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From Knowledge Ecosystems to Capabilities Ecosystems: When Open Innovation Digital Platforms Lead to Value Co-creation

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Abstract

The paper investigates which types of capabilities open innovation digital platforms develop for supporting co-creation in open innovation processes, by enabling the shift from knowledge ecosystems to capabilities ecosystems. By examining the literature on the open innovation digital platforms, the paper develops a theoretical framework and advances propositions by underlining the specific required dynamic capabilities—sensing, seizing, scanning, integrating, and transformative—needed to facilitate and support the interactive coupled open innovation processes essential for firm co-creation activities. Research propositions are provided to address scholars toward new research paths on digital platforms, open innovation, and dynamic capabilities. Implications for practitioners involved in open innovation processes by using digital platforms are provided in the conclusion.

Keywords Open innovation digital platforms · Knowledge ecosystems · Capabilities ecosystems · Co-creation · Interactive coupled open innovation processes

Introduction

The open innovation digital platforms (OIDPs) stimulate and support the firms' openness (Chesbrough 2003) thanks to different functions, activities and services by

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allowing knowledge creation and sharing and innovation co-creation processes in their sophisticated virtual environments (Nambisan and Baron 2009; Abbate et al. 2019) and with their advanced information and communication technologies (ICTs) (Andreeva and Kianto 2012; Soto-Acosta and Cegarra-Navarro 2016; Del Giudice and Della Peruta 2016). They can be observed as "an important carrier for searching external knowledge" (Hossain and Lassen 2017, p. 55) and for activating valuable combinations of internal and external knowledge sources with the aim to foster the flow of collaboration and knowledge sharing and to co-create novel solutions to innovation problems (Aquilani et al. 2016). Concretely, these platforms can permit firms to explore external opportunities for acquiring, integrating, and transforming globally dispersed knowledge (i.e., Jeppesen and Lakhani 2010; Boudreau 2010), by expanding the possibilities to co-create innovative offerings with the contribution of diverse external parties.

Even though existing literature focused on the investigation of the dynamics of two-sided platforms (Rochet and Tirole 2003; Economides and Katsamakas 2006; Eisenmann et al. 2006; Hagiu 2009), OIDPs—a specific kind of two-sided platforms (Esposito De Falco et al. 2017)—are scarcely examined. These platforms are mainly described as virtual environments in which heterogeneous entities are involved in knowledge transfer and integration processes to face open innovation challenges (Jeppesen and Lakhani 2010), where knowledge is considered the most strategic medium of interaction among ecosystem participants (Van der Borgh et al. 2012; Clarysse et al. 2014). Therefore, these knowledge ecosystems encourage complementarities in the value creation processes (Clarysse et al. 2014), resulting in search and combination of new knowledge more effective than those developed by individual participants acting alone (Järvi et al. 2018).

In this respect, these platforms can be observed as open innovation intermediaries (OIIs), capable to perform different activities and tasks, ranging from linking a large variety of parties for collaboration to set up and mediate relationships and filling a wide array of knowledge, resource and competency gaps (Howells 2006; Randhawa et al. 2017, 2018; De Silva et al. 2018). Even though existing literature has investigated the role of these intermediaries in different open innovation processes (Chesbrough et al. 2006), not many studies until today have focused on the specific role of "co-creators" that OIDPs actively assume in the interactive coupled open innovation processes, by facilitating the "creation of open and collaborative ecosystems" (Santoro et al. 2018, p. 347). Similarly, scarce contributions have investigated the capabilities they need to develop for facilitating and sustaining firms willing to use digital platforms for their innovation activities when collaborating with external sources of knowledge and innovation (Randhawa et al. 2017). Specifically, the creation and management of OIDPs and the involvement, participation, and relationships among a large variety of interacting actors (Van der Borgh et al. 2012; Valkokari 2015; Järvi et al. 2018) force the development of specific capabilities deemed to enable and sustain co-innovation processes (Gawer and Cusumano 2002; Iansiti and Levien 2004; Teece 2018). Indeed, in the platform-based context, dynamic capabilities (Teece et al. 1997) enable organizations to generate new ideas, knowledge, and solutions with the contribution of external entities and to create and capture value from the innovation (Van der Borgh et al. 2012), by building and fueling their capabilities ecosystem.

In order to fill these gaps in the existing literature, the paper intends to examine which types of capabilities open innovation digital platforms (OIDPs) have to

develop to support co-creation in open innovation (OI) processes, by enabling the shift from knowledge ecosystems to capabilities ecosystems. In this perspective, we develop a conceptual paper that grounds on the major contributions available in the general literature focused on knowledge and capabilities ecosystems in the attempt to interpret and fine-tuning the emerging findings to the specific context of open innovation digital platforms and open innovation processes and provide important implications for this type of initiatives by formulating several research propositions.

These propositions are focused on the specific dynamic capabilities—sensing, seizing, scanning, integrating, and transformative—needed to facilitate and support the interactive coupled open innovation processes essential for the firm involved in co-creation activities.

This study contributes to both the OIDP capabilities and interactive coupled open innovation processes literature (Piller and West 2014) and advances some directions to bridge two hitherto separate field of research. Firstly, it offers an extended framework for OIDPs combining the dynamic capabilities and the interactive coupled open innovation processes literature. In detail, this framework is particularly suitable to the purpose of the study because the identified dynamic capabilities are central to support the open innovation processes with different external knowledge entities. Second, the study suggests a managerial outline to support practitioners in better understanding which type of capabilities are effectively relevant for the development of successful co-creation processes. Additionally, managerial implications are provided both for OIDPs developing the capabilities necessary to support OI processes and lead them to co-creation, both for firms selecting the OIDP suitable to support them in OI processes and leading to co-creation.

The paper proceeds as follows. Next, it discusses the shift from knowledge ecosystems to capabilities ecosystems, by providing a useful scheme to observe the main differences between the mentioned ecosystems. Then, it examines the extant OIDPs literature, by identifying the required capabilities able to support the co-creation processes and developing several related research propositions. Finally, implications for future research and practice are discussed.

2From Knowledge Ecosystems to Capabilities Ecosystems: the Platform-Based Context

Knowledge Ecosystems vs Capabilities Ecosystems

The concept of ecosystem dates back to 1930, and ecology researchers have investigated its different meanings (Willis 1997). Social science underlines that the economy can be observed as an ecosystem (Moore 2006), and the global economy can be considered an entity in which organizations and individuals are living organisms. In this respect, different organisms (i.e., species in natural ecosystems or actors with complementary roles in man-made ecosystems) have the necessity to preserve the balanced ecosystem because one can cause a chain reaction felt throughout the entire ecosystem. However, as it dynamically changes and evolves through interactions between ecosystem actors, the ecosystem should not be perceived from a deterministic or a linear viewpoint (Dubina et al. 2017).

Moving from the idea that "ecosystem generally refers to a group of interacting firms that depend on each other's activities" (Jacobides et al. 2018), the management literature has developed overlapping concepts, such as business, innovation, and knowledge ecosystems (Clarysse et al. 2014), with the purpose to explain the meta-organizations, conceived as ecosystems, among economic actors (Valkokari 2015). Knowledge ecosystems are mainly oriented to generate new knowledge and technologies through joint research work, various forms of collaboration, and/or the development of a knowledge base (Van der Borgh et al. 2012; Järvi et al. 2018), involving a more heterogeneous group of inputs and actors. These ecosystems could be designed by pointing out the network nodes (Quinn et al. 1998), where the knowledge is efficiently and effectively generated, located, captured, and shared to maintain competitiveness (Manfredi Latilla et al. 2018). The focus is on knowledge exploration instead of knowledge exploitation, by underlining that these ecosystems are predominantly centered on knowledge sharing (Koening 2012). Knowledge ecosystems can emerge around specific relationships among social actors (Caputo et al. 2019) enhancing social networks (Gupta and Thomas 2019) and technological challenges (Dougherty and Dunne 2011), by considering that sometimes these 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" (Järvi et al. 2018, p. 1523). Additionally, knowledge ecosystems can origin among geographically co-located organizations (Lopes and Franco 2019; Quartey 2019) in complementary fields (Van der Borgh et al. 2012) and can be well structured and concentrated around a number of central actors (Clarysse et al. 2014; Overholm 2015) by requiring frequently collaborative research and intellectual capital efforts (Carayannis et al. 2014). Powell et al. (2010) underline two features for the development of knowledge ecosystems: a diversity of organizational forms that generate different standards and rules and the presence of an anchor tenant that assists in providing access to subsequent connections and actively spur economic growth (i.e., local university can assume this role in the knowledge generation processes).

In general, such knowledge ecosystems have been observed as hotspots where research organizations, universities, and innovators, such as technology for-profit firms, play a central role in advancing collaborative exploration of knowledge and developing innovation within the systems (Clarysse et al. 2014). By collaborating to co-create valuable knowledge in a pre-competitive setting (Van der Borgh et al. 2012), the linkages among firms and with universities and research organizations as well as intense labor mobility across different actors can foster interactive and collective learning paths (Caputo et al. 2019) and, consequentially, increase the speed of knowledge creation and innovation diffusion (Baptista and Swann 1998).

For example, Carayannis et al. (2018) highlight that the university can be observed as a new type of "organization capable of higher-order learning and in this regard, a type of open, highly complex and non-linear knowledge production system" (p. 152) by seeking and developing novel ways of combining, recombining, and integrating diverse principles of knowledge generation and knowledge application. The use of alliances, collaborations, and partnerships is increasingly observed as a way of learning and achieving organizational knowledge and innovation objectives (Dooley and Gubbins 2019).

However, in knowledge ecosystems, the involvement and active participation of multiple actors can vary in openness (e.g., Gulati et al. 2012), moving from completely open (Franzoni and Sauermann 2014) to more clearly bounded coalitions that focus, for example, on applied research around the specific needs of an individual actor (Van der Borgh et al. 2012; Järvi et al. 2018). Nevertheless, not all involved actors are equally active all the time or simultaneously (Davis and Eisenhardt 2011; Davis 2016), and the network of associations among multiple actors is continually evolving, blurring the boundaries between the knowledge ecosystem and its environment, as well as between producers and users of knowledge (Garud et al. 2008). Thus, knowledge ecosystem's organization has been contemplated as essentially fluid (Dobusch and Schoeneborn 2015), as an ongoing process where the solution emerge in action (Garud et al. 2008) by the interactions and collaborations among different knowledge sources and across organizational boundaries, reducing the barriers which hinder knowledge creation and sharing (Roth 2003) (Table 1).

In this perspective, knowledge and innovation ecosystems (Gawer and Cusumano 2002; Iansiti and Levien 2004; Still et al. 2014) can be observed as an economic community based on individuals and organizations that interact continually and primarily co-evolve in their roles and capabilities for sustaining the growth and durability of the same ecosystems. Specifically, individual and organizational capabilities can contribute to the creation of knowledge or to the development of practices oriented to the invention of new artifacts/products (Mariano and Awazu 2017). This determines the generation of ecosystems of capabilities considered "critical in constituting ecosystems of enterprise capabilities since all agents in the system possess an indefinite number of effects that can be converted into capabilities in co-dependencies with other agencies in an enterprise's strategic architecture of multiple engagement platforms" (Ramaswamy and Ozcan 2014, p. 84). Thus, a new capability emerges as related to the entire ecosystem and not linked to sole enterprises and allows facing several threats linked to the coordination of resources useful for value co-creation processes (Aquilani 2016). On the other hand, the ecosystem of capabilities is a "meshwork of social, business, civic, and natural communities, whose leveraging of capabilities virtualized agential capacities in value creation" (Ramaswamy and Ozcan 2014, p. 83). In this direction, firms have inevitably to define new forms and approaches of value generation, created

Table 1 Main peculiarities of ecosystem types

	Knowledge ecosystem	Capabilities ecosystem
Focus	Knowledge exploration	Generation of new capabilities
Actors	Research centers, universities, innovators, technology entrepreneurs	Individuals and organizations willing to interact and participate in co-creation processes
Logic of action	A large number of actors that are grouped around knowledge exchange and sharing for the benefit of all involved actors	Not only firms at the center of business ecosystems but also complementary asset providers benefiting from integrative capabilities. The latter firms must align their activities with those of others operating in the same ecosystems

Source: our elaboration

in a shared space of experiences (Ramaswamy and Ozcan 2014) through advanced engagement platforms (Ramaswamy and Gouillart 2010).

Dynamic Capabilities in the Platform-Based Context

Platforms can be defined as "an assemblage of persons, processes, interfaces, and artifacts, whose engagement design affords environments of interactions that intensify agential actions in value creation" (Ramaswamy and Ozcan 2014, p. 34). They are the locus where value co-creation processes develop and the ideas and solutions emerge by insights coming from all individuals interacting and participating in co-creation initiatives (Ramaswamy and Gouillart 2012) within these virtual environments (Nambisan and Baron 2009). The strategic relevance of such initiatives to co-opt different competencies for firm value creation is significant (Vargo and Lusch 2004; Nambisan and Baron 2009). In this respect, firms can assume a critical role of focal actors, by grounding their multiple activities on four relevant principles—as inclusivity, generativity, linkability, and evolvability (Ramaswamy and Ozcan 2014, p. 87)—to assure the development of the ecosystem and the generation of new capabilities from diverse and innovative combinations. Additionally, firms can develop the ability to utilize knowledge to convert existing capabilities into new ones by the integration of new knowledge with existing capabilities and gaining from the internal and external interaction formed by the different knowledge foundations of individuals and groups (Carayannis et al. 2017).

Accordingly to Teece (2018), in the platform-based context, dynamic capabilities (Teece et al. 1997) can enable firms in creating and capturing value from the integration and combination of internal and external knowledge to cope with the dynamic environment and to exploit innovative opportunities (Papa et al. 2018), by building their specific ecosystems of capabilities. Dynamic capabilities are those capabilities that enable firms to create, extend, and modify how they make a living, contemplating alterations in their resources, operating capabilities, scale and scope of businesses, products, customers, ecosystems, and other features of their external environments (Teece et al. 1997; Winter 2003). Specifically, Teece (2018) introduces the concept of second-order capabilities including sensing, seizing and transforming, enabling an enterprise to upgrade its ordinary capabilities and direct these, and the partners' capabilities, toward high pay-off endeavors. Sensing capability refers to the ability of identifying opportunities (and, consequently, scanning technological possibilities, and supporting technological development). Seizing capability includes the ability of designing and redefining the business model as one of the favoring resource commitment in order to anticipate competitors' reaction and defend intellectual property. Finally, transforming capability refers to the ability to realign structure and culture, both through aligning existing capabilities and investing in additional ones.

Focusing on the effect of the digital revolution at a new frontier of knowledge, Teece (2018) claims the increasing relevance of dynamic capabilities for firms at the center of platform-based context (Gawer and Cusumano 2002) because the viability of this emerging ecosystem "depends on continued innovation" (Teece 2018). Specifically, a digital platform-based ecosystem involves the following entities: platform leader; actors on different sides of the platform; input suppliers to the platform leader; and other entities and institutions that interact with or affect the

value and development of a multi-sided platform. In this respect, a platform leader has to design the governance structure of its ecosystem, by defining which parties can access and how they can do so, how open the platform is to external providers for creation of products/services, how parties can interact, and which are the structure of interactions among parties on different sides of the platform. Helfat and Raubitschek (2018) have proposed that in the platform-based ecosystems, three different types of dynamic capabilities at a minimum are mainly critical: innovation capabilities, environmental scanning and sensing capabilities for new promising opportunities, and integrative capabilities for ecosystem orchestration. In particular, the ability to sense changes in a competitive environment accurately (including potential shifts in technology, competition, unexploited customer needs, and regulation) and the ability to act on these opportunities and threats underline the necessity to be ambidextrous. The ability to be ambidextrous is at the core of dynamic capabilities. Additionally, integrative capabilities provide the following: (i) the capacity for the introduction and modification of products, (ii) resources (including knowledge) and capabilities, and (iii) business models and objectives within firms (Helfat and Campo-Rembado 2016; Helfat and Raubitschek 2018). This type of capabilities supports the open system with permeable boundaries (Chesbrough 2003; Dahlander and Gann 2010) and the "interactions and relationships with external parties, enabling firms to align activities and products, resources and capabilities, investments, and objectives with their partners" (Helfat and Raubitschek 2018, p. 1396). They also promote the development of co-creation processes and the growth of the ecosystem in different ways. Dyer and Singh (1998) refer to a specific capability as a "relational capability" that considers the ability to engage in collaborations and partnerships, by including internal and external activities, as well as the orchestration of the interlinked activities of multiple partners simultaneously.

Open Innovation Digital Platforms and Value Co-creation

The mentioned challenging scenario has become one of the main drivers for the development of open innovation digital platforms (OIDPs), contemplated as a specific kind of two-sided platforms (Rochet and Tirole 2003; Economides and Katsamakas 2006; Hagiu 2009; Esposito De Falco et al. 2017). Specifically, OIDPs can be observed as virtual environments in which a large group of external entities, who are often unknown and undefined, are effectively involved in knowledge creation, exchange, and integration processes; they collaborate to solve specific, predefined open innovation challenges (Jeppesen and Lakhani 2010). Indeed, these kinds of platforms encourage the exchange of knowledge and creation of new ideas based on both existing and new resources, which, in turn, creates new value for participating entities (Lee et al. 2012). In doing so, they facilitate and sustain effective interactions and high collaboration paths leading to fruitful co-innovation among involved parties. For this reason, open innovation platforms have "a far-reaching impact" (Hossain and Lassen 2017, p. 55) on how actors collaborate and innovate together through networks, alliances, and ecosystems (West and Bogers 2014).

The literature has highlighted that the OIDPs can be understood as a specific kind of open innovation intermediary (OII) (Abbate et al. 2019), by assuming a critical role in

stimulating, creating, and sustaining successful collaborations and relationships among the multiple entities characterizing the knowledge and innovation ecosystem (Sieg et al. 2010; De Silva et al. 2018). Moving from the idea that this intermediary can assume a "catalyst role" connecting knowledge and experiences for particular purposes (Roth 2003, p. 37), OIDPs perform different tasks ranging from linking a large variety of parties for collaboration to setting up and mediating relationships, bridging a wide array of knowledge resources and competencies gaps (Howells 2006; Dalziel 2010; Agogué et al. 2013; Randhawa et al. 2018). These platforms are engaged in an array of diverse functions, activities, and services (Lopez-Vega 2009; Colombo et al. 2014) to assist firms in their exploration, integration, combination, and exploitation of knowledge and technologies management for successful open innovation processes.

OIDPs support not only inbound and outbound OI processes (Chesbrough and Crowther 2006; Scuotto et al. 2017) but also, and especially, coupled processes, including the interactive coupled processes (Piller and West 2014) which can lead to value co-creation. In particular, within the interactive coupled processes, knowledge creation and sharing happens not inside firms but rather in a shared space; specifically, it is the result of a collaborative process among multiple actors (Chesbrough 2011; Piller and West 2014) supported by a well-defined engagement platforms (Ramaswamy and Gouillart 2010, p. 29). In this respect, OIDPs, observed as special kind of engagement platforms, facilitate and sustain the interactive coupled process (problem definition, finding participants, external collaboration, and leveraging the collaboration results) (Piller and West 2014), by enabling knowledge co-creation with a wider set of ad hoc services (Abbate et al. 2019).

Open Innovation Digital Platforms Capabilities for Co-creation Processes: Research Propositions

Assuming that OIDPs are special kind of engagement platforms, this study suggests that they need to develop and deploy specific dynamic capabilities because in general, these capabilities can confer more reliability to undertaking an activity (Winter 2003) and also can improve the effectiveness of the value co-creation within interactive coupled open innovation processes (Piller and West 2014). The idea here proposed is that OIDPs develop specific "co-creation capability" to foster effective engagement and to co-create value for and with all actors involved in the relative ecosystem.

Piller and West (2014) have proposed a process model for interactive coupled open innovation processes that includes four different phases: problem definition, finding participants, external collaboration, and leveraging the collaboration results. In the here proposed investigation, the fourth stage has not been examined because "leverage" is linked to value capture from each actor participating in the OI interactive process, and not to co-creation developed outside organizational boundaries (Piller and West 2014).

The first phase refers to the definition of "the problem that it is seeking to address via engaging external partners in the co-creation effort" (Piller and West 2014, p. 8). It involves the explanation of the institutions and the rules of

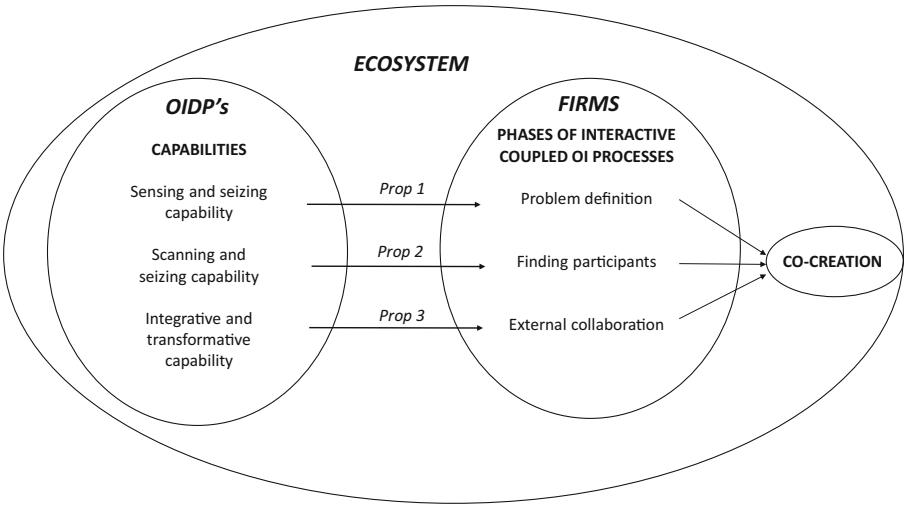
engagement (i.e., control of IP rights; explicit procedures for open innovation processes), the definition of resources, and the level of internal commitment necessary to sustain the ongoing interactions and collaborations with external partners (Dahlander and Gann 2010). In this phase, OIPDs can benefit from the sensing and seizing capability for using and interpreting accurately the information gathered and/or received by the firm (i.e., specific requirements) that intends to profit from external knowledge entities for its innovation process. In this respect, it emerges the organizational ambidexterity of OIPDs that permits to explore new ideas and solutions, by capitalizing on existing resources and knowledge and developing new combination of resources and knowledge to satisfy future market needs (Rossi et al. 2019).

As an initial step for the innovating enterprise sensing, the existence of customers with unmet needs who are willing and able to pay for a product or service that can rectify their predicament is essential (Teece 2018). Secondary, as seizing in terms of designing and refining business model and favoring resource commitment is what in the first step of open innovation processes addressed to co-creation is required. Nevertheless, it seems important to underline the necessity of OIDPs of supporting firms in developing an adequate absorptive capacity (Cohen and Levinthal 1989, 1990; Zahra and George 2002) that allows firms to use and turn available external knowledge into successful innovations.

> Proposition 1. The sensing and seizing capabilities improve the ability of OIDP to sustain the firms' interactive coupled open innovation process in terms of identification of the innovation problem and the related internal resources needed.

The second phase refers to searching for and selecting external participants with diverse knowledge. Different approaches can be used to search for external participants: open call, selective open call, and open search (Diener and Piller 2013). Nevertheless, "both the search for and the acquisition of such knowledge will depend on understanding and strengthening the motivations of partners to create and share their knowledge" (Piller and West 2014, p. 8). Attracting and motivating valuable participants to ensure a high level of collaboration with the firm and substantial contribution to innovation projects (Dahlander and Gann 2010) is a specific issue related to the provision of incentives (monetary rewards or non-monetary) (West and Gallagher 2006). In this respect, OIDPs can benefit from the scanning and seizing capabilities for identifying and integrating different types of external knowledge sources in the firm innovation activities in order to develop ideas, concepts, and solutions to specific, pre-defined problems. This thanks to the ability of OIDP's of connecting firms to different knowledge sources via information scanning, collecting, and exchange (Howells 2006). Additionally, seizing capability can assist to adjust the incentives that the firm offers to attract and retain external partners in order to ensure an efficacious combination of resources and competences for developing new ideas and products (Fig. 1).

> Proposition 2. The scanning and seizing capabilities of OIDP contribute directly to attract and motivate the participation of valuable external knowledge sources in the firm innovation process.



Source: own elaboration

Fig. 1 OIDP's capabilities for co-creation processes. Source: own elaboration

Finally, the collaboration phase is observed as the key co-creation phase in the model (Piller and West 2014). This phase encompasses a variety of activities: the definition and implementation of the processes singled out for collaboration; the creation of tools, technologies, and platforms to support the collaboration process; and the identification of the internal attitudes and capabilities needed to develop collaboration processes. In this respect, OIDP can benefit from the integrative and transformative capabilities to stimulate and assist firms in the definition and management of its collaborations and partnerships aimed at co-creating value for all involved entities. In particular, the integrative capability allows OIDPs to sustain ongoing interactions between a firm and its potentially valuable partners and, consequently, to better orchestrate different knowledge sources involved in the challenging innovation projects. Additionally, the transformative capability can help OIDPs to favor openness firms' attitudes and to realign structure and processes. Doing so, OIPDs continually assist top management and internal resources to open up their mindset, to design permeable organizational boundaries, and to manage open innovation more effectively.

> Proposition 3. The integrative and transformative capabilities of OIDPs contribute directly to the successful collaboration within the interactive coupled innovation processes.

Discussion and Conclusions

Discussions

In the last few years, the OIDP phenomenon has been increasing, becoming a suitable opportunity for facilitating and sustaining knowledge creation and sharing processes

and for improving innovation paths. Particularly, these platforms can enable organizations to explore suitable external opportunities for novel ideas, knowledge, and solutions with the involvement and participation of a large set of external knowledge entities. However, in spite of the rapid accumulation of research contributions on the OIDPs, as well as the increasing relevance of this phenomenon for knowledge sharing and open innovation processes, the number of studies investigating the capabilities they need to have for sustaining firms willing to use digital platforms for their innovation activities when collaborating with external sources is still scant. In the attempt to contribute filling this gap, the study investigated the different types of capabilities that OIDPs have to develop for sustaining co-creation in interactive coupled open innovation processes, by leading effectively knowledge ecosystems to capabilities' ecosystems. Specifically, by sustaining innovation across firm boundaries through the sharing of resources and opportunities from the external knowledge heterogeneity, OIDPs can benefit from different types of dynamic capabilities in order to contribute actively in each phase of interactive coupled open innovation processes, by expanding their functions, activities, services, and digital tools. As noted by the literature (Helfat and Raubitschek 2018; Teece 2018), the study argues that various types of dynamic capabilities are critical for the contribution of OIDPs to facilitate and sustain firm co-creation processes and to both create and capture value (Teece 2018), namely, sensing, seizing, scanning, integrative, and transformative capabilities. Firstly, sensing and seizing capabilities assume particular relevance to identify a firm's innovation problem and to investigate internal resources and competences, by examining emerging opportunities and threats of innovation challenge. Secondarily, scanning and seizing capabilities of OIDPs allow to attract and involve different external knowledge sources in the solution of firm innovation problems, while integrative and transformative capabilities appear essential to the successful collaboration within the interactive coupled innovation processes. Specifically, integrative capabilities allow to "orchestrate" (Teece 2018) external complementary resources and competences in the context of open innovation.

Additionally, moving from the idea that OIDPs renovate their ecosystems over time, they are also likely to learn and consequently develop their dynamic capabilities further. These mentioned capabilities in turn put the ecosystems in an even stronger position to face efficaciously future challenges. In this way, OIDPs, their capabilities and their ecosystems co-evolve (Teece 2018), by triggering the collaboration between firms and external knowledge entities.

The study contributes to the existing literature in a variety of ways. Firstly, the research provides a punctual focus on the "natural" transition from knowledge ecosystems to capabilities ecosystems, stimulated by the pressuring and challenging transformation of the digital revolution and the related development of digital organizations that, observed as virtual environments (Nambisan and Baron 2009), facilitate open collaboration for innovation processes. Secondly, the study represents an advance in the field of digital platforms, open innovation, and dynamic capabilities by developing several research propositions oriented to identify the different types of capabilities that OIDPs can develop to promote and sustain efficacious firm co-creation processes and the value of the ecosystem. Finally, this study takes one step closer to understand the development and evolution of capabilities ecosystems.

Managerial Implications

Firms face a relevant and difficult task of defining and implementing open innovation processes oriented to co-create value with different external knowledge entities, by overcoming the tension of competition within their ecosystems and exploring new opportunities for businesses (i.e., new types of products/services). In this respect, the study underlines that OIDPs can effectively help firms that intend to open up their organizational boundaries and to develop new ideas and solutions with the involvement and the participation of external knowledge sources, by facilitating and sustaining each phase of interactive coupled open innovation processes. By highlighting the distinctive characteristics and problems of each phase of these open innovation processes, firms could achieve a clear understanding of how OIDPs stimulate and support interactions, participations, and collaborations with the aim to provide several benefits for all involved entities. Indeed, they can promote suitable ways of innovation that cross traditional models, embrace ecosystems, and integrate and combine different complementary resources, by encouraging a rethink of how individuals, organizations, and communities may pursue innovative objectives.

Additionally, the study shows that OIDPs have to develop and maintain a specific type of dynamic capabilities for enabling useful collaborations and relationships with and among heterogeneous knowledge sources. These capabilities, aimed at changing the existing resource base (Teece 2007), are important for OIDPs to help and assist firms to overcome problems and barriers related to innovation projects.

Limitations and Avenues for Further Research

The conceptual output of the study represents its main limitation, by stressing the need for empirical validation. This paves the way to several avenues for future research on the use of digital platforms for promoting and supporting open innovation projects. Future studies could aim at validating the research propositions here developed, by designing explorative qualitative studies oriented to investigate the principal characteristics and the evolution process of capabilities ecosystems. Through additional empirical studies, which examine OIDPs capabilities, it will be possible to achieve a deeper understanding of the critical capabilities for the successful definition and implementation of co-creation processes.

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