

## It Depends on the Size: How Firm Strategic Emphasis on Digital Transformation Predicts Market Capitalization

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### Abstract

*Whereas digital businesses can have an enormous market value, it remains an open question, whether firms, embarking on a digital transformation journey, can realize similar benefits. Thus, we rely on the signaling theory to study, whether strategic emphasis on digital transformation – i.e., the extent, to which a firm focuses on digital transformation in its strategy – as well as firm size as an indicator of a large resource basis jointly influence market capitalization. To answer this question, we conducted a longitudinal panel data analysis of the largest German publicly listed companies from 2000 to 2017. Our results show, that strategic emphasis on digital transformation leads to a higher market capitalization for larger firms and to a lower market capitalization for smaller firms. Whereas larger firms should further disclose their strategic emphasis on digital transformation, smaller firms should consider sending additional signals to investors, demonstrating their ability to undergo digital transformation successfully.*

### 1. Introduction

Digital businesses can realize an enormous market value [1]. For instance, five out of ten companies with the largest market value worldwide in 2019 are born digital pioneers [2, 3]: Amazon, Alphabet, Facebook, Alibaba, and Tencent [4]. Unsurprisingly, many pre-digital organizations, i.e., established firms from traditional industries, seek to realize similar benefits by starting to transform digitally [2, 3, 5]. Applying digital technologies such as mobile, social media, analytics, cloud, Internet of things, and platforms [2, 3, 6, 7], they comprehensively transform their business, structure, processes and products to enable major business improvements such as enhanced customer experience, streamlined operations and new value propositions [3, 6, 7].

Yet, it remains an open question, whether firms, embarking on a digital transformation journey, can indeed realize a higher market value. Despite the growing interest of information systems researchers in the digital transformation [7], existing research on the success and risks of digital transformation is scarce and fragmented [2, 3]. This research is limited to case studies, describing signals of improved use of digital technologies as well as possible digital transformation strategies for established firms [2, 5, 8-12]. Hence, empirical evidence on the link between firms' signals of digital transformation and stock market reactions to them is missing [3]. This gap is of substantial importance, as the stock market is likely to react to such signals [13, 14], and firms, facing many challenges on their digital transformation paths, need to anticipate them [2, 3, 5].

To address this research gap, we consider firm strategic emphasis on digital transformation, which we define as the extent, to which a firm focuses on digital transformation topics in its corporate strategy [15, 16], and its link to firm valuation on a stock market. Our first research question is: *How does firm strategic emphasis on digital transformation influence its market capitalization?* To investigate this relationship, we rely on signaling theory [17-19]. According to signaling theory, in order to reduce existing information asymmetry, observers such as investors seek out visible signals of a company to be able to assess its unobservable attributes such as strategic decisions and their likely performance outcomes [17-19]. Thus, if a firm discloses its strategic emphasis on digital transformation, investors might use this information to adjust their interest in firm's shares, leading to changes in market capitalization.

Yet, firms' signals about their digital transformation might be ambivalent for investors because digital transformation requires a plenty of resources such as human, information, and financial resources [2, 5, 20-22]. One typical and highly visible indicator of a large resources base is large firm size [23]. Thus, depending on firm size, investors might react to signals of firm strategic emphasis on digital

transformation with an increasing or decreasing interest in firm shares. Accordingly, we also study, how the relationship between firm strategic emphasis on digital transformation and market capitalization might vary depending on firm size. Our second research question is: *Does firm size moderate the relationship between firm strategic emphasis on digital transformation and its market capitalization?* To investigate these research questions, we conducted a longitudinal panel data analysis of the largest German publicly listed firms (HDAX) between 2000 and 2017.

With this study, we extend research on digital transformation of companies [2, 3, 5, 7, 11, 24] in two ways. First, by exploring the effect of strategic emphasis on digital transformation on firm evaluation on a stock market, we respond to a call of existing studies to investigate the questions related to success, risks and failures of digital transformation for firms [3]. In doing so, we are to our best knowledge the first to provide quantitative empirical evidence on strategic emphasis on digital transformation in firms and its influence on their performance in a longitudinal study over 17 years using panel data [7]. Second, due to examining the effects of an interplay between firm strategic emphasis on digital transformation and firm size on market capitalization, we draw attention to firm characteristics, which might promote or hamper the realization of the benefits, connected with the digital transformation process. Thus, we extend the digital transformation framework as proposed by Vial [7] by adding outcomes to the building blocks of positive and negative impacts of digital transformation and proposing an additional building block of contextual factors, which might influence the path between the changes in value creation paths and digital transformation impacts.

Our study is also important for practitioners, who are embarking on a digital transformation journey [3, 5]. First, we draw their attention to the fact, that strategic emphasis on digital transformation, as signaled by their firms, can matter for firm market capitalization. Second, we provide evidence on which stock market reactions to strategic emphasis on digital transformation firms might anticipate, depending on their size. By highlighting these possible outcomes of the digital transformation process [7], we aim at supporting firms on their digital transformation path.

## **2. Theoretical background and hypotheses**

The goal of digital transformation is to improve a firm, which is undergoing it [7]. Hence, research on digital transformation of companies has highlighted different performance benefits, which a firm can

realize during the process of digital transformation [6, 7]. These benefits include improved operational efficiency, such as cost savings, business process improvement, and automation, as well as better organizational performance, such as firm growth, higher innovativeness, improved financial performance and competitive advantage [7]. Digital transformation further enables firms to explore new paths of value generation and create new business models [3, 5, 7, 21]. Thereby, digital transformation not only leads a higher firm competitiveness, but also provides a basis for its persistence on the market, contributing to a better long-term firm performance [5, 7].

Yet, not all firms might be able to realize these benefits, as digital transformation presents a very complex endeavor, which is hallmarked by a high degree of uncertainty and entails a risk of failure [2, 3, 5, 6, 25]. One of the most common reasons for failure of digital transformation's initiatives is the lack of resources, required for digital transformation, such as information, human and financial resources [2, 5, 6, 20-22]. For instance, firms need knowledge and expertise to define a digital transformation strategy, employ new digital technologies as well as develop digital services platforms and operational backbones [2, 5, 21, 24]. Further, firms require experienced executives such as Chief Digital Officers (CDO) to identify the right digital business opportunities and navigate digital transformation [20, 24], as well as qualified employees, who can take over new roles and responsibilities in firm's IT function and other departments [2, 7]. Finally, to finance these employees, to develop digital services platforms and finance other aspects of digital transformation, firms require financial resources [5, 6, 21]. Thus, firms, which seek to navigate digital transformation successfully, need a large resource basis [5, 21].

A primary indicator of such a broad resource base is firm size [23, 26-28]. Prior research has shown that larger firms possess larger pools of managerial and financial resources [26, 28], which can be invested into digital transformation projects [23]. These resources pools can also be used to bear the risks and costs of digital transformation [23, 26, 28]. Further, larger firm size increases a firm's potential to attract additional resources such as external knowledge networks [23], well-trained employees, further capital, favorable tax conditions and governmental regulations [26, 27]. Additionally, larger firms are usually powerful market players, which do not only have a better access to needed resources, but can also prevent other market participants of gaining access to such resources [23, 29]. Accordingly, larger firms face a decreased risk of failure in digital transformation initiatives [26-28, 30]. Further, even if it comes to a failure, the associated

losses would not threaten the survival of larger firms [26-28, 30]. Hence, performance expectations for larger firms, undergoing digital transformation, are likely to be positive [23]. In contrast, this might not apply to smaller firms, which possess a smaller stock of resources, and are thus much more vulnerable to firm failure and financial losses, which might threaten their survival [26-28, 30].

According to signaling theory [17-19], as digital transformation is bound to risk and uncertainty [2, 3, 5, 6, 25], stakeholders such as investors seek out to reduce the arising information asymmetry. Hence, they look out for observable actions and visible signals of a company to be able to assess its strategic position concerning digital transformation and its likely performance outcomes [17-19]. Hereby, investors can rely on such visible signals as firm strategic emphasis on digital transformation, as reflected in firm's annual reports as a central mean of corporate strategy's communication to external stakeholders [31], as well as firm size as an indicator of a sufficient resources base for digital transformation [5, 21, 23, 26-28, 30]. Thus, if a larger firm discloses a higher strategic emphasis on digital transformation, investors will be likely to assess this firm as having a higher probability of successfully managing its digital transformation and realizing the corresponding performance benefits [6, 7]. Hence, investors, who consider buying company's stock, will be willing to pay a higher price for it, resulting in an increased stock price and market capitalization [13, 14, 32]. As opposed to this, a smaller firm's disclosure of a higher strategic emphasis on digital transformation can signal an endeavor with a higher risk of failure to investors, resulting in lower performance expectations for this firm [26-28]. Thus, potential investors' interest in a firm stock will decrease, leading to a lower market capitalization [13, 14, 32]. Accordingly, we hypothesize:

*Hypothesis. A higher strategic emphasis on digital transformation is associated with a higher market capitalization for larger firms, and a lower market capitalization for smaller firms.*

### 3. Methods

#### 3.1. Sample and procedure

To test our hypotheses, we conducted a panel data analysis from 2000 to 2017 using a sample of the German firms, listed on the public stock index HDAX. It covers 110 largest German stock corporations, including the 30 largest German companies (DAX), the next 50 largest companies (MDAX) as well as the 30 largest technology companies (TecDAX). As TecDAX

emerged in 2003, until then HDAX incorporated 30 DAX and 70 MDAX companies [33]. Besides including publicly listed firms, this sample is suitable for our study for three further reasons. First, HDAX includes firms of different industries. Therefore, we expect the firms in our sample to exhibit different degrees of strategic emphasis on digital transformation [3]. Second, HDAX encompasses not only large companies, but also mid-sized and smaller technology firms. Hence, it generates both variance in market capitalization and firm size among the considered companies [34]. Third, this sample has frequently been used by prior studies [e.g., 34, 35], verifying its suitability to study organizational phenomena.

To construct our sample, we included those companies, which were a member of HDAX as of December, 30th for each year from 2000 to 2017. The year 2012 was the only exception, as we had to use the data as of December, 28th 2012 due to a missing availability of later data for this year. Because we accounted for changes in the HDAX composition, our data was unbalanced.

We gathered our data from three main sources. First, we obtained the list of companies, which were a member of HDAX in each year, from STOXX Ltd., a part of Deutsche Börse Group. Second, we collected firm data from the database Wordscope (Thomson One Banker), which has already been utilized as a source of firm data by existing studies [e.g., 35]. Third, we gathered data on firm strategic emphasis on digital transformation from the annual reports.

We faced the problem of missing data [34, 36, 37], especially with respect to firm financial data and Research & Development (R&D) expenditures. Our sample was further reduced because we used lagged values (t-1) for all our independent variables [38-40], as prior research has shown, that capital markets usually need some time to incorporate the available firm information [41, 42]. Hence, our final sample comprised 1,203 firm-year observations.

#### 3.2. Measures

We measured our dependent variable, *market capitalization*, as firm's market capitalization in the respective year in Euro.

We measured our independent variable, *firm strategic emphasis on digital transformation*, as the count of words, related to digital transformation, by 1,000 words in a firm's annual report [43]. For this purpose, we counted the absolute number of words, beginning with "digit\*", divided it by the total number of words in an annual report in the respective year [31], and then multiplied the result with a factor of 1,000 [43]. This measurement approach is appropriate for our

study for three main reasons. First, both in German and English languages, the root word “digit\*” covers a wide range of words, connected with digital transformation, such as “digital” (transformation, markets, products, processes, technologies, strategies, etc.), “digitalization”, “digitization”, etc. Second, annual reports constitute a representative form of firm’s communication, which does not noticeably differ in its language choice from other sources of organizational communication such as press releases [31]. Annual reports are directed at external stakeholders such as investors or financial analysts, who use these reports as a central information source in order to understand firm’s strategic decisions [31]. Indeed, not only financial analysts [44], but also investors can be expected to read companies’ qualitative announcements in the form of annual reports [44-46]. Hereby, especially long-term oriented investors, who are interested in a future development of firm’s strategic and intangible assets such as strategic emphasis on digital transformation, usually have profound skills in monitoring and detecting the relevant information, which is positioned outside the balance sheet in firm’s annual reports [47]. Third, a word-count approach in annual reports or their selected parts has been widely used in strategic management research to approach an orientation of a company or its executives [e.g., 31, 43, 48]. Therefore, the chosen operationalization of firm strategic emphasis on digital transformation is capable of covering company’s language, related to digital transformation; relies on a data source, which addresses appropriate stakeholders; presents a suitable means of expressing strategic emphasis of a firm; and is a representative and valid source of a firm’s strategy communication [31]. To implement this operationalization, we developed a supporting macro in Microsoft Excel 2016, which counted the words, beginning with “digit\*” as well as the total number of words, in firms’ annual reports in each year.

Additionally, this macro also recoded the words, beginning with “digit\*” as well as the words, which followed them. Table 1 shows the ten most frequently used words of the both groups. The most frequently used word, beginning with “digit\*”, was “digital” in its different declensions (n = 77.47%), followed by “digitalization” (n = 14.19%) and “digitalized” (n = 0.98%). The ten presented most frequently used words accounted for 95.35% of all words, beginning with “digit\*”. Considering words, which followed those containing “digit\*”, the most frequently found word was “lifestyle” (n = 2.69%), followed by “adjacent” (n = 2.51%) and “media” (n = 2.47%). The ten presented most common second words accounted for 16.37% of all words, which followed those containing “digit\*”.

Overall, these words indicate strategically relevant topics, connected with digital transformation of companies, thus providing support for our measure.

We measured *firm size* as the natural logarithm of the number of firm’s employees [49], which represents a reliable measure of an overall firm size in a given industry [26].

Additionally, we controlled for firm’s *R&D expenditures* in order to address the magnitude of the required financial resources for the ongoing digital transformation projects [50, 51], *firm performance* as well as *industry performance* as these factors could both influence firm strategic emphasis on digital transformation and market capitalization [42, 52]. We measured R&D expenditures as the total amount of firm’s R&D expenses in Euro divided by the number of employees [52]. We operationalized firm performance as Return on Assets (ROA) [31]. We measured industry performance as the average ROA values of all firms operating in the firm’s industry [42] according to the Industrial Classification Benchmark [53]. Further, we controlled for the presence of a *CDO*. The presence of this executive might influence strategic emphasis on digital transformation by leveraging digital transformation [20, 24, 54] such as helping the Chief Executive Officer (CEO) to infuse the digital transformation strategy into all business areas [11]. Further, the presence of a CDO can influence market capitalization by making the formulation of the digital transformation strategy more focused and sending an additional signal to the investors [11]. We collected information on the presence of the CDO position from firms’ web pages and their annual reports, and performed an internet-based search via the search engine Google to verify the results. CDO was coded 1 if a position with the title “Chief Digital Officer” or “CDO” existed in the company or there was a board member, who was responsible for digital transformation topics (identified as any words including the letter combination “digit\*” in the area of the responsibility), and 0 otherwise. Finally, to account for macroeconomic trends or shocks such as the financial crisis of 2007-2008, which could have influenced both firm strategic emphasis on digital transformation and market capitalization, we also included *year fixed effects* into our model [55].

### 3.3. Analysis

To estimate the effect of firm strategic emphasis on digital transformation and firm size on market capitalization, we used a panel data analysis in Stata 14.1. We calculated a fixed effects model, which uses a

**Table 1. Ten most frequently used words, beginning with “digit\*”, and following them**

| “Digit*” words                       |           |               | Following words                  |           |               |
|--------------------------------------|-----------|---------------|----------------------------------|-----------|---------------|
| Word                                 | Frequency | Percent       | Word                             | Frequency | Percent       |
| Digital <sup>a</sup>                 | 13,483    | 77.47%        | Lifestyle <sup>c</sup>           | 458       | 2.69%         |
| Digitalization                       | 2,470     | 14.19%        | Adjacent <sup>c</sup>            | 427       | 2.51%         |
| Digitalized <sup>a</sup>             | 170       | 0.98%         | Media                            | 420       | 2.47%         |
| Digital printing <sup>b</sup>        | 108       | 0.62%         | Transformation                   | 284       | 1.67%         |
| Digital cameras <sup>b</sup>         | 83        | 0.48%         | World                            | 246       | 1.45%         |
| Digitalization strategy <sup>b</sup> | 69        | 0.40%         | Business <sup>c</sup>            | 211       | 1.24%         |
| Digitalize                           | 67        | 0.38%         | Company                          | 208       | 1.22%         |
| Digital business <sup>b</sup>        | 62        | 0.36%         | Entertainment <sup>c</sup>       | 197       | 1.16%         |
| Digital sector <sup>b</sup>          | 50        | 0.29%         | Subscriber <sup>c</sup>          | 179       | 1.05%         |
| Digital technology <sup>b</sup>      | 33        | 0.19%         | Limited liability company (GmbH) | 156       | 0.92%         |
| <b>Total</b>                         |           | <b>95.35%</b> |                                  |           | <b>16.37%</b> |

Note: Analysis for 2000-2016 due to lagged values. Translation from German. <sup>a</sup> includes different declensions of this word in German. <sup>b</sup> is written as one word in German. <sup>c</sup> not translated.

within-firm variation in independent and dependent variables and allows for arbitrary correlation between the unobserved effect and the independent variables [56, 57]. By these means, a fixed effects model allows to control for any unobserved firm-specific heterogeneity, which could play a role for performance outcomes [57, 58]. This makes a fixed effects model more convincing for estimating ceteris paribus effects, especially when the used sample cannot be treated as a random sample from a large population of firms [57]. To additionally control for any kind of serial correlation and heteroscedasticity, we allowed for unobserved firm effects in our data by using robust standard errors [57]. Hence, we used the command *xtreg, fe cluster(id)* in Stata. Due to using a fixed effects estimator in combination with robust standard errors, it was not possible to calculate a Hausman test for the comparison between fixed and random effects [57]. Further, we calculated simple slopes of the interaction between strategic emphasis on digital transformation and firm size on market capitalization using the *margins, dydx* command in Stata.

## 4. Results

Table 2 reports descriptive statistics and correlations for our variables. Although some correlations between independent variables were significant, none of them exceeded the critical value, which is considered 0.80 or higher [59, 60]. Hence, multicollinearity did not appear to present a problem for our data. Table 3 presents the results of a fixed-effects regression for our Hypothesis. Figure 1 shows an interaction graph for strategic emphasis on digital transformation and firm size on market capitalization.

### 4.1. Hypothesis testing

Our Hypothesis predicted that a higher strategic emphasis on digital transformation would be associated with a higher market capitalization for larger firms, and a lower market capitalization for smaller firms. When the interaction effect between strategic

**Table 2. Descriptive statistics and correlations**

| Variable   | Obs.  | Mean   | SD      | 1      | 2       | 3       | 4      | 5       | 6      |
|--|-------|--------|---------|--------|---------|---------|--------|---------|--------|
| 1. Market capitalization (100 million)                         | 1,946 | 95.280 | 167.472 |        |         |         |        |         |        |
| 2. Strategic emphasis on digital transformation <sub>t-1</sub> | 1,679 | 0.141  | 0.401   | 0.005  |         |         |        |         |        |
| 3. Firm size <sub>t-1</sub>                                    | 1,674 | 9.371  | 1.946   | 0.569* | -0.064* |         |        |         |        |
| 4. CDO <sub>t-1</sub>  | 1,682 | 0.024  | 0.152   | 0.252* | 0.287*  | 0.096*  |        |         |        |
| 5. R&D expenditures (thousand) <sub>t-1</sub>                  | 1,213 | 12.603 | 21.347  | 0.033  | 0.047   | -0.305* | 0.044  |         |        |
| 6. Firm performance <sub>t-1</sub>                             | 1,661 | 5.375  | 7.566   | -0.025 | 0.027   | -0.093* | -0.008 | -0.127* |        |
| 7. Industry performance <sub>t-1</sub>                         | 1,661 | 5.080  | 1.871   | 0.080* | 0.080*  | 0.193*  | -0.004 | 0.013   | 0.205* |

Note: \* p < .05.

**Table 3. Results of a fixed effects regression with robust standard errors**

|  | Model1   | Model 2  | Model3   |
|--|----------|----------|----------|
| Intercept:   | 0.587    | 0.568    | 0.462    |
| <b>Controls:</b>   |          |          |          |
| R&D expenditures $t_{-1}$  | 0.052    | 0.063    | 0.073    |
| Firm performance $t_{-1}$  | -0.042   | -0.036   | -0.016   |
| Industry performance $t_{-1}$  | -3.226   | -3.225   | -2.857   |
| CDO $t_{-1}$   | 0.770 *  | 0.775 *  | 0.643 †  |
| <b>Main effects:</b>   |          |          |          |
| Strategic emphasis on digital transformation $t_{-1}$                      |          | 0.067    | 0.059    |
| Firm size $t_{-1}$   |          | 0.264    | 0.328 †  |
| <b>Interaction effect:</b>   |          |          |          |
| Strategic emphasis on digital transformation $t_{-1}$ x Firm size $t_{-1}$ |          |          | 0.252 ** |
| F-statistic  | 5.06 *** | 5.21 *** | 5.80 *** |
| R-sq within  | 0.285    | 0.293    | 0.317    |
| R-sq between   | 0.008    | 0.001    | 0.000    |
| R-sq overall   | 0.014    | 0.004    | 0.002    |

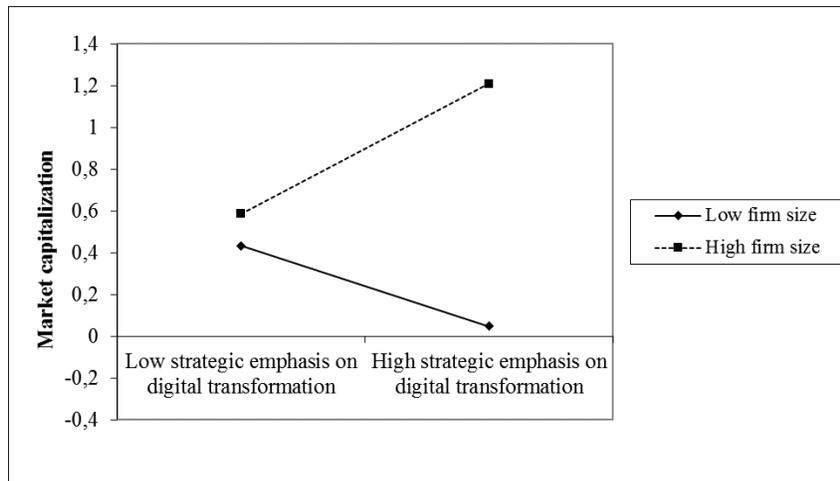
Note: †  $p < .10$ , \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$ . Dependent variable: market capitalization  $t$ . All models include year fixed-effects. Regression with standardized coefficients. N=1,203 observations, clustered in 154 firms.

emphasis on digital transformation and firm size on market capitalization was included into the regression model (Model 3), we were able to explain 31.7% of variance within our firms. This model provided a higher goodness of fit than a model only with control variables (Model 1, R-sq. within = 28.5%), and a model with main effects of strategic emphasis on digital transformation and firm size (Model 2, R-sq. within = 29.3%). The interaction effect between strategic emphasis on digital transformation and firm size on market capitalization was positive and significant ( $\beta = 0.252$ ,  $p < 0.01$ , Model 3). Figure 1 illustrates this relationship. A simple slope analysis revealed, that if Z-scores of firm size were less or equal to -1.190 (small to medium firm size), the average marginal effects of strategic emphasis on digital transformation on market capitalization were negative and significant ( $p < 0.01$ ). If Z-scores of firm size were greater or equal to 0.810 (large firm size), the average

marginal effects of strategic emphasis on digital transformation on market capitalization were positive and significant ( $p < 0.01$ ). Therefore, our Hypothesis was supported.

#### 4.2. Endogeneity and robustness checks

To ensure that our independent variable, strategic emphasis on digital transformation, was not endogenous, i.e., correlated with an error term, e.g. due to omitted variables [57], we conducted two endogeneity tests. First, we used an instrumental variables approach by finding two proxy variables for strategic emphasis on digital transformation [56, 57]. As such instrumental variables we used an average strategic emphasis on digital transformation as well as an average prevalence of a CDO among firm's peers from the same industry in our sample [61].



**Figure 1. Interaction between strategic emphasis on digital transformation and firm size**

These instruments can be considered as appropriate, because on the one hand, they are unlikely to be correlated with the focal firm's omitted variables, and on the other hand, firms from the same industry face a similar market situation and are likely to have similar expectations about it [61]. Utilizing these instrumental variables, we ran a generalized two stage least squares regression and calculated an endogeneity test. As a result, the test was not significant (Chi-sq. = 1.252,  $p = 0.535$ ), indicating no evidence of endogeneity. Second, we used a control function approach by regressing strategic emphasis on digital transformation on all the other independent variables and the two instrumental variables, obtaining the residuals, and adding them to the estimation function of our dependent variable, market capitalization [57, 62]. As a result, the coefficient of the residuals was not significant ( $\beta = 35.338$ ,  $p = 0.213$ ), letting us conclude that strategic emphasis on digital transformation was not endogenous [57].

To verify the results of our hypothesis testing, we conducted several robustness checks. First, we repeated our analysis only for the period between 2010 and 2017, as during the last decade, companies have started to pay a considerably higher attention to the digital transformation topics [5, 7]. Second, we considered the period from 2000 to 2017, but utilized a slightly different measure for strategic emphasis on digital transformation, by using only an absolute number of words, beginning with "digit\*", from firms' annual reports, while including the total number of words in the report as a control variable [31]. Third, we used a different operationalization of strategic emphasis on digital transformation, by counting the words, beginning with "digit\*", only in firm's letters to shareholders, which are published in annual reports, dividing this word count by the total number of words in the letter, and multiplying the result with a factor of 1,000 [43, 48, 63]. Fourth, we measured strategic emphasis on digital transformation as the absolute number of words, beginning with "digit\*", in firm's letters to shareholders, while controlling for the total number of words in the letter [31, 43, 48, 63]. Fifth, we repeated the analysis by using another operationalization of firm size, which we calculated as a natural logarithm of firm sales [43]. Our results remained robust in each of these robustness checks.

## 5. Discussion

In this study, we analyzed the joint impact of firm strategic emphasis on digital transformation and firm size on market capitalization. To perform this analysis, we used a panel data set of largest German publicly

listed companies between 2000 and 2017. Our results revealed that a higher firm strategic emphasis on digital transformation leads to a higher market capitalization for larger firms and to a lower market capitalization for smaller firms.

We explain these results relying on the signaling theory [17-19]. Particularly, we believe, that larger firms, embarking on a digital transformation journey, send clearer and more credible signals to investors, that they are likely to realize performance benefits, connected to digital transformation [6, 7], because of relying on a sufficient resources basis [5, 21, 23, 26-28, 30]. As opposed to this, investors might perceive the digital transformation journey of smaller firms, having a limited resources basis, as riskier and more prone to failure [26-28].

### 5.1. Theoretical implications

With this study, we extend research on digital transformation of companies [2, 3, 5, 7, 11, 24] in two ways. First, by exploring the effect of strategic emphasis on digital transformation on firm evaluation on a stock market, we respond to a call of existing studies to investigate the questions related to success, risks and failures of digital transformation for firms [3]. Hereby, we show that an increased strategic emphasis on digital transformation leads to a higher evaluation of larger firms and to a lower evaluation of smaller firms on a stock market [13, 14]. Hence, we demonstrate, that it might be easier for larger firms to be successful in their digital transformation endeavors [2], because they are rewarded by the stock market in a timely way. At the same time, smaller firms have to face an additional challenge [3, 5] on their digital transformation paths in terms of skeptically reacting investors and decreasing market capitalization. In revealing these results, we are to our best knowledge the first to provide quantitative empirical evidence on strategic emphasis on digital transformation in firms and its influence on their performance in a longitudinal study over 17 years using panel data [7].

Second, due to examining the effects of an interplay between firm strategic emphasis on digital transformation and firm size on market capitalization, we draw attention to firm characteristics, which might promote or hamper the realization of the benefits, connected with the digital transformation process. Thus, we extend the digital transformation framework as proposed by Vial [7] by adding an outcome of positive stock market reactions in terms of increased market capitalization to the building block of positive impacts, and of negative stock market reactions in terms of decreased market capitalization to the building block of negative impacts of digital transformation.

Additionally, we propose a further building block of contextual factors such as firm size, which might radically influence the result of the link between the changes in value creation paths and digital transformation impacts [7].

## 5.2. Limitations and future research

While the utilization of longitudinal research methods in terms of panel data analysis contributes to establishing causality in our results [64], our study has limitations. First, we faced the problem of missing data for our sample [34, 36, 37]. Among the variables used in our study, this problem especially affected firm R&D expenditures and financial data. Although we relied on complete 1,203 firm-year observations for our analysis, the reduced sample size might limit the generalizability of our results to those firms, which did not disclose their R&D expenditures. Further, while we controlled for R&D expenditures to address the magnitude of the required financial resources for digital transformation [50, 51], due to the poor data availability for the HDAX firms [34, 36, 37], we were not able to control for other aspects, which might be related to digital business strategy and its risk, such as IT investments [65]. Therefore, future research may address this limitation by repeating the study using another sample with a better data availability, and in doing so, include additional control variables such as IT investments.

Second, we approached digital transformation through firm strategic emphasis on digital transformation, while controlling for the presence of a CDO. Although these aspects provide a basis for formulating and implementing a digital transformation strategy [3, 5, 20, 21, 24], it encompasses more practices such as setting up governance structures [3], working together with customers and other business partners on digital transformation projects [20], developing digital services platforms and operational backbones or generating revenue, coming from digital products or services [2]. Thus, future research may address an interplay of these aspects of digital transformation with firm size on market capitalization.

Third, our measure of strategic emphasis on digital transformation was based on the count of words, beginning with “digit\*”, in firms’ annual reports. Although our analysis of the most frequently used words, beginning with this word root, indicated topics, connected with digital transformation of companies, we cannot rule out a potential bias, which could arise if firms would use these words differently depending on their industry. Hence, future research might investigate the exact meaning of the words, used by companies from different industries.

Fourth, even HDAX generates a considerable amount of variance with respect to firm size [34], we have to acknowledge that even the smallest company in our sample still had a market capitalization of multiple million. Thus, future research might explore the relationship between strategic emphasis on digital transformation and firm size on market capitalization by considering smaller firms.

## 5.3. Practical implications

Our study is also important for practitioners, who are embarking on a digital transformation journey [3, 5]. First, we draw attention of practitioners to the fact, that strategic emphasis on digital transformation, as signaled by their firms, can matter for firm market capitalization. Second, we provide evidence, that larger firms might anticipate a higher market capitalization as a result of signaling a higher strategic emphasis on digital transformation. Thus, larger companies can be advised to continue disclosing their strategic emphasis on digital transformation, while paying attention also to other signals, which they send in this respect to the public. At the same time, smaller companies might have a more difficult start [3, 5] on their digital transformation paths because investors can react to their signaling of a higher strategic emphasis on digital transformation skeptically, leading to a decreased market capitalization. Hence, smaller firms should be aware of these possible difficulties and should consider sending other signals to investors, demonstrating that they are able to successfully undergo and manage digital transformation as well as risks, associated with it. With these results, we aim at supporting firms on their digital transformation paths.

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