Organization of knowledge ecosystems: Prefigurative and partial forms

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A B S T R A C T

This paper provides a unique perspective on knowledge ecosystems by studying their organization. Grounded in empirical evidence, we propose that knowledge ecosystems consist of users and producers of knowledge that are organized around a joint knowledge search. A distinction is drawn between knowledge ecosystems searching *for* a knowledge domain and those searching *within* an identified knowledge domain, respectively characterized as prefigurative and partial forms of organizing. In a knowledge ecosystem organized in prefigurative form (to identify a knowledge domain), actors whose participation is affiliated, self-resourced, and unobliged probe that domain to identify and establish shared knowledge as a basis for collective actorhood, with no formal rules or coordination mechanisms. In a knowledge ecosystem organized in partial form (where a knowledge domain has already been identified), actors search and reveal problem- and solution-related knowledge, participating though formal membership and access to resources, and their contributions are monitored. The present study contributes to the literature by 1) specifying the distinct types of joint search performed by knowledge ecosystems; 2) considering how the nature of joint search affects how knowledge ecosystems are organized; and 3) distinguishing two forms of organizing knowledge ecosystems, with a focus on participation and coordination.

1. Introduction

Large-scale scientific and societal problems tend to be extremely complex, have multiple causes, and will never have one perfect solution. As the required expertise to address such complex problems is both specialized and scattered, the search for solutions and related knowledge creation increasingly occurs in ecosystems of individual and organizational actors, involving diverse inputs, resource commitments, and motives. This potential has led national policy makers in many countries to actively promote knowledge and innovation ecosystems as engines for growth and well-being. For example, within the Finnish innovation policy, Strategic Centers for Science, Technology, and Innovation were established, operating between the public and private sectors, with the aim to pursue and implement dynamic industry-driven research programs (e.g. Halme et al., 2014). However, recent experiences have confirmed the challenges of sustaining collaboration among actors in such initiatives (Sinnewe et al., 2016). For that reason, it is important for both policy and practice to understand how actions are coordinated in knowledge ecosystems, and how the requisite resources are deployed.

The present study focuses on these emerging collectives –*knowledge ecosystems* – in which actors such as universities, public research institutions, and for-profit firms collaborate to create new knowledge in a

pre-competitive setting (van der Borgh et al., 2012; Clarysse et al., 2014; Valkokari, 2015). Knowledge ecosystems may form around specific technological or societal challenges (Dougherty and Dunne, 2011) or among geographically co-located organizations in complementary fields (van der Borgh et al., 2012). Knowledge ecosystems may also be purposefully facilitated to address a set of basic or applied science problems, leading over time to knowledge exploitation and actor-specific appropriation (Franzoni and Sauermann, 2014; Perkmann and Schildt, 2015). Such ecosystems accommodate complementarities in value creation (Clarysse et al., 2014), resulting in more effective search for new knowledge than by any individual actor alone. At a theoretical level, several important areas on knowledge ecosystems remain unexplored—in particular, the domain of knowledge creation and search, the nature of participation in knowledge creation and search, and the coordination of activities supporting knowledge creation and search.

The present study is motivated by these practical and theoretical implications of the *organizational* aspects in knowledge ecosystems. Here, the term *organization* broadly refers to any "multiagent system with identifiable boundaries and a system-level goal toward which the constituent actor's efforts are expected to contribute" (Puranam et al., 2014: 163). In the same way as individual firms, a knowledge ecosystem can be viewed as a form of organizing. However, as Wilhoit and Kisselburgh (2015) put it, "… when we move away from the *terra firma*

of corporations, nonprofits, and social organizations, we find ourselves on shaky ground in determining what is and is not an organization" (p. 573). While the absence of hierarchies and related coordination mechanisms suggests that knowledge ecosystems are in some sense less organizable than firms, they nevertheless meet the conditions of patterning and structure that create a minimum viable context for organization (see Schreyögg and Sydow, 2010). On that basis, we argue for the theoretical need to examine knowledge ecosystems as forms of organization and organizing. In so doing, we also hope to contribute to existing research on network (Powell et al., 1996) and ecosystem structure (Clarysse et al., 2014; Still et al., 2014); governance of joint knowledge search (Felin and Zenger, 2014; Bogers et al., 2016; Järvenpää and Välikangas, 2016); and, more broadly, the coordination of knowledge and innovation ecosystems, which to date has focused mainly on the role of focal firm (e.g., Rohrbeck et al., 2009; Leten et al., 2013; Ritala et al., 2013). To those ends, the study addresses the following research question: *How are knowledge ecosystems organized?* Specifically, we focus on: *What is the nature of the knowledge search in knowledge ecosystems? Who participates in knowledge search? How are knowledge search and knowledge creation activities coordinated?*

This approach is informed by recent suggestions (e.g., Gawer, 2014) that an organizational perspective can further our understanding of knowledge creation in knowledge ecosystems. We believe the present study is the first to integrate two previously separate streams of research on knowledge ecosystems (early-stage, pre-competitive, and problem-based knowledge creation and search) (Nickerson and Zenger, 2004; van der Borgh et al., 2012; Clarysse et al., 2014; Felin and Zenger, 2014; Valkokari, 2015) and organizational activities outside and beyond the formal organization (e.g., Ahrne and Brunsson, 2011; Gulati et al., 2012). To address the above research questions, we conducted a collective qualitative case study which assembled rich empirical evidence from seven knowledge ecosystems organized around solving challenging problems and involving diverse actors from industry and academia.

Our findings contribute to the knowledge ecosystems literature in a number of respects. First, we show how knowledge ecosystems are organized around multi-actor knowledge creation and search. On that basis, we propose a refined, empirically grounded definition of the knowledge ecosystem: *A knowledge ecosystem consists of users and producers of knowledge, organized around joint knowledge search.* Second, on the basis of our empirical study, we contend that knowledge ecosystems differ in terms of the nature and target of joint knowledge search. The findings differentiate knowledge ecosystems searching *for* a knowledge domain from those searching *within* an identified knowledge domain. We propose that while the search *for* a knowledge domain involves probing and formulating a common goal, search *within* a knowledge domain involves selectively revealing and reinforcing the common goal. Third, we demonstrate that the nature of joint search has implications for how knowledge ecosystems are organized, and we distinguish between two forms of organizing: *prefigurative* and *partial*. Finally, we discuss how these forms enable the organization of participation and coordination. Together, these contributions enhance our understanding of how knowledge ecosystems search for and create new knowledge, and how they are organized around these tasks.

2. Conceptual background

Innovation activities have become increasingly interconnected and open, involving more heterogeneous groups of actors and inputs than before (Sammarra and Biggiero, 2008; Corsaro et al., 2012). This phenomenon is reflected in the broad literature on open innovation (e.g., Dahlander and Gann, 2010; West et al., 2014), where the *innovation ecosystem* lens is increasingly used to understand the growing interdependence and scope of systemic and networked innovation (e.g., Rohrbeck et al., 2009; West et al., 2014). Innovation ecosystems are seen to enable both creation and capture of value from novel, complex

value propositions (Dattée et al., 2018) and are typically organized around a focal firm, technology, platform or value proposition (Ritala et al., 2013; Autio and Thomas, 2014). While related to these literatures, the scope of the present study is much narrower, examining ecosystems in the very early phases of innovation—initial knowledge creation and search. In contrast to the *knowledge ecosystems* that focus on early stages of knowledge creation (Clarysse et al., 2014), innovation ecosystems encompass the broader scope of exploration and exploitation, or the process of invention-to-commercialization (see e.g., Valkokari, 2015; Dattée et al., 2018).

For innovation ecosystems and knowledge ecosystems alike, the key challenge is how such loose collectives can be organized to achieve uncertain, complex, and often highly ambitious goals. To ground this question for the purposes of empirical investigation, the next section brings together two distinct research streams, merging insights from the knowledge ecosystems literature with the literature on organization above and beyond organizations.

2.1. Knowledge ecosystems and their organizing requirements

As knowledge ecosystems occur in pre-competitive, pre-commercialization settings, they are far removed from downstream activities that seek to exploit and commercialize newly generated knowledge (Valkokari, 2015). Knowledge ecosystems have been characterized as geographically co-located hotspots, in which local universities and public research organizations are typically the central actors (Clarysse et al., 2014), and where the key activity of knowledge exploration is accomplished through collaborative research work (Valkokari, 2015). Building on these conceptualizations, we view collaborative exploration of new knowledge as the central activity and output of knowledge ecosystems. However, we make two distinctions to the underlying assumptions. First, while co-location may play a role in knowledge creation, the capacity of new technologies to coordinate knowledge creation across considerable geographical distances means that this is no longer a determining factor in the existence of a knowledge ecosystem (see for example Still et al., 2014). Second, while universities and public research institutions play a key role in knowledge ecosystems, for-profit actors may also make significant inputs to knowledge exploration (see van der Borgh et al., 2012). On that basis, knowledge ecosystems can be seen as organizations comprising diverse actors bound together by a joint search for valuable knowledge while having independent agency also beyond the knowledge ecosystem. We believe that this conceptual lens facilitates examination of the organizing features of knowledge ecosystems, which will now be discussed in greater detail.

In general, any multi-partner collaboration for knowledge creation requires some level of joint goal setting and collective action toward that goal. In the first place, this requires a change in "the situation from one in which appropriators act independently to one in which they adopt coordinated strategies to obtain higher joint benefits" (Ostrom, 1990: 39). For knowledge ecosystems, this means that actors—whose interests may initially be independent and distinct—must engage in a *joint search* for new knowledge in pursuit of the higher-order goals that are unattainable through independent agency. This entails a deliberate search process for new and valuable knowledge that begins by searching and identifying problems – for example in the form of a common knowledge exploration goal – within which a search for high-value solutions is conducted (see Gavetti and Levinthal, 2000; Nickerson and Zenger, 2004; Macher, 2006; Felin and Zenger, 2014; Lopez-Vega et al., 2016). The search for problems is important because, once identified, these are broadly perceived as domains entailing the landscape of valuable opportunities, within which a solution search can be initiated (e.g., Nickerson and Zenger, 2004), although solutions can sometimes be found before problem identification (von Hippel and Von Krogh, 2015). In all cases, search performance depends on how actors' participation is organized (Felin and Zenger, 2014).