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Seeing through the network: Competitive advantage in the digital economy

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Abstract

Firms operate in an environment that is increasingly permeated with digital technology. The incorporation of digital technology into products, services, and operations has significant implications on how firms can attain and sustain competitive advantage. Traditional strategic models of competitive advantage – such as the industry structure view, the resource-based view or the dynamic capabilities approach – are built on assumptions which lack validity in today's digital environments. Digitization radically changes the very nature of products, the process of value creation and, above all, firms' competitive environment. This study contributes to a better understanding of how firms may achieve sustained competitive advantage in this digital economy: It outlines a network-centric view which explains the competitive environment of firms being confronted with digital technology and its affordances. Based on the network-centric view, the firms may achieve competitive advantage by actively shaping the digital environment (i.e. applying a logic of effectuation) and by value co-creating of the interconnected firms in the digital environment. The framework may help firms to design and create strategies in order to attain and sustain competitive advantage in a digital economy.

Keywords: Digitization, Competitive advantage, Interorganizational networks, Service logic, Digital ecosystems, Effectuation, Network theory

> You're real, they're virtual. You build, they collaborate. You're product-driven, they're customer-driven. Face it. You're still trying to make money the old-fashioned way […] you'll have to change your ways. The business model you're after isn't the massive, vertically integrated marketing machine you've worked so hard to create. It's a fluid network of alliances, acutely attuned to the needs of its customers […] Are you nimble enough to keep your people, process and technology focused on strategies that shift frequently and suddenly?
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> Andersen Consulting Ad in the New York Times[1]

Introduction

In summer 2015 the automotive manufacturing companies Audi, BMW and Daimler built a strategic network in form of a consortium in order to acquire Nokia's digital mapping business HERE for 2.8 billion euros (e.g. Geiger 2015; Ribeiro 2015). HERE is one of the main providers of mapping and location services, which are considered to

be a key component for developing automated driving experiences (smart vehicles). The consortium's offer had to compete with the bids from companies outside the automotive industry such as transportation network Uber Technologies and Chinese web service company Baidu. This example of an acquisition of a digital service company by an interorganizational network of car manufacturers shows vividly that business operations, strategies, and the whole competitive environment has dramatically changed since the dawn of a digital economy (e.g. Bharadwaj et al. 2013; Bughin et al. 2010; El Sawy et al. 2010; Iansiti and Lakhani 2014; Porter and Heppelmann 2014; Teece 2012). In the course of an all-embracing transformation former non-digital objects are increasingly digitized and become capable to follow various functions and process different types of data. The architecture of digital goods needs to be reconsidered since information and services become increasingly independent from physical goods (Selander et al. 2013, p. 183; Turber et al. 2014, p. 21; Yoo et al. 2010a, p. 726). Digital technology changes the nature of objects by transforming them into compositions of loosely coupled elements and components that are not limited to particular functions or purposes (Yoo et al. 2010a, pp. 726; see also Schilling 2000). This implies that designers of components may not be able to fully anticipate how and in what combinations their digitized products and services are eventually used. The product boundary cannot be seen as fixed anymore. Under these premises creating value has become more complex. According to traditional product architectures firms are considered to create value through adding product features and thereby enhancing the product's quality (e.g. Bowman and Ambrosini 2000; Vargo et al. 2008). However, instead of a linear sequence of events along a chain where firms individually contribute by value-adding activities (Porter and Millar 1985, pp. 150), value creation processes in an emerging digital environment are based on the contribution of multiple stakeholders who integrate and apply resources for themselves and for others. Value is thus always co-created (Barret et al. 2015, pp. 137; El Sawy and Pereira 2013, p. 4; Lusch and Vargo 2014, pp. 136). Consequentially, the potential for innovation has been increased since digital capabilities of products and services enable firms to combine resources across the traditional industry boundaries, which are usually strictly related to physical products (Selander et al. 2013, pp. 185; Tiwana et al. 2010, p. 675; Yoo et al. 2012, p. 1398; Yoo et al. 2010a, p. 726). The conceptualization of the competitive environment as digital ecosystems results from the new complex architecture of digitized objects and the associated dissolving industry boundaries (Baldwin 2012, pp. 20; El Sawy and Pereira 2013, pp. 1; Iansiti and Levien 2004, pp. 1; Lusch and Nambisan 2015, pp. 161; Selander et al. 2013, p. 184; Teece 2012, p. 104; Yoo et al. 2010a, p. 724). As Moore stated it makes sense to "suggest that a company be viewed not as a member of a single industry but as part of a business ecosystem that crosses a variety of industries" (Moore 1993, p. 76). A digital ecosystem can be understood as a network of companies and other institutions that is inter-linked by a common interest to create and sustain value around a digital platform. Thereby, participants contribute to the viability of an ecosystem through reinforcing network effects (Katz and Shapiro 1994, p. 94) as well as integrating and applying their separated resources and capabilities in order to enhance digital objects (Yoo et al. 2010a, p. 729).

Traditional management research conceptualizes competitive advantage in terms of a firm's positioning within a chosen industry (Porter 2004a; 2004b) or firm-internal non-

imitable resources (Barney 1991; Penrose 1959; Rumelt 1984, 1991; Wernerfelt 1984). Porter's industrial organization framework and the resource-based view (RBV) provide explanations why and how some firms manage to sustain supernormal returns regardless a competitive environment (Rumelt et al. 1991). However, both perspectives implicitly rely on assumptions of analogue technology and non-digital product architecture. In general, prevailing management studies have not considered yet the wider implications of digital technology on the underlying assumptions of business strategies (Bharadwaj et al. 2013, p. 478). Rather, the digital economy has been solely limited to one of many triggers causing "dynamic environments where destabilizing forces such as technical innovation, globalized competition, and entrepreneurial action operate with amplified frequency" (Eisenhardt et al. 2010, p. 1263). In response, research has sticked to traditional perspectives, like market positioning or assembling capabilities and competencies, on how firms may create sustainable competitive advantages under these new circumstances (e.g. Nevo and Wade 2010; Porter and Heppelmann 2014). The dynamic capabilities approach (e.g. Teece et al. 1997) has gained attention by focusing on organizations' agility (Chakravarthy et al. 2013; Overby et al. 2006), fluidity (Schreyögg and Sydow 2010), improvisational capabilities (Pavlou and El Sawy 2010) or adaptability (e.g. see Reeves and Deimler 2011) as important prerequisites for reacting properly on rapid changes in the environment. Furthermore, some scholars have rejected the concept of sustainable competitive advantages in favor of temporary advantage according to the impracticality to preserve them facing the dynamics of globalization and hyper-competition (D'Aveni et al. 2010; Tanriverdi et al. 2010).

Although these models differ from each other due to several aspects, they all have a common core, i.e. the conception that digitization is first and foremost a hyper-dynamic condition to which organizations need to find responsive solutions. However, the underlying assumptions of their models with respect to the source of competitive advantage have not been challenged. Most research has reduced the role of information, communication and connectivity technologies (IT) to being *enablers* of organizational capabilities (Pavlou and El Sawy 2010) or as capability itself (Rai and Tang 2010) to sustain competitive advantage. Thus, IT strategy has been rather derived from a firm's chosen business strategy and located on functional-strategy level than being integrated in business strategy (Bharadwaj et al. 2013; Luftman and Brier 1999; Sabherwal and Chan 2001). The subordinate role of digital technologies in strategic management does not cater for their fundamentally business reshaping character. Although there has recently been increased attention on organizational implications of digitization and *turbulent* environments in diverse research fields, no attempt has been made to systematically examine how digital technology challenges the basic assumptions of the different perspectives in strategic management. Therefore, there is a need for "new strategic frameworks that are aimed at deliberately harnessing the unique capabilities of digital technology that are embedded into products to gain competitive advantage" (Yoo et al. 2010a, p. 730).

The major contribution of this study is to outline a *network-centric view* as an alternative to the traditional models of competitive advantage by integrating results from organizational studies, information systems, marketing, entrepreneurship and strategic management research. Thereby, we aim to provide a better understanding of the source of sustained competitive advantage by taking into consideration the increasing pervasiveness of digital technology, the changed product architecture, alternative

modes of value creation and the shift from relatively static industries to dynamic digital ecosystems. Specifically, the study reveals the interorganizational network structure as primary source of competitive advantage in an environment with dissolving industry boundaries and digital technology as focal point of value creation. Interorganizational networks encompass a firm's relationships to suppliers, customer, competitors, or other entities, across boundaries of industries or countries. Overall, the framework may help firms to revise former patterns of strategic actions and to design and create strategies in order to attain and sustain competitive advantage in a digital economy.

The digital economy and its implications for the competitive landscape

Affordances of the digital technology

During the last decade impressive developments in communication, information, and connectivity technologies such as pervasive computing, digital convergence, Web 2.0, service-oriented architectures, cloud computing, and the open source revolution have reshaped the competitive landscape by bridging boundaries of time, distance, and function (Bharadwaj et al. 2013, p. 472; Merali et al. 2012, pp. 128; Yoo et al. 2010a; p. 724; Zammuto et al. 2007, pp. 751). By becoming digitally enabled these technologies have created uniquely powerful affordances (Kallinikos et al. 2010). *Technology affordance* refers to "an action potential, that is, to what an individual or organization with a particular purpose can do with a technology or information system" (Majchrzak and Markus 2012, p, 832).

According to Yoo et al (2010a) digital technology needs to be distinguished from earlier technology in terms of its reprogrammability, the homogenization of data, and its self-referential nature. First, digital computers are based on the Von-Neumann-Architecture, which means that both processing unit and storage unit are integrated in the same digital device. Programs and data are therefore kept in the same format and location (Yoo et al. 2010a, p. 726). Consequentially, digital objects are able to execute multiple functions (Selander et al. 2013, p. 183). Second, data homogenization refers to the fundamental difference between digital and analog signals. Whereas analog data are tightly coupled with analog devices (e.g. in vinyl records, VHS cassettes or photographic films but also in books or magazines), digital data can be stored, transmitted, processed and displayed by the same device, regardless of the actual contents (Tilson et al. 2010b, pp. 2; Yoo et al. 2010a, p. 726). Thus, the homogenization of data separates the content from the medium. Third, the self-referential nature of digital technology concerns the fact that digital innovation is, in turn, dependent on digital technology (Yoo et al. 2010a, p. 726). In order to participate in the digital innovation process, entrepreneurs need to have access to digital technology. Consequently, greater availability of digital technology entails "positive network externalities that further accelerate the creation and availability of digital devices, networks, services, and contents" (Yoo et al. 2010a, p. 726). Moreover, the diffusion of digital innovation has lowered the entry barriers for potential innovators (e.g. Bharadwaj et al. 2013, p. 472; Iansiti and Lakhani 2014, p. 92; Yoo et al. 2010b, p. 9; Zammuto et al. 2007, p. 750).

This *digitization*, i.e., the process by which analog information is converted into digital format, enhances former analog objects by becoming programmable, addressable, sensible, communicable, memorable, traceable, and associable (Yoo 2010, pp. 225). The

utilization of constantly improving small microprocessors on non-digital objects enhances these former analog objects with software-capabilities (Kallinikos et al. 2010; Zammuto et al. 2007, p. 754). However, digitization comprises more than the mere increasing use of digital technology. For example, e-books are not only digitally advanced replacements of conventional books (with radically reduced marginal production, storage and distribution costs). Rather, their digital characteristics challenge publishers' traditional model of having control over content creation, production, and distribution. As a consequence, digitization must be understood as a process, which goes beyond the mere technical aspect of representing diverse types of information in digital form. Since digital technology is embedded in firms' very core of products, services and operations, its pervasiveness changes the organizing logics among heterogeneous firms, which are increasingly interconnected by a common digital infrastructure (Tilson et al. 2010a, p. 749). Therefore, drawing on Tilson et al. (2010b, p.3), *digitization* can be better defined as the socio-technological process of applying digital technology across industries and contexts in ways that affect and shape their underlying infrastructures for the creation, storage, and distribution of content, applications, and services.[2]

The incorporation of digital technology into former non-digital objects changes their very nature, with huge consequences for design, production, distribution, and use (Sosa et al. 2004, pp. 1676; Tilson et al. 2010b, p. 3; Yoo et al. 2010a, p. 724). More precisely, embedding digital technology changes the product architecture, i.e. the scheme by which the functional elements of the product are allocated to physical components and connected by interfaces (Ulrich 1995, pp. 420). Yoo et al. (2010a) offer a useful concept by which digitized objects feature a four-layered architecture applicable to all kind of digital objects and related services (Benkler 2006, pp. 520). These four layers are devices, networks, services, and contents. First, the device layer comprises hardware, which can be any kind of device (e.g. TV, PC, mobile phone, car) or operating system to control the hardware and to connect it with other layers. Second, the network layer enables the transmission of data in terms of physical requirements (cables, radio spectrum, transmitters etc.) and logical requirements such as protocol standards (e.g. TCP/IP or P2P). Third, the service layer features application programs by which users are able to create, manipulate, store, and consume contents. Thus, users can, for example, listen to music, send emails, receive navigation data, and write texts. Finally, the content layer hosts the data such as texts, sounds, images or videos.

Due to the characteristics of digital technology the four layers of a digitized product can be de-coupled, which means that design decisions for components in each layer can be made rather independently from other layers (e.g. Google needs not to consider the specific shape of the iPhone when it develops a navigation app). That gives various firms the possibility to participate in value creation processes by combining components from different layers in order to create new digital products (Gao and Iyer 2006, pp. 122). Components need not to be derived from one dominant design hierarchy of a single product, but can be designed without having much knowledge about the actual product (Yoo et al. 2010a, p. 728). As a consequence, components are developed without consideration of a specific product context. Providers of components may even not be able to foresee how and in what combinations their digitized products and services come into use (e.g. Google Maps has been developed as a standalone digital mapping service, which is now applicable to diverse devices such as mobile phones, desktop

computers, car navigation systems or even digital cameras). This, in turn, dissolves product boundaries and makes digital objects open for new meanings. For example, when Apple introduced the iPhone in 2007, it not only combined phone, digital camera and portable media player but also provided the opportunity for other firms to develop mobile applications regarding mobility, social media or multi-media. Therefore, the iPhone, or smartphones in general, cannot be considered only as mobile phones but also act, among other uses, as cameras, clocks, navigations systems, e-book readers, game devices, photo albums, flashlights, and as personal medical diagnostic devices.

The products, services, and operations transformed by digital technology create new affordances characterized by convergence and generativity. *Digital convergence* can be defined as "an essential, pervasive and interactive reconfiguration of the technical and social information infrastructures of modern society" (Tilson et al. 2010b, p. 2). It refers to the convergence of media, storage and distribution technologies, which unifies formerly separated *user experiences* (Yoo et al. 2012, p. 1399). This results in new possibilities to combine and re-combine devices, networks, services and contents, which were originally created for different purposes and finds now expression in the layered product architecture. Thereby, it may happen that "computing, telecommunications, and broadcasting all merge into a single stream of discrete bits carried on the same ubiquitous network" (Odlyzko 2001, p. 1). *Generativity* refers to the dynamically changing design of digital objects (see Zittrain 2006). Since layers in digital product architectures are only loosely coupled, they can be recombined in various ways so that novel unexpected combinations emerge (Yoo et al. 2012, p. 1399). Hence, generativity is a consequence from the dynamic and malleable character of digital objects, whose designs are considered to be in a permanent flux, independent from their actual intended purposes (Zittrain 2008, p. 43). Thus, the modular layered architecture makes products ambivalent and open for new meanings (Yoo et al. 2010a, p. 729).

Digital value creation

The shape and affordances of products is strongly related to firms' organizing logic (Sosa et al. 2004, p. 1674; Yoo et al. 2010a, p. 725). *Organizing logic* is defined as the "managerial rationale for designing and evolving specific organizational arrangements in response to an enterprise's environmental and strategic imperatives" (Sambamurthy and Zmud 2000, p. 107). Therefore, an emerging four-layer architecture of products and related services requires strategic considerations challenging the ways by which firms used to create value (Normann 2001, p. 9; Yoo et al. 2010a, p. 725).

Digital products and services are rooted in the precepts of generativity. Value creation through generativity differs distinctly from other sources to the extent that innovations occur in unforeseen ways and neglect previously established value chains (Tilson et al. 2010a, p. 750; Yoo et al. 2012, p. 1400). Generativity, which denotes the "capacity to produce unprompted change driven by large, varied, and uncoordinated audiences" (Zittrain 2006, p. 1980), is accomplished by the ability of digital objects – besides their functional use – to serve as platforms for other firms to develop complementary products, technologies and services (Barret et al. 2015, p. 143; Gawer 2009, p. 45; Evans and Schmalensee 2016, p. 40; Yonatany 2013, p. 54; Yoo et al. 2012, p. 1399). Instead of a centralized process in which a focal firm determines the product

architecture and coordinates the actors adding value to the product, generative value creation processes rather evolve through uncoordinated interactions among distributed and heterogeneous firms. Firms create value by creating platforms, which connect various firms and encompass several layers which may function as products or platforms (Yoo et al. 2012, p. 1400). Since the layers in a layered-modular architecture can be decoupled, digital objects may serve as a platform relying on their own installed base at one layer and function as component at another. Firms can collaborate and compete in the same time dependent on the particular layer. Moreover, digital platforms form hubs or central points of control for multisided markets connecting firms, coordinating exchange and enabling otherwise impractical strategies (e.g. Eisenmann et al. 2011; Evans and Schmalensee 2016; Ghazawneh and Henfridsson 2013). In multisided markets platforms have an intermediating role facilitating service exchange without having ownership and control over components and modules (Thomas et al. 2014; p. 205). Consequentially, the pervasiveness of digital technology has turned the digital platform into the central focus of value creating activities enabling firms across industries to develop and integrate new devices, services, networks, and contents (Yoo et al. 2012, p. 1400, see also Gawer and Phillips 2013; Gawer 2009; Yonatany 2013). Yoo et al. (2010a, p. 730) call this organizing logic behind digital objects *doubly distributed*. It is *distributed* because generativity as source of value creation needs to be achieved by combining heterogeneous resources across layers and it is *doubly* distributed since control and knowledge are distributed across multiple firms.

Generativity has triggered new market dynamics and the emergence of complex webs of activities among market actors. Vargo and Lusch introduced the service-dominant (S-D) logic, which takes into consideration the digitization-driven transformations of value creation (Vargo and Lusch 2004; Vargo et al. 2008). Rejecting the strict differentiation between goods and services the S-D logic considers *service* as the common denominator of all economic exchange and value creation (Normann 2001, pp. 121; Vargo and Lusch 2008, p. 4). *Service*[3] is defined as "the application of specialized knowledge and skills for the benefit of another actor or the actor itself" (Lusch and Nambisan 2015, p. 159). This shall reflect the shift of value creation from output-centric to a process of doing something beneficial. Instead of focusing on tangible, static resources requiring some actions to make them valuable (i.e. goods and services), S-D logic considers economic exchange as a process of deploying knowledge and skills for the benefit of others and oneself (Vargo et al. 2008, p. 148). Accordingly, goods are considered as *appliances* (tools, distribution mechanisms), which are specialized forms of service provision (Lusch and Nambisan 2015, p. 159). Thus, value is the "comparative appreciation of reciprocal skills or services that are exchanged to obtain utility; value [means] 'value in use'" (Vargo and Lusch 2004, p. 7). Drawing on use value implies that value only occurs when the offering of a service is beneficial or useful to another actor (e.g. customer) in a particular context. Thus, value must always be co-created since "there is no value until an offering is used – experience and perception are essential to value determination" (Vargo and Lusch 2006, p. 44). Value is co-created by the integration of various resources of multiple actors (Vargo et al. 2008, p. 148). The value creation process involves at least the firm and the beneficiary (e.g. the customer). The single firm proposes value and provides service which the beneficiary may use in the process of acquisition, usage and disposal. Therefore, value

can only be achieved if the beneficiary participates in the value creation process. Given the multi-layered architecture of digital objects where a variety of firms may provide components and elements, the context of value creation is depicted by several relationships directly and indirectly connected to the exchange. It is shaped by the interactions among market actors applying and integrating various resources via value propositions for mutual benefit. All these interrelationships provide the context within which firms experience value. Since relationships change continuously, use value is experienced as dynamic in nature (Lusch and Nambisan 2015, p. 159). Firms do not deliver value per se but offer value propositions in order to engage with other market actors to co-create value. In accordance with that, Normann focuses on the relationships between market actors building value-creation networks in which single firms act, in the first place, as "organizer[s] of value creation" (2001, p. 24).

Thus, the S-D logic shifts the locus of value creation from the firm-level to the network-level. Instead of a linear sequence of events along a chain where firms individually contribute by value-adding activities, value creation processes in an emerging digital environment are based on the contribution of multiple stakeholders who integrate and apply resources for themselves and for others (Barret et al. 2015, pp. 137; El Sawy and Pereira 2013, p. 4; Lusch and Vargo 2014, pp. 136). The S-D logic is not just a re-conceptualization of economic exchange but helps to understand how firms create value in a digitally permeated economy. The generative character of digital technology makes products inherently *unfinished*. Firms constantly create new meanings of goods and services by redefining the product boundaries (Verganti 2009; Chandler and Vargo 2011). The dynamic and flexible nature of products makes it necessary to rethink the rather static added-value approach. The shift from the output of something to the process of doing something and the focus on use value instead of exchange value is, thus, a consequence of the evolving dynamics. Generativity is the primary source of value creation: Firms engage in increasingly dynamic, complex, and diverse networks of relationships in order to seek ways to create value. Consequently, the clear distinction of industries begins to vanish.

Digital business ecosystems

The concept of the ecosystem has recently become popular since it explicitly shows interdependencies between organizations and their environment and provides an innovative view on co-evolution and value creation (Adner and Kapoor 2010, p. 309; see also: Iansiti and Levien 2004; Moore 1993). Due to an "explosion of alliances" (Dyer and Singh 1998, p. 661) and the increasing importance of interorganizational relationships, strategy research has shown greater interest in value creation and capture across firm boundaries including concepts such as meta-organizations (Gulati et al. 2012), actor-oriented architectures (Fjeldstad et al. 2012) or business ecosystems (Adner 2006; Baldwin 2012; Brandenburger and Nalebuff 1996; Kapoor and Lee 2013; Teece 2007). In contrast to other network constructs in management research (such as clusters, innovation networks, industry networks, etc.) but in accordance with S-D logic, the business ecosystem comprises all actors who are directly or indirectly involved in the co-creation of value. Ecosystems provide firms with resources and is considered to be the playfield on which firms co-create value with each other. The performance of any

firm is dependent on the characteristics and the structure of the business ecosystem, which is shaped by the interactions of its participants. Due to the upheaval of digitization, *digital business ecosystems* emerge with digital technology triggering environmental turbulence and, simultaneously, providing firms with capabilities to deal with it (El Sawy et al. 2010, p. 836; Lusch and Nambisan 2015, p. 167). A digital business ecosystem can be understood as "a collective of firms that is inter-linked by a common interest in the prosperity of a digital technology for materializing their own product or service innovation" (Selander et al. 2013, pp. 184). Firms contribute to this prosperity by participating and, thus, advancing the installed base of the digital technology as well as by applying and integrating heterogeneous resources in order to improve the technology. Technology and ecosystem participants co-evolve to the extent that the ecosystem can be positively or negatively affected (Selander et al. 2013, p. 185). As a consequence, a *coopetitive* environment emerges in which various actors form relationships in order to co-create value for themselves and others (Selander et al. 2010, p. 2). Coopetition refers to a state, where firms compete and cooperate in the same time (e.g. see Brandenburger and Nalebuff 1996; Walley 2007). The loosely coupled layers of digital objects enable firms to collaborate at one layer (such as contents, service, network and device) and compete at another (Yoo et al. 2010a; p. 729). Ecosystems consist of relationships actively being shaped by their participants. Participants are confronted with ambiguous situations and need to deal with conflicting interests. On the one hand, individual firms need to shape these relationships in a way to capture value for their own. On the other hand, value creation processes rely on the cooperation of ecosystem participants. Hence, firms also need to take into account the thrive of the ecosystem. The evolutionary dynamics of the digital business ecosystem are influenced by the co-evolution of its participants' choices (Tiwana et al. 2010, p. 677).

In order to understand the impact of digital technology on competition, it seems beneficial to adopt a competitive dynamics perspective (see Chen and Miller 2012; Smith et al. 2001). From this perspective competition is interactive or *dynamic*. This characterization of competition accounts "for the dynamic and adaptive process-based relationships in complex, interactive research contexts and focuses on the process of how firms act-react to their environment to achieve greater competitiveness" (Ferrier et al. 2010, p. 414; see also Chen and Miller 2012; Schumpeter 1942). Digital business ecosystems evolve constantly and unfold dynamically due to generative affordances of digital technology. Theoretically, any digital service can simultaneously serve as platform upon which other firms may create value. Thereby, ecosystems are intertwined with other ecosystems to the extent that value of service varies in one ecosystem according to changes in another ecosystem. This results in a competitive landscape, which can be characterized as complex, turbulent and fast changing (El Sawy and Pereira 2013, p. 2). Complexity refers to dramatic increases in the number and the heterogeneity of included components, relationships, and their dynamic and unexpected interactions with digital infrastructure (Hanseth and Lyytinen 2010, p. 1; Tanriverdi et al. 2010, p. 823). The digitization of products, services, and processes has resulted in more diverse, adaptive, interconnected, and interdependent firms. Complexity is thus not only evident in the nature of products induced by IT but also in business systems across a wide range of industries. Environmental turbulence refers to unpredictable change in an industry (see e.g. Melville et al. 2007) induced by high frequency

of firm entries and exits as well as high degrees of structural instability (Mithas et al. 2013, p. 517). Thus, strategic variables are not only changing but they are also changing in an unexpected way. Due to the self-referential nature of digital technology diffusion of digital service results in positive network externalities: Digital technology generates, in turn, even more digital technology (Yoo et al. 2010a, p. 726). Since value creation activities may occur across organizational boundaries and even across traditional industry boundaries (Selander et al. 2013, p. 184), digital ecosystems evolve at an accelerating pace (El Sawy and Pereira 2013, p. 2).

Competitive dynamics research considers competition to be both dynamic and interactive. Interaction consists of dyads of action-reaction. Therefore, research focuses on firms' actual competitive actions and their consequences on firm performance (Chen and Miller 2015, p. 759). Furthermore, competitive dynamics research emphasizes competitive interdependencies since actions occur in a specific context, upon which firm's strategic actions and reactions need to be examined.

Firms need to find ways to effectively organize and strategize in these complex, turbulent and fast changing environments (Eisenhardt et al. 2010, p. 1263). Participation in ecosystems is not an option for individual firms but a necessity (Selander et al. 2013, p. 184). This involves a strategic decision about which particular ecosystem to choose within which the firm would co-create value and co-evolve in the narrow future. In general, the increasing strategic importance of digital ecosystems requires firms to design, build and sustain vibrant platforms. Due to the highly uncertain nature of their environment (i.e. complex, turbulent, and fast changing), firms may *effectuate* digital business ecosystems in order to achieve competitive advantage (Perry et al. 2012; Sarasvathy 2001). Traditionally, strategic research assumes a decision-making model according to which firms predetermine concrete goals and select resources in order to attain these goals. The environment is considered to be exogenous and, thus, outside the firm's range of control. Therefore, firms attempt to predict future states of the environment in order to adapt to changes in a timely manner (Read et al. 2009, p. 2; Wiltbank et al. 2006, pp. 983). In other words, the better firms can predict the future, the better they can control it. However, Sarasvathy and Simon have challenged this established conception by bringing up the question: "Where do we find rationality when the environment does not independently influence outcomes or even rules of the game (Weick 1979), the future is truly unpredictable (Knight 1921), and the decision-maker is unsure of his/her own preferences (March 1982)" (Sarasvathy and Simon 2000, p. 5). Effectuation provides an alternative of reasoning to the predictive rationality and the so-called *causation logic*. Whereas "causation processes take a particular effect as given and focus on selecting between means to create that effect […] effectuation processes take a set of means as given and focus on selecting between possible effects that can be created with that set of means" (Sarasvathy 2001, p. 245). Effectuation is based on the conception of non-predictive control, i.e. the better firms can control the future the less they need to predict it (Read et al. 2009, p. 2). Accordingly, the environment is regarded as endogenous, which is subject to shape through the actions of a network of partners (Sarasvathy 2001, p. 253). In sum, effectuation turns upside down traditional approaches of decision-making by proposing an inverted logic from established linear, goal-driven and analytic approaches (e.g. see Wiltbank et al. 2006). Effectuation is especially relevant for those firms, which need to cope with dynamic,

non-linear and ecological environments which do not allow to predict and measure the future (Perry et al. 2012, p. 838; Sarasvathy 2001, p. 251). Thus, firms operating in digital ecosystems make strategic decisions and choose competitive actions by effectuating their environment. Digital ecosystems are constantly changing their shape due to value-creating activities of multiple firms related to the generative character of digital technology. Effectual firms make strategic decisions based on resources and knowledge they can interactively use within a network of firms. This can be associated with the S-D logic according to which value can only be created by the integration of various resources of multiple actors (Lusch and Nambisan 2015, p. 161; Read et al. 2009, p. 2). Accordingly, value is always dependent on the specific context – the digital ecosystem. Firms shape their context by collectively creating their environment or digital ecosystem. The digital economy makes uncertainty a constant in firm's strategic considerations. Effectual actors may not be capable of predicting the future, but they can take actions to affect it by proactively stimulating value-creating activities.

Interorganizational networks and sustained competitive advantage

Interorganizational networks as value creating systems

Understanding a firm's sources of competitive advantage has become a major field of interest in strategy research (e.g. Barney 1991; Porter 2004b; Rumelt 1984; Teece et al. 1997). The concept of sustained competitive advantage is often associated with a firm's value creating strategy, whose benefits cannot easily be duplicated by others in the present or future (Barney 1991, p. 102). Traditional models focus on firm-internal processes, resources or dynamic capabilities, while value creation in the digital economy results from the collaboration of several economic actors. In order to pursue value co-creating activities, organizations have started to open up their value creation structures and processes by collaborating with other firms in various forms (Fjeldstad et al. 2012, p. 734; Snow 2015, p. 7; see also Baldwin and von Hippel 2011; Bollingtoft et al. 2012; Chesbrough 2003). Instead of maintaining large, vertically integrated firms, organizations establish *multi-firm networks* and *community-based structures* to "built on a strategy of persistent exploration of an expanding set of complementary markets whose participants continuously adapt technologies to new uses" (Miles et al. 2009, p. 65). Accordingly, the locus of value creation as well as the shape of organizational forms has shifted from individual firms towards interorganizational networks (Miles et al. 2010, pp. 96; see Miles et al. 2009; Powell et al. 1996).

Firms have become increasingly embedded in interorganizational networks with respect to social, professional, and exchange relationships (see Granovetter 1985; Gulati 1998; Parkhe et al. 2006; Snow 2015; Snow et al. 2016). Digitization has become an accelerator for this development to the extent that firms have changed their modus operandi from competition to cooperation to collaboration due to social and technological conditions (Snow 2015, p. 1). Interorganizational networks encompass a firm's relationships to suppliers, customers, competitors, or other entities across boundaries of industries or countries. Thereby, they can take different forms such as strategic alliances, joint ventures, franchising, long-term marketing and licensing contracts, reciprocal trade agreements, R&D partnerships, buyer-supplier relationships, director interlocks, investment bank ties, personnel movement links or cross-patent citation ties

(Gulati et al. 2000, p. 203; Zaheer et al. 2010, p. 62). Interorganizational networks are constituted of organizations which are connected through a wide range of social and economic relationships. In general, a network is considered to be "a set of nodes and the set of ties representing some relationship, or lack of relationship, between nodes" (Brass et al. 2004, p. 795). Nodes are referred to actors (e.g. persons, teams, units, organizations) which are connected by ties to a set of binary social relations. Ties can have varying contents, strengths, and directions, "limited only by a researcher's imagination" (Brass et al. 2004, p. 795). The pattern of ties forms a specific structure in a network whereas actors occupy positions within this structure. Nodes in interorganizational networks are referred to as firms connected by ties which represent a set of relationships such as exchange, power, or solidarity. Organization scholars have developed a huge and diverse network research generating broad insights about the fragmented field of interorganizational networks (Baker and Faulkner 2002, p. 520; Zaheer et al. 2010, p. 64). Drawing on different theoretical approaches, network-related research has gained insights on how firms may intentionally affect structure and ties of networks to generate superior outcomes by accessing valuable and inimitable resources and capabilities (e.g. Dyer and Singh 1998; Gulati et al. 2000; Gulati 1999; Powell et al. 1996), gaining power and control (e.g. Burt 1992; Cook 1977; Santos and Eisenhardt 2009), establishing trust (e.g. Beamish and Lupton 2009; Coleman 1988; Gulati 1995; Zaheer et al. 1998) and signaling status (e.g. Baum et al. 2000; Higgins and Gulati 2003; Podolny 2005, 1993).

According to Normann and Ramirez, "the only true source of competitive advantage is the ability to conceive the entire value creating system and make it work" (Normann and Ramírez 1993, p. 69). From this perspective, understanding a firm's interorganizational network and knowing how to enact it is crucial for achieving and sustaining competitive advantage. Therefore, there is need for a theoretical framework to systematize the vast network-related literature and make sense of network effects on firm performance.

Network theory

The network approach has become more popular in the last decades for providing an explanation for organizational phenomena (e.g. Borgatti and Foster 2003; Borgatti and Halgin 2011; Snow and Fjeldstad 2015; Zaheer et al. 2010) since it shifts the focus from attributes of single actors to relationships among systems of dependent actors (e.g. Bergenholtz and Waldstrøm 2011; Borgatti et al. 2014; Gulati et al 2000; Parkhe et al. 2006). Accordingly, firms' behavior is interpreted "in terms of structural constraints on activity, rather than in terms of inner forces within units" (Wellman 1988, p. 20). Thereby, network theory provides a holistic view, since outcomes are not only explained by actors' characteristics but are also attributed to actors' network environments (Borgatti et al. 2014, p. 4). Organizational research has taken the network perspective in order to understand an array of outcomes such as individual, group, and organizational performance, power, turnover, job satisfaction, promotion, stakeholder relations, innovation, leadership, creativity, inter-firm collaboration, unethical behavior, and so on (Borgatti and Foster 2003; Brass et al. 2004; Kilduff and Brass 2010). Likewise, network analyses have become popular as prescriptive tools in management

consulting (e.g. Anklam 2007). Some have criticized network research for wavering between metaphor and methodology and lacking theory (e.g. Salancik 1995; Knoke 2001). In order to address these critics, a number of literature reviews have tried to make sense of network research by outlining the theoretical foundations of network theory (e.g. Borgatti et al. 2014; Borgatti and Halgin 2011; Borgatti and Foster 2003; Parkhe et al. 2006; Moliterno and Mahony 2011).

Granovetter's theory of the strength of weak ties (Granovetter 1973) and Burt's structural holes theory (Burt 1992) are central to network theory. The former states that the diffusion of ideas or information tends to have a bigger impact if networks consist of weaker ties. Granovetter assumes that strong ties are rather established between actors who are similar to each other with respect to their social environment. Strong ties are likely to describe relationships between actors of the same third parties. Weaker ties, however, emerged between actors having not that much in common. Weaker ties, connecting actors who do not share similar social environments, can bridge ties since they connect different networks of similar actors. Granovetter considers bridging ties to be the source of new ideas and information because of the exclusive connection between actors. Thus, bridging ties facilitate the diffusion of new ideas and information. Therefore, weak ties have the best potential for achieving competitive advantages.

The second fundamental network theory is Burt's structural holes theory (Burt 1992). Burt argues that actors will outperform others with the same amount of ties in similar strength if the actors' network exhibits more structural holes. Structural holes are ties, which connect an actor with other cohesive networks. Whereas the information within one network is considered to be redundant, structural holes provide actors with new information and, thereby, with a competitive advantage. Burt's theory offers a rather strategic view on networks as opposed to Granovetter's notion of the random emergence of networks. However, both network theories emphasize the value of new information provided by structural holes respectively bridging ties. Burt's theory of structural holes gives a theoretical explanation for Granovetter's observation that weaker ties are more likely to bridge cohesive networks. As Burt states, tie weakness is a correlate rather than a cause of the value deriving from bridging ties. Therefore, both theories are strongly related to each other (Borgatti and Halgin 2011, p. 1171).

Fundamentally, network theory is based on two explanatory concepts. First, it focuses on structure and position as key characteristics to predict organizational outcomes. In accordance with Burt (1992; 2000; 2001) and Granovetter (1973), a network's structure and an actor's position in it are determinants for network as well as actor outcomes. Actors' attributes are taken into account by relating them to structural aspects of networks. However, attributes play only a subordinate role, whereas the focus remains on structure. Secondly, networks are based on the pipe or flow model, which means that they function as distributors of information (Borgatti and Halgin 2011, p. 1172; Borgatti and Foster 2003, p. 1003; see also Burt 1992). The flow model implicates that the position and the distance between nodes have an impact on the length and frequency of flows, which, in turn, are related to more general outcomes. The flow model suggests that the point of time when nodes receive the flow, the degree of certainty as well as redundancy of flows are of major importance to understand organizational phenomena (Borgatti and Halgin 2011, pp. 1172). Thus, "network theory consists of elaborating how a given network structure interacts with a given process

(such as information flow) to generate outcomes for the nodes or the network as a whole" (Borgatti and Halgin 2011, pp. 1172). Nodes taking up a central position may have an advantage since they are more likely to receive the flow earlier than others. The content of ties is of little importance with respect to flows, whereas the patterns of interaction have a huge impact on which and when flows are received. Actors having a central position gain advantages since they can more easily access resources controlled by their alters.

Borgatti and Halgin propose another fundamental model of network theory. The bond or coordination model of networks suggests that networks give nodes the opportunity to align and collaborate (Borgatti and Halgin 2011, p. 1174). Structure has also an impact on power relations between nodes. However, as opposed to the flow model the mechanisms behind it are different. Power in networks can be expressed by dependency relationships (see Cook and Yamagishi 1992; Cook and Emerson 1978). The nodes' positions in networks matter not because one position is more likely to receive flows than others, but because positions determine the dependencies among nodes. Furthermore, network power is related to virtual amalgamation where ties of solidarity exist among dependent nodes, which may lead to unionization of nodes (Uzzi 1996, p. 676). Solidarity ties and exchange ties may be intertwined like in so-called network organizations (e.g. Powell 1990) where independent actors seem to act as one entity (Borgatti and Halgin 2011, p. 1174). Hence, the bond model considers network ties as bonds, which align nodes with each other and coordinate their actions. Actors gain advantage if their positions prevent them from being excluded from exchange deals.

Structure of interorganizational networks: a field of tension

Although network theory provides a valid theoretical foundation, the mechanisms behind network effects on firm performance are complex to understand and prevailing research provides only limited insights. A recent study by Baum et al. (2014) casts doubt on the validity of empirical results regarding the impact of network effects on firm performance and, thereby, challenges derived strategic prescriptions regarding network positions. Network research provides explanations for organizational behavior and choices (Borgatti and Foster 2003, p. 1003; e.g. see Davis 1991) as well as performance (e.g. see Burt 1992; Lin 2001) based (most often implicitly) on either the pipe or the bond model. However, in order to understand the underlying complexities of network structure and to explain the contradictions in network research it is necessary to consider both models as two complementing perspectives. Zaheer et al. (2010, pp. 64) have categorized the vast body of interorganizational network research into four mechanisms underlying the different theoretical considerations used in the literature. These mechanisms can be understood as the trigger for network operations and, as a matter of fact, are also implicitly considered in the flow or bond model of networks.

The first mechanism considers the interorganizational network as source of *resources* and *capabilities.* The notion of organizations accessing resources and capabilities through networks is especially elaborated in social capital theory (e.g. Coleman 1988; Uzzi 1996). According to Bourdieu and Wacquant (1992, p. 119), "social capital is the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue

of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition". Drawing mostly on the flow model, many studies discuss how ties or networks should be shaped in order to facilitate the flow of resources (e.g. information) finding expression in the dichotomy of cohesive networks and structural holes (Burt 2001; Coleman 1988; Gargiulo and Benassi 2000).

However, social capital may also cause lock-in effects in maladaptive situations. Organizations attempting to adopt their social capital due to environmental changes or endogenous forces are limited in their actions by previous established ties (e.g. Gargiulo and Benassi 1999; Sorensen and Waguespack 2006; Rowley et al. 2000). Ties with alters – especially when they have been considered as successful in the past – have been proven difficult to untighten since actors may feel a social obligation to preserve them (Coleman 1988, p. 98; Uzzi 1997, p. 36). Furthermore, firms tend to be inert in realizing that social capital may have lost value since strong bonds lead to a cognitive lock-in from developments outside the network (e.g. Kim et al. 2006). Strong interorganizational ties are characterized by relation-specific assets, e.g. institutionalized assets and human capital, which have initially been intended to induce competitive advantages (Dyer and Singh 1998). Dissolving or replacing these ties is therefore perceived as costly, which makes them extremely resilient despite losses in social capital.

The majority of social capital research implicitly relies on the flow model of networks. Here, networks function as conduit for a flow of resources (especially information) in which network structure and position determine flow outcomes (time of reception; share of non-redundant information). However, drawing on the bond model, strong interorganizational ties increase the tendency to preserving unprofitable relationships due to higher need for fulfilling social obligations and higher susceptibility for network inertia.

Secondly, networks may be used as a tool for *power and control*. According to Burt (2000, pp. 348; 2001, 1992), organizations bridging structural holes benefit from a position, where they are capable to influence and control the behavior of their alters. Due to an absence of connections between alters, actors may filter and maneuver information in order to exercise control over the network structure. Organizations occupying broker roles may exploit opportunities by excluding others from these opportunities, especially when “ambiguous or distorted information is strategically moved between contacts by the tertius” (Burt 2000, p. 355). However, network structures with structural holes invoke two major challenges. First, structural holes may cause an action problem, since brokers have more difficulties to coordinate or mobilize their dispersed and unconnected alters than in dense networks (Obstfeld 2005). Moreover, dense networks are characterized by close bonds facilitating collaboration and decreasing tendencies for opportunism (Adler and Kwon 2002, pp. 28). Therefore, strong ties are better for contexts, which require trust as basis for gaining benefits such as the transfer of tacit knowledge (Uzzi and Lancaster 2003, p. 385). Secondly, actors may benefit from structural hole positions only as long as opportunistic behavior does not negatively affect collaboration in the future. Brokers’ power-oriented behavior can be detrimental for group functioning and climate (Bizzi 2013). Although beneficial on an individual level, structural hole positions negatively affect individual outcomes on an aggregate level (Bizzi 2013, p. 1555). This results in a shared perception of potential opportunistic behaviors, which leads to increasing monitoring efforts (Bizzi 2013, p. 1558), a logic of

calculation and personal gain (Buskens and van de Rijt 2008, p. 372), learning races within interorganizational networks (Gulati et al. 2000, p. 211), or even network failure (Schrank and Whitford 2011, p. 168).

The emphasis on brokers' power-oriented behavior does not explicitly address flows since the focus is rather on the patterns of interconnections than on the content of ties. However, forming and exploiting ties in order to achieve objectives may have repercussions on the resource flow provided by the alters. Opportunistic behavior may influence the quality and quantity of resources since actors in a network are seldom independent but affiliated to others.

Thirdly, networks are seen as a source of *trust*. Traditionally, trust is considered to be the premise for cooperation and the consequence of established cohesive social ties and, thus, network closure (e.g. Coleman 1988). Trust decreases transaction costs in interorganizational relationships since it facilitates collaboration between actors and increases performance by reducing uncertainty (e.g. Beamish and Lupton 2009; Herz et al. 2016). Furthermore, adding third parties to a relationship even amplifies trust and diminishes the risk of opportunism affecting cooperative relationships (Granovetter 1985, p. 490).

However, trust in networks entails also a dark side (for an overview see Gargiulo and Ertug 2006). Strong ties between network partners may filter external information and ignore new ideas causing a cognitive lock-in (Uzzi 1997, pp. 57). Therefore, actors tend to disregard declining network performance or other warning signals. As a consequence, the social capital of these cohesive networks becomes a liability leading to a decrease in performance. Moreover, high trust between actors eventually leads to unnecessary social obligations resulting in actors becoming "overembedded" in a network and, thus, causing a number of suboptimal exchanges (Uzzi 1997, p. 59). Finally, trust impairs actors' ability to detect opportunistic behavior and to control the negative consequences due to reduced monitoring and safeguards (Granovetter 1985, p. 49). Although high network density enables organizations to share information faster and facilitates collaboration, it also poses a threat for protecting intellectual property (2010, p. 72).

Most of the network studies regarding trust contain flow-based explanations for achievement. Strong ties and cohesive networks facilitate the building of trust and collaboration and provide, therefore, access to resources. However, these studies may neglect bonding aspects of trust. Relationships, which are characterized by a high degree of trust, also form ties of solidarity, which potentially lead to unnecessary obligations.

The fourth underlying mechanism triggering network operations is the *signaling* mechanism. Organizations, which affiliate with high-status partners or have been recognized by high-status peers, provide signals about the quality of the organizations to other actors (Baum et al. 2000; Podolny 1993; 2005; Stuart et al. 1999). Reducing uncertainty, this kind of signals may increase visibility, prominence, and supposedly organizations' access to resources as well as (potential) network partners.

However, affiliations with high-status partners contain some negative consequences. Prominent partners often pose a thread of misappropriation (e.g. Katila et al. 2008). Especially, new entrepreneurial firms may be exposed by corporate sharks and not be able to protect valuable resources (e.g. knowledge) from their prominent partners (Katila et al. 2008, p. 296). Moreover, negative consequences for new firms are

implicitly addressed when researchers argue that established firms "manage threats from market entry by selectively providing and withholding entering firms' opportunities to collaborate with incumbent firms" (Jensen 2008, p. 723). Furthermore, poorly embedded firms need to accept rather unfavorable terms in negotiations since highly embedded partner may exploit their bargaining power in relationship agreements. Thus, firms attempting to endorse their quality and position by shaping networks may constrain further expansions (Ahuja et al. 2009, pp. 945).

Studies dealing with signaling aspects of networks are mostly based on bond-based explanations since network ties are considered to provide clues to audiences in order to signal quality of an actor. However, these studies may neglect the flow perspective that characterizes relationships by asymmetric ties since actors differ in terms of network position and centrality. Hence, better-embedded actors may use network relationships in order to get access to re-sources and capabilities.

The ambivalent effects of the four mechanisms reveal the bi-functional character of ties in an interorganizational context. Ties between firms simultaneously serve as pipes as well as bonds with both having consequences on outcomes.[4] This turns the structure of an interorganizational network into a *field of tension*, in which firm performance can either positively or negatively be influenced by network position and structure.

Strategic implications: balancing the network

A common catchphrase in network research is that network structure and position provides actors with opportunities and constraints. Although agency has played a rather minor role in network research, the opportunities-and-constraints-perspective indicates that actors need to take actions in order to exploit opportunities and to deal with the constraints (Borgatti et al. 2014). Digital technology has dissolved previously stable industries and linear value chains in favor of dynamically emerging networks increasing the necessity to discuss structural effects on firm performance. Firms need to find strategies helping them to achieve and sustain competitive advantage under new circumstances which request digital technology to be an integral part of strategy formulations (Bharadwaj et al. 2013, p. 472; Yoo et al 2010a, p. 730). Given the high uncertainty in digital ecosystems, firms may attempt to shape their digital ecosystems instead of predicting developments or adapting to rapid changes. Strategic decisions concerning the control of digital platforms or the application and integration of resources into platforms owned by others influence the shape and the structure of networks around firms. In turn, the structure of networks and how firms are embedded in them have an impact on firms' performance (Gnyawali and Madhavan 2001). Network structure and individual agency are intertwined: structure determines actions, which subsequently shape the structure (Bourdieu 1977; Gulati and Gargiulo 1999). Therefore, firms embedded in interorganizational networks seek to achieve beneficial positions and to form valuable ties in order to explore business opportunities and gain competitive advantage (Baum et al. 2014, p. 653; Gulati et al. 2000, p. 207; Zaheer and Bell 2005).

Strategic research concerning networks pays attention, especially, to the identification of factors and conditions under which firms may benefit from either open or closed network positions (e.g. Ahuja 2000; Baum et al. 2012; Rowley et al. 2000). Most studies

are particularly concerned with contingent explanations for beneficial network effects, thereby neglecting the complexity of network effects on firm performance as well as how firms exert agency and intentionally alter their networks.

The notion of the interorganizational network as a field of tension shows that pitfall of networks may emerge if negative repercussions of presumptive beneficial network strategies are neglected. For example, the control benefit notion in structural hole theory focuses on the power of actors provided by structural hole positions, however, neglecting the potential negative effects on future resource flows with dependent alters. This example illustrates that actions that benefit certain aspects of interorganizational networks may have negative consequences on others. Zaheer et al. (2010) have identified network mechanisms according to which firms form networks. In order to access resources, to establish trust, to gain power, or to signal quality to other firms, organizations may pursue different strategies. The proposed strategies most often rely implicitly on one of the underlying network models – flow or bond – which consider ties between nodes as conduits that facilitate the flow of something or as bonds that align and coordinate action respectively. The double-sided character of ties between actors serving as pipes and bonds often leads to contradicting effects on organizational outcomes. Hence, strategic decisions need to balance the opportunities and constraints of certain network ties and structures and consider the trade-offs.

According to the model of constrained agency firms actively create, perpetuate, and modify network structure by acquiring, activating, altering, and adjusting relationships (see Gulati and Srivastava 2014). Firms take actions through the choices they make regarding given interorganizational ties. Network positions determine firms' resources at hand and shape their motivations to employ these resources. This constrained agency is expressed by network actions, which subsequently can alter firms' initial position in interorganizational networks. The question of forming new ties or dropping old ones becomes therefore a strategic matter with respect to the design of digital platforms (e.g. Evans and Schmalensee 2016; Gawer 2009). Digital platforms connect actors by facilitating their value co-creating activities that shape the structure of certain digital ecosystems. A platform creates value by attracting third parties (e.g. customers, business partners, research companies etc.) to use the platform for applying and integrating their resources. Platform owners govern relationships and control with whom to establish ties by deploying technical boundary resources (Eaton et al. 2015; Ghazawneh and Henfridsson 2013). Third party participation enhances functionality and network effects and, thereby, allows owners to increase the value of their platforms (Gawer and Cusumano 2002, p. 6). Firms take network actions by leveraging their resources through the platform in order to increase their own performance (Ceccagnoli et al. 2012, p. 267). Thus, the structure of digital ecosystems enables firms to acquire, activate, alter, and adjust ties. Simultaneously, the structure shapes motivation to do so. As a consequence, the ecosystem structure itself tends to constantly change.

Due to the prevalent interdependence of structure and agency in digital ecosystems, the only remaining relevant source of sustained competitive advantage is the interorganizational network structure. Accordingly, firms effectuate digital ecosystems through digital ecosystems by balancing the different effects of network structure to their favor.

Toward a network-centric view

Porter's industry structure model, the resource-based view and the dynamic capabilities approach provide valuable insights to better understand how firms are capable to attain

and sustain competitive advantage. However, due to the pervasive digitization of products and processes, some of their underlying assumptions need to be revised. This section will contrast the main characteristics of the above mentioned perspectives with the elaborated implications of digital technology from previous chapters. Furthermore, propositions for an alternative *network-centric view* are developed (see Table 1).

Interorganizational network as unit of analysis

The industry structure view, the RBV as well as the dynamic capabilities approach pay special attention to the unit of analysis, whose characteristics are considered to be most important for understanding sustained competitive advantage. The industry structure view and RBV have identified different but somewhat complement sources of competitive advantage. According to Porter (e.g. Porter 2004a, 2004b) firm's strategic position within a chosen industry explains different firm performance with respect to the external environment. Contrarily, the RBV argues that firms may sustain competitive advantage through the possession of firm-specific valuable, rare, inimitable and non-substitutable resources (Barney 1991). Both views assume that a firm's environment is relatively stable and uncertainty is depicted as a consequence of a change towards new equilibrium. However, the digital environment is characterized as complex, turbulent, and fast changing. Value creation and competition occur in unforeseen ways resulting in high degrees of uncertainty. Therefore, it is questionable whether competitive advantage can be sustained or even exists per se (e.g. D'Aveni et al. 2010; McGrath 2013; Tanriverdi et al. 2010). Without clear industry boundaries and relative stable industry structures, competitive advantage is perishable. Moreover, under these turbulent circumstances it is hardly possible to identify or measure competitive forces of an industry (D'Aveni et al. 2010, p. 1374). Similarly, the nature of the digital environment casts doubt in the constant value and inimitability of resources, and therefore on the sustainability of competitive advantage. Thus, positioning and VRIN resources as sources of sustained competitive advantage become less valid in the digital economy.

In contrast to the industry structure view and the RBV, the dynamic capabilities approach claim to provide an understanding of how firms attain and sustain competitive advantage in turbulent environments (e.g. Eisenhardt and Martin 2000; Helfat et al. 2007; Teece et al. 1997). Superior performance is based on dynamic capabilities, which enable firms to rapidly response to a changing and turbulent environment. Dynamic

Table 1 Models of Sustained Competitive Advantage

	Industry Structure View	Resource-Based View	Dynamic Capabilities Approach	Network-Centric View
Unit of Analysis	Industry: Positioning	Firm: Resources	Firm: Dynamic Capabilities	Interorganizational network structure
Conception of the Environment	Relatively stable industries	Relatively stable industries Focus on internal organization	Turbulent	Dynamic digital ecosystems
Logic of Strategy-Making	Predictive: Strategic planning	Predictive: Strategic planning	Adaptive: Planned Adaption	Transformative: Effectuation
Value Creation	Exchange value Firm Sequential value chain	Exchange value Firm-owned resources	Exchange value Dynamic capabilities	Use value Network of firms Value co-creation

capabilities "are in a continuously unstable state" (Eisenhardt and Martin 2000, p. 1113), upon which firms need to constantly create and combine resources. As a result, firms tend to become flexible, agile or improvisational, which makes them better equipped to adapt to environmental changes as well as to capture new opportunities. Nevertheless, there is a debate about the validity of conceptualizing dynamic capabilities as sources of sustained competitive advantage (e.g. Peteraf et al. 2013). Although dynamic capabilities may enable firms to achieve sustained superior performance under specific circumstances, there is apparently a lack of evidence that this applies to different contexts and time periods (D'Aveni et al. 2010, p. 1372). Furthermore, dynamic capabilities cannot be sustained since they are considered to be mere *best practices*, which are substitutable and, thus, violate the VRIN condition (Eisenhardt and Martin 2000, p. 1106). The unlimited possibilities to combine and recombine various resources in digital settings increase the potential to create resources with the same functionality as previously rare or unique dynamic capabilities. Thus, dynamic capabilities may serve as source of competitive advantage only in specific contexts.

To sum up, the traditional approaches to explain sustained competitive advantage – namely the industry structure view, the RBV, and the dynamic capabilities approach – are challenged through the emergence of digital technology. The relevance of the originally identified sources of competitive advantage – positioning, VRIN resources, and dynamic capabilities – is diminishing in the digital economy. Firms tend to have less influence on achieving and sustaining competitive advantage since industry structures are blurred and ambiguous (e.g. Yoo et al. 2010a; Tilson et al. 2010a). Firms are embedded in dynamic and turbulent ecosystems characterized by high degrees of uncertainty, value is co-created with several other firms and strategy-making is based on actively shaping the environment. In the digital environment firms participate in intertwined networks – the one remaining constant under these circumstances – to create value and compete. Thus, from a network-centric perspective, it can be concluded that firms' resources and capabilities extend beyond firm boundaries and be embedded in set of relationships between firms (e.g. Dyer and Singh 1998; Gulati et al. 2000; Lavie 2006; Snow 2015). Consequently, the unit of analysis of a network-centric view is a firm's interorganizational network as the primary source of sustained competitive advantage (see Table 1).

Conception of the environment

Both, the industry structure view and the RBV consider the external environment as rather stable with incremental changes over time and only rare radical changes. The external environment is constructed as separated industries, which are clearly defined by industry boundaries. However, digital technology provides affordances, which result in dissolving industry boundaries. Digital convergence and generativity enable firms to create value across firms as well as industry boundaries (Tilson et al. 2010a; Yoo et al. 2010a). Since digitized products are not bound and fixed, the assumption of stable industries becomes questionable. This casts also doubt on the assumption of change as a phase between two equilibria. Digital environments are constantly evolving due to the generative affordance of digital technology giving opportunities for various competitive actions. As a consequence of this dynamic environment, industries never reach equilibrium (see Smith et al. 2001).

The dynamic capabilities approach is considered to be a direct answer to these problematic assumptions of the industry structure view and RBV (e.g. Eisenhardt and Martin 2000; Teece et al. 1997; Helfat et al. 2007). In order to include rising phenomena such as hyper-competition, high-velocity environments or globalization, the dynamic capabilities approach assumes external environments as dynamic and turbulent in nature. Yet, it misses an appropriate metaphor to capture the specific characteristics of this turbulent environment. Industries become less relevant constructs to depict the reality of networked value creation and competition. In contrast, Teece recently introduced the concept of the ecosystem in order to cope with this new reality (Teece 2012, pp. 104; Teece 2014, p. 329). Digital ecosystems embrace the dynamic nature of competition and value creation as well as their embeddedness in complex dynamic networks. Thus, we can state the following proposition:

Proposition 1: From a network-centric view, firms in a digital environment operate in multiple intertwined dynamic ecosystems, which enable and restrict firms in their competing and value creating activities. *Specifically, the higher the degree of digitization, the more the firm's competitive advantage is influenced by the complexity, turbulence and dynamics of the digital environment.*

Underlying logic of strategy making

Drawing on the industry structure view, RBV, and the dynamic capabilities approach strategic decisions follow either of two basic logics: Firms attempt to predict an uncertain future better than competitors (see planning school of strategy) or adopt faster to changing circumstances (see learning school of strategy) (Wiltbank et al. 2006, p. 983). Since the industry structure view and the RBV assume a relatively stable environment with a moderate degree of uncertainty, it should be feasible for firms to analyze, scan, and evaluate alternatives in order to accurately predict future developments. The dynamic capabilities approach emphasizes less the role of strategic planning in favor of responsive systems to adapt faster to turbulent environments. Both logics of strategy-making assume the environment as exogenous and given (Wiltbank et al. 2006, p. 983). Strategic decisions, therefore, implicitly serve the purpose to establish a fit between the firm and its external environment. Firms align the resources they own to the environment. The better they succeed in doing so, the more likely they can achieve sustaining competitive advantage.

Recently, the introduced effectuation approach has provided an alternative view, which considers the environment as endogenous (e.g. Read et al. 2009; Sarasvathy 2001). Instead of predicting or reacting on rapid changes in the environment, firms attempt to affect their environment in order to control the outcome of their activities. In digital ecosystems, which are characterized by high uncertainty, complexity and turbulence, attempts to control or influence the evolution of the ecosystem may help firms to achieve superior performance and competitive advantage rather than attempts to predict or react to an uncontrollable and disruptively changing environment. According to Knight (1921), predictions in such shaped environmental settings cannot be used for achieving control, since the future is not just difficult to predict, it does not even exist. Instead, it may be necessary for firms to shape and effectuate the uncertain environment in order to attain and sustain competitive advantage. Firms are capable to

efficiently effectuate ecosystems by attracting heterogeneous actors to co-create value on their digital platforms and controlling these platforms through technical boundary resources (such as APIs and SDKs). Strategic decisions, therefore, should rather tend to actively shaping digital ecosystems. Thus, we can formulate the following proposition:

Proposition 2: From a network-centric view, strategy-making is based on effectual actors, who actively shape their environment in order to achieve and sustain competitive advantage. *Specifically, the higher the degree of digitization, the more the firm creates competitive advantage by actively shaping the digital environment.*

Value creation process

The traditional approaches of understanding competitive advantage have initially been criticized for lacking a theory of value creation (Pitelis 2009, pp. 1117; see also Makadok and Coff 2002). Originally, industry structure view, RBV, and the dynamic capabilities approach have been focused on the capture of value (although often denoted as value creation), since their purpose is to provide an understanding of firm profitability. Use value, and therefore value creation, has played only a subordinate role and become only relevant insofar as it affects firms' capabilities to capture value (Makadok and Coff 2002, p. 10).

From this perspective, the traditional models locate value-creating activities within firm boundaries. Porter has elaborated the concept of the value chain in order to depict value-creation as a sequential process of activities (Porter 2000; 2004a; 2004b). The single firm occupies a certain position in this chain, in which it receives input from its suppliers, adds value and delivers the product to the customer (Peppard and Rylander 2006, p. 131). However, the underlying assumptions of fixed product boundaries and economies of scale and scope as primary sources of value creation lack validity in times of digitization. Value creation in the digital economy is rooted in the precepts of generativity, which opens the value creation process for multiple firms to limitlessly combine and recombine digital components. Thereby, value creation becomes decentralized in terms of product architecture and organization. Hence, the context in which value is created has changed fundamentally – away from predetermined and linear value chains towards rather dynamically emerging value constellations, which comprise cooperative networks of providers and customers (Normann 2001, pp. 106).

This notion of value added can also be found in the RBV (Barney 1995; 1991). Likewise the industry structure view as well as the dynamic capabilities approach defines *value* as willingness to pay less its costs (Helfat et al. 2007, pp. 12; Peteraf and Barney 2003, p. 315). This conception of value differs from exchange value to the extent that it emphasizes the perception of the beneficiary rather than reflecting the realized monetary amount. However, it remains doubtful if market prices are the appropriate means to measure use value of a service (Pitelis 2009, p. 1118). The value of digital service may be difficult to determine due to the willingness to pay of beneficiaries. For example, Apple introduced the App Store as a digital platform, upon which other firms could develop applications. Apple did not charge these firms for using its resources since these activities increase the use value of the platform. Use value increases by attracting others to actively utilize the digital object. This enables Apple to potentially capture the created value on another level. Since the context of value cannot be

conceptualized as a value chain any more, it has become dynamic and more difficult to grasp. Therefore, the prevailing conception of value of the traditional approaches needs to be revised (e.g. Normann and Ramírez 1993). Alternatively, the S-D logic seems to be more capable of capturing the network-oriented reality of dynamic value constellations (Vargo and Lusch 2004; Vargo et al. 2008). Accordingly, value can only be created when it is used. This conception shifts the focus from the output to a process of value creation, in which service is exchanged for the benefit of others and oneself (Vargo et al. 2008, p. 148). Value is, thus, always co-created. Whether a firm will use a value proposition by another firm or not is dependent on the context, which is shaped by relationships and interactions, directly and indirectly connected to the exchange (i.e. the digital ecosystem). Thus, we can state the following proposition:

Proposition 3: The network-centric view draws on the S-D logic in order to conceptualize value creation in the digital ecosystem. In accordance with this notion, value is always co-created by several firms, directly and indirectly connected to the service exchange. *Specifically, the higher the degree of digitization, the more the firm creates competitive advantage through value co-creation of the interconnected firms.*

Conclusion

During the last decade impressive improvements in digital technology have unleashed new functionalities with implications for product architecture, value-creation, and environmental settings. Products and infrastructures have changed their very nature since digital technology increasingly permeates goods, services, and processes. This phenomenon is often denoted as *Industrial Internet, Industry 4.0* or *Internet of Things*. Fixed product design dissolved in favor of a *layered modular architecture* (i.e. contents, service, network, and device layer) and the process of value creation changed fundamentally from linear-oriented sequential value chains to complex value networks. Due to the generativity of digital products heterogeneous firms are able to limitlessly mix-and-match combinations of various products and services and to establish new forms of *value co-creation*. Whereas certain layers may serve as *digital platforms* upon which others are endorsed to apply and integrate resources, other layers may function as components for different platforms. Firms co-create value across firms and industry boundaries. This results in blurred industry structures and the emergence of *digital ecosystems*. A digital ecosystem describes a network of various, heterogeneous, and diverse actors who differently participate and contribute to value creation processes. Due to the heterogeneous and unpredictable role of actors a digital ecosystem is a highly volatile, complex, and uncertain environment. These digital ecosystems are considered to be the playing field, which restrict and enable firms in their *competitive actions*. The high degrees of uncertainty impede firms' ability to base strategic decisions on predictive rationality. Instead, firms may *effectuate* their environment in order to shape it for their benefit and, thus, for long-term performance. Due to the hardly predictable nature of complex ecosystems and, in particular, such dynamic value creation processes, the exchange value of goods and services tends to be more volatile and unsure. In contrast to the prevailing notion of value focusing on actors' willingness to pay for a ready-made product or service, the value of a digitized product or service is – according to the S-D logic – a result or function of the value being created while it is used. The increase in value of a digital platform is determined by how this platform

is used (both by applying and integrating resources). Due to the fact that the eventual purpose of a product or service is not predefined, not easily anticipated, and in a permanent state of flux, exchange values of goods and services are also hardly predictable.

These implications of pervasive digital technology challenge the environmental and conceptual assumptions of traditional models of sustained competitive advantage – the industry structure view, the resource-based view, and the dynamic capabilities approach. In contrast, by integrating diverse theories from organizational studies, information systems, marketing, entrepreneurship research, and strategic management, the outline of a *network-centric view* proposes a framework which explains differential firm performance due to characteristics of a digital economy. This framework is valuable because it provides a theoretical basis for further research on the understanding of the sources of competitive advantage in a dynamic digital environment.

Drawing on *network theory* as methodological core of the network-centric view, this study proposes a framework, which helps to understand the complex and often contradicting effects of network structure on firm performance. Effectual firms, which affect their firm-specific network structure, can influence value creation, and competition to their benefits. Firms need to balance different network mechanisms (i.e. resources, trust, power and control as well as signaling) in order to prevent potential pitfalls. The analytical framework contributes to network research by providing an explanation for ambiguous empirical results with respect to network effects as well as giving an understanding of the structure of interorganizational networks structure as major source of sustained competitive advantage in the digital economy. Nevertheless, network structure is not considered to be the only determinant of firm performance (Zaheer et al. 2010, p. 63). Industry structure view, resource-based view, and dynamic capabilities approach provide a robust umbrella for generating insights about specific firm characteristics and their implications on firm performance. However, taking the increasing digitization of products, services, and processes into account, networks of firms should be included in future research on firms' possibilities and capabilities to create value, compete and conceive their environment.

The network-centric view integrates diverse concepts such as the model of layered modular product architecture (Yoo et al. 2010a), the service-dominant perspective (Lusch and Nambisan 2015; Vargo and Lusch 2004, 2006), ecosystems (Moore 1993), competitive dynamics perspective (Chen and Miller 2012; Smith et al. 2001), and effectuation (Perry et al. 2012; Read et al. 2009; Sarasvathy 2001). Overall, the digital economy is depicted as a magnitude of intertwined and dynamic interorganizational networks, through which firms compete, collaborate, and create value by forming, altering or dropping relationships with other firms. Network theory can be considered as the theoretical foundation of the network-centric view. It connects the different concepts in such a way that firms' activities need to be construed as network actions. Future research might examine the coherence of network actions and the network-centric view in greater detail. Further research is required, in particular, with respect to competitive strategies which incorporate the specific affordances of digital technology. Traditionally, IT strategy has been separated from business strategy since it has been considered to be a functional strategy aligned with and subordinated to a chosen business strategy. Instead, due to pervasive digital technology, business and IT strategy need to be merged to a digital business strategy (Bharadwaj et al. 2013). Additionally, further

research is required with respect to how firms should strategically control their digital platforms. Which layers should be closed, which one should remain open? Furthermore, future research concerning network capabilities and network structure would deepen the understanding of sustained competitive advantage in the digital economy (e.g. Wang and Rajagopalan 2015; Mitręga et al. 2011; McEvily and Zaheer 1999).

Most discussions around Industry 4.0 depict digitization as an opportunity or possibility to increase efficiency and optimize production processes. However, this paper has emphasized that there are more implications of digital technology then mere increases in efficiency. Changes concern not only enhancements in production technology but also challenge established business models, environmental conceptions, and sources of competitive advantage. Therefore, from a practical point of view, managers need to consider how digital technology change the whole context, in which they operate. Former competitive advantages may vanish due to unbeneficial network positions or structures. New opportunities may emerge since the layered modular architecture represents a range of possibilities for incorporating digital components into physical products. Managers need to make strategic decisions where, when and with whom they want to co-create value. Likewise, they must decide which layers should serve as digital platforms and which as components for other platforms. All these decisions have an impact on a firm's network structure and its position in the network, and, thereby, its potential competitive advantage.

When the car manufacturers Audi, BMW, and Daimler acquired Nokia's digital mapping business HERE, they made the strategic decision to building a digital platform upon which other firms should be attracted to apply and integrate their resources. Although the digital mapping service does not belong to the core competencies of car manufacturers, it is of strategic importance. If successful, the increased value of the platform would contribute to a viable ecosystem, in which the three car manufacturers would take a central position. The car firms consider themselves – as VW's former CEO Martin Winterkorn stated it – as *mobility enablers*[5] rather than as mere producers of cars. Confronted with high uncertainty (e-mobility, test drives of the Google Car, Apple's setup of an automotive section), they actively affect the digital ecosystem by shaping the digital automotive platform. What the car manufacturers actually did was to see through the networks, which are emerging around the automobile. Sustaining competitive advantage is becoming less a function of internal resources or capabilities but is increasingly more dependent on the networks surrounding firms.

Endnotes

[1]Found in DiMaggio 2001, p. 212.

[2]Some scholars (e.g. Tilson et al. 2010a; Yoo et al. 2010b) make a semantic distinction between *digitization* (technical process) and *digitalization* (social-technical process of applying digital technology to social contexts). This study relinquishes this differentiation due to the fact that in the context of the digital economy *digitization* cannot be understood without its social-technical implications.

[3]Note that service is not considered in the sense of the product-service-dichotomy (services as output) but as common denominator of all economic exchange (Lusch and Nambisan 2015, pp. 158).

[4]For further remarks on the issue of content of ties in network research see Borgatti et al. 2014.

[5]The original term was *Mobilitätsermöglicher*.

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The first author provided the main contribution. Both authors read and approved the final manuscript.

Competing interests
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