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## Digital Innovation Units: An Empirical Investigation of Performance Implications

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# Digital Innovation Units: An Empirical Investigation of Performance Implications

*Completed Research Paper*

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## Abstract

*Digital innovation is both a necessary and a challenging endeavor for most firms. To achieve progress in this regard, firms across contexts increasingly set up digital innovation units (DIUs). Despite its popularity in practice, the prospects of this initiative are to date unclear. Building upon dynamic capabilities theory, we hypothesize the performance implications of DIUs and employ panel data regressions to a longitudinal and cross-industry data-set to investigate our predictions. We find that DIUs increase performance and that this effect is strengthened by the presence of digital ventures in the industry as well as the degree to which the industry relies on tangible assets. Our additional analyses provide a nuanced perspective on the implications of DIU establishments. On the base of these findings, we derive important implications for IS research about digital innovation and transformation as well as DIUs and provide recommendations for managerial practice.*

**Keywords:** Digital Innovation Units, Digital Innovation, Digital Transformation, Dynamic Capabilities, Firm Performance, Panel Data Regression

## Introduction

Competitive advantage without embracing digital innovation (DI), defined „as the creation of [and consequent change in] market offerings, business processes, or models that result from the use of digital technology” (Nambisan et al. 2017, p. 224), appears to be unattainable in recent times (Nambisan et al. 2017; Yoo et al. 2012). Inactivity with regards to DI exposes firms to the risk of losing customers, market shares, and reputation to emerging digital players in their industry (Gregory et al. 2018). Yet, DI comes with specific hurdles as firms must build the capabilities to engage in the development of new, digital market offerings (Piccinini et al. 2015; Yoo et al. 2012). One popular initiative to overcome these hurdles is the establishment of digital innovation units (DIUs). DIUs can be defined as autonomous entities that aid their respective main organization (MO) in the development of digital capabilities and in the search for and creation of new digital products, services, and processes (e.g. Raabe et al. 2020a; Svahn et al. 2017). Although this initiative is popular in business practice (e.g. Lau et al. 2021) and has recently garnered some attention in IS research (e.g. Jöhnk et al. 2022; Raabe et al. 2020a; Svahn et al. 2017), there is no large-scale empirical evidence to verify its presumed beneficial impact.

IS research documents a variety of initiatives aimed at building capabilities for DI (e.g. Jöhnk et al. 2022). Among other initiatives, including the installment of digital institutional entrepreneurs (e.g. Firk et al. 2021), investment in digital M&A (Hanelt et al. 2021b), and the formation of external partnerships (Chaniyas et al. 2019), DIUs are of special interest for research and practice (e.g. Barthel et al. 2020; Svahn et al. 2017). Compared to other initiatives, DIUs are unique since they can, as organizational entities, internally enhance and aid the development of novel, idiosyncratic capabilities via research, production, and integration of digital products (Barthel et al. 2020; Raabe et al. 2021). Thereby, sourcing novel capabilities internally is considered as competitive advantage (Teece 2007), as it enables an intrinsic link to the firm's strategy and activities (Teece 2018). Further, in contrast to other initiatives, DIUs can be characterized as structural alterations, which represent manifestations of a firm's digital transformation (DT), defined "as organizational change that is triggered and shaped by the widespread diffusion of digital technologies" (Hanelt et al. 2021a, p. 1160). However, research frequently leaves unexplained if DIUs are more than a media phenomenon or signaling effort by the respective firms and whether they achieve substantial and quantifiable benefits (e.g. Mayer et al. 2021; Raabe et al. 2020b). Further, research reveals significant hurdles and tensions when it comes to integrating DIUs' digital outputs in a pre-digital context (Svahn et al. 2017). Relatedly, a practitioner study, for instance, describes a significant number of closures (10%) on over 250 monitored European DIUs (Lau et al. 2021). Thus, while previous research on DIUs provides valuable qualitative insights into their areas of activities, objectives (Raabe et al. 2021), and purpose (Barthel et al. 2020; Fuchs et al. 2019), we have less empirical evidence on their performance impacts, their ramifications for building competitive advantage and associated driving forces (Mayer et al. 2021).

To build and sustain competitive advantage in the digital era, a solid foundation of digital capabilities is necessary (Yoo et al. 2012), which must be compatible with the new logics underlying digital technologies (Hund et al. 2021). Karimi and Walter (2015) point out that building digital capabilities requires so called dynamic capabilities, which foster the creation and modification of ordinary (daily business) capabilities (Teece 2007). Dynamic capabilities are defined "as the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al. 1997, p. 516) and are associated with three key elements of *sensing*, *seizing*, and *transforming* (Teece 2007). They are described as the fundamental criteria that determine whether a business can survive or thrive in an era of growing digital challenges, turbulence, and pressure (Ellström et al. 2021). In line with prominent examples of IS research on the subjects of DI and DT, we apply the established perspective of dynamic capabilities to understand the influence of DIUs (Karimi and Walter 2015; Steininger et al. 2022; Warner and Wäger 2019).

An organizational foundation consisting of "distinct skills, processes, procedures, organizational structures, decision rules, and disciplines" is required to enable the emergence and advancement of dynamic capabilities (Steininger et al. 2022). Initial research associates the establishment of DIUs with the emergence of dynamic capabilities since DIUs' desired objectives, entrepreneurial setup, and post-bureaucratic organizational setting can be related to the required characteristics to build dynamic capabilities (Hellmich et al. 2021; Warner and Wäger 2019). Further, DIUs may be used to modernize firms' ordinary capabilities for the digital era (Hellmich et al. 2021; Warner and Wäger 2019), as indicated by prior DIU research (Fuchs et al. 2019; Hellmich et al. 2021). Despite the fact that some research suggests that DIUs can build and increase their MO's dynamic capabilities (Hellmich et al. 2021), other studies highlight challenges and hurdles with regard to their integration (Svahn et al. 2017). In the absence of large-scale empirical investigations regarding these assertions, our study aims to clarify this pertinent instance. Further, there is a dearth of empirical data demonstrating the dynamic capability framework's favorable impacts in DI contexts when built and realized in a distinct organizational entity (Ellström et al. 2021; Karimi and Walter 2015; Teece 2018; Warner and Wäger 2019). Additionally, recent research on DIUs is mostly based on the distilled expertise of employees directly associated with DIUs (e.g. Holotiuik and Beimborn 2019; Raabe et al. 2020a). This may result in an exaggerated and glossed-over - thus maybe biased - positive impression of DIUs' advantages, which is currently not validated nor confirmed by quantifiable empirical investigations. By leveraging independent and quantifiable empirical data, we seek to overcome this research gap on the true impacts of DIUs. Aiming to close these gaps, our investigation focuses on the following research question: *How does the establishment of DIUs influence firm performance?*

To address this question, we employ panel data regressions to a longitudinal dataset of Standard & Poor's 500 (S&P 500) firms in the years 2011 and 2019. We observed that establishing a DIU is associated with

higher future firm performance on average. Further, our findings suggest that the degree of tangible assets and the presence of digital ventures in the industry environment positively moderates the influence of DIUs on firm performance. Finally, additional tests reveal that the influence on firm performance may stem from three developments, each of which is intimately linked to the dynamic capability perspective. Specifically, we discovered a beneficial effect (1) of DIUs on the number of produced digital patents (*sensing* capability), (2) of DIUs on the number of digital market offerings (*seizing* capability), and (3) of DIUs on the firm's digital transformation (*transforming* capability), showing that the establishment of DIUs can serve as a valuable foundation to build and realize dynamic capabilities.

This research contributes to the increasing body of knowledge on DIUs by presenting the first large-scale empirical investigation on their performance implications (Mayer et al. 2021; Raabe et al. 2020a). We further provide insights about moderating contextual factors that positively influence DIUs' performance implications. In addition, we contribute to the framework of dynamic capabilities by providing an indicator of how they are built and realized within an organizational entity (i.e., a DIU) (Ellström et al. 2021; Karimi and Walter 2015; Teece 2007). By providing applicable metrics to assess the advantages of DIUs and dynamic capabilities our additional analysis contributes to both streams of literature. Additionally, our results contribute to both DI and DT research by demonstrating and examining the impact of one initiative in depth (Hanelt et al. 2021a; Vial 2019). Finally, this study has significant implications for management practice.

## **Background**

### ***Digital Innovation and Transformation***

Given the pervasiveness of digital technology in practically every product and service, being at the forefront of DI is becoming increasingly critical for competitiveness (Nambisan et al. 2017; Yoo et al. 2012). Specifically, new digital ventures compete for customers, market share, and reputation, also in established industries, and may thereby alter or disrupt the competitive landscape (Gregory et al. 2018). Examples are the famous Kodak-Moment (Lucas and Goh 2009) or the disruptive introduction of mobility providers such as UBER or Lyft into the car sector (Bohnsack et al. 2021). In established contexts, DI requires "a new organizational form that departs dramatically from traditional industrial production" (Berente 2020, p. 92), since creating DI puts pressure on both the offered products and services and institutionalized organizational forms (Yoo et al. 2012). Accordingly, organizational determinants (Hund et al. 2021), such as the establishment of a DIU, can have a favorable influence on enabling and fostering DI (e.g. Barthel et al. 2020; Svahn et al. 2017). Therefore, while DIUs are dedicated to create DI (Svahn et al. 2017a), their establishment, as structural alteration of the MO, represents a manifestation of a firm's digital transformation (DT) (Göbeler 2020; Jöhnk et al. 2022). DT propels organizations into a continuous state of change and reconfiguration with the purpose of successfully developing and supplying DI as well as preserving continual adaptability within digital business ecosystems (Hanelt et al. 2021a). Considering the turbulent and challenging context of DT, triggered by the widespread diffusion of digital technology (Hanelt et al. 2021a), researchers argue that the dynamic capabilities perspective provides an effective lens through which to perceive a firm's transformation endeavor (Warner and Wäger 2019). Firms have been urged to develop dynamic capabilities capable of swiftly creating, implementing, and transforming business models in order to remain ahead in the emerging digital environment (e.g. Karimi and Walter 2015; Teece 2018). More broadly, the continual adaptation, implementation, and refinement of an organization's business and organizational structures necessitates the development of dynamic capabilities (Teece 2007; Teece 2018). Due to the inherent dynamism of digital innovation (Nambisan et al. 2017; Yoo et al. 2012), the demand for dynamic capabilities is more of an ongoing requirement than a selective one (Warner and Wäger 2019). To stay competitive in the digital age, firms must provide organizational foundations to build and realize dynamic capabilities (Karimi and Walter 2015; Steininger et al. 2022). Despite their crucial role in firms' DI and DT activities, there is a scarcity of research on how firms can build and realize dynamic capabilities (Warner and Wäger 2019).

### ***Digital Innovation Units***

DIUs have been illustrated as an important initiative to carry out digital research and development (Dremel et al. 2017; Svahn et al. 2017), to enable the implementation of a DT strategy (Chanias et al. 2019), to

overcome DT inertia (Haskamp et al. 2021c) or to enable organizational hybridity (Schumm and Hanelt 2021). While different types of DIUs may have distinct attributes, they all share an emphasis on digital technologies at their core (Fuchs et al. 2019; Raabe et al. 2020a), which distinguishes this phenomenon from those discussed in other streams of literature, such as new business incubators (e.g. Gassmann and Becker 2006). DIUs operate with a focus on flexibility (Barthel et al. 2020), with creative methodologies (Svahn et al. 2017), using agile principles and a close customer orientation in the context of DI (Fuchs et al. 2019; Raabe et al. 2020a). Thus, establishing a DIU to foster DI activities can be understood as a firm's effort to change its organizational structure, routines, and culture to become more adaptable to digital environments (Göbeler 2020; Schumm and Hanelt 2021). Recent IS research identifies multiple objectives for DIUs, all of which stem from a strong emphasis on DI, including research, selection, development, and dissemination of digital offerings (Holotiuk and Beimborn 2019). Creating and providing novel digital products or services, DIUs' outcomes entail various beneficial ramifications for their MOs (Holotiuk and Beimborn 2019; Raabe et al. 2021). Research associates the creation and integration of novel digital offerings into an existing product landscape as superior to gain new customers and market share (Gregory et al. 2018), which can be related to an improvement in (financial) performance (Hanelt et al. 2021b). Further, by participating actively in DI, DIUs are related to building up digital capabilities, for example in the field of big data analytics (Dremel et al. 2017). Consequently, the establishment of DIUs is deemed to serve as a foundation to build and realize dynamic capabilities (Fuchs et al. 2019; Jöhnk et al. 2022; Raabe et al. 2021). Concluding, DIUs' purpose includes the research on or the development of digital offerings (Barthel et al. 2020; Fuchs et al. 2019), the enablement of the MO's DT endeavors (Dremel et al. 2017), as well as, at a higher abstraction level, the building and realization of new, dynamic capabilities (Hellmich et al. 2021; Svahn et al. 2017). Yet, despite the fact that research on DIUs is generally associated with a positive effect (e.g. Dremel et al. 2017), these studies have not determined whether the establishment of the observed DIUs results in a measurable improvement (e.g. Mayer et al. 2021; Raabe et al. 2020b). Further, the establishment of DIUs into a pre-digital environment has been shown to have a generally beneficial impact (Smith and Beretta 2021), yet numerous tensions and hurdles during their integration have been noted (Svahn et al. 2017). Relatedly, there have been reports about relatively high closure rates among DIUs in business practice (Lau et al. 2021). Thus, large-scale empirical insights on DIUs' performance implications are currently missing and would contribute to a greater understanding of their underlying impacts and benefits. Regarding our theoretical lens, additional research is required to determine whether DIUs can serve their MOs as an organizational foundation for building and realizing dynamic capabilities.

## Hypotheses Development

Prior research on DI has shown the increased need for digital capabilities (Hund et al. 2021; Yoo et al. 2012). These can be built by drawing on dynamic capabilities, aiding organizations in adjusting their ordinary capabilities to the digital era (Karimi and Walter 2015). Dynamic capabilities, with their key elements of *sensing*, *seizing* and *transforming* (Teece 2007), enable organizations to adapt their business models to substantial changes in their environment (Steininger et al. 2022). The presence of dynamic capabilities is therefore said to be related to competitive advantage in changing and turbulent business environments (Teece 2007; Teece et al. 1997). Organizational foundations to build and realize dynamic capabilities should be internally incorporated, not bought, to enable an intrinsic link to the firm's strategy and activities (Teece 2018). Therefore, DIUs may be thought of as foundations where dynamic capabilities may be built, and realized (Hellmich et al. 2021), since they can provide the structural, processual, and entrepreneurial framework deemed essential for the emergence of dynamic capabilities (Teece 2007).

Moreover, DIUs as dedicated DI engines are aimed at searching for, developing, and integrating novel digital offerings into the existing product landscape of an incumbent (Svahn et al. 2017). Therefore, expanding the current business with digital products and services is considered to generate additional income and thus can be advantageous to the firm's performance (Hanelt et al. 2021b). Concluding, DIUs may have a positive influence on firm performance, yet their inherent advantages may vary, since they are based on conditions that render benefits particularly valuable (Göbeler 2020; Holotiuk 2020). Their impact may be amplified, particularly in contexts where the internal hurdles and external threats to participating in DI are comparably high.

**Performance Implications.** The continuous and increased utilization of digital technology places firms in the position of requiring novel capabilities to generate new digital products and services to foster firm

performance (Yoo et al. 2012). Establishing DIUs may therefore have a positive effect on firms' performance (Hellmich et al. 2021; Warner and Wäger 2019), as they can serve as foundation to build and realize dynamic capabilities, which may lead to competitive advantage (Teece 2007; Teece et al. 1997). More specifically, via *sensing* and *seizing*, DIUs may "serve as a fast lane for developing new ideas and products" (Haskamp et al. 2021a, p. 1), resulting in the exploration of new client groups and the establishment of new or advanced revenue streams, which can improve the firm's performance (Hanelt et al. 2021b). Smith and Beretta (2021), for example, describe a DIU inside an industrial pump manufacturer that is responsible for identifying (*sensing*) and developing (*seizing*) digital components with the goal of extending existing physical goods to create "intelligent pumps". These new, digital features provide the MO with a plethora of technical data that can be used to optimize internal development and maintenance processes, while also paving the way for new business models in platform-based ecosystems (Smith and Beretta 2021). This digital enhancement can result in new digital income streams, increasing the overall firm performance (Hanelt et al. 2021b). Further, the establishment of DIUs may facilitate critical DT efforts (Barthel et al. 2020; Fuchs et al. 2019), such as by supplying and supporting the MO with digital knowledge and expertise (Fuchs et al. 2019; Raabe et al. 2021). Dremel et al. (2017) present an example of DIUs developing and integrating new (digital) capabilities in the field of big data analytics in order to change (*transforming*) the organizations' capabilities to current digital requirements. Another example illustrates how a DIU may serve as a best practice for new methods of working, cultural changes, and DT strategy enhancements (Chaniyas et al. 2019). These *transforming* capabilities pave the way for integrating novel capabilities and DIs into established business models (Barthel et al. 2020; Fuchs et al. 2019). To conclude, we suggest that DIUs contribute to performance improvement by producing DIs and assisting in their integration. Further, they can be seen as the foundation to build and realize vital dynamic capabilities (e.g. Fuchs et al. 2019; Hellmich et al. 2021) relevant to increasing competitive advantage (Teece 2007; Teece et al. 1997). This leads us to the following hypothesis:

*H1: The establishment of DIUs is positively associated with future firm performance.*

### **Contextual conditions**

The need to change in response to the diffusion of digital technology and therefore the importance of dynamic capabilities for firm performance may differ from firm to firm depending on the respective contextual conditions (Singh and Hess 2020). DIU outcomes are characterized to be especially advantageous when external environmental "pressure [...] is exacerbated by pervasive digitalization" (Göbeler 2020, p. 10) and internal hurdles to creating DI are significant (Barthel et al. 2020). Thus, DIUs' influence on firm performance and thus their inherent advantages may vary. Their impact on firm performance may be influenced in two ways: (1) internally, by the current organizational hurdles to develop DIs, characterized by the extent to which an industry relies on physical, tangible assets; and (2) externally, by environmental concerns prompted by new actors threatening traditional industrial roles.

**Internal DT Hurdles.** The internal DT hurdles may be linked to the (in)ability to produce digital components and the prospect of digitizing a firm's present business model (Firk et al. 2022). DI is considered as a central requirement for all industries and firms to preserve or expand competitive advantage in recent times (Nambisan et al. 2017; Yoo et al. 2012). Yet, the ability and effort to create them seems to differ between industries (Hanelt et al. 2021b; Karimi and Walter 2015; Piccinini et al. 2015). While business models depending on non-physical, intangible assets are rather associated with digitization (Yoo et al. 2012), business models based substantially on tangible assets come with specific pitfalls and hurdles in DI as to the semantic difference in the underlying knowledge and the static nature of physical materiality (e.g. Hanelt et al. 2021b; Piccinini et al. 2015). Given the fact that firms in physical-product industries have a long history of manufacturing physical, non-digital goods (Bohnsack et al. 2021; Hylving and Schultze 2020), they often lack critical digital capabilities and organizational preconditions necessary to build DI (Yoo et al. 2012). This is plausible, given their "strong hardware legacy, where development processes and organizational structures are typically adjusted and reflected in the physical product, i.e., the car" (Hylving and Selander 2012, p. 2). It presents distinct internal hurdles since there is not only a scarcity of knowledge for obtaining digital capabilities, but also a scarcity of organizational flexibility and autonomy for innovative activities (Smith and Beretta 2021). Accordingly, we argue that in industries that rank high in tangible assets, firms face more internal hurdles in creating DI (Dremel et al. 2017; Svahn et al. 2017). Thus, DIUs have a greater impact on performance as the need for the dynamic capabilities they instantiate is comparatively higher (Teece 2007; Teece 2018) and digital products and services are more vital to be

provided by DIUs (Dremel et al. 2017; Svahn et al. 2017). Concluding, firms with a strong emphasis on tangible assets, may experience a positive influence on DIUs' performance implications. This leads us to the following hypothesis:

*H2a: The level of tangible assets positively moderates the positive association between the establishment of DIUs and future firm performance.*

**External DT Threats.** The external DT threats may be linked to the presence of digital ventures entering the respective industry (Firk et al. 2022). The existence of digital ventures underscores the critical need to create and develop DI (e.g. Huang et al. 2017). Previous research demonstrated their influence on established industries via large-scale empirical studies and observed a triggering impact on incumbents to respond (Firk et al. 2021; Zapadka et al. 2022). Flexible and agile digital ventures that can leverage digital technologies successfully and swiftly (Huang et al. 2017) are infiltrating current competitive environments or creating new ones that supersede previously dominating ones (Skog et al. 2018). These digital ventures can rapidly test new business models and scale up successful concepts globally (Kelestyn et al. 2017). Accordingly, the presence of digital ventures equals an increase in environmental change that drives the importance and benefits of dynamic capabilities (Teece 2018). Firms could particularly profit from DIUs digital outcomes since they are described as an explicit initiative when “new market entrants from the technology industry increase the competitive pressure” (Holotiuk 2020, p. 7). When organizations face larger external threats as a result of a strong presence of digital ventures, DIUs' ability to predict digital disruptive challenges may create more value, since firms must respond even quicker. Being able to supply digital offerings on their own may have a positive impact on firm performance in sectors where digital competition is comparably strong (Holotiuk 2020). Furthermore, when the external environment is more threatening, DIUs may have a stronger influence on competitive advantage since the demand for the dynamic capabilities they can aid to build (Teece 2007; Teece 2018) and the MO's pressure to accept and integrate DIUs' digital outcomes is comparatively higher. Concluding, we argue that DIUs' impact on firm performance may be even higher, in the presence of intense digital competition. As a consequence, the following hypothesis is proposed:

*H2b: The number of digital ventures in the industry positively moderates the positive association between the establishment of DIUs and future firm performance.*

## Methodology

### *Sample Selection*

We focus on a longitudinal sample of S&P 500 firms over the years 2011 to 2019. Data related to the establishment of DIUs was hand-collected from press releases and media articles in newswires on the LexisNexis database. We further retrieved data on firm performance, tangible assets, and further financial and industry characteristics from Datastream, whereas data on digital ventures was retrieved from the CrunchBase database. Based on the availability of this data, we end up with a final sample covering 618 firms and 4,823 firm-years.

### *Variables*

**Dependent Variable – Firm performance.** To measure firm performance, we use, similar to prior research in the IS economics literature (Banker et al. 2011; Ho et al. 2017; Van Peteghem et al. 2019), a market-based performance measure. Specifically, we focus on the firm's stock returns (market return 2fy) over the next two years (t+1 and t+2). We decided for a market-based measure instead of an accounting-based measure as accounting measures are often criticized for not appropriately capturing the performance of digital business models (e.g., due to long lead times) (Govindarajan et al. 2018). To calculate the two-year stock returns, we use the RI variable as specified in Datastream.

**Independent Variable – DIU establishment.** To measure the establishment of DIUs, we exploited press and company announcements regarding DIUs. In order to gather all relevant search strings, we carefully studied the current DIU literature. It contains several distinct descriptions, archetypes, and names (e.g. Barthel et al. 2020; Raabe et al. 2020a). We derived a list of 12 unique descriptions for DIUs, like "Digital Lab", "Digital Innovation Lab", "Innovation Lab", "Innovation Hub", "Digital Innovation Hub" etcetera, to compile a list of their descriptions that considers different terms. We then manually hand-

collected and coded all press releases and business announcements from newswires on the LexisNexis database, based on our S&P 500 firms, between 2011 and 2019. We verified the DIU's assignment to the MO to ensure that it is directly related to the MO and not, for example, mentioned in terms of a consortium of firms cooperating. Our final DIU variable (*DIU*) takes the value of one if a MO established a DIU in the respective year, and zero otherwise.

**Moderator variable – Internal DT hurdles.** To measure internal DT hurdles, we focus on the firm's reliance on tangible assets such as machinery or other equipment. Similar to prior research (Antia et al. 2010; Custódio et al. 2019), we measure the reliance of a firm on tangible assets by dividing the level of property, plant and equipment by a firm's total assets (*Tangible assets*).

**Moderator variable – External DT threats.** To measure the threats that digital ventures place on incumbent firms, we follow prior research and use a measure that captures the number of new digital ventures per industry incumbent. Specifically, Firk et al (2021) extracted all ventures in the Crunchbase database and evaluated whether it was a digital venture by evaluating the descriptions. They further classified each digital venture's industry affiliation. In line with prior studies (e.g. Zapadka et al. 2022), we carefully matched this industry-level construct to our firm-level abstraction. Based on the classification of Firk et al. (2021), we counted the number of new digital ventures in each industry and year and divided this number by the number of industry incumbents (i.e., all firms that had been listed for more than 3 years in the Datastream database) to measure our external DT threat variable (*digital ventures*). Finally, similar to Firk et al. (2021) we calculated the average of this variable over a 3 year period (t, t-1 and t-2) as we expect that the pressure of new ventures may evolve over time.

**Control variables.** We selected several variables that may drive both the firm's decision to establish a DIU and firm performance to control for confounding effects. We screened prior research focus on the relation between IT-related constructs and firm performance to select control variables (Banker et al. 2011; Ho et al. 2017; Mithas et al. 2012). We include *firm size* as the natural logarithm of net sales. We then included a *firm's leverage* proxied by total debt in relation to total assets and *firm risk* as the standard deviation of the return of equity over the last 3 years divided by its mean. We included *R&D intensity* measured as R&D expenditure by net sales. Moreover, we captured the current performance by including *ROA* as a measure for profitability and *sales growth* as the 3 year growth in sales prior to the respective year. Finally, we followed Mithas et al. (2012) and included the yearly average of the *industry's Tobin's q* as well as the *industry concentration* calculated via a Herfindahl index. We used for both a Fama-French 30 classification.

### ***Empirical Method***

To examine performance implications of establishing DIUs, we follow the IS economics literature by estimating a firm-fixed effects regression (Mithas et al. 2012; Pan et al. 2016). This decision was supported by running a Hausman (1978) test. The firm-fixed effects regression assigns each firm an individual effect to control for any firm-specific unobservable factors. We further specified the firm-fixed effects model as a treatment effects model. The treatment effect model is a type of selection model that can be used to mitigate self-selection concerns (Certo et al. 2016). To apply the treatment effect model, we first employ a probit model that estimates the likelihood of establishing a DIU and calculate an inverse Mills' ratio based on its results. Second, we include the inverse Mills' ratio as an additional variable in our firm-fixed effects model to control for self-selection. The literature outlines the importance of including an appropriate exclusion criteria in the first-stage probit model (Lennox et al. 2012). We use the peer industry average of firms that have at least one DIU established as our exclusion variable. We believe that this variable could be appropriate because peer industry average of firms could influence the firms' decisions to establish a DIU (relevance condition). We further expect that this variable is rather exogenous from a focal firm's performance and that it is valid to exclude this variable from our second stage estimation (exclusion restrictions). In the first stage probit model (untabulated), we further include all our second stage control variables and added the market performance in the two years before the DIU establishment. Based on the results, we then calculated the inverse Mill's ratio and estimate the following regression to test our first hypothesis.

$$I. \quad \text{Market Return } 2fy_{i,(t+1,t+2)} = \alpha + \beta_1(DIU)_{i,t} + \gamma_1IMR_{i,t} + \gamma_2(CONTROLS)_{i,t} + Y_t + \eta_i + \varepsilon_{i,t}$$



Besides the dependent variable (*Market Return 2fy*) and our independent variable (*DIU*) the item *CONTROLS* represents a matrix reflecting the selected control variables. The item *IMR* stands for the inverse-Mill's ratio that addresses selection concerns. The remaining items are the year fixed effects ( $Y_t$ ), the constant term ( $\alpha$ ), the firm-fixed effects ( $\eta_i$ ), and the error term ( $\varepsilon_{i,t}$ ).

To test Hypothesis 2a and Hypothesis 2b, we further add our moderator variables as well as interaction terms between the moderator variables and the *DIU* variable. The moderator variables were standardized before adding them to the model. We use the following regression to estimate Hypothesis 2a and Hypothesis 2b.

$$II. \text{ Market Return } 2fy_{i,(t+1,t+2)} = \alpha + \beta_1(DIU)_{i,t} + \beta_2(DIU * \text{Tangible assets})_{i,t} + \beta_3(DIU * \text{Digital ventures})_{i,t} + \beta_4(\text{Tangible assets})_{i,t} + \beta_5(\text{Digital ventures})_{i,t} + \gamma_1 IMR_{i,t} + \gamma_2( \text{CONTROLS})_{i,t} + Y_t + \eta_i + \varepsilon_{i,t}$$

## Findings

### Descriptive Results

Table 1 illustrates the diffusion of DIUs in our sample. The establishment of DIUs has grown significantly in recent years. While we observed barely twenty DIU establishment in the first three years of our sample period (i.e., 2011-2013), we observed seventy DIU establishments in the last three years of our sample period (i.e., 2017-2019). In total, we found 131 DIU establishment over the entire sample period. Furthermore, about fifteen percent of all firms established at least one DIU in our sample period.

Year	Obs.	DIU establishments	DIU establishments (%)	DIU users	DIU users (%)
2011	536	9	1.7%	9	1.7%
2012	544	7	1.3%	15	2.8%
2013	544	4	0.7%	18	3.3%
2014	542	11	2.0%	27	5.0%
2015	541	14	2.6%	38	7.0%
2016	532	16	3.0%	46	8.6%
2017	523	24	4.6%	57	10.9%
2018	531	29	5.5%	74	13.9%
2019	530	17	3.2%	81	15.3%
<i>Total</i>	<i>4823</i>	<i>131</i>	<i>2.7%</i>	<i>365</i>	<i>7.6%</i>

Table 2 displays the mean, standard deviation, as well as the bivariate correlations of all our regression variables. The means and SDs are comparable to prior research. All continuous variable have been winsorized at the 1<sup>st</sup> and 99<sup>th</sup> percentiles thus mitigating any issue due to exceptional outliers. The correlations further indicate a positive and small correlation between DIUs and firm performance. Moreover, the correlations did not indicate multicollinearity issues as all correlations were below 0.5 and most far below 0.2.

Variable names	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13
(1) <i>Market ret. 2fy</i>	0.13	0.20	1.00												
(2) <i>DIU</i>	0.03	0.16	-0.01	1.00											
(3) <i>Tangible assets<sup>b</sup></i>	0.28	0.27	-0.09	-0.07	1.00										
(4) <i>Digital ventures<sup>b</sup></i>	0.05	0.09	0.03	0.01	-0.22	1.00									
(4) <i>Firm size<sup>a</sup></i>	15.67	1.29	-0.11	0.17	-0.18	-0.08	1.00								

(5) Leverage	0.26	0.18	-0.06	-0.03	0.20	0.03	-0.02	1.00							
(6) R&D intensity	0.02	0.04	0.13	0.06	-0.17	0.07	-0.19	-0.16	1.00						
(7) Sales growth	0.33	0.54	0.14	-0.03	-0.03	0.04	-0.14	-0.05	0.23	1.00					
(8) ROA <sup>c</sup>	7.46	7.18	0.18	0.03	-0.15	0.06	-0.02	-0.05	0.07	0.01	1.00				
(9) Firm risk	0.28	1.65	0.02	0.02	0.00	-0.03	0.02	-0.02	0.00	0.02	0.02	1.00			
(10) Ind. Tobin's q	1.97	0.87	0.12	0.08	-0.43	0.42	-0.03	0.04	0.36	0.08	0.33	0.00	0.40	1.00	
(11) Ind. concentr.	0.12	0.09	-0.03	-0.01	-0.14	0.07	0.15	0.11	-0.10	-0.03	0.07	-0.01	0.16	0.10	1.00

**Notes:** N = 4,823; a = natural logarithm; b = standardized variable is used in the regression model; c = measured in percent; all variables except from the binary variable *DIU* have been winsorized at the 1<sup>st</sup> and 99<sup>th</sup> percentiles; correlations exceeding the value of 0.02 are significant at the 10 percent level.

### Regression Results

The results of firm fixed effects models estimating the influence of establishing a DIU and future market returns are displayed in Table 3. Model 1 shows the direct influence of establishing a DIU. We find a positive and significant coefficient ( $p < 0.05$ ) for the DIU variable. In practical terms, the establishment of DIU is associated with a 9 percentage point increase in market returns over the next two years. Hence, the results support our first hypothesis suggesting that establishment of DIUs is positively associated with firm performance.

Model 2 to Model 4 of Table 3 test the moderating influence of DT hurdles (*tangible assets*) as well as the moderating influence of DT threats (*digital ventures*). With regard to internal DT hurdles, we find a positive interaction term between the level of tangible assets and DIU establishment in Model 2 ( $p < 0.05$ ) and Model 4 ( $p < 0.01$ ). In practical terms, the results of Model 2 suggest that a 1SD increase in the level of tangible assets strengthens the positive association between establishing DIUs and future market returns by 38 percent. This result supports our hypothesis H2a suggesting that firms with more tangible assets that have a higher DT hurdle could particularly benefit from the establishment of DIUs. With regard to external DT threats, we find a positive interaction term between digital ventures and DIU establishment in Model 3 ( $p < 0.1$ ) and Model 4 ( $p < 0.01$ ). The results of Model 4 indicate that a 1SD increase in the level of digital ventures in the industry strengthens the positive association between establishing DIUs and future market returns by 18 percent. Hence, this results supports hypothesis H2b suggesting that firms in industries with more digital ventures, and thus a higher external DT threat, benefit more from DIUs' presence. We also plotted both interaction terms (untabulated). The plot supported the positive moderation of tangible assets as well as digital ventures.

**Table 3: Regression results: DIU establishments and firm performance**

Model	1	2	3	4
Dependent Variable	Market return 2fy	Market return 2fy	Market return 2fy	Market return 2fy
Method	Firm-fixed effects	Firm-fixed effects	Firm-fixed effects	Firm-fixed effects
<i>DIU (H1)</i>	0.090** (0.034)	0.121*** (0.009)	0.090** (0.036)	0.124*** (0.007)
<i>DIU * Tangible assets (H2a)</i>		0.045** (0.039)		0.054** (0.010)
<i>DIU * Digital ventures (H2b)</i>			0.016* (0.059)	0.021*** (0.003)
<i>Tangible assets</i>		-0.038*** (0.007)		-0.038*** (0.007)
<i>Digital ventures</i>			0.006 (0.732)	0.005 (0.772)
<i>Inverse mills ratio</i>	0.029* (0.087)	0.034* (0.051)	0.030* (0.082)	0.035** (0.048)
<i>Firm size</i>	-0.076*** (0.000)	-0.085*** (0.000)	-0.076*** (0.000)	-0.085*** (0.000)

<i>Leverage</i>	0.012 (0.817)	0.006 (0.902)	0.011 (0.826)	0.006 (0.911)
<i>R&amp;D intensity</i>	-0.667* (0.079)	-0.615 (0.116)	-0.662* (0.083)	-0.613 (0.119)
<i>Sales growth</i>	-0.003 (0.792)	-0.004 (0.713)	-0.003 (0.787)	-0.004 (0.708)
<i>ROA</i>	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)	0.003*** (0.000)
<i>Firm risk</i>	0.002 (0.301)	0.002 (0.287)	0.002 (0.310)	0.002 (0.294)
<i>Industry Tobin's q</i>	0.101*** (0.000)	0.101*** (0.000)	0.100*** (0.000)	0.100*** (0.000)
<i>Industry concentration</i>	-0.003 (0.985)	-0.005 (0.979)	0.012 (0.947)	0.009 (0.960)
<i>Intercept</i>	1.088*** (0.000)	1.199*** (0.000)	1.088*** (0.000)	1.200*** (0.000)
Firm effects	yes	yes	yes	yes
Year effects	yes	yes	yes	yes
N	4823	4823	4823	4823
Adjusted R-Square	0.308	0.310	0.308	0.310
<b>Notes:</b> *p<0.10; **p<0.05; ***p<0.01. Robust standard errors clustered at the firm-level. P-values in parentheses. The moderator variables <i>Tangible assets</i> and <i>Digital ventures</i> are standardized (i.e., mean value of zero and a standard deviation of one) to facilitate the interpretation of the moderating effects.				

### Robustness of Results

**Endogeneity concerns.** The establishment of DIUs and firm performance could be simultaneously driven by an unobservable factor. To address such endogeneity concerns, we used in our main analysis a firm-fixed effects regression and a correction factor that accounts for self-selection issues. To further tackle endogeneity concerns, we also employ three matching procedures: propensity score matching, coarsened exact matching as well as entropy balancing. All these matching procedures aim to account for the fact that observations with DIU establishments (i.e., treatment group) are not randomly distributed in our dataset. Matching procedures adjust the control group (i.e., observation with no DIU establishments) to reduce systematic differences in observable characteristics between the treatment and the control group. The idea is that this likely reduces differences in unobservable characteristics between the two groups (Hainmueller and Xu 2013; Shipman et al. 2017) and thus endogeneity issues. For the propensity score matching, we specified a one-to-one match and thus matched the control observation with the most similar propensity score to a respective treatment observation (Shipman et al. 2017). In the coarsened exact matching, we divided our controls into “bins” (quartiles) and then matched treatment observations and control observations that are in the same bin (Iacus et al. 2012). Both the propensity score matching and the coarsened exact matching reduces the number of total observations. Entropy balancing, however, does not exclude dissimilar control observations. It reweights the observations in the dataset to diminish any systematic differences between observations in the control and the treatment group (Hainmueller and Xu 2013). For all matching procedures, we used all of our control variables as well as the market performance over the last two years. Table 4 displays regression results on the matched samples. The results consistently support our previous findings.

**Table 4: Regressions results on matched samples**

Model	PS matched		CEM matched		Entropy balanced	
	1	2	3	4	5	6
Dependent Variable	Market return 2fy	Market return 2fy	Market return 2fy	Market return 2fy	Market return 2fy	Market return 2fy
Method	OLS	OLS	OLS	OLS	OLS	OLS
<i>DIU (H1)</i>	0.046*** (0.005)	0.065*** (0.003)	0.037*** (0.004)	0.040*** (0.003)	0.032*** (0.008)	0.051*** (0.001)
<i>DIU * Tangible assets (H2a)</i>		0.055* (0.093)		0.021** (0.074)		0.055** (0.015)

<i>DIU * Digital ventures (H2b)</i>		0.050*** (0.002)		0.022** (0.046)		0.028*** (0.001)
<i>Tangible assets</i>		-0.034* (0.094)		-0.004 (0.539)		-0.027* (0.072)
<i>Digital ventures</i>		-0.011 (0.448)		0.001 (0.948)		0.013** (0.016)
Control variables	yes	yes	yes	yes	yes	yes
Year effects	yes	yes	yes	yes	yes	yes
N	255	255	2501	2501	4823	4823
Adjusted R-Square	0.440	0.462	0.375	0.376	0.371	0.390
<b>Notes:</b> *p<0.10; **p<0.05; ***p<0.01. Robust standard errors clustered at the firm-level. P-values in parentheses. The moderator variables <i>Tangible assets</i> and <i>Digital ventures</i> are standardized (i.e., mean value of zero and a standard deviation of one) to facilitate the interpretation of the moderating effects.						

**Alternative specifications.** We run several (untabulated) robustness tests. First, we alternatively run a random effects model and found consistent results. Second, we tested alternative time-windows for our market return variable and found that the effects also hold for a shorter window of one-year as well as a longer window of three years. Third, we also tested Tobin's Q as alternative performance measure and found similar results to those reported. Finally, we also tested an alternative specification of the DIU variable. We used the number of DIUs as well as the first DIU establishment as alternative variable and found again support for our hypotheses.

### Additional Analysis

Our investigation revealed that establishing DIUs has a considerable effect on the MOs' firm performance. Our arguments for the positive performance effect of DIUs are based on the idea that DIUs might be able to serve as a foundation to build and realize dynamic capabilities (Fuchs et al. 2019; Hellmich et al. 2021). Specifically, this implies that DIUs may lead to increased dynamic capabilities with regard to their key elements of - *sensing*, *seizing*, and *transforming* (Teece 2007). Hence, in additional tests, we focused on three outcome variables that could indicate an increase in terms of these three key elements.

First, DIUs can be thought of as an organizational entity tasked with performing research and screening for (external) digital possibilities (Barthel et al. 2020; Raabe et al. 2020a). From the dynamic capability perspective, this may position firms in a leading role when it comes to *sensing* the environment for possible future business opportunities, putting them one step ahead of the competition in terms of gaining new digital expertise and meeting new customer expectations (Teece 2007; Teece 2018). Building this dynamic capability likely has a beneficial influence on digital knowledge (Warner and Wäger 2019). Hence, we follow earlier research using digital patents as a proxy for a firm's internal digital knowledge base (e.g. Firk et al. 2022; Hanelt et al. 2021b) and test whether DIUs are positively associated with the filings of digital patents in the next two years, and if they can serve as a foundation to build the dynamic capability of *sensing*. We revised all patent profiles for digital ones and measured them similar to Firk et al. (2022) as the natural logarithm of the number of digital patents in the next two years. The data is collected from the USPTO database.

Second, DIUs aim to assist their MOs by developing new digital components, such as digital products and services that may result in new income streams (Svahn et al. 2017). Applying the dynamic capability perspective, *seizing* emerging opportunities is critical when attempting to build and execute new (digital) business models and may lead to a competitive advantage (Teece 2018). Regarding our theoretical lens, earlier studies observed a theoretical connection between this dynamic capability and digital product and service innovation (Limaj et al. 2016). We hence investigate whether DIUs are associated with more digital market offerings (i.e., digital products and services) in the next two years, and if they can serve as a foundation to build the dynamic capability of *seizing*. We focus on press releases and news articles regarding product and service releases and then classified these product and service releases as a new digital market offering or not. Again, we counted the number of digital market offerings and calculated the natural logarithm of digital market offerings over the next two years.

Third, establishing DIUs can be associated with facilitating a firm's internal organizational and cultural transformation (Göbeler 2020; Jöhnk et al. 2022). When it comes to aligning and enhancing existing business models and capabilities with new ones, the dynamic capability of *transforming* may be seen as

unique benefit in gaining competitive advantage (Teece 2018). This capability is associated with both the adoption of new technologies (Karimi and Walter 2015) and the change of existing business models and structures (Ellström et al. 2021). Hence, we decided to further investigate the influence of DIUs on the firm's DT in the next two years and investigate if DIUs, can serve as a foundation to build the dynamic capability of *transforming*. To measure DT, we follow the approach of prior studies (Li et al. 2021a), by applying textual analysis to the firm's annual report. Specifically, we measure the increase of digital-related words (e.g., identified by using a word embedding model; see, Li et al. (2021b)) in the firm's 10k report from the time  $t$  to  $t+2$ . We first calculate the relative occurrence of digital words in a 10k report and then measure the relative increase over the next two years.

The results of these tests are summarized in Table 5. We find that DIUs are associated with more digital patents (Model 1) as well as more digital market offerings (Model 2) in the next two years. We also find a positive and significant association between DIUs and the firm's digital transformation (Model 3). Hence, DIUs' outcomes can be empirically associated with the subdivided outcomes of dynamic capabilities - *sensing*, *seizing*, and *transforming* which leads us to the assumption that they aid in the creation and realization of dynamic capabilities.

Model	1	2	3
Dependent Variable	Digital patents 2fy	Digital market offerings 2fy	Digital transformation 2fy
Method	Firm-fixed effects	Firm-fixed effects	Firm-fixed effects
<i>DIU</i>	0.636*** (0.004)	0.220** (0.026)	0.196* (0.066)
Firm effects	yes	yes	yes
Control variables	yes	yes	yes
Year effects	yes	yes	yes
N	3,745	4,832	3,759
Adjusted R-square	0.06	0.10	0.09
<b>Notes:</b>			
* $p < 0.10$ ; ** $p < 0.05$ ; *** $p < 0.01$ . Robust standard errors clustered at the firm-level. P-values in parentheses. The control variables included are the same as the ones used in Table 3. We also included the two moderator variables <i>digital ventures</i> and <i>tangible assets</i> in the models. <i>Digital Patents 2fy</i> refers to the natural logarithm of the number of digital patents (see Firk et al. 2022) in the next two years. For digital patents 2fy, we could only rely on data until 2019, which reduced our sample significantly. <i>Digital Market Offerings 2fy</i> refers to the natural logarithm of the number of digital service and product releases in the next two years. <i>Digital transformation 2fy</i> refers to the change in the relative number of digital words in a firm's 10k report. We could here only rely on data until the year of 2020 and to firm-years where we could match a 10k-report in the EDGAR database.			

## Discussion of Findings

In this study, we use a cross-industry and longitudinal dataset to provide empirical insights about the performance implications of DIU establishments. We first demonstrate a wide distribution of DIUs in our sample. With a DIU presence in about 15% percent of all 618 firms examined, we may deduce that DIUs are not a theoretical phenomenon, but a real-world initiative embraced by a diverse variety of businesses across several industries and sectors (Haskamp et al. 2021a; Raabe et al. 2020b). Second, we find a positive association between DIU establishment and future firm performance. This demonstrates how establishing a DIU may help firms address digital challenges and threats (Haskamp et al. 2021b; Mayer et al. 2021) and provides first empirical support for conceptual and qualitative literature emphasizing benefits of DIUs in digitalizing environments (Fuchs et al. 2019; Raabe et al. 2021).

Additionally, our research uncovers moderators on the performance implications of DIUs, as defined internally by the degree to which an industry depends on physical goods and high tangible assets, and externally by the existence of digital ventures. According to our results, a high amount of tangible assets positively moderates the firm performance implications of DIUs. In accordance with previous research (Svahn et al. 2017), we propose that enterprises with a long history of developing physical goods seem to encounter greater hurdles when it comes to developing DIs within their present organizational structures (Hanelt et al. 2021b; Piccinini et al. 2015). These firms have institutionalized tightly coupled product architectures and hierarchical organizational structures (Hylving and Schultze 2020). Yet, to build DI and

their loosely coupled product architectures (Yoo et al. 2010), more adaptable, agile and flexible work environments as well as new digital capabilities are required (Vial 2019; Yoo et al. 2012). We argue that DIUs can serve as a foundation to build capabilities and structures for DI (Hellmich et al. 2021; Raabe et al. 2020a). Accordingly, firms in physical product-based industries may profit even more from DIUs performance implications. Furthermore, we discovered that firms in industries with a higher number of digital ventures benefit more from DIUs' effects on firm performance. According to previous research, firms in those competitive environments appear to face greater competitive threats to their business models, since digital ventures can leverage digital technologies more quickly (Huang et al. 2017) and infiltrate current industries or create new ones that supersede previously dominating ones (Skog et al. 2018). As customers get more used to the impact of digital technologies provided by digital ventures (Lucas and Goh 2009; Vial 2019), firms in such industries may benefit even more from DIU outcomes and gain greater profit from creating their own DIs. Our findings indicate that both internal and external influences have a favorable impact on DIUs' effects on firm performance. This may be related to the assumptions underlying our theoretical perspective. According to the dynamic capability framework, its competitive advantage is particularly advantageous in environments with significant turbulence and pressure for change (Teece 2018). Both the internal and external factors increase the need to change, which elevates the value of dynamic capabilities. Taken together, the main effect and the moderating effects lend support to the idea that DIUs can be considered as a foundation to build and realize dynamic capabilities in the digital era and can corroborate that dynamic capabilities positively influence firm success in an environment of digital threats and turbulence (Ellström et al. 2021; Steininger et al. 2022).

Our additional analysis further supports the view that DIUs lead to the building and realization of dynamic capabilities. Our findings suggest that the beneficial impact of establishing DIUs may be threefold. First, our research demonstrates a positive influence on firms' digital patents. This may be related to DIUs' ability to build *sensing* capabilities (Teece 2007). Second, our data shows a significant positive association between the establishment of DIUs and future digital market offerings. This can be related to DIUs' aiding in building *seizing* capabilities (Teece 2007). Third, we can observe a positive influence on the digital transformation of firms that have established DIUs. It can be related to DIUs' ability to serve as a foundation to gain *transforming* capabilities (Teece 2007). We can relate all three subdivided outcomes to our applied perspective of dynamic capabilities. Our findings imply that, in addition to a more theoretical correlation between DIUs and dynamic capabilities (Hellmich et al. 2021), there is also a correlation between their objectives and outcomes, connected to *sensing, seizing, and transforming capabilities* (Teece 2007; Teece 2018), leading us to the assumption that DIUs can serve as a foundation to build and realize dynamic capabilities.

## Implications

Our findings contribute to prior IS research with regards to DIUs, DI, and DT. First, regarding the DIU research stream, we identified several implications. Our study shows a significant beneficial influence on firm performance via the establishment of DIUs. We suggest that DIUs are more than a management trend or a nice-looking practice to pretend DI activities, but help to create real value. Apart from a number of qualitative studies based on (possibly biased) employee impressions about DIUs (Haskamp et al. 2021b), this quantitative analysis demonstrates the positive correlation between the establishment of DIUs and firm performance. It allows us to acknowledge that DIUs and MOs can incorporate mechanisms to overcome the anticipated hurdles and tensions resulting from their establishments (Svahn et al. 2017a). Moreover, our additional analysis allows us to provide a more nuanced picture of DIUs' beneficial influence on firm performance and their role in serving as a foundation to build and realize dynamic capabilities (Hellmich et al. 2021). The results may be further interpreted as an attempt to provide additional metrics to measure the effectiveness of DIUs (Haskamp et al. 2021b; Mayer et al. 2021). Both on a broad level, as measured by firm performance, and on a more granular level, as measured by digital patents, digital market offerings, and DT. Further, the additional analysis results contribute quantitatively to the literature's categorization of DIU objectives and outcomes, which had hitherto been presented rather qualitatively (e.g. Barthel et al. 2020). We contribute to the DIU literature by shedding light on possible positive moderators on the effects of DIUs (Barthel et al. 2020; Raabe et al. 2021). Thereby, we illuminate the influence of external and internal environments on DIUs and their effectiveness. We see that industries with a high number of digital ventures are more receptive to DIUs' outcomes and gain even more from their competitive advantage. We notice the same notion in physical product-based industries, although they face distinct

tensions in combining digital and physical components (Hylving and Schultze 2020), termed as digital-physical paradox (Piccinini et al. 2015). Finally, we contribute to the DIU literature by highlighting their widespread presence within the US. Despite a large number of European researchers and a strong research emphasis in Europe (e.g. Dremel et al. 2017; Lau et al. 2021; Svahn et al. 2017), our data demonstrates that DIUs are not a uniquely European phenomenon.

Second, our results contribute to the IS literature with distinct implications for the DI stream. The substantial number of established DIUs in our samples qualifies them as a commonly utilized initiative targeted at tackling DI-related challenges. While other initiatives, such as digital M&A (Hanelt et al. 2021b), have been empirically investigated, this step was missing with regards to DIUs. Our additional analysis further contributes to the stream of DI, particularly by empirically examining different positions in theoretical stage models (e.g. Kohli and Melville 2019). By observing three kinds of outcomes, digital patents, digital market offerings, and digital transformation, we may argue that they are comparable with three stages of DI such as discovery (associated with digital patents), development (associated with digital market offerings), diffusion (associated with digital transformation) - and impact (associated with overall firm performance) by Fichman et al. (2014). Our final contribution to the DI literature regards our moderators. By emphasizing the importance of DIUs in product-based industries, our findings may prove the difficulties inherent in developing DIs within their hierarchical, traditional organizational contexts (Piccinini et al. 2015; Svahn et al. 2017).

Moreover, our results contribute to research on digital transformation. In this regard, DIUs may be considered as another step in the overall “shift towards malleable organizational designs which enable continuous adaptation” (Hanelt et al. 2021a, p. 3) by providing a glimpse of how to design hybrid organizational forms suitable for the digital age (Schumm and Hanelt 2021). Given the beneficial performance implications of DIUs, we hypothesize that this phenomenon will be a persistent one, rather than a passing management fad. Nonetheless, this may result in ongoing challenges and stumbling blocks in contemporary hybrid organizations (Piccinini et al. 2015; Svahn et al. 2017).

Regarding our theoretical lens, our results contribute to the literature of dynamic capabilities. First, we present a large-scale and practical example of how dynamic capabilities can be built and realized in the context of DI and DT (Steininger et al. 2022). Additionally, our research establishes a baseline of actual evidence on the competitive advantages associated with dynamic capabilities in today's turbulent, digitalized economy (Warner and Wäger 2019). Although we examined only one approach how dynamic capabilities can be built and realized, we may offer applicable metrics to evaluate the advantages of the dynamic capabilities *sensing* (digital patents), *seizing* (digital market offerings), and *transforming* (DT) in the digital age (Ellström et al. 2021; Warner and Wäger 2019). Finally, the beneficial impact on firm performance demonstrates that the perspective of dynamic capabilities is significantly relevant and applicable in today's digital environment (Steininger et al. 2022).

Finally, our study has significant managerial implications. To begin with, amid the prevalent conversation around DI and DT, managers seeking viable initiatives to mitigate challenges and achieve progress may consider establishing DIUs. Furthermore, managers determining the applicability of DIUs to their environment and circumstances may consider our moderators as an appropriate variable. Although we found that DIUs have a general positive effect on firm performance, we propose that managers consider their firm's present internal and external environments. Establishing DIUs may be particularly beneficial in physical-based product industries with high tangible assets, as well as in surroundings with a high concentration of digital ventures. Finally, managers and organizations who are unsure about how to target their DIU's objectives, and purpose may discover direction in terms of sensing for digital patents, seizing new digital market offerings, and transforming the MO.

## Limitations and Future Research

The findings of our study should be interpreted in light of the following limitations. Our sample is limited to the United States and, thus, we cannot assure whether our findings hold outside this context. Future research may focus on whether our findings also hold in non-U.S. contexts. It would also be interesting to consider differences in culture or the national digital infrastructure (Firk et al. 2021) as a country-level moderator for DIU performance effects. In this context, also more nuanced measures for DT threats such as investments in digital ventures would be interesting to explore. Second, while our study considers, in

addition to market returns, also several outcomes related to DI and DT, these proxies might not be able to capture the full picture of DI and DT outcomes. For example, while we are able to measure the number of digital market offerings, we cannot track the specific performance of these offerings or while digital patents likely capture an increase in DI expertise, it may not fully capture more tacit DI expertise in the firm. Third, despite our best efforts (i.e., firm-fixed effects, self-selection controls and matched sample analyses), we cannot completely rule out all endogeneity concerns. Fourth, our work makes no attempt to consider other theoretical interpretations. For example, assumptions regarding the establishment costs of DIUs and their real financial effects give intriguing insights for future study, particularly when considering transaction costs and resource dependence. Further, more nuanced characteristics of DIUs could be tested to gain a deeper understanding of the detailed effects of DIUs. Finally, we noticed that although the outcomes of DIUs impact their MO, we currently know very little about particular processes and practices for joint and collaborative digital innovation, innovation transfer, and digital transformation endeavors between DIUs and MOs. Further empirical investigation is required to close this knowledge gap about how DIUs and MOs collaborate and develop their intertwined relationship and overcome potential (paradoxical) tensions.

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