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Rethinking the process of diffusion in innovation: A service-ecosystems and institutional perspective

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ABSTRACT

The diffusion of innovation is generally referred to as the spread or adoption of a technology within a social context. This view separates technological and market aspects of innovation by relying on an underlying assumption of a unidirectional flow of innovation–that is, from the technological side to the market side. More recent work, however, points toward more dynamic, inclusive, and integrative approaches to studying innovation and diffusion. We develop a theoretical framework for rethinking the process of diffusion in innovation, using a service-centered, ecosystems, and institutional lens. This framework helps to overcome narrow conceptions that separate technological aspects of innovation from processes of diffusion or adoption, and highlights the importance of institutional change. Specifically, our framework does not privilege one actor as an innovator/producer and another as an adopter/consumer, but rather considers all actors as resource integrators, and diffusion as a critical part of recursive innovation processes.

1. Introduction

Diffusion is critical for spreading new solutions throughout society. Conventional models representing the diffusion of innovation highlight the importance of adopters in the use and spread of new technologies and shed light on the trajectories of adoption that occur as the diffusion process unfolds (e.g., Rogers, 1976). However, traditional models generally delineate innovation and diffusion in a way that separates technological and market aspects of innovation. Whereas technological aspects of innovation are often referred to as "supply side" or "upstream," market aspects are often referred to as "demand side," or "downstream" (Schumpeter, 1934; Geels, 2004; Vargo and Lusch, 2011; Vargo et al., 2015). The supply-side, or production-focused view often conceptualizes innovation as the development of something—a new idea, product or technology (Rogers, 2003, p. 12). This typically occurs through a firm's efforts, though in some cases, might be generated through user-driven ideas and activities (e.g., von Hippel, 2005). The demand-side, or consumer-focused view of innovation generally explores the process of diffusion, or the adoption, of such ideas, products or technologies (e.g., Rogers, 1976).

Traditionally, diffusion research investigates attributes of innovative offerings, commonly captured under the rubrics of "relative advantage," "compatibility," "complexity," "trialability," and "observability" (Rogers, 2003, p. 16-17), as well as characteristics of "adopters" (e.g., "consumers") that impact the rate and scale of diffusion. More recent literature, on the other hand, offers integrative and systemic perspectives (e.g., Geels, 2002, 2004; Rogers et al., 2005; Adner, 2017) that move away from unidirectional views on innovation and emphasize the role of social influences in adoption (e.g., Geels, 2002, 2004, Rogers et al., 2005) or ecological configurations (Adner, 2017). However, most of these approaches continue to view innovation as firm-produced units of output, and diffusion as the consumer-centered social process that follows. Thus, we argue, a deeper understanding of innovation requires further exploration of the relationship between innovation and diffusion in complex systems.

The purpose of this paper is to develop a theoretical framework for conceptualizing diffusion in an extended innovation process, using a service-ecosystems and institutional lens. Rather than focusing narrowly on diffusion as the adoption of a unit of output developed by a single firm or an industry for a particular purpose, we consider diffusion as an institutional change process, which occurs as a novel technology or idea is applied across multiple purposes, perspectives, and contexts. We build on previous work (Vargo et al., 2015) that views innovation as a process through which novel solutions emerge as multiple actors integrate and exchange resources to create value for themselves and for others–i.e., to cocreate value. Specifically, service-dominant (S-D) logic

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describes innovation as a cocreative process that is embedded in service ecosystems—"relatively self-contained, self-adjusting system[s] of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange" (Vargo and Lusch, 2016). In this view, innovation is a process of *institutionalization* (e.g., the establishment of social norms, rules, values, and symbols, etc.) and includes not just the development, but also the diffusion of both technologies and markets.

This S-D logic-based, service-ecosystems approach is inclusive and accommodative of other approaches to diffusion, including the traditional framework of Rogers (2003) and more contemporary orientations, such as the sociotechnical framework of Geels (2004), the neo-sociotechnical framework of Winter et al. (2014), and the ecosystemic orientation of Adner and Kapoor (2016). It is also accommodative of other systemic and institutionally grounded research streams that can be used to update the seminal work by Rogers (2003), including work by Giddens (1984), Lawrence and Suddaby (2006) and Czarniawska and Joerges (1996). Furthermore, it resonates with Rogers et al.'s (2005) complexity-centric theoretical update.

Importantly, the service-ecosystems framework considers diffusion as integral to the process of innovation and advocates an actor-to-actor (A2A) orientation (Vargo and Lusch, 2011), which does not privilege one actor (e.g., firm) as an innovator and another (e.g., customer) as an adopter. This view depicts diffusion as part of a recursive cocreation and innovation process that reflects the integration of new solutions within and across social structures (c.f.; Chesbrough, 2003; von Hippel, 2005). In other words, a service ecosystems view suggests that innovation (i.e., evolution of useful knowledge) involves the institutionalization of new solutions. It offers an understanding of diffusion as a general, institutional change process, as well as the adoption of technology for a contextually-specific purpose.

To converge on an ecosystemic and institutional understanding of innovation diffusion, we structure the paper as follows. We begin by providing a brief overview of the diffusion of innovation literature and background on a service-ecosystems and institutional view. We then conceptually explore key service ecosystem elements–technology, institutionalization, institutional arrangements, and emergence–and propose a metatheoretical framework for rethinking the relationship between innovation and diffusion by conceptualizing diffusion as a cocreative process. This metatheoretical framework highlights the need to study diffusion as integral to, and intertwined with, other value cocreating, innovation processes, which have reverberations that can be observed across various nested levels of aggregation (Vargo and Lusch, 2017). We discuss the extended consequences of diffusion and conclude with a discussion of the theoretical and managerial implications of this framework.

2. Diffusion of innovation

Traditional diffusion of innovation research broadly focuses on understanding what drives adoption of a resource (e.g., idea, product, or technology) and then alters a particular social structure and context. More specifically, Rogers' (2003) seminal framework draws on various fields of research and presents diffusion as a communication process. He argues, "*Diffusion* is the process by which an innovation is communicated through certain channels over time among the members of a social system. Diffusion is seen as a special type of communication concerned with the spread of messages that are perceived as new ideas" (Rogers, 2003, p. 35, emphasis in original). This focus on communication is notable because it emphasizes the disconnect between the process through which a technology is developed (i.e., innovation as an outcome) from the process through which it spreads (i.e., diffusion of innovation).

In Rogers' (2003, p. 221) diffusion of innovation framework, "the relative speed with which an innovation is adopted by members of a social system" represents how quickly a new idea or technology is

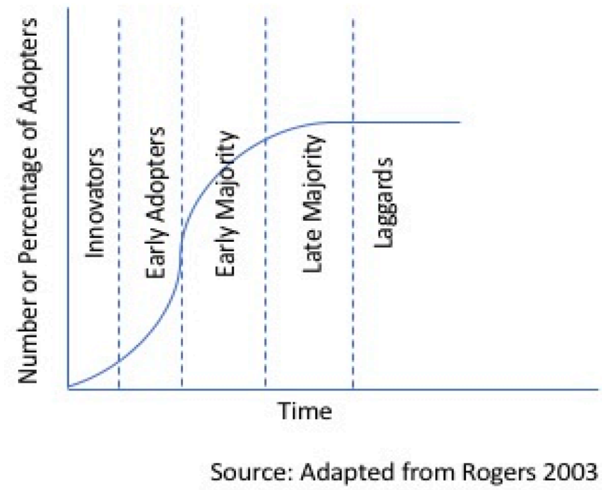

Fig. 1. The role of adopters in the diffusion of innovation.

diffused throughout a particular social context. Rogers also highlights how the rate of adoption is influenced by (1) individual actors and their characteristics (i.e., the innovativeness of these actors), (2) attributes of particular innovations, (3) network patterns, and (4) characteristics of the system that enable the adoption of a particular innovation.

2.1. Adopters, attributes and networks

Rogers proposes that adopters fall within several categories of innovativeness that guide diffusion–innovators, early adopters, early majority, late majority and laggards–and that the adoption of an idea occurs in an S-shaped curve. Fig. 1 illustrates the primary types of adopters who adopt an idea or technology at different stages of diffusion.

Based on this framework, actors who first adopt new ideas that may fail are considered "innovators" and are instrumental in initiating diffusion. For example, the idea of ride sharing began with Garret Camp and Travis Kalanick, co-founders of Uber. They launched a company called UberCab in San Francisco that enabled users to get a ride using their smartphones. According to Rogers' (2003) framework, they initiated diffusion by promoting (communicating) their service as a solution for people who were looking for alternative modes of transportation. However, the "innovators" were the first drivers and riders and, without their participation, the ride sharing idea as an alternative to taxi cabs would have failed. They established the availability of a new resource for early adopters to further diffuse.

Although Rogers (2003) argues for innovators and early adopters as critical enablers of diffusion of innovation, he also recognizes that the trajectory of the rate of adoption is influenced by the attributes of an idea or product. This includes (1) the relative advantage of a new idea over an existing idea, (2) the compatibility of the new idea with the values, beliefs and needs of adopters, and (3) the complexity of an idea or product (e.g., ease of use). The idea of ride sharing opened up new and improved opportunities for people to access transportation in a more efficient and cost-effective manner. In general, the idea was simple and compatible with prior transportation practices, which enabled the spread and diffusion of ride sharing.

Awareness of the social elements impacting diffusion have been recognized in discussions regarding systems approaches to diffusion (Rogers, 2003; Rogers et al., 2005). This draws attention toward the role of networks and characteristics of the systems in enabling adoption. Rogers (2003, p. 274) suggests "The S-shaped curve of diffusion 'takes off' once interpersonal networks become activated in spreading individuals subjective evaluations of an innovation from peer to peer in a system." The role of the network is clearly evident in the example of ride sharing, particularly because the relationships between service providers and beneficiaries rely on a network that represents both supply and demand. In this way, current ride sharing networks, such as Uber and Lyft, represent both technology and market sides of innovation as well as diffusion. This example highlights the need to consider the role of diffusion in the process of innovation itself–because without adoption of the idea across both drivers and riders, innovation could not occur. Furthermore, although the success of ride sharing is evident, the introduction and diffusion of this novel solution has incurred resistance as well.

2.2. Complex adaptive systems

The general focus on innovation as the creation of an idea or artifact has both dominated and limited understanding of the diffusion of innovation. This is because diffusion is often studied apart from innovation, and much of the adoption research centers on the rate with which an idea or product is subsequently infused "downstream" within a particular social system. The recent shift in emphasis toward understanding the interaction between the technological (supply-side) and market (demand-side) aspects of innovation highlights a need for understanding the social processes and outcomes that underlie innovation, in general, and diffusion, in particular (Akaka and Vargo, 2013; Vargo et al., 2015).

Recent literature seems to converge on a more systemic perspective of diffusion that highlights the importance of "multiple factors" through which alterations "in the structure and function of a social system" occur (Rogers, 2003, p. 6). This shift points to diffusion as a social process that contributes to innovation in the context of *complex-adaptive systems* (Rogers et al., 2005), rather than diffusion as a separate and subsequent process. Some have begun to move away from a unidirectional or bidirectional orientation of diffusion to network (e.g., Choi et al., 2010) or system (e.g., Johannessen, 2013) orientations, which have been conceptualized in terms of "innovation ecosystems" (Adner and Kapoor, 2010) or, more generally "sociotechnical systems" (Geels, 2004). Some of these reorientations also include consideration of social context, including institutional structures (Geels, 2004; Fuenfschilling and Truffer, 2014).

The exploration of diffusion of innovation in complex-adaptive systems highlights the process through which individuals, organizations and societies continually adapt to changing contextual requirements, while simultaneously creating this change. This approach to diffusion stems from the realization that a reductionist view of the world cannot be used to describe systems that operate in a non-linear and dynamic manner (Levin, 1998). Common to such complex systems are patterns that are characteristically unpredictable. These patterns are often repeating (i.e., fractal) and form from individual actions, recursively responding to the patterns they produce (Arthur, 2015; West, 2017). Complex adaptive systems interact with their environments, are subject to resulting feedback effects, evolve over time, and adaptively adjust to the pressures imposed on them (Holbrook, 2003). In this way, the diffusion of innovation can be viewed as a complex-adaptive process, which contributes to social change.

In general, the investigation of diffusion within complex adaptive systems recognizes time, based on the rate of adoption, as an important element of innovation, but also requires a broader lens for exploring how diffusion enables innovation through iterative and recursive feedback loops regarding new ideas and viable solutions. In other words, the systems view requires the consideration of the consequences of innovation on the wider social structure. However, there is no full, systematic synthesis of these various approaches, especially as they apply to the diffusion process through which knowledge evolves (i.e., innovation emerges and spreads) (Chandler et al., 2019). In the next section, we introduce a service-ecosystems and institutional perspective to provide insights into how diffusion contributes to innovation and the creation and dissemination of new and useful knowledge.

3. Innovation as institutionalization: a service-ecosystems view

The S-D logic, service-ecosystems framework (Vargo and Lusch, 2004, 2008, 2016) applied here points away from the fallacy of a linear, sequential flow of the creation and destruction of value. This ecosystems perspective embraces a mutually constitutive perspective of structure and agency (Giddens, 1984) in which institutions are not only viewed as the *rules of the game* (North, 1990) but also as the outcome of and social context for human action. Specifically, using an A2A designation, Vargo and Lusch (2011) claim that "at an appropriate level of abstraction, all actors are fundamentally doing the same things": they co-create value through resource integration and service provision. We argue that this broader, more holistic and unifying perspective is necessary to grasp the more general, structural diffusion process. To better understand this, we discuss the central elements of innovation in service ecosystems—technology, institutionalization, institutional arrangements and emergence—and how they enable and restrict diffusion.

3.1. Technology

Drawing on sociotechnical views of technology, Vargo et al. (2015, p. 64) conceptualize *technology* as a dynamic (operant) resource, or potentially useful knowledge (Mokyr, 2004); *markets* as institutionalized solutions (Lusch and Vargo, 2014); and *innovation* as collaborative recombinations, or "combinatorial evolution" (Arthur, 2009), of institutions that provide novel solutions for new or existing problems. This service-ecosystems approach reveals an iterative and cocreative process of interaction and institutionalization that drives innovation, as well as diffusion, for technologies, business models, and markets (Wieland et al., 2017). That is, this orientation accommodates and fuses the "supply side" (i.e. focal firm and its ecosystem) of technological development and the "demand side" (i.e., customers and their ecosystems) of value creation for customers, and highlights the process of diffusion as a central part of innovation and the institutionalization of new technologies and markets.

3.2. Institutionalization

The study of *institutional work* (Lawrence and Suddaby, 2006) provides insight into the multidirectional process of institutionalization and emphasizes that institutional developments are not only concerned with transformative action, but also with repairing and concealing tensions and conflicts within and across institutions. Specifically, Lawrence and Suddaby (2006, p. 217) define institutional work as the purposive action of actors "aimed at creating, maintaining, and disrupting institutions," and Zietsma and McKnight (2009) describe it as a recursive process in which multiple actors cocreate institutions iteratively, by competing and collaborating, until common templates emerge as shared conceptions of problems and solutions.

It is important to note that institutional work also includes the actions of those who resist change. In our ride sharing example, the resistance of competitors and regulators maintains institutional stability in such a way that traditional modes of transportation are still available and continue to provide service. Consequently, and not surprisingly, the exploration of institutional multiplicity (i.e., heterogeneity) in both mature and emerging fields is needed to understand how institutionally embedded actors are able to imagine alternatives to their current institutional arrangements and to overcome lock-ins and path dependencies. Different actors engage in value cocreation and innovation with varying perspectives and *institutional arrangements* (i.e., "interdependent assemblages of institutions") (Vargo and Lusch, 2016, p. 6).

3.3. Institutional arrangements

Institutional arrangements reveal different combinations or assemblages of institutions that influence innovation. Drawing attention to the relationship between technology and institutions in *institutional arrangements*, Nelson and Winter (1982) argue,

> [I]n the normal flow of events, new social technologies, new "institutions," often come into the picture as changes in the modes of interaction–new ways of organizing work, new kinds of markets, new laws, new forms of collective action–that are called for as the new technologies are brought into economic use. In turn, the institutional structure at any time has a profound effect on, and reflects, the technologies that are in use, and which are being developed.

This consideration of how varying technologies and institutions influence an individual's actions and interactions aligns with Rogers' (2003) discussion of *homophily* and *heterophily*. Rogers describes the former as the degree to which individuals are similar and the latter as the degree to which they are different in certain attributes. These attributes include institutional elements such as beliefs, mutual understandings, common meanings and language, and elements that shape institutional arrangements, such as socioeconomic status and education.

As noted, institutional arrangements can be observed from various levels of aggregation. These "levels" are not fixed; rather, they allow for a variety of viewpoints for studying social change. For ride-sharing, institutional arrangements include relative perspectives of micro-level institutions, such as those associated with prior transportation experiences of individuals, groups, and firms; meso-level institutions, such as those governing rules or laws associated with transportation professions, markets, or industries; and macro-level institutions, such as social norms or cultural meanings that frame the transportation industry as well as individual experiences (Lawrence and Suddaby, 2006; Thornton et al., 2012; Vargo and Lusch, 2016).

Furthermore, institutional arrangements can be conceptualized as operant resources because they are capable of acting on other resources and influence the outcomes of value creation. According to Rogers, high degrees of homophily between and among actors results in, and breeds, effective human communication and, consequently, most communication takes place between homophilous individuals. However, Rogers (2003, p. 306) argues that "homophily can act as an invisible barrier to the flow of innovation within a system." In his complexity-centered update, Rogers and colleagues argue "diffusion occurs most often in heterogeneous zones," i.e., transitional spaces where differences across actors are evident (2005, p 4). This suggests that resource heterogeneity plays an important role in the plasticity, or flexibility, of a service ecosystem and in the dynamics of institutional arrangements (Chandler et al., 2019).

3.4. Structural emergence

Institutional arrangements are emergent social structures that have the potential to expand throughout entire social systems (i.e., diffusion). Highlighting the nested nature of social structures, Geels (2002) describes how institutional "niches" serve as "incubation rooms" for radical innovations and as places for learning. These niches have less established institutional elements such as "design heuristics, user preferences, behavioral patterns, public policies, etc." (Geels, 2004). Although resources within a particular institutional niche may not vary greatly, zooming out to higher, aggregated levels of interaction points toward variety and heterogeneity across niches. Geels argues that micro-level niches are part of nested hierarchies of meso-level regimes (e.g., technological developments) and macro-level landscapes (e.g., cultural and normative values and material aspects such as highways and electrical infrastructures). In this way, heterogeneity is revealed not only within institutional landscapes and patchworks of regimes, but also across institutional niches (zones) and new structures emerge at the intersections of these clusters (see Fig. 2).

The nested service ecosystems perspective highlights the importance of *emergent phenomena*. These phenomena are structural characteristics that can be observed at one level in a system that are not present in its constituents. The classical example is the wetness of water, which is not present in either of its constituent components, hydrogen and oxygen, but emerges from their interaction. While the concept of emergence is frequently studied in system-oriented disciplines, such as biology and sociology, it has only recently been explored by marketing scholars, particularly from a service-ecosystems view (see Peters, 2016; Taillard et al., 2016). Taillard et al., for example, explore how emergence shapes service ecosystems, or, more specifically, how service ecosystems emerge through collective agency. Chandler et al., (2019) find that innovation emergence is not only an outcome of purposeful effort but also greatly influenced by the plasticity – or fluidity of dynamics – of institutional structures within a service ecosystem. In other words, those ecosystems with high levels of institutional plasticity are more susceptible to innovation than those that are more static.

4. Diffusion as a cocreative process

A service-ecosystems perspective emphasizes operant resources (Vargo and Lusch, 2004)—those that can act upon other resources to create value—as a critical component of service provision and value cocreation. Value cocreation occurs as multiple actors integrate, exchange and apply operant (and operand) resources as they interact with other actors. Through this process, value is cocreated at multiple levels, which include individual experiences as well as collective forms of value, such as social norms and symbolic meanings (i.e., institutions) (Akaka et al., 2013). With regard to diffusion, operant resources are applied in various ways and lead to unique outcomes.

Because institutional arrangements influence the way resources are integrated and value is cocreated, *diffusion can be conceptualized as an emergent, cocreative process that involves multiple actors integrating new resources and altering their institutional arrangements*. Institutional work continually occurs as new resources are integrated with existing resources and resource integration draws on and feeds into pre-existing institutional arrangements. As the number of individuals who integrate a new resource increases, the diffusion process spreads throughout the wider ecosystem. Fig. 3 depicts the recursive process that drives diffusion and feeds into broader innovation processes.

From an aggregated, service-ecosystems perspective, innovative ideas can spread *horizontally*, as can be seen by looking across a level of analysis, including across a particular application (intra-niche) and across applications (inter-niche). Moreover, novel ideas can also "travel" *vertically*, as can be seen from the perspective of different levels of analysis (aggregation)[1], through the restructuring of the more general, conceptual meso- (e.g., "industry") and macro-level (e.g., social) landscapes (c.f. Geels, 2002). This multi-directional movement of new knowledge helps to (1) solve specific problems in multiple classes of problems (e.g., transportation) and (2), more abstractly, legitimize an underlying idea, which in turn facilitates its diffusion across, often unrelated, problems (e.g., sharing economy).

For example, Airbnb, can be seen as the horizontal diffusing of shared housing, as well as other forms of sharing, such as ride sharing (micro-level). Additionally, the abstracted idea of sharing/selling of excess capacity can be seen as the vertical diffusion of a more general conceptualization of the "sharing economy" (meso-level) and sharing versus buying in general (macro- level). As noted, we suggest that these diffusion processes are best understood as mutually constitutive

[1] As noted in Vargo (2018), "levels" of analysis (aggregation) are considered epistemological, rather than ontological. They are also distinct from levels of abstraction, though in this discussion, abstraction can be considered to covary with levels of analysis.

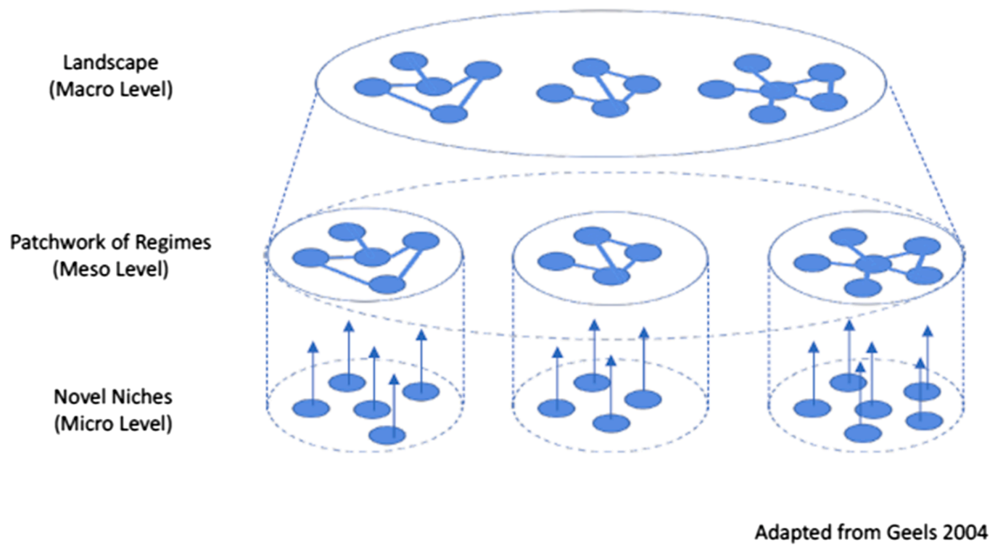

Fig. 2. Nested levels of innovation.

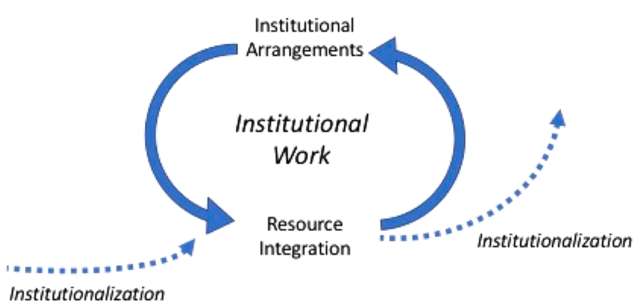

Fig. 3. Diffusion as a cocreative process.

institutional-change processes, with the relationship between horizontal institutionalization and vertical institutionalization considered as recursive processes.

Importantly, in the institutionalization process, these levels of abstraction, as seen from different levels of aggregation, are mutually reinforcing; intra- and inter-niche diffusion of local ideas/conceptualizations (e.g., Airbnb) give rise to the diffusion of higher-level conceptualizations of sharing (more general ideas of sharing versus owning) which, in turn facilitates the inter- and intra-niche diffusion. This is similar to Giddens (1984) concept of "structuration," the (re) formation of social structure through integration of resources and enactment of practices, in this case applied to the diffusion of ideas and technologies.

From a service-ecosystems perspective, it follows that, rather than diffusion representing the wholesale adoption of a particular technology, or the ideas behind it, as envisioned by one actor (e.g., a firm), it should be understood as an iterative process through which ideas evolve as actors interact, integrate resources, and interpret ideas from their heterogeneous perspectives. It is the process discussed by "Scandinavian institutionalists" in terms of translation (see also Latour, 1986; e.g.,Czarniawska and Joerges, 1996) and is similar to the effectual process discussed by Read et al. (2009; see also Korsgaard, 2011), as the ideas are interpreted in relation to a single class of applications, as well as to similar applications. More generally and abstractly, it is in line with Pinch and Bijker's (1987) *interpretive flexibility* – subjective interpretation.

Consistent with Latour (2005) and Korsgaard (2011), this implies that rather than diffusion being driven by the agency of a principal actor, it results from *distributed agency* among a full range of relevant agents (including non-humans; see also Vargo (2018)). To borrow a term from Alderson and Martin (1965), the travel, or diffusion, of ideas might be thought of in terms of conceptual, *recursive transvections*, which, while heterogeneously influenced, represent feedback loops that can lead to a more or less homogeneous, intersubjective convergence. In other words, the ideas become institutionalized, which legitimizes both technological approaches to a specific problem or a class of problems, at least for a period of time, as well as general approaches to similar problems. These institutional arrangements are enacted through *performativity* (Kjellberg and Helgesson, 2006)–the enactment of institutional arrangements. It is the collective enactment of new institutional arrangements that drives institutional change.

As noted, the process for innovation is recursive. Tenuous equilibrium in complex adaptive systems is maintained through nonlinear positive and negative feedback loops. Borrowing from complexity theory (e.g., Arthur, 2015) and cybernetics (e.g., Maruyama, 1963), structure has two influences: "deviation-amplifying, mutual causal processes" or positive feedback (morphogenesis)–and "deviation-counteracting, mutual causal processes" or negative feedback (morphostatis) (Maruyama, 1963). These forces counterbalance each other, allowing systems to be self-adjusting–i.e., complex adaptive systems (cf. service ecosystems). In this case, positive and negative feedback are provided to the originator of the idea and to the wider social system. Positive feedback supports the spread of an idea and negative feedback limits or restricts diffusion and prevents institutional change (Colyvas and Jonsson, 2011).

In the case of ride sharing, deviation-amplifying, or positive feedback, can be seen in the growth of companies such as Uber and Lyft, as well as the number of competitors that enter the market. Increasing numbers of drivers, riders, and service providers (e.g., competitors to Uber and Lyft) reveal the positive feedback in the system. However, deviation-counteracting, or negative feedback, can be seen in the regulatory and cultural responses of particular countries (e.g., the United Kingdom) and the continued use of more traditional modes of transportation, such as taxi cabs. Too much disorder can cause system ossification but the right degree of counterbalance leads systems to self-adjust into new patterns of relationships, from which new phenomena emerge (Holbrook 2003; Mason and Staude 2009). Arthur (2015, p. 17) points out,

> Positive feedbacks in fact are very much a defining property of complex systems–or I should say more accurately, the presence of positive and negative feedback's acting together is. If the system contains only negative feedback (in economics, diminishing returns) it quickly converges to equilibrium and shows "dead" behavior.

> With a mixture of both it shows "interesting" or complex behavior. With positive feedback interactions add to each other and cause structure, and time to be offset by negative forces and dissipate. Structures then come and go, some stay to be further built on and some lead to further structures. The system is "alive."

This view draws attention to *innovation diffusion* as one part of the broader innovation process. Specifically, a service-ecosystems perspective suggests that *diffusion is part of the innovation process*; it does not follow innovation. Without diffusion or the spread of an idea, innovation–conceptualized as institutional change–does not occur. However, the rigidity of existing institutions mediates the ability for new ideas to be adopted or novel operant resources to be integrated within a particular social context. In this sense, the integration of resources draws on existing institutional arrangements and potentially leads to innovation diffusion. However, positive or negative feedback enables or restricts institutionalization, respectively.

This service ecosystems approach to innovation diffusion overcomes the traditional divide between *innovators* and *adopters,* in which the latter are often described as somewhat passive actors, and suggests that service ecosystems can range from highly institutionalized to loosely coupled. The former state is described as having interrelationships among actors that are structured by "long-lasting relations and cooperation" through contracts and accepted norms (i.e., institutions) (Sundbo and Gallouj, 2000). The latter state, on the other hand, is described as "fields" in which the constellations among actors, and their behavioral patterns and traditions are weaker. However, this analytical distinction does not mean that some service ecosystems are institutionalized and some are not. Instead, it points to the nested and overlapping nature of institutional arrangements in which, as stated, ruptures and contradictions can lead to institutional fringes and niches (Geels, 2004; Wieland et al., 2017).

4.1. Diffusion of technologies, business models, and markets

This institutional and emergent approach draws on, and fits well with Geels (2002) view on market formation as socio-technical and systemic processes. That is, viewing technologies, business models, and markets as emergent outcomes of institutional change refocuses the study of innovation on understanding how institutions change and reconceptualizes diffusion as the formation or reformation of social structure. Stated alternatively, a service ecosystems perspective extends Rogers' (2003) notion of diffusion as a social shift or wide-spread adoption of an idea, practice or object to broad *restructuration processes of institutional arrangements* that can be seen from various levels of aggregation (e.g., micro, meso, macro). In the case of ride sharing, the application of "new" knowledge to connect drivers and passengers throughout mobile devices can be seen as the emergence of a new technology. The business model that underpins a community of self-employed drivers and passengers emerged through the use of the new technology and a strategic vision that led to a new value proposition. Finally, the numerous exchanges that are facilitated by the technology and the business model (and others like it) enabled the emergence of a market through which service is exchanged and value is cocreated.

This consideration of institutional development through innovation diffusion reflects the movement from actor interactions, to markets and industries, to societal institutions. Fig. 4 depicts how cocreation processes contribute to diffusion across horizontal and vertical spaces.

In the case of ride sharing, Uber, or the company that began as UberCab, can be considered as part of a micro-level niche from which novel innovation sprouted. However, the meso-and macro-level dominant institutions within which Uber emerged influenced the trajectory of diffusion. According to McAlone (2015), "Uber has fought rivals and regulators as it transformed from a black-car service into a sprawling logistics company gunning for a future of self-driving cars. It has confronted threats from the taxi industry and even its own drivers." Despite the negative feedback, "its valuation has continued to climb, and it has attracted more and more investors." This suggests that Uber and its riders and drivers are not only contributing to the development of new forms of knowledge, but also contribute to wider societal change.

Understanding restructuration through innovation can only be accomplished by overcoming narrow conceptions of unidirectional or bidirectional flows of influence, in favor of multiple factor combinations of deviation amplifying (positive) and deviation counteracting (negative) processes. Geels (2002), for example, argues that micro-level processes, such as the emergence of niches, are strongly shaped by meso and macro level structures and material arrangements (i.e., regimes and landscapes). A "need," such as an alternative mode of transportation, can be viewed as a "chink" in the structure and a filled need can amplify that chink and thus provide positive feedback. This amplification can spread within one level of aggregation (e.g., niches) but also to higher-level structures (e.g., routines and landscapes).

4.2. Consequences of diffusion: an ecosystems view of S-curves

As discussed, traditional diffusion literature depicts the characteristic nature of diffusion as an S-curve. That is, diffusion initially creeps in rather linearly and then accelerates before leveling off again. Its formation is often thought of in terms of countervailing forces, representing three parameters: (1) the incremental number of new, non-users who are amenable to external effects, such as promotion, (2) the new adopters who are susceptible to internal effects, such as imitation of current adopters, and (3) price (see Bass, 1969; Robinson and Lakhani, 1975; Phillips, 2007). It is important to note that the S-curve in most diffusion literature is expressed in terms of the proportion of potential adopters whom have adopted a specific value proposition. As implied above, however, a more general version of S-curve factors can be understood in terms of institutional feedback loops. Positive feedback loops accelerate adoption and are manifested in the inflection points of diffusion, both of the specific and general technologies. Phillips (2007) argued that *resistance to change* also needs to be considered.

Institutionalization processes can be accelerated and, in turn, made more robust by what might be considered a *second-order institutionalization*. This occurs as supporting institutions emerge as a result of primary institutionalization processes. For example, in the personal transportation market, a network of roads, filling stations, suburban living, etc. have emerged as supportive and derivative institutions. These not only help accelerate innovations, they provide the context for future innovations. As McLuhan has been credited with saying "we shape our tools and thereafter they shape us" (Culkin, 1967). This also resonates with sociomateriality (Orlikowski and Scott, 2008) and structuration theory (Giddens, 1984).

A service-ecosystems and institutional perspective can inform the innovation literature by showing that a single S-curve represents a combinatorial structural change that can only be understood in the context of both positive and negative feedback, complementary innovations and downstream adoptions (Adner, 2006), and broader institutional and technological developments. The diffusion of the Uber ride-sharing solution, for example, can be narrowly viewed as the creation of a new technology (by a firm) and the adoption of the solution by both riders and drivers. This adoption process could be modeled as an S-curve and riders and drivers could easily be classified into adopter categories. However, while the service ecosystems perspective can explain such processes, it also mandates a broader, more systemic view, which can draw attention to the social structures that enable diffusion of technologies, business models and markets, at the same time, shedding light on wider social change (e.g., sharing economy).

Although solutions from companies such as Uber initially diffused in particular cities and urban settings, the institutionalization of ride sharing relied heavily on complementary innovations such as the

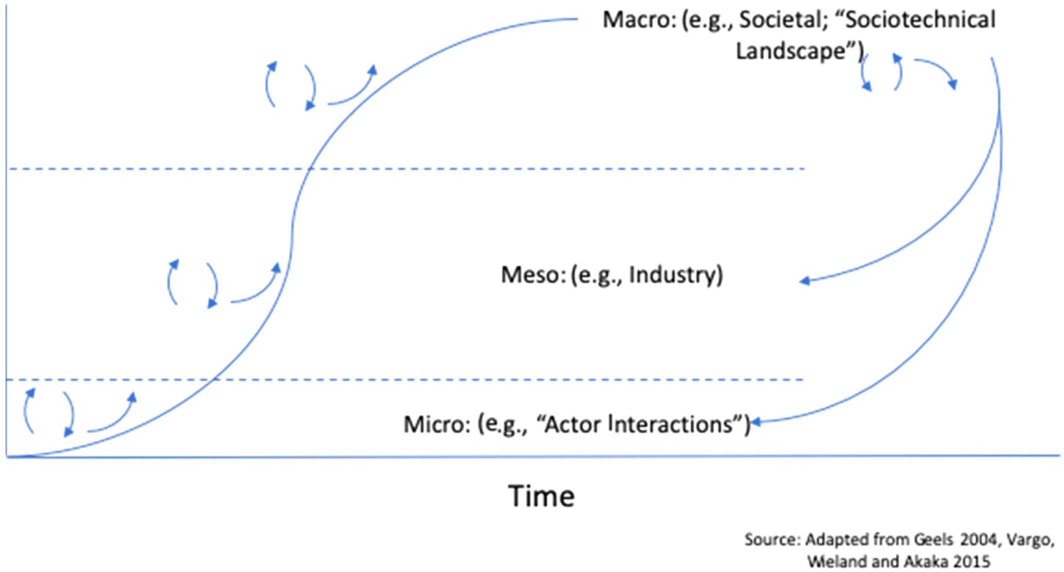

Fig. 4. Innovation diffusion throughout a service ecosystem.

institutionalization of payment per distance traveled (e.g., traditional taxi solutions), the institutionalization of mobile applications and online rating systems (e.g., app stores, eBay), and the institutionalization of sharing solutions (e.g., Zipcar, Airbnb) just to name a few. Furthermore, using the vocabulary of institutional work (Lawrence and Suddaby, 2006), the institutionalization of the Uber ride-sharing solution maintained institutions (e.g., pay for distance traveled), changed others (e.g., the need to rate the behavior of passengers), while disrupting established ones (e.g., the need for professional drivers regulated by local authorities).

This broader and systemic view of the service ecosystem aligns with West's (2017) views on scaling and growth within social systems. In particular, West's (2017) recognition of positive and negative energy or feedback draws attention to the "social metabolism" of a service ecosystem and provides important insights into how value is created through the balance of energy as actors interact and exchange. In the context of city developments, West argues "just as food must be metabolized into a form that is useful for supplying cells and sustaining life, so the incoming energy and resources digested by a city must be transformed into a form that can be used to supply, sustain, and grow socioeconomic activities such as wealth creation, innovation and the quality of life" (p. 373). Based on this, the integration and use of operant, and operand, resources through positive and negative energy (or feedback) serve as the mechanism for creating value and sustaining life within ecosystems.

The balance of positive and negative energy (West, 2017) provides system feedback and influences the spread of innovation. Scaling represents how a system responds to a change in size. Thus, to understand the long-term or broad consequences of innovations and their diffusion throughout a service ecosystem (Rogers, 2003), the processes and outcomes of scaling must be considered. Most quantifiable characteristics of systems scale *nonlinearly*. If a characteristic increases with the size of the system, it is called *superlinear scaling*, representing *increasing returns to scale*. If it decreases, it is called *sublinear scaling*, representing decreasing returns to scale (West, 2017). Increasing returns to scale thus exhibit nonlinear, upward-sloping curves like the accelerated growth of the S-curve. However, there are also countervailing forces, which can decrease returns to scale in some characteristics (e.g., metabolic rate) thus limiting growth and in some cases leading to death. If increasing returns went unabated, growth would spiral out of control and eventually collapse from depletion of resources or limitations of structure. If there were only constraints, there would be no life (c.f., Arthur, 2015). Rogers et al. (2005, p. 13), in line with West, seem to be headed for a scaling explanation based on complexity theory. They argue:

> Once the rate of adoption in the system reaches critical mass at the inflection point it is difficult or impossible to stop further phase transition around the diffusion. The eventual flattening of the curve owes to a decline in the numbers of potential adopters, as the innovation is taken up by more and more adopters, and more easily so. […] In terms of diffusion, individual adoption decisions at the microlevel lead to the emergence of innovation adoption by the social system as a whole at the macro level. The S-curve and other aggregate measures are depictions of such macro-level phenomena.

The reverberations of individual actions and interactions to the wider service ecosystem are evident in Sawyer's (2005) discussion of social emergence (Taillard et al., 2016) and Geels' (2004) framework for innovation and institutional change. They are central to the multilevel and cross-institutional approach for value cocreation in service ecosystems (Akaka et al., 2013). According to West (2017), large heterogeneous social systems exhibit trajectories that indicate the possibility for open-ended growth. This potential is often depicted in the steep pitch of the S-Curve, or the evidence of superlinear scaling in diffusion of innovation.

5. Discussion and implications

As discussed, a service-ecosystems approach converges with other systems approaches to innovation and diffusion (e.g., Sundbo and Gallouj, 2000; Geels, 2004). This approach highlights the need to understand how each higher order of structure emerges from lower orders and individual action. It suggests that innovation involves both emergence and diffusion of ideas, technology and markets, and that this process potentially leads to more than the sum of its interactive parts. As ideas and technologies are adopted by many people, the outcome of "invention and diffusion" (Rogers, 2003) is the growth of ideas and knowledge as well as the evolution of a broader sociotechnical structure. Innovation occurs over an extended period of time and through multiple cycles of diffusion and institutionalization. This process is supported by continual cocreation (Fig. 3) and the (re)emergence of new structures (Fig. 4).

The service-ecosystem and institutional approach presented in this paper highlight the need for positive and negative feedback within the system and suggests that the trajectory of diffusion and institutionalization is dependent upon dominant institutional structures and the continual need for improvement and innovation. This need for continual improvement and innovation, is grounded in the scaling behavior of systems. As West (2017) points out, superexponential growth, or superlinear scaling, is not sustainable at the point in time when its curve is steepest. Specifically, West (2017) argues, "In this scenario demand gets progressively larger and larger, eventually becoming infinite within a finite period of time. It is simply not possible to supply an infinite amount of energy, resources and food in a finite time." Thus, the lack of innovation can lead to system stagnation and collapse.

Several things should be noted about this recursive diffusion process. First, something more seems to be happening at the inflection, or tipping, point than mere acceleration. Instead, there is a qualitative change from which there is no return. This implies a process of social emergence (Sawyer, 2005; Taillard et al., 2016) and shows that outcomes of sociotechnical change (Geels, 2004) provide additional insight into the inflection point of the S-curve and the scaling of innovation as well as the reason innovation does not often result in collapse; rather innovation provides a basis for future innovation in a path-dependent way. Second, as in the Bass (1969) curve, the limiting factor in the continual upward extension of the S-curve is the potential size of markets. However, more generally, as suggested above, the restrictions can be seen in terms of existing structures, especially high-order structures, necessary to support the trajectory; institutional niches (Geels, 2004) that frame potential "customers," or different "adopters" in Rogers' view, can be seen as a subset. West (2017) extends this discussion to the sustainability of resources, but, even the "resourceness" of these resources (Lusch and Vargo, 2014, p. 121) can only be understood in terms of (sociotechnical) structures that innovatively transform them.

As West (2017) argues, the trajectory of growth and scale as implied by superlinear scaling is unattainable, without some "intervention." This intervention is the emergence of innovation, or probably more precisely "paradigm-shifting" innovation, what often appears to disrupt or destroy existing markets. He states, "A major innovation effectively resets the clock by changing the conditions under which the system has been operating and growth occurring. Thus, to avoid collapse, *a new innovation must be initiated that resets the clock, allowing growth to continue and the impeding singularity to be avoided"* (p. 416, emphasis in original). In other words, the emergence and diffusion of paradigm-shifting ideas, technologies and markets enable the sustained growth of knowledge and value cocreation within a service ecosystem, even with, or perhaps because of, the resource limitations of operand resources. This reinforces the primacy of operant resources in value cocreation, which is the heart of S-D logic and its service-ecosystems view, and underscores the influence innovation has on a multitude of other resources, including the service ecosystem itself. "Innovate or die" becomes a mantra not only for businesses in competitive landscapes, but for the service ecosystem as a whole.

For managers, a service-ecosystems view for innovation highlights an organization's role in innovation within a wider ecosystem. In this view, managers should consider the role of the organization as engaging in *distributed institutional work* processes and in identifying and taking advantage of institutional frictions and contradictions. This systemic view showcases the potential for collaboration with other organizations, including users and universities, who will have alternative perspectives and may not be viewed as direct competition. Collaboration can also potentially aid in the continuation of value creation because as new operant resources emerge, the limitations of a finite supply of operand resources can be alleviated.

Companies should also consider the potential for innovation when surrounded by diverse actors and leverage opportunities for collaborating with "competitors" as well. This can potentially lead to more paradigm-shifting innovations and accelerate the diffusion process, as well as lead to the emergence and shaping of markets (higher-level patchwork of regimes). Ultimately, to avoid the collapse of a service ecosystem, managers should be considerate of their company's role in both positive feedback for new ideas and negative feedback for sustaining core institutions. At the same time Uber is working to grow its company, it must also consider the legal, regulatory and cultural institutions that will enable the ride-sharing solution to be sustained over the long term.

Future research in this area can provide important insights into how value cocreation occurs in, and among, nested and overlapping service ecosystems through innovation diffusion–as processes of systemic institutional maintenance, change, and disruption. Furthermore, innovation emergence and diffusion can be studied through an extended ecosystem perspective, which would require investigations of innovation across longer lengths of time and broader social spaces (e.g. global). This framework provides valuable insights into the scaling of ideas and the evolution of knowledge, but prior research (West, 2017) suggests that organizations often scale sublinearly, because they lack variety within them, whereas many social systems, such as cities, scale superlinearly. This has implications for the limitations of growth for large companies, as well as the importance of internal diversity and cross-functional collaboration. Thus, it would be helpful to explore institutional arrangements that exist within organizations and how this type of internal diversity would impact an organization's capacity for sparking innovation.

The proposed framework also has implications for public policy. Clearly, it suggests that regulation has played an essential, positive role in innovation. However, it also implies that over regulation can stifle diversity and thus the innovation process. A major purpose of public policy is to establish resiliency and stability, but resiliency can also lead to rigidity, which stifles further innovation (see e.g., Moore et al., 2012). This is especially true if stability is approached with what Arthur (2015, p. 24) calls "equilibrium thinking." The proposed framework suggests that public policy should be approached from an orientation of agility and flexibility, as social and economic structures change and evolve through continual processes of value cocreation and innovation.

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