating the implementation of digital innovation (Tumbas et al. 2018). In contrast, a high level of power dispersion may hamper the communication process and the collaboration of IT executives with other TMT members through negative affect, unfair comparisons, and hierarchical distances between the IT executives and the TMT (Siegel and Hambrick 2005; Yanadori and Cui 2013). In other words, we propose an inverted U-shaped relationship between the IT executives-TMT power dispersion and digital innovation.

In addition, we further leverage the digital innovation literature to hypothesize the moderating effects of IT executives' expertise on this inverted U-shaped relation. We first join the conversation of the digital innovation literature and propose that technological expertise steepens the inverted U-shaped curve. Technological expertise increases the motivation to engage in digital innovation through the salience of its potential and subsequently increases collaboration efforts due to increased unfairness and social distances. Second, we propose that firm-specific expertise limits both the positive and negative effects of power dispersion. Higher commitment and understanding to a specific firm reduce motivation to engage in digital innovation for personal gains and ease communication and collaboration with the TMT members. Data from 199 U.S public firms belonging to the list of top IT innovators support our theorizing. This short study potentially contributes to the digital innovation as well as the IS leadership literature by highlighting the ambivalent influences of power dispersion and the moderating role of two important types of expertise of the IT executive, a key member in the TMT leading digital innovation.

Theory and Hypotheses

Power distribution and dispersion in the TMT

Past research has shown that power dispersion – defined as the differences in power markers such as the status and compensation of a single team member relative to the TMT – is non-linear with positive and negative implications. First, using the argument of ability-matching or tournament incitement, scholars argue that power dispersion creates a motivation for the individual to take risks, such that this member aim for higher returns, in compensation, status, or prestige (Ridge et al. 2015). When the power in a team is unequal, there is more motivation for members to participate in highly risky initiatives, enhancing team members' innovation endeavors (Amore and Failla 2020; Fleştea et al. 2017; Wang et al. 2015). Conversely, research following equity or social comparison theory contends that power dispersion is harmful to group information processing, collaboration, and supportive group climate (Siegel and Hambrick 2005; Yanadori and Cui 2013).

These two separate mechanisms are considered the benefits and pitfalls of power dispersion. The beneficial effect of power dispersion is linear as motivation further increases when dispersion becomes larger (Connelly et al. 2014). The cost effect is a non-linear function such that collaboration barriers (such as involvement) do not change significantly at the lower level of dispersion and surge when dispersion grows past a tolerable point (Wang et al. 2015). In collective and highly interdependent tasks such as digital innovation, it is generally agreed that the positive and negative effects of power dispersion manifest at the respective low and high levels of dispersion. Put differently, innovation outcomes initially increase with dispersion and subsequently decrease after a tipping point.

Inverted U-shaped impact of IT executive-TMT power dispersion on digital innovation

Drawing on the power distribution in the TMT literature, we argue that the power dispersion of the IT executive and the TMT at the low to moderate level is beneficial for digital innovation. IT executives will be incentivized to participate in digital innovation thanks to its promises of performance enhancement (Hanelt et al. 2021; Wang et al. 2015), and correspondingly reward them with more power and better status. Extrinsic motivation and incentives motivate executives to actively engage in risky initiatives such as digital innovation (Choi et al. 2021; Patel et al. 2018). Second, under increasing power dispersion, IT executives are motivated to increase cognitive efforts in leading digital innovation because they believe in the recognition and rewards of their efforts (Fleştea et al. 2017). While digital innovation is a shared task and requires the participation of various members of the TMT, the IT executives play a major role in initiating, leading, and coordinating to create and capture business value from digital innovation (Chen et al. 2021; Tumbas et al. 2018). Power dispersion is associated with individual input (Shaw et al. 2002), the risk of free-riding and neglection of personal contribution is reduced in the presence of power dispersion. Thus, IT executives are incentivized to engage in and champion risky digital innovation initiatives to ascend the executive ladders.

Moreover, an excessive level of power dispersion (or power disparity) decreases information processing and collaboration, which is particularly relevant for digital innovation because it is complex and cross-functional (Firk et al. 2021; Kohli and Melville 2019). Without frequent interaction and fluid communication, the IT executive could not exchange and instill the possibilities of digital technologies for innovation to other elite members (Ling and Kellermanns 2010). Further, digital innovation often engenders high task interdependence (Siegel and Hambrick 2005; Yoo et al. 2012) and necessitates effective collaboration among TMT members. IT executives' initiatives to collaborate with other TMT members allow knowledge bundling and recombination for digital innovation (Holmström 2018; Nambisan et al. 2017; Patel and Cooper 2014). The power disparity between the IT executive and the TMT, however, prevents such collaboration for digital innovation among executives, including the IT executive. When the competition within the TMT is intense, socially dysfunctional behaviors including knowledge hiding and distancing of members with different relative power occur (Pfeffer and Langton 1993; Yanadori and Cui 2013). Taken together, we propose an inverted U-shaped relationship between IT executive-TMT power dispersion and digital innovation.

Hypothesis 1: A firm's digital innovation initially increases and then decreases as the IT executive-TMT power dispersion increases.

The moderating role of the technological expertise of IT executives

Technological expertise refers to the knowledge and experience in information technologies IT executives obtain throughout their education and career (Lim et al. 2013). Thanks to its direct relevance to digital innovation, digital expertise is influential in this outcome (Choi et al. 2021; Firk et al. 2021). First, technological expertise increases the bias in favor of digital technologies and visualizes the potential of digital innovation in generating firm value. This vision motivates IT executives to advance digital innovation in the belief that its success will grant them more extrinsic rewards. Furthermore, technological expertise might alleviate the IT executives' risk avoidance through an in-depth understanding of technologies (Choi et al. 2021). Combined with the effect of power dispersion and the need for IT executives to show their mettle to assume higher power (Ridge et al. 2015), heightened awareness of the benefits of digital innovation increases IT executives' motivation to initiate and follow through with digital innovation.

Conversely, higher technological expertise of the IT executives hinders the collaboration caused by structural power disparity (Tarakci et al. 2016). First, power disparity might contribute to ineffective information processing because it prevents social interactions and knowledge sharing. While IT executives with high technological expertise are highly relevant to digital innovation, digital innovation is unlikely to enter the strategic agenda because other TMT members are less aware of or believe in such risky attempts (Chen et al. 2021). Further, collaborative behaviors are much harder to realize because of the focus on isolated behaviors and individual benefits. Finally, negative effects are also more severe under high power disparity. From a sorting perspective – that is more knowledgeable and productive employees will be highly rewarded (Trevor et al. 2012), and the IT executives will perceive higher resentment and dissatisfaction because their relevant expertise and potential contribution are not acknowledged (Lazear 2000; Trevor et al. 2012). Counterproductive behaviors ranging from knowledge hiding and opportunistic acts to sabotaging team initiatives and misconduct are thus more likely.

Hypothesis 2: IT executives' technological expertise steepens the inverted U-shaped relationship between IT executive-TMT power dispersion and the firm's digital innovation.

The moderating role of firm-specific expertise of IT executives

In this study, we define firm-specific expertise as the managers' (i.e., the IT executives) understanding of the firm, including its strengths and weaknesses as well as the approach to deploying resources (Dong 2016; Kor and Mahoney 2005). This unique and inimitable expertise can only be generated when the IT executives have long tenure and commitment to a specific firm (Raffiee and Coff 2016). On the one hand, IT executives with a higher level of firm-specific expertise show psychological commitment to the firm (Le et al. 2013), implying two different mechanisms. First, such an IT executive is more likely to favor familiarity and the status quo of the firms. As digital innovation indicates major changes to the firm (Nambisan et al. 2017), IT executives with firm-specific expertise are more hesitant to engage in these strategic initiatives. Second, the IT executive also focuses more on the growth of the firms than on individual benefits thanks to his/her long-term commitment and identification. As power dispersion is argued to lead to the prioritization of individual benefits, firm-specific expertise will reduce the incentive-inducing effect.

On the other hand, firm-specific expertise gained through a continued commitment to the firm allows repeated interactions with the TMT members. IT executives can leverage this increased interaction and trust to instill the innovation potential of digital technologies in the TMT. Further, through these interactions and social exchange, IT executives will develop a mutual understanding with the TMT and the firm (Eisenhardt and Schoonhoven 1990). As a result, collaborations between the IT executive and TMT members are facilitated. Finally, the positive emotions and the solidarity with the team are also enhanced through increasing tenure (Lawler 2001). These mechanisms counteract the adverse effects on collaboration and negative team affects caused by excessive power dispersion (or power disparity).

Hypothesis 3: IT executives' firm-specific expertise flattens the inverted U-shaped relationship between IT executive-TMT power dispersion and the firm's digital innovation.

Methods

We construct panel data of public US firms using various sources. First, our initial sample includes the top 100 US firms from 2005 to 2017 in Information Week (IW). Different from other corporate rankings, IW tracks the firms' technology, strategies, investment, and corporate practices and identifies the most IT innovative firms in the US[2]. As our outcome of interest is digital innovation, we choose to focus on these top IT innovators to limit potential confounds and increase the reliability of our results. In addition, IW facilitates the collection of IT executives' demographic and backgrounds. Because public reports such as 10-K filings detail only a limited number of executives in the TMT, IT executives are not always included. IW, on the other hand, includes the name of IT executives. This enables us to trace them and obtain further information. We end our sample in 2016 because IW stopped providing the list this year. We collect

[2] Please see: https://www.informationweek.com/iw500

information on IT executives through annual reports of US securities and exchange commissions, as well as public profiles including LexisNexis, Press Release, LinkedIn, ZoomInfo, Bloomberg, etc. We supplement this data set with Compustat for financial variables, BoardEx and Execucomp for TMT variables, and patent data (WRDS US patent and DISCERN) to complete the data set.

We follow past studies to measure digital innovation using two indicators: the number of digital patents a firm applies each year and (2) the cumulative forward citations subsequently made to a firm's digital patent applications. We follow Firk et al. (2021) to categorize digital patents. To account for truncation in patent citations, we adjust the number of citations of each patent by the average citations of all patents in the same two-digit class and application year before summing the citations of a firm's digital patent applications. We normalize these count measures by taking the natural logarithm. Finally, given that these measures are highly correlated, we combine the two measures using a principal component analysis (PCA). The PCA creates 1 component with an eigenvalue higher than 1 and both indicators highly load in the component (>0.7). We use the score of the components as a measure of digital innovation.

We use the number of titles as the measure of structural power (Finkelstein 1992). Because we are interested in the power distribution of IT executives in the TMT, we use the polarization formula provided by past research (Patel and Cooper 2014). The polarization formula essentially measures the distance between the actual distribution relative to the ideal distribution (0.5 or ½ with equal power between the IT executive and the TMT). Following past studies, we used a summative index of (1) educational background, (2) work experience, and (3) industry experience to measure IT executives' technological expertise (see Lim et al. 2013). We manually searched public profiles of the IT executives and created 3 dummy variables indicating whether the CIO has (1) an IT-related educational background (i.e., in computer science, information systems, and electrical engineering), (2) prior IT-related employment (e.g., IT engineer, IS managers) and (3) experience in IT industries (with the Standard Industrial Classification of 357, 367, and 737, see Haislip et al. 2021). We use the number of years the CIO work in the company to measure IT executives' firm-specific expertise (Dong 2016). We include an encompassing set of controls following past research on digital innovation, including individual-level controls (gender and education), firm-level controls (firm size, R&D intensity, slack resource, capital intensity, past performance, and patent portfolio size), and environmental controls (environmental dynamism and environmental complexity).

We use fixed-effect GLS regression to estimate our model. Fixed-effect models limit potential endogeneity and variability between firms. Our selection is supported by Hausmann's test. We standardize the independent variable and the moderators prior to calculating the interaction terms to limit multicollinearity. We also lagged predictors by one year to limit simultaneity.

Preliminary results

Model 1, Table 1 shows that power dispersion has a positive significant effect on digital innovation. Further, the power dispersion squared is negative and significant. Following Haans et al. (2016), we calculated the slopes at the low and high ends of power dispersions. Using the utest command in Stata (Lind & Mehlum, 2010), we find that the slope is significant and positive on the left side ($b = 0.536$; $p < 0.01$) and significant and negative on the right side ($b = -0.722$, $p < 0.05$). Moreover, the standardized turning point is 1.620 which is well within our data range. To check whether the curve has a different shape than the proposed inverted U-shape, we include the cubic term of power dispersion in model 3. We find an insignificant effect of the cubic term. Figure 1 illustrates the inverted U-shape relationship. Overall, the results support hypothesis 1.

Moreover, we obtain a significant and negative interaction term between power dispersion squared and IT executives' technological expertise, indicating a steepening effect of technological expertise (models 3 and 5, Table 1). Figure 2 demonstrates that the curve steepens as technological expertise increases. Thus, hypothesis 2 is supported. We also find that the interaction term between power dispersion squared, and the IT executive's firm-specific expertise is positive and significant (model 4 and 5, Table 1). Figure 3 shows that the inverted U-shaped relationship flattens as the IT executive's firm-specific expertise increases. The results lend support to hypothesis 3.

DV: Digital innovation	Model 1	Model 2	Model 3	Model 4	Model 5
Power dispersion	0.221⁺ (0.127)	0.234⁺ (0.134)	0.238* (0.119)	0.237⁺ (0.127)	0.249* (0.130)
Power dispersion_squared	-0.097* (0.041)	-0.131 (0.106)	-0.119*** (0.037)	-0.108* (0.048)	-0.128*** (0.036)
Power dispersion_cubic		0.008 (0.023)			
Power dispersion x Technological expertise			0.145 (0.105)		0.133 (0.106)
Power dispersion_ squared x Technological expertise			-0.105* (0.044)		-0.099* (0.043)
Power dispersion x Firm-specific expertise				-0.116 (0.104)	-0.114 (0.101)
Power dispersion_squared x Firm-specific expertise				0.056* (0.028)	0.052* (0.025)
Control	Included	Included	Included	Included	Included
Within R-squared	0.075	0.075	0.079	0.077	0.080
F	2.21	2.09	2.26	2.04	2.28
Observations (firms)	1378 (208)	1378 (208)	1378 (208)	1378 (208)	1378 (208)

Notes: ⁺ p <0.1, * p <0.05, ** p <0.01. Robust standard errors in parentheses.

Table 1: Fixed-effect GLS results

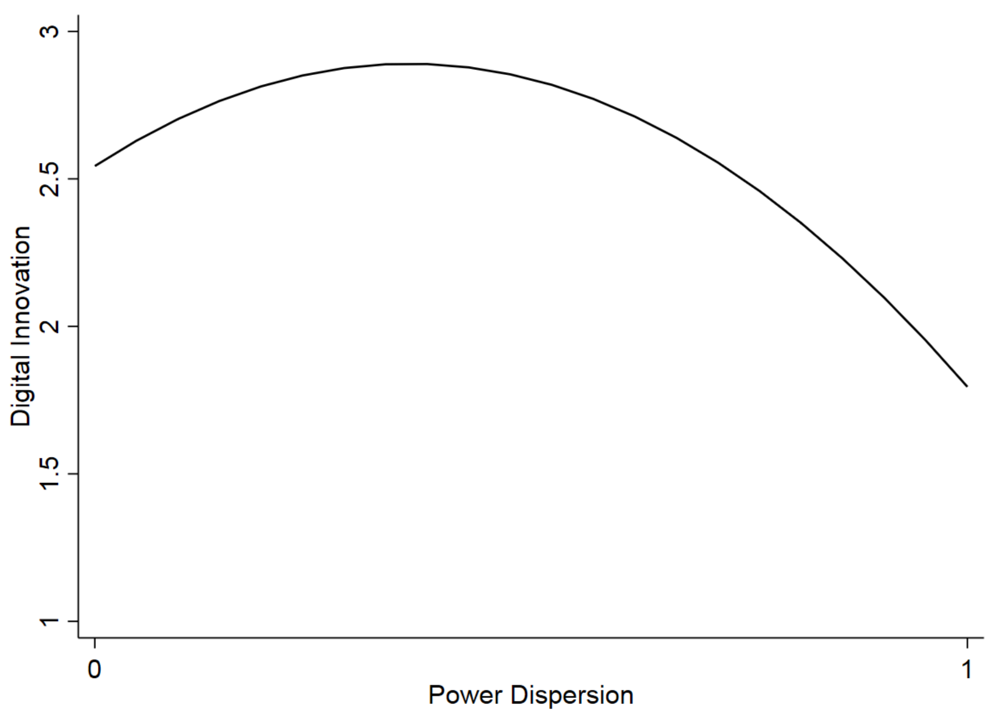
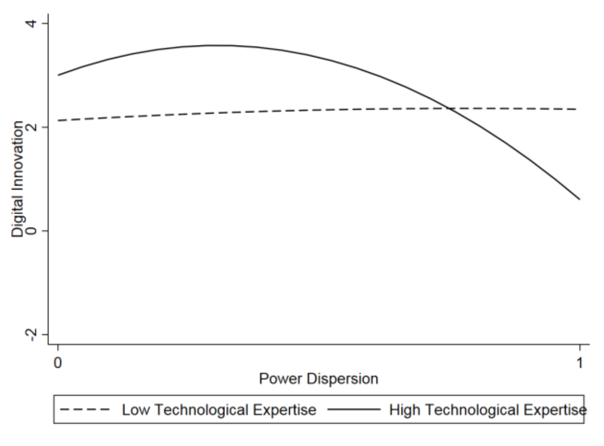


Figure 1. Inverted U-shaped relationship between power dispersion and digital innovation



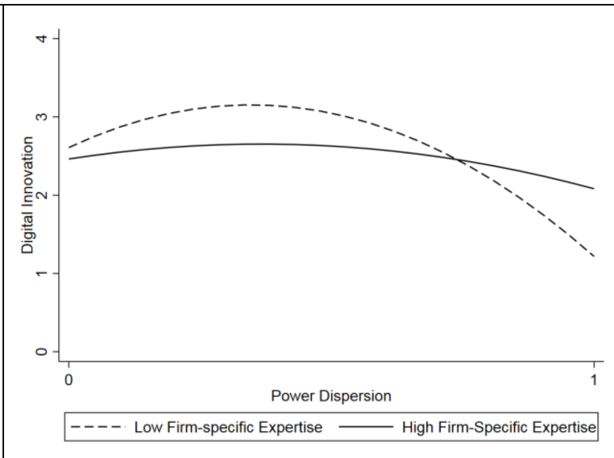


Figure 2: Moderating effect of IT executives' technological expertise	**Figure 3: Moderating effect of IT executives' firm-specific expertise**

To assess the robustness of our results, we conduct several checks. First, instead of using the PCA-generated score, we use the normalized count of (1) the number of digital patents and (2) the number of adjusted citations to the digital patent stocks as alternative dependent variables. We estimate the models in table 1 and found similar results (i.e., confirming H1, H2, and H3). Second, to control for endogeneity such as reverse causality and simultaneity, we estimate a two-stage Heckman's model using the industry mean of CIO-TMT power dispersion as the exclusion restriction (Bharadwaj et al. 2007). We find qualitatively similar results when estimating the models in table 1 with the inverse Mills ratio as an additional control variable.

Discussion, potential contributions, and future prospects

With the relevance and omnipresence of digital technologies, digital innovation, or the innovative use and implementation of digital technologies for business value, has become interesting for both scholars and practitioners. The role of senior management is shown as an important driver and enabler of digital innovation in both IS and management research (Kohli and Melville 2019). This study taps into an under-researched area of power distribution. We use digital innovation as the context of research and investigate the power dispersion between IT executives and the TMT. The results from the data of top US IT innovators support our theory regarding an inverted U-shaped relation between IT executives-TMT power dispersion and digital innovation. On the one hand, a moderate level of power dispersion generates extrinsic incentives for IT executives to contribute to digital innovation, while a high level of power dispersion disturbs the collaboration of the IT executives with other TMT members which is essential for digital innovation. The findings also shed light on the moderating effect of two relevant types of expertise in digital innovation: Technological expertise and firm-specific expertise.

Our study contributes to the digital innovation literature by illuminating the nuanced and complex effect of power dispersion. We synthesize the light and dark sides of power dispersion in the context of innovation. We demonstrate that moderate power dispersion is beneficial for innovation, but that excessive level is detrimental to the firm's digital innovation. Thus, we direct attention to the power distribution of IT executives, especially when firms intensively focus on digital innovation. We also emphasize the importance of two relevant types of managerial expertise. We join the conversation in current digital innovation literature by showing the role of technological expertise. We show that while IT executives' technological expertise can be combined with a moderate level of power dispersion to drive digital innovation, we warrant that IT executives' technological expertise can exacerbate collaboration at the high level of power dispersion because it intensifies the collaboration barriers in the TMT. On the contrary, IT executives' firm-specific expertise is helpful under a high level of power dispersion as it attenuates the hierarchical distance and the collaboration hindrances. We also contribute to the IS leadership literature, which acknowledges the important role of the power of IT executives within the TMT. However, this literature has shown that increasing the relative power of IT executives (toward more equal power within the team) is beneficial for overall performance (Feng et al. 2021) and digital innovation (Chen et al. 2021). We, nevertheless, show that power dispersion can generate motivational benefits and increase engagement in digital innovation if power dispersion is properly managed and aligned with the corresponding expertise of the IT executive. Managerially, we give managers guidance on TMT designs in terms of power distribution that will drive digital innovation. We also discuss the characteristics of the IT executives that fit with different designs.

In the future, we aim to extend this research. While the titles of the IT executives are one source of structural power, we aim to collect different power sources such as total compensation, pay rank (Feng et al. 2021), or board inclusion. Alternative measures of power will lend robustness to our findings and corroborate our theorizing. In addition, while the fixed-effect model can limit potential endogeneity, we aim to control for endogeneity using the instrumental variable approach. One possible instrument is CEO power, which is shown to influence the power dispersion (and equality) of functional executives in the TMT.

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