

Entering the Digital Era – The Impact of Digital Technology–related M&As on Business Model Innovations of Automobile OEMs

Completed Research Paper

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Abstract

Digital technologies have reached the sphere of industrial-age, primarily physical industries, thus forcing incumbent firms to digitally innovate their business models. Employing a longitudinal dataset of the world's largest automobile manufacturers from 2000 to 2013, we found empirical evidence of a positive effect of digital technology–related mergers and acquisitions (M&As) on digital business model innovativeness. Moreover, this effect is enhanced by previous non-digital M&A experience, a diversified M&A history, as well as early experience with digital technology–related M&As. Consequently, our findings reveal that OEMs acquiring complementary and heterogeneous external knowledge on digital technologies and possessing the absorptive capacity to integrate as well as commercialize this type of knowledge are better prepared to master the digital transformation of their business. Furthermore, we find indications of a positive influence of digital business model innovations on the expected future firm performance of automobile manufacturers, thus substantiating the importance of digital transformation.

Keywords: Mergers and acquisitions, digital innovation, business model, automotive industry, panel data regression

Introduction

In his visionary commentary recently published in *Nature*, Burns (2013) illustrates what the future of mobility may look like by describing an imaginary everyday trip: “Joe requests a car using a smartphone application. A driverless electric vehicle arrives within minutes and transports him to his destination. During the trip, Joe can read, work, eat, talk on the phone, watch a film or send e-mails. There is no need to park – the vehicle zooms off to pick up another rider” (p. 181). This future vision indicates the importance of information systems (IS) and their transformative impact (Lucas et al. 2013) on what has been known by incumbent players in the automotive industry for more than a century.

This industrial-age industry (Yoo et al. 2010) is clearly en route to a digital transformation. Advances in the diffusion of networks (e.g., 4G) and computing devices (e.g., smartphones) have enabled the mobile usage of IS (Lyytinen and Yoo 2002) and also allowed physical mobility – especially car use – to be increasingly accompanied by digital connectedness (Henfridsson and Lindgren 2005). However, not only are digital technologies and automobiles used simultaneously but they are also merging more and more into new digital innovations (Hylving and Schultze 2013). With embedded and connected digital sensors or processors come smart products and services incorporated into innovative business models (Yoo et al. 2012). More specifically, Yoo (2010) describes a variety of applications resulting from the constantly increasing presence of digital technologies in the car, such as navigation, safety, and infotainment services.

For incumbent automobile manufacturers, this development represents a fundamental change on various dimensions. First, ensuring connectivity with or even integrating digital artifacts into their core products demands a profound understanding and skill set to innovate digitally (Hylving and Selander 2012). As the automobile industry has a strong foundation in engineering, this represents a major deviation from their core competencies. Second, digital innovations follow a different logic in terms of their architecture and comprise several distinct layers including devices, networks, contents, and services (Selander et al. 2013; Yoo et al. 2012). Consequently, this architecture is enlarging the areas of expertise needed to innovate for incumbent firms. Third, the digital transformation gives rise to new kinds of business models building upon digital technologies, as Yoo (2010) illustrates by drawing on the example of GM’s OnStar. Thus, for automobile original equipment manufacturers (OEMs) entering the digital era, innovation is no longer just about new technologies but now also includes distinct business models necessary to deploy them (Chesbrough 2007). These are primarily service-oriented, thus representing another paradigmatic change for automobile OEMs (Barabba et al. 2002), who, for decades, have deployed a product-focused, transaction-based business model, occasionally accompanied by product-oriented services (e.g., maintenance) (Williams 2007). Now, many of the new offerings, e.g., infotainment services, deal increasingly with contexts separate from the actual car domain.

The fundamental dynamics in the automotive industry stemming from the emergence of digital eco-systems thus create an enormous need for OEMs to acquire and integrate diverse and dispersed knowledge and commercialize it by innovating business models: “Even though all innovations require successful integration of heterogeneous knowledge, [...] the convergence of pervasive digital technology intensifies the degree of heterogeneity and the need for dynamic balancing and integration of knowledge resources. For example, convergent products may derive from completely different industries and unrelated bodies of knowledge” (Yoo et al. 2012, p. 1401).

In this regard, prior research in the field of management science has emphasized the role of external collaboration, especially in the form of mergers and acquisitions (M&As), in acquiring distant knowledge and capabilities (de Man and Duysters 2005). However, empirical results with respect to innovation outcomes are mixed due to the reportedly massive organizational and managerial post-deal efforts stemming from the need to implement different mindsets and competences (Clodt et al. 2006). Hence, for digital innovation, the organizational ability to integrate the new and diverse knowledge might be the key driver of success (Clodt et al. 2006; Selander et al. 2010).

While substantial research has focused on describing the peculiarities of digital innovation (e.g., Yoo et al. 2010) and its organizational consequences (e.g., Selander et al. 2013), an important research gap can be filled by answering the question of how the digital acquisition strategies of incumbent firms from a primarily physical industry influence their digital innovativeness. Therefore, in this paper, we employ a multivariate regression analysis based on a longitudinal dataset of the world’s largest automobile manufacturers from 2000 to 2013 to provide insights on the following research questions:

1. What are the effects of OEMs' digital technology-related M&As on subsequent digital business model innovations?
2. How are these effects moderated by OEMs' organizational knowledge integration capabilities?

The remainder of this paper is organized as follows. First, we will lay out our theoretical background by drawing on both the literature on digital innovations in the automobile industry as well as research on the acquisition and integration of external knowledge for innovation. Afterwards, we will describe our methodological approach before presenting and discussing our results. Finally, we will derive implications for IS research and business practice and present our concluding thoughts.

Theoretical Foundation

Digital Innovation in the Automotive Industry

In recent years, the digital transformation has also reached physical industries through the incorporation of increasingly powerful microprocessors and memory, broadband communication, and efficient power management into industrial-age products (Yoo et al. 2010). Scholars have investigated this phenomenon, e.g., for cameras (e.g., Lucas and Goh 2009), phones (e.g., Selander et al. 2010), and cars (e.g., King and Lyytinen 2005). This development, in conjunction with the increased penetration of IS into everyday life (Yoo 2010), affords new opportunities for innovation.

Following Schumpeter's (1934) understanding of innovation, Yoo et al. (2010) define digital innovation as "the carrying out of new combinations of digital and physical components to produce novel products" (p. 2). This integration of digital technologies, i.e., "combinations of information, computing, communication, and connectivity technologies" (Bharadwaj et al. 2013, p. 471), into physical products enables the development of new products, service designs, business models, and organizational forms (Fichman et al. 2014; Yoo et al. 2012). Thus, digital technologies offer new opportunities for product-developing firms by encompassing both the augmentation and enhancement of previously existing business models as well as a generation of radically new ones (Hylving et al. 2012; Jonsson et al. 2008). In the automotive industry, this phenomenon is being observed as manufacturers incorporate digital technologies into their cars to gain valuable data for a plethora of applications and offer an increasing number of services such as advanced diagnostics, communication and entertainment systems, driver assistance, and routing (Cho et al. 2006; Juliussen 2003). These developments have already been investigated in detail by prior academic work. For instance, King and Lyytinen (2005) investigate a business model where sensor data is used for vehicle diagnostics and related maintenance services. Furthermore, Lenfle and Midler (2009) describe an IT-enabled, subscription-based service that automatically conducts emergency calls in case of accidents or breakdowns.

In primarily physical industries (Hanelt et al. 2015a), digital innovation implies a hybridization of digital and physical components as well as their associated modes of production and organization logics (Hylving and Schulze 2013). However, when digital components are implanted in tangible products, existing product designs and associated organizational processes are put under pressure (Hylving et al. 2012). The automotive industry traditionally follows a dominant engineering logic whereby the tangible goods (i.e., the cars) occupy center stage and both product design as well as organizational logic have evolved over many years of incremental refinement (Hylving et al. 2012; Wikhamn et al. 2013). Traditional manufacturing relies on linear and sequential production processes, between which quality controls are conducted in a planned manner (Cooper 1990; Wikhamn et al. 2013). Thereby, the complete production process follows strict targets, as the entirety of the products' functionalities and all relevant components are determined and designed beforehand. Once the product characteristics are settled, firms concentrate on process innovation and economies of scale rather than furthering technology innovation (Hylving et al. 2012; Murmann and Frenken 2006).

In contrast, digital innovations follow a different logic with reference to their architecture (Yoo et al. 2012). While physical products (e.g., cars) build upon a modular architecture whereby interlocking components are assembled to a single physical entity (Lusch and Nambisan 2015), digital technologies rely on a layered architecture in which each of the loosely coupled layers of devices, networks, services, and contents follows a different functional design hierarchy (Gao and Iyer 2006; Yoo et al. 2010). Thus, the physical aspects of digital artifacts (i.e., hardware) are separate from the non-physical function (i.e., software). As a result, the

different components are not bounded by a single product and are exchangeable, which offers ample combination possibilities. By embedding digital components into physical products, a hybrid, layered modular architecture emerges, inducing profound changes in the way firms organize their logic of innovation. This especially holds true for the amount and heterogeneity of knowledge required for innovation. As Yoo et al. (2012) point out, in the classic modular architecture, the knowledge needed is product-specific and possessed by a set of specialized firms. In digital innovation, however, it is “distributed across heterogeneous disciplines and communities” (p. 730). As automotive incumbents come from a tradition of internal knowledge creation and incremental knowledge sharing with their traditional core partners (Hylving and Selander 2012), they must source new knowledge from very different actors and fields to close their capability gaps (Henfridsson et al. 2009) that are emerging in the digital era. Hylving and Selander (2012), for instance, drawing on a case study in the automotive industry, describe the challenges that arise due to the existing organizational structures and mindsets.

In sum, when automobile manufacturers (and other product-developing firms) strive towards digital innovation, they must adjust their traditional innovation processes and learn how to cope with the hybridization of digital and physical products. Due to the peculiarities of digital innovation, OEMs cannot simply rely on the established inter-organizational relationships and existing competencies within their eco-systems (Yoo et al. 2010). Instead, additional knowledge in fundamentally different areas of expertise is required, thus “particularly intensifying the need to integrate heterogeneous knowledge resources” (Yoo et al. 2012, p. 1404). Initial research has described the specific tensions arising through digital innovation in the automotive industry (Andreasson et al. 2010) and the specific importance of openness towards and acquisition of new external knowledge due to the fundamentally different logics of innovation (Hylving and Selander 2012). However, what is missing to date are insights concerning the means by which firms in such established industries can integrate the external knowledge required for digital innovation and how successful these initiatives are.

Leveraging External Knowledge for Innovation

Each innovation process, at least to a certain degree, relies on the extension of a firm’s knowledge. While an increase of the knowledge base might also be achieved by several internal initiatives (Ahuja and Katila 2001), external knowledge is of specific importance when companies enter different contexts, e.g., new market settings (de Man and Duysters 2005) or discontinuous technologies (Lambe and Spekman 1997), as these often represent business logics distinct from the established one (Kathuria et al. 2011; Xu et al. 2013). Thus, by utilizing external knowledge, firms primarily try to access skills and capabilities to innovate in previously unknown business areas (Kathuria et al. 2011), as is the case for many traditional firms entering the digital era. West and Bogers (2014) describe the leveraging of external sources of innovation, including market or technology knowledge, as a three-phase process comprising an obtaining, integrating, and commercializing phase (all of the phases are influenced by interaction procedures, such as feedback systems).

M&As are among the most prominent forms of the initial phase of obtaining external knowledge and “occur when independent companies combine their operations into one new entity” (de Man and Duysters 2005, p. 1378). Although prior research “demonstrates that acquisitions expose firms to new ideas and in the long run lead to broader knowledge” (Kathuria et al. 2011, p. 2), empirical investigations concerning the consequences of M&As on the innovativeness of the respective companies are rather disenchanting. In the best case, neutral effects of M&As have been discovered in previous research, as the integration of a whole firm brings along multiple and diverse managerial challenges such as the deterioration of innovation processes (De Man and Duysters 2005; Haspeslagh and Jemison 1991). Negative impacts on innovativeness are also found by Lin (2009), who analyzes M&As in the global auto industry and attributes these negative impacts to the high transaction costs, distraction of management attention away from internal innovation, and general organizational barriers, e.g., concerning communication. However, the impacts of M&As on innovativeness have been relativized by research highlighting the importance of the specific type of knowledge that is involved in the deal (e.g., Ahuja and Katila 2001; Cloodt et al. 2006; Makri et al. 2010).

What becomes apparent in the empirical investigations is that the second phase of the model by West and Bogers (2014), integration, is the key to enabling positive returns from acquiring external knowledge (Cloodt et al. 2006; Xu et al. 2013). Here, organizational capabilities, such as absorptive capacity (Cohen and Levinthal 1990), have been reported as being of particular value (West and Bogers 2014). According to

Roberts et al. (2012), absorptive capacity “is defined as the ability to identify, assimilate, transform, and apply external knowledge” (p. 628) and was deployed in various contexts in IS research, e.g., concerning the organizational assimilation of enterprise information systems (Saraf et al. 2013). With reference to M&As, superior absorptive capacity is associated with benefits in, first, identifying the right acquisition targets, and, second, a successful utilization of the acquired knowledge for the firms commercial ends (Desyllas and Hughes 2010). However, the ability is path dependent in the sense that a firm’s past experiences shape its capability to acquire new knowledge, since the search behavior is dependent on what was learned in the past (Zahra and George 2002). Therefore, in prior empirical studies (e.g., Ahuja and Katila 2001; Cloudt et al. 2006), existing knowledge bases have been described as influencing post-M&A innovation outcomes due to the associated level of absorptive capacity.

Finally, in the commercialization phase, the achieved outputs of the innovation process manifest themselves, e.g., through the achieved value creation and value capture, which, taken together, constitute a firm’s business model (Rai and Tang 2014; West and Bogers 2014). Business models are conceptual tools that describe the core logic of a business and comprise various elements, such as the value proposition of the offering or the customer relationship (Osterwalder et al. 2005). The focus on business models is of particular importance when focusing on innovation, as research has found consensus on the notion that the value of new ideas or technologies is dependent on the respective business model in which they are incorporated (Al Debei and Avison 2010; Cavalcante 2014). As a firm’s success depends greatly on the fit of its business model with the external environment (e.g., Chesbrough and Rosenbloom 2002), to profit from innovation efforts, it is not enough to just develop and patent new technologies. Chesbrough (2007) states, “Today, innovation must include business models, rather than just technology and R&D” (p. 12). While substantial research has described the components and taxonomies of business models, thus employing a static view on the concept, a dynamic view is required when reasoning about innovation (e.g., Aspara et al. 2011). Due to their peculiarities, especially their overarching nature resulting from their multiple diverse components, business model innovations are becoming an increasingly important unit of analysis for transformative change in various industries, especially through digital innovations (Fichmann et al. 2014).

Hypotheses Development

Drawing on the theoretical background we laid out above, we derive our hypotheses in the following section. Building upon West and Bogers’s (2014) three-phase model, we consider digital technology–related M&As as an opportunity for OEMs to access external knowledge (obtaining phase) in order to enhance their digital business model innovativeness (commercializing). Further, we evaluate the role of absorptive capacity, manifesting in different kinds of past acquisition experiences, in helping to identify and integrate external knowledge (integrating phase). Thus, the focus of our study is clearly on the investigation of OEMs’ strategies to acquire external knowledge for enhancing their digital innovativeness. However, as the commercialization phase via business models is directly connected to a firm’s economic perspective (Rai and Tang 2014), we additionally want to give an indication of the potential benefits resulting from digital business model innovations by assessing firm’s predicted future performance. Figure 1 depicts our research model and hypotheses.

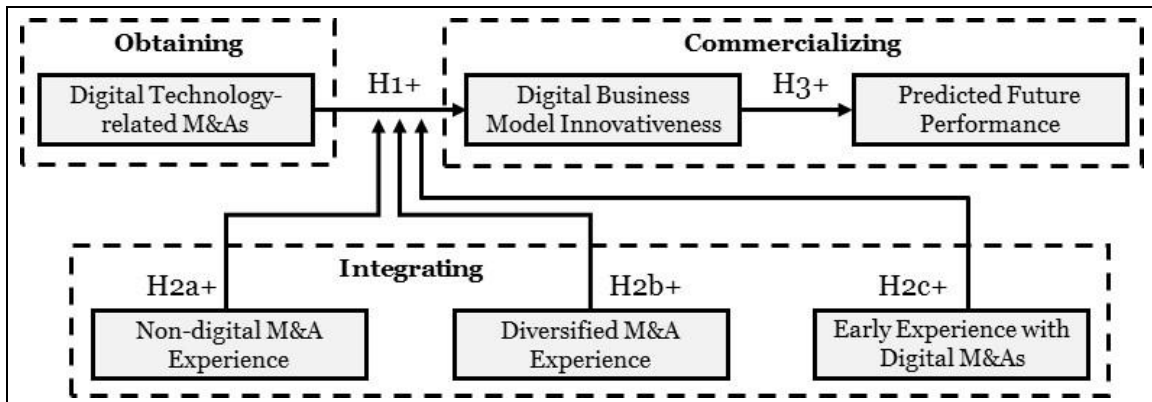


Figure 1. Research Model and Hypotheses

The increased penetration of digital technologies in and around the vehicle (Yoo 2010) affords options for adapting existing and developing entirely new business models (Henfridsson et al. 2009). As the car is increasingly “expected to provide advanced computing and connectivity capabilities” (Henfridsson and Lindgren 2005, p. 97), OEMs have started to advance or develop services building upon digital options (Sambamurthy et al. 2003). Accordingly, even though traditional business models are still dominant, digital business model innovation, referred to as “a significantly new way of creating and capturing business value that is embodied in or enabled by IT” (Fichmann et al. 2014, p. 335), is becoming more and more crucial for an OEM to be successful (Hylving and Selander 2012).

To realize these potentials, automakers need to be capable of digital innovation and account for its specifics. Although, in general, external knowledge is important for explorative innovation endeavors (Raisch et al. 2009), Yoo et al. (2012) point out that in digital innovation, the quantity and heterogeneity of required knowledge radically increases. When developing convergent products that comprise digital and physical aspects, distant, previously unknown sources of knowledge are particularly important (Hylving and Selander 2012). Thus, digital innovation initiatives of players from traditional industries must rely on an increased utilization of external knowledge, which is difficult for them to develop on their own (Raisch et al. 2009). Henfridsson et al. (2009) conclude, “Seemingly stuck in the industrial society, new knowledge about these issues is vital for automakers that attempt to close existing capability gaps and redefine their current innovation path” (p. 22). M&As have been described as a means for acquiring external knowledge, especially for explorative purposes (de Man and Duysters 2005; Raisch et al. 2009). According to Makri et al. (2010), firms using such measures to acquire knowledge complementary to existing knowledge, which is the case for OEMs and digital knowledge, can expect a positive impact on their innovation outcomes. Furthermore, as described above, if automobile manufacturers want to innovate digitally, they must understand radically different types of innovation logic and processes (Hylving and Selander 2012). One of the major disadvantages of M&As – disrupting innovation routines – might thus indeed be a blessing for automobile manufacturers as they could help them to adapt in the fundamental manner that is necessary in a world of digital innovation (Desyllas and Hughes 2010; Hylving and Selander 2012; Yoo et al. 2012). As Makri et al. (2010) maintain “complementarities would make discontinuous strategic transformations more likely” (p. 602), this may be of particular importance for the case of OEMs facing the severe challenges of the digital transformation. Accordingly, we present the following hypothesis:

Hypothesis 1 (H1): Digital technology–related M&As increase the digital business model innovativeness of automobile OEMs.

However, as stated above, the impact of external collaboration on the innovativeness of the respective firms is dependent on their ability to identify and integrate valuable external knowledge, i.e., its absorptive capacity (Cohen and Levinthal 1990; Desyllas and Hughes 2010). Inherent in this concept is the notion that the ability to integrate new external knowledge from external sources, e.g., from M&As, builds upon the prior experience of the firm in doing so (Zahra and George 2002). Lambe and Spekman (1997) point at the importance of prior experience for acquisition success, especially in contexts of discontinuous change. Inexperienced acquirers might not properly identify and care about the need to integrate disparate cultures, processes, IS, etc., thus failing to anticipate and invest the organizational efforts required to do so, which can in turn lead to M&A failure (Kim et al. 2011). Therefore, although collaboration with digital players is a rather new endeavor for OEMs, they are likely to benefit from their general openness to external knowledge and their experiences with cooperation and acquisitions in other, non-digital contexts. De Man and Duysters (2005) maintain that general experience with external collaboration increases the likelihood that new collaborations improve the innovation performance of the related companies, as experienced companies have already set up structures or procedures to deal with collaborations. Thus, we propose the following hypothesis:

Hypothesis 2a (H2a): Non-digital M&A experience positively moderates the impact of digital technology–related M&As on the digital business model innovativeness of automobile OEMs.

Furthermore, according to prior research, this argument applies not only to the amount but also to the type of prior experiences with external M&As that shape the ability to integrate new external knowledge. For instance, Gassmann et al. (2010) point out that the managerial challenges arising from cross-industry collaboration are clearly distinct from those that result from collaboration with related partners. Moreover, conducting a large-scale empirical analysis, Halebian and Finkelstein (1999) were able to demonstrate that experiences gained in past acquisitions positively influence the success of similar ones in the future. These outcomes occur due to learning effects with respect to target selection, additional resource allocation, and

further success factors of integration (Haleblian and Finkelstein 1999). Thus, as digital innovation is based on heterogeneous knowledge resources (Yoo et al. 2012), past experiences with acquiring and commercializing external knowledge from heterogeneous sources drives the ability to do so in further cases (Zahra and George 2002). This is underpinned by Lane et al. (2006), who assert that discontinuous innovation “is best supported by an absorptive capacity based on a broad range of loosely related knowledge domains and helps to further increase that breadth” (p. 850). Such an absorptive capacity may “endow an acquirer with the requisite knowledge variety and experience in order to deal with the complexity involved in importing and exploiting external knowledge from unrelated acquisitions” (Desyllas and Hughes 2010, p. 1118). As stated above, digital business model innovations represent a discontinuous endeavor for automobile OEMs, rendering a rather diversified past collaboration portfolio beneficial. Therefore, we propose the following hypothesis:

Hypothesis 2b (H2b): Diversified M&A experience positively moderates the impact of digital technology-related M&As on the digital business model innovativeness of automobile OEMs.

The latter two hypotheses focus on the organizational ability, the know-how, of integrating new external knowledge. However, the ability to understand the content of the knowledge involved, the know-what, is also of particular importance for the success of external collaborations (Makri et al. 2010). Prior research has investigated this issue under the theme of the relatedness of the existing knowledge bases of the respective firms involved in M&As. Cloudt et al. (2006) state, “It is advantageous to the acquiring firm to obtain knowledge in areas that are still somewhat related to its existing activities” (p. 650). If prior knowledge exists, at least to some degree, it helps firms to understand and recognize the value of new knowledge in this area, as skills, languages and mindsets become somewhat familiar for the respective firms (Ahuja and Katila 2001). As IT knowledge itself is rather unrelated to an automotive OEM, early experiences with integrating this type of knowledge should provide them with a relatively larger available timespan to comprehend and internalize the distinctive characteristics of this field. Consequently, this pre-understanding building upon early IT-acquisition experience is beneficial for acquiring new knowledge from digital actors (Prabhu et al. 2005). Hence, we propose the following hypothesis:

Hypothesis 2c (H2c): Early experience with digital technology-related M&As positively moderates the impact of digital technology-related M&As on the digital innovativeness of automobile OEMs.

The importance of digital business models for OEMs’ future performance becomes obvious when looking at the well-documented enormous efforts they undertake in digital innovation (e.g., Hylving and Schultze 2013; Hylving et al. 2012). Moreover, practitioners’ literature highlights the potential impact of digital business models on OEMs’ performance and thus the related market expectations: “Delivering services through the car – Internet radio, smartphone capabilities, information/entertainment services, driver-assistance apps, tourism information, and the like – is a promising area for future profits and differentiation” (Mc Kinsey 2013, p. 14). This development also becomes apparent as more and more players from the digital space, such as Google, Apple or Intel, enter into the industry. As “digital innovation presents new options and threats to automakers” (Henfridsson et al. 2009), incumbents may perceive uncertainty when it comes to the economic benefits of digital innovations. However, initial research on digital business models of OEMs, e.g., concerning GM’s OnStar, has emphasized the success of doing so (Barabba et al. 2002; Yoo 2010). New digital business models may not impact the earnings of a firm forthwith but are likely to do so in the future. Hence, developing new digital business models may be a major factor for the future success of OEMs. Therefore, we propose the following hypothesis:

Hypothesis 3 (H3): Digital business model innovations have a positive impact on automobile OEMs’ predicted future performance.

Methodological Approach

Sample and data

To test our derived hypotheses, we investigated a longitudinal panel of the world’s largest automotive manufacturers between 2000 and 2013. We selected the 30 largest automotive manufactures by motor vehicle production in our starting year to avoid survivorship bias (Oica 2001). Hence, companies may drop out of the sample due to a delisting or dissolving of the firm, but no new companies were allowed to enter the sample. From the resulting sample we only included OEMs that had available both M&A data from the

Securities Data Corporation (SDC) as well as all other financial and informational data for regressions. The final sample was made up of 22 OEMs, which altogether account for 281 firm-year observations. Applying a longitudinal panel of a fixed industry sample leads to essential advantages when measuring the effects of M&As on later innovation outcomes. Therefore, this sample contains not only firms actively performing M&As, but also inactive ones. By disregarding the second group, it might be hard to argue that M&As are the only decisive factor for good or bad performances (Ahuja and Katila 2001; Fowler and Schmidt 1988). Our data comprises a combination of multiple commercial and public data sources frequently used in empirical research. The financial data was retrieved from Thomson Financial Datastream. To investigate predicted future firm performance, we extracted analysts' forecasts and analyst coverage from the Institutional Brokers' Estimate System (IBES). M&A data was taken from the SDC databank. Data referring to digital business model innovations was hand-collected via press releases taken from LexisNexis.

Variables

Independent Variable: Digital M&As

To identify OEMs' digital technology-related M&As, two independent coders carefully analyzed and evaluated each M&A. Digital technology-related M&As were coded as "digital M&As" and the others as "non-digital M&As". For the classification, the coders used elements such as targets' business descriptions and industry information. In most cases, these descriptions were precise enough to judge the M&A's relevance. An exemplary business description would be "[...] is a developer of automotive music solutions [and] develops software to let drivers access their electronic content through their vehicles".

However, when the descriptions were not clear enough, we relied on manual information gathering. Afterwards, partly overlapping subsamples of the two independent coders were analyzed. To assess the inter-rater reliability, Cohen's Kappa (1960) was calculated; the value of .95 yielded indicates a very good strength of agreement. Nevertheless, the authors discussed discrepancies in detail until a consensus on the allocation was reached. In total the independent coders screened 1099 M&A events and classified 105 relevant M&A events. Finally, the number of digital M&As was summed up for each year. We expected more than just immediate effects of digital M&As on digital business model innovations; while some changes might be introduced expeditiously, e.g., when an OEM acquires a firm with an already existing business model and absorbs it, others might require a longer lead time, e.g., when new digital capabilities must be integrated in a car's product design in order to offer a new service. Hence, we anticipated varying lead times and therefore accumulated digital M&As over the last three years.

Moderating Variable: Non-digital M&A Experience

M&As are regarded as digital M&As if they involve digital actors (see also independent variable); all other events are considered as non-digital M&As. To describe the non-digital M&A experience, we counted non-digital M&As and constructed an average of prior non-digital M&As.

Moderating Variable: Industry Diversity of M&As

To measure industry diversity, we screened all M&As in a given year and counted the number of different first two digits of the targets' Standard Industrial Classification (SIC) codes. We used the first two digits of the SIC codes because previous research (e.g., Haushalter et al. 2007; Moeller et al. 2004; Wiersema and Zhang 2011) has indicated that the first two digits are sufficient to classify industries as related or unrelated. Hence, if the M&A activity of an OEM provides a higher number of different first-two-digit SIC codes, this indicates a greater industry diversity of M&As, whereas a low number of different first-two-digit SIC codes reveals a strong industry focus. Analogous to non-digital M&A experience, industry diversity is measured as the rolling average of the number of different industries in which firms are active in M&As.

Moderating Variable: Early Digital M&A Experience

The number of early digital M&As indicates whether an OEM has experience with M&As targeting digital actors prior to our starting year (2000). Hence, we also screened M&As from the years 1995 to 2000 to identify early digital M&As. The variable counts the number of relevant events prior to 2000.

Dependent Variable: Digital Business Model Innovations

The dependent variable indicates the firm's innovation outcomes and is measured by the number of reported business model changes (Cavalcante et al. 2011) that were induced by digital technologies (henceforth described as digital business model innovations). For our data-collection procedure, we used a commonly applied event-study approach (e.g., Aggarwal et al. 2006; Dehning et al. 2003; Dewan and Ren 2007; Miranda et al. 2012). In our case, the events examined were automotive firms' announcements of digital business model innovations between 2000 and 2013. For this purpose, in line with the proceedings of prior research (e.g., Aggarwal et al. 2006; Dewan and Ren 2007), the search process encompasses announcements in PR Newswire and Business Wire in Lexis-Nexis. Within the regarded timeframe of 13 years, shifts occurred within the automotive industry, e.g., Chrysler was separated from Daimler in 2007. To account for these shifts, we followed the SDC's approach and related activities to the ultimate parent.

Digital trends are manifold and, since we aimed to obtain comprehensive coverage of relevant articles, we adopted a keyword search algorithm already used by Hanelt et al. (2015a), which contains "significant digital technologies [i.e., cloud computing, social media, mobile technology, and big data] in the automotive industry, as well as names of each of these technologies industry leaders" (p. 1317). Thus, we linked each of the search words with each member of our list containing the 22 automotive firms, for instance "digital technolog*" AND "SOURCE Toyota". Two independent coders examined each article to extract the ones that describe business model innovations and are also related to at least one of the search words. Referring to the concept of business model innovation, we followed Cavalcante et al. (2011), who provide a comprehensive framework describing business model innovations according to the change they induce on a business-process level. An exemplary announcement being classified as relevant would be "*Toyota to Launch Global Cloud-platform-based Next-Generation Telematics Services in Emerging Markets*". During the analysis process presented, duplicates were excluded. Again, we compared the resulting lists; a Cohen's Kappa (1960) of .98 indicates a very good agreement, but we nevertheless discussed the differences in detail to ensure a comprehensive classification. In total, we obtained a final list of 430 announcements.

Dependent Variable (H3): Predicted Future Performance

To investigate whether digital business model innovations indicate an increase in future firm performance, we used quarterly analysts' one-, two-, and three-year earnings per share (EPS) forecasts. The EPS value indicates a company's profitability on the financial market, as it depicts the portion of a firm's profit relative to one share of common stock. Analysts' forecasts are based on ongoing information gathering and the evaluation of corporate decisions to give shareholders an estimation of future firm performance (Cordeiro and Kent 2001). In this context, analysts exhibit another advantage; as they are specialized in specific industries and cover only a few firms, they have great expertise in the automotive industry and thus the ability to assess the need of OEMs to develop digital business model innovations. Given the attributes of analysts' forecasts, various empirical studies choose analysts' EPS forecasts as the dependent variable for evaluating future performance expectations of specific events (e.g., Bassemir et al. 2013; Dhaliwal et al. 2011; Li et al. 2014). As analysts regularly adjust their forecasts, we extracted the quarter-end analysts' EPS forecasts (one-year, two-year, and three-year) of the IBES databank.

Control Variables

We included a broad set of control variables for others factors that may confound any effect of digital M&As on digital business model innovations. To select our control variables, we used commonly applied controls in empirical studies on innovation outcomes, such as firm size (logarithm of net sales), leverage (ratio of total debt to total assets), return on equity (net income divided by book value of common equity), profitability (operating profit margin), growth (low-year growth in sales), liquidity (cash divided by total assets), and research and development (R&D) intensity (R&D spending divided by net sales) (Ahuja and Katila 2001; Ahuja and Lampert 2001; Bena and Li 2014; Katila and Ahuja 2002). Furthermore, we included capex (capital expenditures divided by total assets) for internal investments because these may bind internal resources, thus negatively affecting the integration of external knowledge and decreasing digital business model innovations. Capital intensity (property, plant, and equipment divided by total assets) controls for the manufacturing intensity of OEMs. In our analysis of the predicted future performance, we also included analyst coverage (number of analysts covering a firm), as forecasts might be related to the number of analysts issuing forecasts. Moreover, we included gross domestic product (GDP)

growth as provided by the World Development Indicator (WDI) database of the World Bank, which reflects the annual growth rate of GDP at market prices based on constant local currency. Finally, all our models included dummy variables for time effects.

Model Specification

To examine the causes for digital business model innovations, our regression model must address several challenges. First, our dependent variable counts the number of digital business model innovations and thus takes only non-negative integer values. Hence, the assumptions of homoscedastic, normally distributed errors in a linear regression model are violated. Prior empirical research investigating the effect of a dependent count variable, e.g., patents, has indicated that a Poisson regression approach is an appropriate choice for such a dependent variable (Ahuja and Katila 2001; Ahuja and Lampert 2001; Henderson and Cockburn 1996; Katila and Ahuja 2002). Second, we must account for unobserved firm heterogeneity in our panel data; if unobserved heterogeneity has not been addressed in our empirical model, estimations might be biased by inaccurate standard errors. Generalized estimating equation (GEE) regression allows us to address both of these challenges, as it provides a direct approach for modeling longitudinal Poisson data and accounts for autocorrelation by estimating the correlation structure of the error terms (Ahuja and Katila 2001; Ahuja and Lampert 2001; Katila and Ahuja 2002; Liang and Zeger 1986). Therefore, we used the *xtgee* command provided by STATA 12 and specified a log link function of the Poisson family and autoregressive within-group correlation with semi-robust Huber-White sandwich variance estimates. The following model with Y representing digital business model innovations was used to analyze Hypothesis 1:

$$Y_{j,t} = \alpha + \beta(\text{digital M\&As})_{j,t} + \gamma(\text{controls})_{j,t} + T_t + \mu_{j,t}.$$

Besides our dependent, independent, and control variables, the remaining items are the intercept (α), the dummy variable for time effects (T_t), and the standard error term ($\mu_{j,t}$).

To investigate our suggested moderating effects in Hypotheses 2a-c, we included an interaction of the moderator and our independent variable. In line with prior empirical studies, we centered the variables included in the interaction term on their means (Katila and Ahuja 2002). This approach avoids potential multicollinearity problems and helps us to interpret the results (Aiken and West 1991). Specifically, the following model with Y equaling digital business model innovations was used to analyze Hypotheses 2a-c:

$$Y_{j,t} = \alpha + \beta_1(\text{digital M\&As})_{j,t} + \beta_2(\text{moderator})_{j,t} + \beta_3(\text{digital M\&A} \times \text{moderator}) + \gamma(\text{controls})_{j,t} + T_t + \mu_{j,t}.$$

Additionally, to investigate the capital market reaction on digital business model innovations, we had to choose a time window that is closely related to the business model innovation. Therefore, we created a dummy variable representing whether an OEM exhibits a digital business model innovation in a certain quarter and used the subsequent analyst's EPS forecast as the dependent variable. We also need to control for firm-specific unobservable factors to isolate the effect of digital business model innovations on the capital market. To do so, we used a panel fixed effects regression, where each cross section is an assigned individual effect to control for firm-specific unobservable factors. Hence, only time-variant effects within a firm are estimated. This means that we analyzed the effects of a digital business model innovation of an OEM on the incremental change in the analyst's EPS forecast. In line with this, fixed effects regressions are commonly employed in empirical studies to estimate performance effects (e.g., Cornett et al. 2007; Custódio 2014; Kandel et al. 2011). Specifically, we used the following model with analysts' EPS forecasts as Y to analyze Hypothesis 3 (the item *fixed_j* includes the firm-specific effects in the fixed effects regression):

$$Y_{j,t} = \alpha + \beta(\text{digital business model innovation})_{j,t} + \gamma(\text{controls})_{j,t} + T_t + \text{fixed}_j + \mu_{j,t}.$$

Results

Descriptive Statistics

Table 1 displays the means, standard deviations, and pairwise correlations. Due to the partially strong correlations among some control variables, we also investigated variance inflation factors (VIFs) to check for multicollinearity. All resulting values were below critical thresholds (the highest VIF was 4.27), indicating that our analysis is not constrained by multicollinearity (Wooldridge 2002).

Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
digital business model innov.	1.08	2.98	1																		
digital M&As	2.35	1.46	0.33	1																	
non-digital M&A exp.	2.01	2.42	-0.01	0.05	1																
diversified M&A exp.	1.52	1.11	-0.07	-0.06	0.13	1															
early digital M&A exp.	1.02	1.03	0.27	0.36	0.54	-0.15	1														
return on equity	9.42	17.79	0.18	-0.03	-0.01	-0.07	-0.04	1													
profit margin	4.11	8.43	-0.12	0.01	0.03	0.04	0.05	0.08	1												
capex	6.31	4.08	0.05	-0.04	-0.03	-0.27	0.00	0.23	0.10	1											
R&D intensity	2.56	1.91	0.16	0.13	0.16	-0.15	0.41	-0.09	0.22	-0.01	1										
liquidity	9.20	7.74	0.01	0.15	-0.19	-0.12	-0.19	0.04	-0.02	0.17	-0.15	1									
leverage	48.43	21.82	0.07	0.14	0.28	0.00	0.38	-0.20	-0.10	-0.14	0.15	-0.46	1								
capital intensity	32.16	16.66	0.20	-0.31	-0.24	0.11	-0.28	-0.02	0.01	-0.04	-0.26	-0.24	-0.13	1							
size	16.70	2.06	0.25	0.33	0.44	-0.08	0.68	-0.02	0.13	-0.12	0.60	-0.22	0.51	0.63	1						
sales growth	1.12	0.37	-0.01	0.09	-0.04	0.03	-0.21	0.14	-0.03	0.11	-0.25	0.21	-0.24	-0.04	-0.12	1					
1y analyst forecast (EPS)	2.60	4.90	0.07	0.03	0.23	-0.03	0.09	0.13	-0.12	0.15	0.06	-0.16	-0.22	-0.17	0.29	-0.05	1				
2y analyst forecast (EPS)	2.90	4.28	0.14	0.03	0.23	-0.04	0.23	0.11	-0.14	0.13	0.06	-0.17	-0.07	-0.20	0.34	-0.09	0.83	1			
3y analyst forecast (EPS)	3.46	4.75	0.16	0.05	0.24	-0.04	0.28	0.08	-0.16	0.10	0.06	-0.18	0.12	-0.23	0.37	-0.10	0.87	0.98	1		
analyst coverage	21.39	10.90	0.12	0.17	0.34	0.39	0.08	0.07	0.00	0.29	0.02	0.18	0.01	0.11	-0.38	0.14	-0.04	0.43	-0.17	1	
GDP growth	2.78	3.86	-0.12	-0.10	-0.21	0.08	-0.37	0.11	0.04	0.02	-0.42	0.44	-0.36	0.11	-0.53	0.35	-0.12	-0.12	-0.15	-0.22	1

N = 281. All correlations above .1 are significant at p < .05.

Table 1. Descriptive Statistics and Correlations

The Impact of Digital Technology–related M&As on Digital Business Model Innovations of Automobile OEMs

To test Hypothesis 1, we estimated a GEE Poisson model with digital business model innovations as the dependent variable and digital M&As as an independent variable while controlling for various confounding effects. Table 2 reports the results of the GEE Poisson regressions. In Model 1, we observe a highly significant ($p < .05$) and positive effect of digital M&As on digital business model innovations. Therefore, our results confirm Hypothesis 1, implying that the higher the degree of digital M&As, the higher the digital business model innovativeness of OEMs.

	Model 1	Model 2	Model 3	Model 4
Method	GEE Poisson			
Dependent variable	digital business model innovations			
<i>Hypothesis 1:</i> digital M&As	0.076 ** (0.023)	0.045 * (0.080)	0.098 *** (0.001)	0.064 ** (0.028)
<i>Hypothesis 2a:</i> non-digital M&A experience		-0.149 (0.140)		
non-digital M&A experience * digital M&As		0.063 *** (0.006)		
<i>Hypothesis 2b:</i> diversified M&A experience			-0.502 (0.493)	
diversified M&A experience * digital M&As			0.238 ** (0.026)	
<i>Hypothesis 2c:</i> early digital M&A experience				0.053 (0.760)
early digital M&A experience * digital M&As				0.051 ** (0.039)
<i>Controls</i>				
return on equity	0.015 (0.152)	0.033 * (0.090)	0.019 (0.206)	0.012 (0.239)
profit margin	0.026 (0.367)	0.025 (0.490)	0.043 (0.299)	0.044 (0.146)
capex	-0.137 ** (0.027)	-0.169 *** (0.008)	-0.140 ** (0.028)	-0.131 *** (0.004)
R&D intensity	0.002 (0.991)	0.093 (0.442)	0.046 (0.684)	-0.02 (0.842)
liquidity	-0.051 (0.174)	-0.033 (0.468)	-0.049 (0.205)	-0.050 * (0.095)
leverage	-0.019 (0.315)	-0.013 (0.279)	-0.02 (0.130)	-0.014 (0.297)
capital intensity	0.031 (0.169)	0.038 ** (0.025)	0.039 * (0.065)	0.039 * (0.061)
size	0.773 *** (0.005)	1.135 *** (0.000)	0.954 *** (0.000)	0.888 *** (0.009)
sales growth	0.243 (0.510)	-0.369 (0.552)	-0.061 (0.918)	0.172 (0.712)
constant	-14.584 *** (0.002)	-21.197 *** (0.001)	-18.981 *** (0.001)	-16.95 *** (0.004)
time effects	yes	yes	yes	yes
Chi-square	553.01	1165.21	1111.47	1233.71
N	281	281	281	281

***, **, and * indicate significance at the 1%, 5%, and 10% levels (two-tailed), respectively. Standard errors are heteroscedasticity consistent. P-values are reported in parentheses. The explanatory variable digital M&As and the interaction terms are in bold. In Models 2, 3, and 4, digital M&As, the moderator, and the interaction term are mean centered.

Table 2. Regression Results (Hypotheses 1 and 2)

The Moderating Effect of Non-digital M&A Experience

To test the moderating effect of non-digital M&A experience on digital business model innovativeness, we investigated GEE Poisson regressions with moderating effects. Specifically, we included an interaction term between digital M&As and non-digital M&A experience; Model 2 shows the result of this regression

analysis. In terms of the main effect of digital M&As on digital business model innovativeness, the regression displays a positive and significant coefficient. The results for the interaction term indicate high statistical significance ($p < .01$) and a positive coefficient. The interpretation of Model 2 suggests that non-digital M&A experience amplifies the positive effect of digital M&As on digital business model innovativeness. Hence, we find support for hypothesis 2a.

The Moderating Effect of Diversified M&A Experience

To investigate this relationship, we included an interaction term between the industry diversity of M&As and digital M&As in Model 3. In terms of the main effect, the GEE Poisson model displays a statistically significant and positive coefficient, indicating that these results are in line with our first hypothesis. For the interaction term, Model 3 exhibits statistical significance ($p < .05$) with the anticipated positive sign. These findings are consistent with Hypothesis 2b, which proposes that diversified M&A experience enhances the ability of digital M&As to increase digital business model innovativeness.

The Moderating Effect of Early Digital M&A Experience

To proxy for early digital M&A experience, we count digital M&As within the five years prior to our time period. Analogous to the procedure for testing the previous hypotheses, we run GEE Poisson regressions and include an interaction term of early digital M&A experience and actual digital M&As (see Model 4). In terms of the main effect, we again find a positive and highly significant effect. Furthermore, as predicted, we observe positive and significant ($p < .05$) coefficients in terms of the interaction term. This implies that the probability of high digital business model innovativeness under a high degree of digital M&A is amplified by early digital M&A experience. Therefore, we also find support for Hypothesis 2c.

The Impact of Digital Business Model Innovations on Future Performance

To test this hypothesis 3, we investigated fixed effect regressions to calculate the impact of digital business model innovations on analysts’ quarterly EPS forecasts while controlling for various confounding effects. Table 3 presents the results of these regressions. In Model 5, we observe a positive and statistically significant ($p < .05$) effect of digital business model innovations on the 1-year analyst EPS forecast. Models 6 and 7 substantiate the positive impact of digital business model innovations on the capital market, since we find positive and significant coefficients ($p < .1$) for digital business model innovations on the 2-year and 3-year analyst EPS forecast. Hence, we find indications that analysts evaluate digital business model innovations as a positive sign for future firm performance and are thus able to support our third hypothesis.

	Model 5	Model 6	Model 7
Method	panel fixed effects	panel fixed effects	panel fixed effects
Dependent variable	1-year analyst forecast (EPS)	2-year analyst forecast (EPS)	3-year analyst forecast (EPS)
<i>Hypothesis 3:</i> digital business model innovation	1.269 ** (0.040)	1.120 * (0.068)	1.130 * (0.062)
<i>Controls</i>			
return on equity	0.001 (0.870)	-0.002 (0.613)	-0.003 (0.396)
profit margin	0.234 *** (0.003)	0.189 *** (0.005)	0.149 ** (0.013)
capex	-0.049 (0.508)	-0.067 (0.338)	-0.069 (0.325)
R&D intensity	0.515 (0.121)	0.429 (0.213)	0.374 (0.257)
liquidity	-0.05 (0.207)	-0.041 (0.290)	-0.04 (0.321)
leverage	-0.067 ** (0.031)	-0.065 ** (0.032)	-0.063 ** (0.042)
capital intensity	-0.071 (0.468)	-0.071 (0.483)	-0.098 (0.352)
size	0.308 (0.646)	0.064 (0.922)	-0.148 (0.841)
sales growth	0.388 (0.366)	0.323 (0.456)	0.363 (0.416)

analyst coverage	0.067 (0.373)	0.086 (0.243)	0.092 (0.205)
GDP growth	-0.04 (0.549)	-0.082 (0.128)	-0.094* (0.099)
constant	-0.905 (0.939)	3.717 (0.758)	8.447 (0.532)
time effects	yes	yes	yes
adjusted R ²	0.216	0.254	0.261
N	974	977	943

***, **, and * indicate significance at the 1%, 5%, and 10% levels (two-tailed), respectively. Standard errors are heteroscedasticity consistent. P-values are reported in parentheses. Observations are on a quarterly basis in order to better allocate the reaction of analysts to the respective digital business model innovation.

Table 3. Regression Results (Hypothesis 3)

Discussion of Findings

Digital innovation is seen as a valuable opportunity for automotive OEMs, as it propagates the diversification of their portfolios by augmenting and enhancing previously existing business models and generating radically new ones (Hylving et al. 2012; Jonsson et al. 2008). As digital innovations become a “strategic imperative” (Hylving and Schultze 2013, p. 14), in order to stay relevant, OEMs must not only adapt to emerging digital eco-systems but also develop their own digital innovations and incorporate them into business models to account for changed customer behaviors and deliver attractive digital user experiences. Knowledge that is fundamentally different from the engineering, physical product-based field of expertise is required to do so. While prior research on the emerging theme of digital innovation has focused on the internal perspective on automotive OEMs in order to examine how they manage to evolve towards the digital paradigm (e.g., Hylving and Schultze 2013), we concentrated on the impacts of OEMs’ strategies to become digital innovators by obtaining external knowledge through digital technology–related M&As. To the best of our knowledge, we are among the first to empirically study the impacts of such strategic actions (Lin 2009) in the context of and with special reference to the digital transformation of an industrial-age industry (Yoo et al. 2010).

Conducting panel data regressions, we found that digital technology–related M&As are positively associated with digital business model innovations. When assessing prior literature on M&As and innovation, this finding is not obvious as they have often been reported to have negative impacts on innovation in various industries (see de Man and Duysters 2005), including the automotive industry (Lin 2009). However, a physical player that acquires a digital one to develop innovations that are primarily a combination of physical and digital elements (Yoo et al. 2010) seems to be a situation in which the complementariness between the actors results in positive innovation outcomes (Makri et al. 2010). While big distances in knowledge due to differences in skills, languages or cultures and the resulting organizational efforts have been found to have a negative impact on post M&A innovation within the same contexts (e.g., Ahuja and Katila 2001), they are of particular value in the digital transformation of industrial-age industries. The findings indicate that by acquiring external heterogeneous knowledge via M&As, automotive OEMs avoid the trap of deploying the same processes and mindsets they established for physical innovations (Hylving and Selander 2012) and thus are able to embrace the full potential of digital technologies (Henfridsson et al. 2009). By doing so, OEMs can also ensure complementarities of their offerings to the surrounding digital eco-systems, which is a key success factor of IT-enabled business models (Rai and Tang 2014). Furthermore, when looking at the emerging research stream on digital innovation (e.g., Fichman et al. 2014), our results support the peculiarities of this type of innovation, which implies openness towards and integration of diverse external knowledge sources (Hylving and Selander 2012). As digital innovation is a distinct phenomenon, empirical results derived from investigations of external collaborations in other forms of innovation cannot be applied, even if they focus on the same industry (e.g., Lin 2009). While prior research (e.g., Hylving and Selander 2012) has highlighted the internal tensions resulting from, e.g., following two different types of innovation logic, our results indicate that acquiring targets – and thus knowledge, skills, and mindsets – from the digital space can be a way to resolve these tensions.

The relationship between digital technology–related M&As and digital business model innovations was in turn found to be positively influenced by the amount and kind of an organization’s experiences with M&As. Following theory on absorptive capacity (Cohen and Levinthal 1990), knowledge gathered in the past drives

the capability to identify and integrate external knowledge in the future (Zahra and George 2002). We demonstrated that firms experienced with collaborations in general, but also with early digital technology-related and heterogeneous partners, are best suited for making use of digital M&As and translating them into digital business model innovations. The variety in the knowledge gathered is of particular importance. Desyllas and Hughes (2010) point out that firms with general and diversified knowledge bases, in contrast to those with very focused ones, are less susceptible to organizational inertia and core rigidities that hinder their ability “to select suitable acquisition targets and exploit the acquired knowledge base” (p. 1118). Consequently, they are better positioned to profit from unrelated acquisitions, as managerial attention is less distracted from innovation (Desyllas and Hughes 2010). Thus, absorptive capacity that builds upon knowledge acquisitions from diverse sources is a key competence for digital innovators, as it fits digital innovation properties that have been described multiple times as building upon diverse knowledge from distant areas (e.g., Yoo et al. 2012).

However, our results also highlight the importance of having gathered digital technology-related knowledge in the past. Even though digital innovation implies the use of heterogeneous external knowledge, there should at least be some overlap in the knowledge bases to be able to identify and acquire it (Cloud et al. 2006). Hence, OEMs with a more long-lasting experience with external digital technology-related knowledge might be better equipped to identify suitable collaboration partners and understand the different types of innovation logic as they have already internalized some related knowledge by early acquisitions, which provides fruitful ground for new digital knowledge (Prabhu et al. 2005). Due to the different properties of digital and physical technologies, such a pre-understanding can help to mitigate the tensions that can result from combining the two for digital innovation (Hylving and Selander 2012).

Based on our analysis, we found that digital business model innovations by automotive OEMs indeed positively impact performance forecasts. These results indicate a tremendous transformation in the role and importance of IS in this industry; while IS have always been relevant, in former decades they generally supported businesses in production or administration processes (King and Lyytinen 2005). As we focused our analysis on digital technology-driven changes at the business model, the activities there and the positive feedback from the capital market reveal the increased value of IS in the automotive industry. Hence, the digital transformation of business has reached industries that must rely on a substantially physical core, in contrast to, e.g., the media (Hanelt et al. 2015a). Even in such an industrial-age setting (Yoo et al. 2010), incumbents in physical industries must develop digital business strategies (Bharadwaj et al. 2013; Setia et al. 2013) to meet the expectations of analysts. With our findings on the business model level, which logically connects business strategy and business processes (Al Debei and Avison 2010), we document that incumbents in the automotive industry have started to do so as digital business models are instances of digital business strategies. Our findings suggest that the capital market values the efforts of those companies that did not “passively observe the evolution by which digital technology eventually transforms their industry and value propositions” (Hylving et al. 2012, p. 15) but rather proactively used them to innovate their business models.

Our study contributes to the IS community in three specific ways. First, we provide empirical evidence for the digital transformation in primarily physical industries and thus follow Yoo et al.’s (2010) call to investigate this highly relevant phenomenon as well as Lucas et al.’s (2013) invitation to examine IS-driven transformations. We do not only shed light on how incumbents can master the digital transformation, i.e., by being open towards and integrating heterogeneous external knowledge, but also demonstrate the positive impacts and importance of digital business model innovations on future profit expectations. Moreover, our findings document an enormous increase in the role and importance of IS to be played for business success even within physical industry firms (Guillemette and Paré 2012). Because of this relevance, the results of this study underpin the notion that IS strategy research needs to increasingly contribute to strategic management research in general (Merali et al. 2012). Second, our findings point at the importance of absorptive capacity for realizing digital business model innovations. The ability to identify, integrate and utilize external knowledge and especially diverse and distant knowledge is likely to be a major determinant for future business success in digital eco-systems. Although the construct has been of importance for IS research before (Roberts et al. 2012), it is likely to increase in value for the community to examine organizational impacts of digital transformation as digital innovation, per definition, requires integrating diverse and dispersed knowledge (e.g., Yoo et al. 2012). Third, drawing on Chesbrough’s (2007) claim that today’s innovation must include business models rather than R&D or technology, we applied an event-study approach (e.g., Aggarwal et al. 2006; Dehning et al. 2003; Dewan and Ren 2007; Miranda et al. 2012) in

order to capture business model innovations that build upon digital technologies. We suppose that this approach embodies a reasonable alternative for measuring innovation outcomes. Previous studies have mostly used patents and R&D expenditures (e.g., Abernathy and Chakravarthy 1979; Benner and Tushman 2002; Griliches 1984; Henderson and Cockburn 1996). However, in the automotive industry, a large share of R&D expenditures is related to traditional manufacturing innovation and not grounded on digital technologies; further, a variety of innovations that are in our focus are not patented or not patentable at all (Ahuja and Katila 2001; Cohen and Levin 1989; Griliches 1990). As prior research (e.g., Al-Debei and Avison 2010; El Sawy and Perreira 2013) has pointed at the importance of the business model construct when it comes to digital technology, we contribute in transferring this business model lens also to the empirical evaluation of digital innovation efforts.

Moreover, our study has valuable implications for business practice. As our findings indicate that digital business model innovations are evaluated as a positive sign for future firm performance on the capital market, they emphasize the need for managers, even in industrial-age industries, to be alerted to the transformative impact of digital technologies on their businesses. Thus, also in primarily physical industries (Hanelt et al. 2015a), managers need to formulate a digital business strategy (Bharadwaj et al. 2013) to proactively adapt to the emerging risks and opportunities. Our study provides evidence on the effectiveness of acquiring external, heterogeneous knowledge to drive digital business model innovations. However, managers must avoid the pitfall of assuming that just “buying” this knowledge on the market is sufficient to succeed innovating digitally. In contrast, our study shows that they need to work on their organizations ability to identify, integrate and commercialize this valuable and diverse knowledge, as, due to the distinct characteristics of digital innovation (Yoo et al. 2012), it will be a core competence in the digital era.

Limitations and Future Research

Our study has some limitations worth noticing. First, we restricted our sample to the automotive industry. Although it represents a class of traditional, manufacturing-focused industries, the generalizability of our findings is limited. Therefore, to glean more general insights that are also valid for other primarily physical industries, further research should repeat the study in other industries. Second, the dependent variable – digital business model innovations – relies on a secondary data analysis concerning press releases published by the firms themselves. Here, we followed a commonly applied event-study approach (e.g., Aggarwal et al. 2006; Dehning et al. 2003; Dewan and Ren 2007). However, the results must be viewed with a critical eye because they rely on subjective announcements by the firms’ press departments. Further, the thoroughness needs to be questioned to a certain degree, as business model changes must not necessarily be announced. The retrieval strategy is based on an established approach conducted by Hanelt et al. (2015a) to ensure an appropriate assessment of relevant trends in digital technologies. Nonetheless, the identification and characterization of digital business model changes is not free from subjectivity, a circumstance that is shared with other studies applying similar approaches (e.g., Dewan and Ren 2007).

The results of our study provide fruitful insights on the digitalization of primarily physical industries. However, we focused on one single source of external knowledge (i.e., M&As) and one single industry (i.e., the automotive industry). Thus, further research is needed to understand this facet more completely. A promising area of further research would be to repeat the study in other industries in order to obtain more general insights that are also valid for other primarily physical industries. Expanding the focus on other sources of knowledge such as strategic alliances (e.g., de Man and Duysters 2005), but also internal sources might be another encouraging aspect.

Moreover, while the results of our study indicate that digital technology-related M&As enhance the digital business model innovativeness of OEMs, the deeper dimensions of both M&A activity and business model innovations offer exciting perspectives for future research. Considering the concept of absorptive capacity, the type and specifics of the respective knowledge bases are of great importance, as various characteristics challenge the ability of firms to integrate and apply external knowledge to varying degrees. Here, a more in-depth analysis might provide promising insights for the community. Also interesting are the dimensions of business model innovations (e.g., Cavalcante 2014) resulting in different forms of radicalness. For instance, existing business models can be simply extended by means of digital capabilities, while others might follow a substitution approach describing a truly disruptive impact (Hanelt et al. 2015b). Besides further investigations on a quantitative level, qualitative, in-depth analysis could help us to understand how organizations absorb and use external digital technology-related knowledge. The challenges arising from

the need to integrate physical and digital logics is of particular interest for the emerging stream of work on digital innovation. In this regard, we would point to an interesting and current Delphi-study drawing on insights from automotive managers on these issues (Piccinini et al. 2015). The main focus of our study lies on OEMs' strategies of acquiring external knowledge for fostering their digital business model innovativeness. However, as the commercialization phase described by West and Bogers (2014) is strongly connected to economic benefits, we additionally give a first indication on a positive correlation between digital business model innovations of OEMs and predicted future firm performance. Therefore, an investigation of realized benefits from digital business model innovations and a deeper understanding on the interdependencies between digital business model innovations and OEMs' actual firm performance would be another promising direction for further research.

Conclusion

Employing a multivariate regression analysis based on a longitudinal panel including the world's largest automotive manufacturers between 2000 and 2013, our findings demonstrate that players from the physical world can use digital technology-related M&As to achieve progress in the digital transformation and close the emerging capability gaps for digital innovation (Henfrisson et al. 2009). This strategy of sourcing heterogeneous external knowledge for developing new business models is particularly suited to the elements and requirements of digital innovation, which have been described as convergent, distributed, and combinatorial (Yoo et al. 2012). Thus, through M&As, physical incumbents can acquire the complementary knowledge necessary for business models that build upon hybrid physical-digital technology combinations. The optimal returns can be achieved if they already have a base knowledge on digital technologies and are able to professionally handle diverse external collaborations by drawing on an absorptive capacity, which is shaped by diversified M&A experiences. Thus, with our work we add to research on digital transformation and digital innovation, which has primarily described the changes occurring and their consequences for organizations. We contribute an investigation of a specific response strategy for incumbents, i.e., acquiring the necessary external knowledge via M&As, as well as an assessment of their effectiveness that includes specific organizational contingencies.

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