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Platform Sponsor Scope and Ecosystem Structure: A Configurational Approach to Ecosystem Heterogeneity

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Abstract

The burgeoning literature on digital platform-based ecosystems has emphasized understanding the influence of platform ecosystem structure and governance strategies on the growth of the ecosystem. However, the platform sponsor should often make these strategic choices simultaneously and continually. This paper adopts a configurational approach to shed light on how the simultaneous decisions of ecosystem structure and governance shape ecosystem growth. We contend that a platform sponsor's latitude in the governance of platform ecosystems is shaped by its choice of platform sponsor scope. We build a configurational model to inductively identify configurations of ecosystem structure and platform sponsor scope for different types of ecosystems and at different stages of the ecosystem lifecycle. Our results of the fsQCA analysis demonstrate several trade-offs between the elements of structure and scope and show that high-performing ecosystems depict an alignment between the two.

Keywords: digital platform ecosystems, ecosystem structure, platform sponsor scope, fsQCA, ecosystem lifecycle stages.

Introduction

The rapid proliferation and growth of platform-based firms and the ecosystems accompanying them have drawn the interest of both practitioners and researchers. A platform-based ecosystem (hereafter referred to as platform ecosystems or ecosystems) refers to a set of symbiotic actors who depend on each other to create value over a central infrastructure called the platform (Adner & Kapoor, 2010; McIntyre & Srinivasan, 2017; Shipilov & Gawer, 2020). A prominent issue that the burgeoning literature on this topic has sought to understand is how the platform ecosystem structure and governance strategies influence the growth of the ecosystem (McIntyre et al., 2020; McIntyre & Srinivasan, 2017). Broadly, the ecosystem structure includes elements such as access control points, interface openness, complementarity, and complement category (Shipilov & Gawer, 2020; Thomas et al., 2014). The governance choices include aspects such as the ecosystem participants' activities, decision rights, and platform sponsor's orchestration within the ecosystem (Jacobides et al., 2018; Kretschmer et al., 2020).

Although scholars have extensively studied the role of ecosystem structure and governance separately, it is not clear how the "overall mixes of [these] strategic choices that platform [sponsors] undertake" shape ecosystem performance (Dushnitsky et al., 2020, p. 3). This is particularly important because the platform sponsors simultaneously choose the ecosystem structure and governance elements. Moreover, it is unclear how the strategic choices of structure and governance span out across different types of ecosystems. Scholars have argued that "multidimensional constellations of conceptually distinct characteristics that commonly occur together" are best studied using configurational theories (Meyer et al., 1993, p. 1175). A configurational approach emphasizes causal complexity where one factor's implication on the outcome depends on the other factors that co-occur (Miller, 1986; Misangyi et al., 2017). Such an approach examines the phenomenon holistically and brings clarity through boundary conditions and typologies in the form of discrete configurations of explanatory factors (Greckhamer et al., 2018). Despite the merits of a configurational approach, the platform literature has so far not fully documented how ecosystem structure and governance elements combine holistically to shape performance (for an exception, see Dushnitsky et al. (2020)).

Furthermore, we do not fully understand how the mix of these strategic choices varies temporally over different ecosystem lifecycle stages (Gawer, 2020). It is particularly important to understand how the strategic choices may change before and after the market tips, i.e., at the incipient and mature stages. Whereas the platform sponsors are keen to rapidly grow their ecosystems in the initial stages to enjoy the benefits of winner-take-all dynamics (Arthur, 1989; Katz & Shapiro, 1994), their goal at the mature stages shifts towards value capture (Gawer, 2020). We do not fully understand how the shift in platform sponsor's priorities affects the ecosystem structure and governance across different types of ecosystems.

In this paper, we fill the above gaps in the literature by asking the following questions: How can a platform sponsor configure the ecosystem structure and governance for superior performance across different types of ecosystems? And how does the configuration vary between the incipient and mature stages of the ecosystem lifecycle? As a first step, we build on prior research that studied the differences in platform-enabled markets (Cennamo, 2019; Cusumano et al., 2019) to identify four types of platform ecosystems – complementary innovation, open-source, information exchange, and marketplace ecosystems. This typology is consistent with the prior classification of ecosystems as enabling transactions, innovation, or both (Cusumano et al., 2019; Gawer, 2020) but brings more granularity to the differences in their value proposition.

In platform ecosystems, both the platform sponsors and autonomous complementors co-create value (Adner & Kapoor, 2010; Kapoor, 2018) by performing different parts of the value creation process. Consequently, the actor who performs a focal process has control over the corresponding part of value creation. Thus, we contend that a platform sponsor's latitude in the governance of platform ecosystems is shaped by its choice of scope vis-à-vis the complementors. We conceptualize *platform sponsor scope* as constituting of the following elements of governance: (i) the platform sponsor's choice of activities to perform internally, (ii) the degree to which the platform sponsor exerts decision rights over the complements, and (iii) the extent to which the platform sponsor orchestrates value creation in the ecosystem.

Using a configurational approach (Fiss, 2007; Miller, 1986), we explore the interplay between the elements of platform sponsor scope and ecosystem structure associated with the ecosystem's superior performance. Specifically, we examine how the platform sponsor's extent of control, degree of interface openness, type of complementarity, and complement categories vary alongside the elements of platform sponsor scope across different types of ecosystems in the incipient and mature stages. We use fuzzy-set qualitative comparative analysis (fsQCA) and data from 40 platform ecosystems at both the incipient and mature stages to inductively identify configurations of ecosystem structure and governance.

The principal insights from our analysis are threefold. First, we find empirical support for our typology as distinct configurations of ecosystem structure and governance emerge, and those configurations map to the four different types of ecosystems. We propose that the typology of ecosystems represent points on a broader *ecosystem continuum*, an organizing framework based on platform sponsor scope that helps visualize ecosystem heterogeneity. Second, we find that ecosystems exhibit superior performance when there is an alignment between the elements of governance and ecosystem structure. Specifically, we find that a broad platform sponsor scope aligns with a more restricted ecosystem structure, whereas a narrow platform sponsor scope aligns with a less restricted ecosystem structure. Third, we find that the configurations of ecosystem structure and governance change from the incipient stage to the mature stage for each of the ecosystem types. However, we find that despite the change in configurations, the alignment between the ecosystem structure and governance is preserved.

This paper makes several contributions. First, we provide an empirically validated typology of ecosystems and provide a framework to organize ecosystem heterogeneity in the form of an ecosystem continuum. We demonstrate that the elements of ecosystem structure and governance vary across the different types of ecosystems. Second, using the configurational approach, we show that an alignment among the elements of ecosystem structure and governance is associated with superior ecosystem performance. The configurations show that there exist tradeoffs among the different elements. For instance, a wide variety in complement categories is found in ecosystems with open interfaces and low variety in those with more closed interfaces. Finally, we shed light on the temporal aspects of ecosystems by demonstrating that the configurations of ecosystem structure and platform sponsor scope differ from the incipient to mature stages. This finding demonstrates that not only are structure and scope static decisions made at the outset but also are choices made in consideration of the market tipping point.

Typology of Platform Ecosystems

Some of the early studies differentiated among two-sided markets and multi-sided markets (Evans, 2003; Rochet & Tirole, 2006). Later studies have juxtaposed the market dynamics within ecosystems with architectural differences to arrive at meta-logics. One such typology differentiates platform ecosystems based on how the ecosystems reuse assets, interfaces, and standards in production, innovation, or transactions to drive economies and efficiencies in operating the platform (Thomas et al., 2014). Another typology based on organizational settings and form classifies platforms as internal platform, supply-chain platform, and industry platform (Gawer, 2014). The typologies aimed at integrating research streams to arrive at meta-logics have not focused on the differences in the value propositions of the platform ecosystems.

A few recent studies have addressed the above gap by focusing on the "role played by the platform" to "reveal differences in the way they operate" (Cennamo, 2019, p. 6). Platform ecosystems are classified as innovation or transaction platform ecosystems depending on whether the platform facilitates innovation or transaction (Cusumano et al., 2019). Another study focuses on the differences in the markets that emerge around platforms and classifies ecosystems as complementary innovation, marketplace, or information ecosystems (Cennamo, 2019). This classification captures the underlying differences in value proposition but does not consider another important type of ecosystem – open-source ecosystems – which are similar to complementary innovation ecosystems in terms of the activities and actors' positions (Adner, 2017) but are distinct in the overall value proposition.

We identify four types of platform ecosystems based on the differences in their value propositions as *complementary innovation, open-source, marketplace, and information ecosystems.* This typology is in accordance with the earlier classifications based on value propositions but is broadened to include open-source ecosystems. Further, the typology brings more granularity to the classification of ecosystems as innovation or transaction ecosystems (Cusumano et al., 2019). As we detail in the following sections, the typology recognizes the differences between complementary innovation and open-source ecosystems although the platform facilitates innovation in both types. Similarly, information and marketplace ecosystems are different although the platform facilitates transactions in both types.

<u>Complementary Innovation Ecosystems</u>: In these ecosystems, the value proposition is to make available optional complementary products that enhance the value of a core product (McIntyre & Srinivasan, 2017). The platform is the innovation engine and serves as the core infrastructure over which complementors produce their products (Gawer, 2014). However, its value is further enhanced when the users choose to use complementary products. The Apple app store and video game consoles and their corresponding game stores are examples of this type of ecosystem.

<u>Open-Source Ecosystems</u>: These are similar to complementary innovation ecosystems as the value proposition includes making available optional complementary products. However, these ecosystems differ from the complementary innovation ecosystems as the platform sponsor opens

the complete platform infrastructure to third-party complementors to contribute to the platform as well as to produce complements over the platform (Jacobides et al., 2018). Furthermore, the platform sponsor often plays a minimal role or may be replaced by a core community of users. Mozilla Firefox, Linux, and LibreOffice are examples of this type of ecosystem.

Marketplace Ecosystems: The platform sponsor of this ecosystem provides an infrastructure to match actors on two sides of the platform and facilitate transactions among them. Amazon, eBay, Amazon MTurk, and Kickstarter ecosystems are examples of this type of ecosystem. Such ecosystems have been referred to as two-sided markets (Rochet & Tirole, 2003). The sellers list their products on the platform for buyers to view. In some cases, such as Kijiji, buyers list their needs on the platform, which is then catered to by the sellers. However, unlike an ideal market, the platform sponsor seeks to benefit from facilitating the transactions between the two sides.

Information Ecosystems: In these ecosystems, the primary role of the platform is to serve as an information exchange channel, categorize information, and enable the search of the relevant information (Cennamo, 2019). These ecosystems match the users with the information they require and thus differ slightly from marketplace ecosystems that match the goods and services of sellers with buyers. Similar to the marketplace ecosystems, the platform sponsors seek to benefit from matching and information exchange over the platform. Examples of this type of ecosystem include Google's search engine, Facebook, and dating service platforms.

Overall, the above typology depicts the differences in the value proposition of the platform ecosystems. With these differences as the starting point, in the following section, we explore how the ecosystem structure and governance may vary across the different types of ecosystems. We also examine how the ecosystem structure and governance for each type of ecosystem varies between the incipient and mature stages of the ecosystem lifecycle.

Configurational Approach to Platform Ecosystems

Scholars have examined several aspects of platform ecosystems including platform technology, ecosystem design, pricing, governance, and dynamics that influence performance of the platform sponsor and complementors (Kretschmer et al., 2020; McIntyre & Srinivasan, 2017; Shipilov & Gawer, 2020). However, there exists a lacuna in our understanding of how the factors combine and interact to shape performance outcomes. This gap is attributed to the distinct origins of the platform literature in technology management, economics, and strategy streams. Consequently, there have been calls to integrate the findings from the different streams to build a comprehensive understanding of platform ecosystems (McIntyre & Srinivasan, 2017).

The few studies that have integrated the different streams or the underlying explanatory factors have provided greater clarity of the phenomenon. In studying the influence of platform interface openness on innovation outcomes, Boudreau (2010) demonstrates that opening platform interfaces promotes innovation. However, the magnitude of such innovation reduces when the platform sponsor completely devolves control as such a strategy shifts the bottleneck from the sponsor to the complementors. This study demonstrates that platform sponsors should balance the design choice of openness with their governance choice of control.

In a recent study of transaction platform ecosystems, Dushnitsky et. al. (2020) show that platform sponsors' strategic choices of pricing and governance factors cluster around three strategy mixes. This study makes an important contribution by highlighting the prevalent mix of strategic choices in transaction ecosystems as well as equifinality in ecosystem performance. However, the study does not consider different types of ecosystems and the underlying configuration of factors. This limitation may be overcome using a configurational approach based on set-theory as it is particularly well-suited to examine typological differences (Fiss, 2011; Furnari et al., 2020).

A configurational approach constitutes a holistic mode of inquiry that examines "multidimensional constellations of conceptually distinct characteristics that commonly occur together" (Meyer et al., 1993, p. 1175). Management scholars using different theoretical lenses have argued that "organizational outcomes tend to depend on the alignment or conflict among interdependent [factors]" (Fiss, 2007; Miller, 1986; Misangyi et al., 2017, p. 256; Siggelkow, 2002). The focus of the configurational approach is to identify complex causal relationships, in the form of patterns of factors related to an outcome of interest, rather than individual variables to identify the net effects of causal conditions (Meyer et al., 1993; Ragin, 2009).

Three features of a configurational approach make it particularly suitable to study complex organizational phenomenon such as platform ecosystems – causal complexity, equifinality, and asymmetry (Fiss, 2007; Furnari et al., 2020; Misangyi et al., 2017). *Causal complexity* is found when outcomes "result from the interdependence of multiple conditions" (Misangyi et al., 2017, p. 256) and thus the effect of a condition may vary based on the other co-occurring conditions. *Equifinality* in outcomes demonstrates that the desired outcome may be reached from different initial conditions and paths. *Asymmetry* implies that factors related in one configuration may be unrelated or inversely related to the outcome in another configuration.

In this paper, we develop a configurational model (Figure 1.1) of platform ecosystems considering various elements of ecosystem structure and governance. The model explores how the elements of structure and governance are configured in high-performing ecosystems across the different types. In the following sections we elaborate on the different elements of governance (as shaped by the platform sponsor scope) and ecosystem structure.

Platform Sponsor Scope

The success of a platform ecosystem is attributed to the potential of the platform sponsors and complementors to co-create value (Kapoor, 2018). Such a value co-creation process entails the platform sponsor and the complementors performing different parts of the process. Consequently, the actor that performs a focal process retains control over the corresponding part of value creation. Such an arrangement begins with the platform sponsor, as the initiator of the ecosystem, choosing to perform parts of the value creation process while opening the rest to the complementors. In essence, the platform sponsor chooses their scope in the value creation process vis-à-vis the complementors. We refer to such a choice as the *platform sponsor scope*.

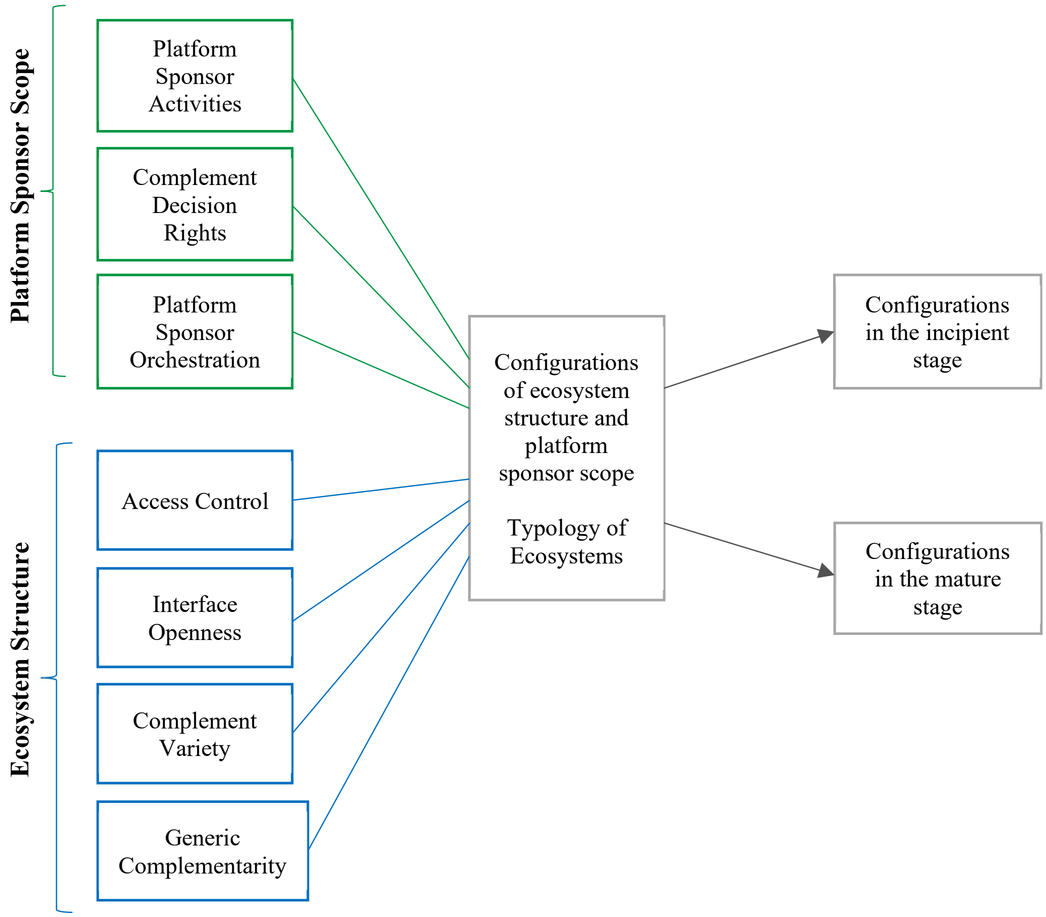


Figure 1. 1: Configurational Model of Platform Ecosystem Structure and Sponsor Scope

Early work referred to platform scope as the platform sponsors' choice of which complements to make internally and which to leave to autonomous complementors (Cusumano & Gawer, 2002). More recent studies have adopted broader definitions of platform scope as the role played by the platform in the digital markets they enable (Cennamo, 2019) and the "vision that defines the ecosystem value proposition" (Dattée et al., 2018). Gawer (2020) refers to platform scope as comprising of the assets owned, labor employed, and activities performed by the platform sponsor. Building on these, we refer to *platform sponsor scope* as constituting of three distinct elements: (i) the activities that the sponsor chooses to perform internally while opening the others to complementors, (ii) the sponsor's decision rights over complements, and (iii) the sponsor's degree of orchestration within the ecosystem. Our definition of platform sponsor scope encompasses prior conceptualizations as activities underpin the delivery of the value proposition and the nature of the market around the platform. It also includes a focus on orchestration which is not only key to the emergence of a coherent value proposition of the ecosystem (Adner, 2017) but also vital to maintain the quality of the ecosystem (Tiwana, 2013).

Platform sponsor scope shapes the latitude that the sponsor has to govern the ecosystem. Three elements of platform sponsor scope contribute to the sponsor's latitude in ecosystem governance. First, the platform sponsor has complete control on the activities it performs internally. When complementors depend on the sponsor's activities, the platform sponsor has greater flexibility to frame rules and procedures involving such dependencies. Second, the platform sponsor can define governance rules for complementors and the broader ecosystem by defining who exerts decision rights over the complements. Finally, the platform sponsor as the orchestrator of the ecosystem can govern through indirect mechanisms such as incentives, subsidies, and coordination between the different ecosystem actors. Thus, we contend that examining the three elements of platform sponsor scope can shed light on how the platform sponsor governs the ecosystem.

Platform Sponsor Activities: Since the platform sponsor and the complementors together co-create value in ecosystems, the value creation activities are performed by both the actors. At the outset, the platform sponsor as the "hub" (Jacobides et al., 2018) and initiator of the ecosystem chooses the activities to perform internally. Such a choice implicitly signals to the complementors the other activities available to be performed. The platform sponsor has complete control on the activities it performs internally. The complementors are often dependent on the platform sponsor's activities. Such dependence provide latitude to the platform sponsor to frame rules for complementors' activities beyond its boundaries. Such latitude of the platform sponsor to frame rules and govern the ecosystem increases as complementors' dependence on platform activities increases. Thus, the choice of activities to perform internally constitutes a key element of platform sponsor scope definition.

Furthermore, the platform sponsors' activity choices define the kind of interactions that are available to prospective complementors on the platform. The nature of interactions restricts not only the type of complementors and users who would participate on the platform but also the type of market the platform enables (Cennamo, 2019). Thus, the platform sponsor's choice of activities to perform internally while opening the other activities to complementors shapes the value proposition and the alignment structure necessary to materialize it (Adner, 2017).

Complement Decision Rights: Complementors leverage the platform infrastructure to produce their products or complements (Thomas et al., 2014). Such dependence on the platform infrastructure allows the sponsors to exert decision rights over the complements to a varying degree. With decision rights over the complements, the platform sponsors can better control the quality, variety, and timing of the release of the complements and thereby improve their own competitive position (Cennamo & Santalo, 2013; Wareham et al., 2014). We contend that platform sponsors make a strategic decision about the complement decision rights similar to the choice of value creation activities to perform internally. The platform sponsors' choice of decision rights over complements signals the extent of control complementors would have on their contributions to the ecosystem and the opportunities for value capture. Such signaling about value capture also shapes the participation decisions of the complementors.

Platform sponsors exert decision rights over the complements through various types of arrangements such as exclusivity agreements, where the complement is available solely to the users of the focal platform ecosystem (Cennamo & Santalo, 2013) as well as when the complementors cede complete control of the complements after producing them, such as in crowdsourcing and innovation contests (Felin & Zenger, 2014). In ecosystems aimed at producing open-source hardware and software, the decision rights of the platform offerings and the complements reside within the community of ecosystem participants (Jeppesen & Frederiksen, 2006). On the other hand, in ecosystems where the sponsor is more like a market intermediary, the decision rights of the complements remain with the autonomous complementors (Hagiu & Yoffie, 2009; Thomas et al., 2014).

Platform Sponsor Orchestration: Extant research has increasingly acknowledged the orchestrating role of platform sponsors in platform ecosystems (Tajedin et al., 2019; Tee & Gawer, 2009; Tiwana, 2013). Platform sponsors' ability to orchestrate is aimed at facilitating innovation (Tee & Gawer, 2009) as well as matching demand and supply whilst benefiting from it (Tajedin et al., 2019). Since the platform sponsor does not have direct control over the actors within the ecosystem, tacit and indirect mechanisms like coordination of complementors, incentives, and selective promotion of complements are used to maneuver value creation, encourage loyalty, and capture value from the ecosystem (Jacobides et al., 2018; Kretschmer et al., 2020; Rietveld et al., 2019).

Broadly speaking, orchestration mechanisms may be implemented either before the complements are made or after the complements are hosted within the ecosystem. This distinction of the type of orchestration mechanism employed, i.e., ex ante or ex post, is key to understand the extent to which the platform sponsor intervenes, albeit indirectly, in value creation and capture in the ecosystem. This is because the platform sponsor's ex-ante orchestration is a more focused involvement to maneuver value creation in a particular direction whereas an ex-post orchestration is a more tacit involvement to induce market forces into action in a way that benefits itself. Specifically, ex-ante orchestration involves mechanisms such as coordination of complementors, explicit identification of potential complements or areas for contributions from complementors. In contrast, ex-post orchestration involves mechanisms such as selective promotion of complements and targeted discounts on platform fees.

We posit that the platform sponsor's choice of orchestration is another way of defining their scope vis-à-vis the complementors. This is because each orchestration type enables the sponsor to intervene to varying degrees and forms in the value creation process. The platform sponsor scope broadens when the sponsor chooses to employ orchestration mechanisms both before and after the complements are hosted in the ecosystem. With this approach, the platform sponsor not only orchestrates how value is created ex-ante but also is able to affect competition among complementors ex-post. The platform sponsor scope is narrower when the orchestration mechanisms are restricted to one of the two orchestration types – ex-ante or ex-post mechanisms.

Platform Ecosystem Structure

The term 'platform ecosystem structure' has received a variety of treatment in the literature. Ecosystem structure is used to depict the technological and modular architectures (Baldwin & Clark, 2000; Tiwana, 2013) as well as the arrangement of different actors and their activities (Adner, 2017). In this paper, we consider elements of platform ecosystem structure – access control, interface openness, complement categories, and type of complementarity.

Access control: The literature on collaboration among firms has established that, after partner selection, the focal firm can retain a certain level of control over the outcome of collaboration through structural arrangements such as contracts (Dyer, 1997; Gulati & Singh, 1998). In the case of ecosystems, similar structural arrangements are not so suitable as the participants are not selected by the firm. However, architectural and processual constraints over access to the platform can enforce some levels of control on the output and behavior of complementors (Boudreau, 2010; Tiwana, 2015). The platform sponsor may exercise such control in multiple ways. First, *ex-ante control* where the platform sponsor approves complementors' participation and their complements before hosting them within the ecosystem. This form of proactive control is an intervention by design where complementors are free to participate once approved. Second, *ex-post control* where the platform sponsor intervenes as a corrective measure to maintain the ecosystem integrity. Third, the most restrictive control is where the platform sponsor employs a combination of both ex-ante and ex-post methods of control.

Interface openness: This refers to the extent to which the platform provider grants access to core modules of the platform to outside complementors. Whereas some studies have considered openness as an inherent part of platform architecture (Baldwin & Clark, 2006; Boudreau, 2010), others have shown that a flexible platform architecture can lend itself to changes in the extent of openness (Tiwana et al., 2010). Furthermore, as the platform interface becomes more open, it is expected that more complementors would co-create in the ecosystem (Gawer, 2014). Interface openness plays a key role in attracting complementors and facilitating innovation through their contributions to the ecosystem (Boudreau, 2010; Parker & Van Alstyne, 2017).

Complement Category: The platform sponsor plays a key role in grouping the complements into pre-defined categories. The complement categories define the breadth and depth of the ecosystem that in turn shape the adoption decisions of users (Rietveld et al., 2019). Further, complement categories can negatively influence complementors' performance when competitive crowding within the same category (Rietveld et al., 2020) outweighs user preferences (Zhu & Iansiti, 2012). Platform sponsors leverage the complement categories to selectively promote complements or their categories (Rietveld et al., 2019). Moreover, the users of different types of platforms place a different value on the variety of complements, which in turn influences the strength of network effects in the ecosystem (Zhu & Iansiti, 2012). Users across different ecosystems may value the complements differently because the platform's intrinsic value, in addition to the complements, determines the users' overall utility (Parker & Van Alstyne, 2017). If the platform's intrinsic value increases, then the complements may be less important to users.

Complementarity: Modularity in the architecture of platforms allows building value-enhancing complements. However, these complements may either be standardized and not need specific coordination to create value or be specific to a structure or architecture provided by the platform (Jacobides et al., 2018). The former is referred to as generic complementarities and the latter as non-generic complementarities. Jacobides et al. (2018) argue that ecosystems are those that have non-generic complementarities on both the production and consumption sides. So, two-sided markets that do not need "nonfungible relational investment" (p. 2266) are not ecosystems. Thus, we expect the type of complementarity to differ across the different types of ecosystems.

In summary, the configurational model (Figure 1.1) explores the interplay between the elements of ecosystem structure and governance. We argued that the platform sponsor's latitude in governance of ecosystems is shaped by the platform sponsor scope. Hence, in the configurational model, we considered three elements of platform sponsor scope – platform sponsor activities, complement decision rights, and platform orchestration – and four elements of ecosystem structure

– access control, interface openness, complement category, and complementarity – to find configurations in high-performing platform ecosystems.

Platform Ecosystem Life Cycle Stages

Research about the lifecycle stages of the platform ecosystem and its implications for the platform sponsor's and complementors' strategies has been scant, with the exception of a few recent studies. Dattèe et al. (2018) demonstrate that in the incipient stages, when uncertainty is high, value creation is a "collective discovery" (p.467) process performed by both the platform sponsor and complementors. They argue that the platform sponsor should exercise dynamic control over the creation process in this stage. Thus, in the incipient stage, the ecosystem structure and scope choices should be flexible to accommodate the emerging value propositions.

Furthermore, the platform sponsor's priorities at the incipient stage (i.e., before the market tipping point) are different from those at the mature stage (i.e., after the market tipping point) (Gawer, 2020). During the incipient stage, the platform sponsor is focused on growing the ecosystem to reach a critical mass of users (Schilling, 2002; Schmalensee, 2010) as this is key to initiate network effects and enjoy winner-take-all dynamics (Arthur, 1989; Katz & Shapiro, 1994). Thus, it is plausible that the ecosystem structure and scope choices are geared towards attracting complementors' participation. In contrast, during the mature stages, the platform sponsor seeks to capture value from the ecosystem by prioritizing profits "while building and maintaining barriers to entry against rivals or newcomers" (Gawer, 2020, p. 8). Thus, it is likely that the ecosystem structure and sponsor scope are configured to facilitate value capture.

Overall, the literature around ecosystem lifecycle stages suggests that ecosystem structure and governance elements may differ between the incipient and mature stages. In considering the ecosystem lifecycle stage, we can examine how the various elements combine in the two stages across the different ecosystem types. So, we can compare the configurations of the elements of platform sponsor scope and ecosystem structure in both stages for each type of ecosystem.

Method

We use the fuzzy-set qualitative comparative analysis (fsQCA) method to empirically validate our typology and inductively identify configurations of the ecosystem structure and platform sponsor scope. The fsQCA method adopts a configurational approach and relies on "logical minimization to identify necessary and sufficient conditions that predict the occurrence and non-occurrence of an outcome" (Vergne & Depeyre, 2016, p. 1657). fsQCA is suitable for testing typologies because it "conceptualizes cases as combinations of attributes and emphasizes that it is these very combinations that give cases their uniqueness" (Fiss, 2011, p. 401).

Data

Our dataset comprised of 40 platform ecosystems such that each type of ecosystem had ten platforms across two categories. Table 1.1 depicts the chosen categories and the corresponding platform ecosystems. We chose this dataset for a number of reasons. First, fsQCA does not rely on probabilistic statistical inference and hence does not generalize the findings beyond the sample

(Misangyi & Acharya, 2014; Ragin, 2009). So, we chose ecosystems covering all the types but under two separate categories. This approach to case selection ensures a broad coverage of ecosystems within each type. Second, the outcome-based sample selection is not a problem in fsQCA as it employs calibrated sets for all constructs. Finally, the number of cases chosen in our dataset meets the recommendations corresponding to the number of attributes considered (Greckhamer et al., 2018; Marx, 2010).

We identified the popularity of each category using search data from Google Trends. We considered the time frame of 2004 to 2019 to exclude any influence of the pandemic on search popularity scores. Next, we identified the year the category hit the 25th percentile in popularity for the first time. This year was designated as the incipient stage. Similarly, the year at which the category peaked in popularity was identified as the mature stage. Table 1.1 depicts the incipient and mature stages for each category. For each platform, we collected data on outcomes and explanatory factors during both stages. The outcome is lagged by one year, and data for incipient and mature stages correspond to the year of 25th percentile and 100th percentile category popularity, respectively. Our data sources comprised of Google Trends, archived platform webpages from Wayback Machine, ProgrammableAPI (a global repository of APIs and SDKs), and company reports and news releases. We calibrated our measures using the direct calibration method as detailed next and summarized in Table 1.2 (Greckhamer et al., 2018; Ragin, 2009).

Table 1. 1: Dataset Construction – Categories and Timelines

Ecosystem Type	**Category**	**Year of 25th percentile Popularity**	**Year of Peak Popularity**
Complementary innovation ecosystems	Smartphone OS	2009	2013
	Customer data management platforms	2011	2019
Open-source ecosystems	Image editing	2004	2012
	Password manager	2006	2019
Information exchange ecosystems	Social networking platforms	2008	2012
	Dating service platforms	2014	2019
Marketplace ecosystems	Crowdfunding	2012	2015
	MOOC	2012	2017

Outcome

We measure the outcome of platform ecosystem performance as the relative *popularity* of the focal ecosystem at the incipient and mature stages of the category. Following prior research (Ren et al., 2019), we measure relative popularity as the relative frequency of search for the platform ecosystem using Google's search engine. As Ren et al. (2019) highlight, Google Trends data "provides volume indexes for queries consumers have entered into the Google search engine" (p.264). Google Trends data provides the search frequency information by comparing up to five search terms (in our case, five platform ecosystems) for years dating as far back as 2004. The Google Trends popularity data is particularly well suited for our purpose for a number of reasons: First, the popularity scores are ranked based on comparison across the five platforms within a category. Second, the popularity scores serve as a proxy for the interest of complementors and consumers in the focal ecosystem. Third, as an indexed measure the popularity scores help us to compare the outcomes across different ecosystems and types.

Table 1. 2: Set Calibrations and Descriptive Statistics

	Fuzzy Set Calibrations			***Measure Descriptives***			
Measure / Fuzzy Set	***Fully In***	***Crossover***	***Fully Out***	***Mean***	***SD***	***Max***	***Min***
Access control	1	0.67/0.33	0	0.54	0.35	1	0
Interface openness	1	0.5	0	0.31	0.46	1	0
Generic complementarity	1	0.5	0	0.51	0.49	1	0
Complement variety	15	10	5	10.4	8.4	33	0
Complement decision rights	1	0.66/0.33	0	0.41	0.46	1	0
Narrow scope of sponsor activities	1	0.5	0	0.63	0.32	1	0
Platform sponsor orchestration	1	0.5	0	0.53	0.34	1	0

Explanatory Factors

Access Control: The platform sponsor may exercise ex-ante control, ex-post control, or a combination of both. The combination of ex-ante and ex-post control is the most restrictive, whereas ex-post control is the least restrictive as the control measures are reactive in nature. In the ex-post scenario, the complementors have had a chance to participate in the ecosystem, albeit restricted later on. In contrast, the ex-ante control is more restrictive than the ex-post but less restrictive than the combination because once the complementors are approved, the platform sponsor does not intervene in their participation.

Interface Openness: Though interface openness has received much attention in the platform literature, its operationalization has been mostly categorical or often specific to a single platform. Since we were interested in comparing the level of openness across different platforms, we needed an operationalization that was consistent across the different platform architectures. As Gawer (2014) argues, application programming interfaces (APIs) are “a key resource for the digital platforms' ecosystem developers, allowing them to access the platform user data and build applications” (p. 1246). Thus, from the API documentation data, we measured interface openness as the number of APIs comprising of distinct methods or unique functionality (ex. APIs that yield a search result or user ratings against a product). The distinct API methods indicate the different platform functionality accessible to complementors. We arrived at the thresholds for calibration by examining the API data from ProgrammableWeb. We found that the above thresholds are consistent with ProgrammableWeb’s report of the API listings against each provider (Santos, 2018).

Complement category: As discussed earlier, the platform ecosystems match demand with supply, buyers with sellers, and problems with solutions. In order for this matching to be efficient, platforms tag the complements into related categories. The process of tagging involves attributing labels that are searchable as keywords as well as serve as a classification mechanism for the complements listed on the website. For example, on the Kickstarter website, a project may be tagged as 'Arts' or as 'Film' depending on the relevance. We used this property of platforms to measure complement category as the number of distinct categories of complements available on the platform. Though a complement may often be tagged under multiple categories to enable efficient matching, it does not conflate our measure as we are only concerned with the number of distinct categories. We relied on average number of categories in our dataset to arrive at these thresholds as no estimates of complement category were found in the literature.

Complementarity: We are interested to understand whether the configuration of ecosystems varies between generic and non-generic complementarity. The non-generic complementarities require the "creation of a specific structure of relationships and alignment to create value" (Jacobides et al., 2018, p. 2263). This can be equated to the platform's mandate to complementors to use a specific software development kit (SDK) for creating complements. Thus, we coded the ecosystems as comprising of non-generic complementarities when such a mandate existed and otherwise as comprising of generic complementarities.

Platform Sponsor Activities: The platform sponsor performs the activities that are not performed by the market around the platform. The platform sponsor may be argued to have a broad scope of activities when the market performs few activities whereas the sponsor has a narrow scope of activities when the market performs most of the activities for value creation. We identified the key activities underpinning the markets (Cennamo, 2019) in each type of ecosystem. The markets in the complementary innovation and open-source ecosystems primarily performed matching and information exchange activities to enable complementors to seek platform resources and reach consumers. Some complementary innovation ecosystems additionally enabled trading of complements and competition between complementors in the markets around their platforms. The information ecosystems primarily performed matching and information exchange activities. The marketplace ecosystems performed matching and information exchange activities as well as enabled trading of complements and competition between complementors. Overall, the markets around platforms perform one or more of the following activities – information exchange, matching, trading, and competition. When the market around the platform encompasses most of these activities, then it follows that the platform sponsor has retained few activities to be performed internally and therefore has a narrow scope. We coded each campaign for the activities encompassed within the markets around the platform. The presence of activity was coded as 1 or 0 otherwise. We then calculated the platform sponsor scope as the ratio of the sum of the activities performed by the platform to the maximum score of 4.

Complement Decision Rights: The decision rights of the complements can remain with the complementors, within a subgroup or community, or with the platform sponsors. We coded the ecosystems using a four-value fuzzy set of *platform sponsors' decision rights on complements.*

Platform Sponsor Orchestration: We coded campaigns for the type of orchestration depending on whether the mechanisms were implemented before the complements are made or after the complements are hosted within the ecosystem. The orchestration mechanisms used before the complements are produced include the complement approval process, listing areas requiring complementors' contributions, and release of SDKs for targeted complement areas. In contrast, orchestration mechanisms used after the complements are hosted in the ecosystem include the selective promotion of complements and targeted incentives to complementors (Kretschmer et al., 2020; Rietveld et al., 2019). We coded the presence of each type of orchestration mechanism as 1 and absence as 0. We then computed the average orchestration scores across both types.

Analytical procedure

We used the standard fsQCA software 3.0 to perform our analyses. The analysis was performed on the sample of platform ecosystems at the incipient stage (N=40), and then repeated for the same platform ecosystems at the mature stage (N=40). As a first step, we sought to identify any necessary conditions, which are the causal conditions that must be present for an outcome to occur. We conducted a necessity analyses of all conditions and their negation using the recommended benchmark of 0.9 for consistency scores (Greckhamer et al., 2018; Ragin, 2009). We did not find any necessary conditions from our dataset.

Next, we conducted sufficiency analyses using the truth table algorithm, which lists all logically possible combinations of causal conditions and outcomes. Following recommended guidelines for an intermediate-N dataset like ours, we chose a minimum frequency threshold for a configuration's inclusion in causal analyses as 1, which included 80% of our cases (Greckhamer et al., 2013). Finally, we applied a consistency threshold of ≥ 0.75 and a PRI (proportional reduction in inconsistency) of ≥ 0.7. We performed the sufficiency analyses for both the outcome and non-outcome using the same thresholds and cut-offs.

Results

Tables 1.3 and 1.4 depict the fsQCA results for the occurrence of high popularity during incipient and mature stages, respectively. Table 1.5 and 1.6 depict the results for the non-occurrence of the outcome during incipient and mature stages, respectively. In each configuration, the full circles indicate the presence of a factor or condition, and the crossed-out circles indicate the absence of the factor. Further, the larger circles indicate core conditions that occur in both the parsimonious and intermediate solutions and thus indicate a strong causal relationship. The smaller circles indicate peripheral conditions that occur only in intermediate solutions and thus indicate weak causal relationships (Fiss, 2011). Our results show that the overall solution consistency is 0.75 (coverage of 0.58) for the high popularity configurations in the incipient stage and 0.75 (coverage of 0.46) for high popularity configurations in the mature stage, both exceeding the recommended threshold. The fsQCA results indicate distinct configurations (solutions 1a through 4b and solutions 5a through 8b) of the different elements of platform sponsor scope and ecosystem structure (Table 1.3 and 3.4). Using the underlying case data for each of the configurations, we find that the cases map onto the different ecosystem types. Thus, we have labeled the configurations corresponding to the ecosystem types. Below we elaborate the configurations for each type of ecosystem in the incipient and mature stages.

Configurations in the Incipient Stage

Solutions 1a through 5 (Table 1.3) depict the configurations for high popularity in the incipient stage. We found two configurations (solution 1a and 1b) for complementary innovation ecosystems. From solution 1a (Table 1.3), we find that platform sponsors exerted decision rights over the complements, retained a broad scope of activities to perform internally and exercised high access control. The platform interfaces were more closed, the ecosystem imposed non-generic complementarity requirements from the complementors and had fewer categories of complements. Overall, the configuration in solution 1a depicts a broad scope of the platform sponsor and a restricted ecosystem structure with controlled access, interfaces, and few categories. The complementary innovation ecosystems with this configuration (e.g., Apple iOS and Emarsys data management ecosystems) were successful in the incipient stage with a restricted approach to scope and ecosystem structure as the platform sponsors created most of the value and the complementors were heavily dependent on the platform infrastructure.

Solution 2 depicts configurations for open-source ecosystems where we found that the platform sponsors retained a narrow scope of activities to perform internally but exerted decision rights over complements and retained a broad scope of orchestration. The platform sponsors also exercised high control within the ecosystem and imposed non-generic complementarity requirements. However, the interfaces were kept open, and the ecosystem exhibited more complement categories. The configuration in solution 2 depicts a narrower scope of the platform sponsor and a less restricted ecosystem structure compared to those in solution 1a discussed above. Similar to the ecosystems in solution 1b, the open-source ecosystems (e.g., image editing software platforms like GIMP and password managers like Bitwarden) leveraged complementors' contribution through less restrictive ecosystem structure. However, the higher levels of access control in these types of ecosystems ensured that the contributions of complementors lead to the development of a coherent product as well as helped maintain the integrity of the ecosystem.

Table 1. 3: Configurations of Ecosystems with High Popularity - Incipient Stage

	Solution					
	Complementary Innovation Ecosystems		Open Source Ecosystems	Marketplace ecosystems		Information ecosystems
	1a	1b	2	3a	3b	4
Platform Structure						
High access control	•	⊗	•	●	●	⨂
High interface openness	⨂	●	●	●		⊗
Generic complementarity	⊗	⊗	⊗	●	●	•
High complement variety	⨂	●	●		●	⨂
Platform sponsor scope						
Narrow scope of activities	⨂	•	•	•	•	•
Complement decision rights	•	⊗	•	⨂	⨂	⊗
Broad scope of orchestration		•	•	•	•	●
Consistency	0.75	0.92	0.80	1.00	0.83	0.75
Raw Coverage	0.23	0.17	0.14	0.22	0.26	0.15
Unique Coverage	0.13	0.06	0.03	0.02	0.10	0.04
Overall Solution Consistency		**0.75**				
Overall Solution Coverage		**0.58**				

Note: Full circles indicate the presence of a condition. Crossed-out circles indicate the absence of a condition.
Large cirlces indicate core conditions and small cirlces indicate peripheral conditions.

Solutions 3a and 3b (Table 1.3) depict the configurations for high popularity in marketplace ecosystems. Across both the configurations, the elements of scope exhibit the same configuration. The platform sponsors retain a narrow scope of activities to perform internally and exert no decision rights on the complements but retain a broad scope of orchestration. This choice of scope elements may be attributed to the fact that the platform sponsors play a minimal role in enabling matching, interactions, and transactions over the platform. However, the platform sponsor retains a broad scope of orchestration which implies that they choose to not only orchestrate how value is created before the complements are hosted in the ecosystem but also to affect competition among complementors. Such a scope choice allows the platform sponsor to match actors on the platform in a way that benefits itself.

Table 1. 4: Configurations of Ecosystems with High Popularity - Mature Stage

	Solution					
	Complementary Innovation Ecosystems		Open Source Ecosystems	Marketplace ecosystems		Information ecosystems
	5a	5b	6	7a	7b	8
Platform Structure						
High access control	●	⊗	⨂	●	⬤	⊗
High interface openness	⊗	⊗	⬤	⬤	⊗	⊗
Generic complementarity	⊗	⊗	⨂	⬤	⬤	●
High complement variety		⊗	●	●	⨂	⊗
Platform sponsor scope						
Narrow scope of activities	⨂		●	●	●	●
Complement decision rights	●	●	⊗	⊗	⊗	⊗
Broad scope of orchestration	●	●	●	●	●	⨂
Consistency	0.92	0.83	0.86	1.00	0.79	0.76
Raw Coverage	0.2	0.18	0.15	0.16	0.16	0.18
Unique Coverage	0.01	0.03	0.05	0.06	0.01	0.03
Overall Solution Consistency		**0.75**				
Overall Solution Coverage		**0.46**				

Note: Full circles indicate the presence of a condition. Crossed-out circles indicate the absence of a condition. Large cirlces indicate core conditions and small cirlces indicate peripheral conditions.

From solution 3a (Table 1.3), we find that platform sponsors exercise a high level of access control but foster open interfaces and generic complementarity. The high level of access control helps the platform sponsor maintain the quality and integrity of the platform, especially in the context of a narrow scope of activities. However, the complement category was not of significance in this configuration. The marketplace ecosystems with this configuration (e.g., Coursera and edX) were popular with a moderately restrictive ecosystem structure and a narrower scope as they focused on maintaining the quality of the ecosystem.

From solution 3b (Table 1.3), we find that the platform sponsors exercise a high level of access control and ecosystems exhibit generic complementarity and more complement categories. However, interface openness is not of significance in this configuration. The marketplace ecosystems with this configuration (e.g., Kickstarter and Ulule) were popular with a moderately restrictive ecosystem structure as they leveraged more complement categories to overcome the downsides of enhanced access control and not having open interfaces. This counterintuitive configuration in solution 3b may be explained by the presence of generic complementarity as a core condition which implies that the complementors make only fungible investments in these ecosystems. Such an investment fosters multihoming on different ecosystems (Cennamo et al., 2018) and attracts more participation from complementors.

From solution 4, we find that in the information ecosystems with high popularity, the platform sponsor retains a narrow scope of activities to perform internally, does not exert decision rights over the complements and retains a broad scope of orchestration. The broad scope of orchestration helps the platform sponsor enable matching in a way that benefits itself. The platform sponsor does not exercise a lot of control within the ecosystem but maintains closed interfaces and thereby fewer complement categories. The ecosystem also requires generic complementarity. In a nutshell, the configuration in solution 4 depicts a narrow platform sponsor scope and a least restrictive ecosystem structure. The information ecosystems with this configuration (e.g., Facebook and Tumblr) were successful as they leveraged the complementors' contributions that were facilitated by a less restrictive ecosystem structure and also attracted more complementors with their generic complementarity requirements.

Configurations in the Mature Stage

Solutions 5a through 8 (Table 1.4) depict the configurations for high popularity in the mature stage. Solutions 5a and 5b (Table 1.4) depict the configurations for complementary innovation ecosystems. From solution 5a (Table 1.4), we find that the platform sponsor exerted decision rights over the complements, held a broad scope of activities to perform internally as well as a broad scope of orchestration. In the mature stages, the ecosystem has attained a significant size and hosts several complementors. The element of broad scope of orchestration is important to ensure value creation is coherent and benefits the platform sponsor. The platform sponsors exercise high control, keep the interfaces more closed, and impose non-generic complementarity requirements. However, the restriction of complement category is not of concern here. The configuration in solution 5a depicts complementary innovation ecosystems (e.g., Apple iOS) with a broad platform sponsor scope and a restricted ecosystem structure.

From solution 5b (Table 1.4), we find that the platform sponsors exerted decision rights over the complements as well as retained a broad scope of orchestration regardless of the scope of activities to perform internally. In the mature stage, such a scope choice helps maintain the quality of the ecosystem and coherence in value co-creation. The platform sponsors imposed non-generic complementary requirements and did not exercise high control. However, ecosystems exhibited closed interfaces and few complement categories. Overall, the configuration in solution 5b depicts, on one hand, a narrower platform sponsor scope (compared to the one in solution 5a) as the scope of activities are not of significance and, on the other hand, a less restricted ecosystem structure. The complementary innovation ecosystems with this configuration (e.g., Google Android) succeeded by not only leveraging the ecosystem growth from the incipient stage but also maintaining ecosystem quality through restrictive ecosystem structure and broad platform sponsor scope in the mature stage.

From solution 6 (Table 1.4), we find that the platform sponsors in open-source ecosystems retain a narrow scope of activities to perform internally, a broad scope of orchestration but do not exert decision rights on the complements. The platform sponsor does not exercise high levels of control in the ecosystem. The ecosystem exhibits open interfaces, non-generic complementarity requirements, and more complement categories. The configuration in solution 6 depicts a narrower platform sponsor scope and a less restricted ecosystem structure than the one in solution 5b discussed above. The open-source ecosystems with this configuration (e.g., image editing software GIMP) leveraged complementors' contribution through a less restrictive ecosystem structure whilst orchestrating value creation for their own benefit.

Solutions 7a and 7b (Table 1.4) correspond to the marketplace ecosystem in mature stages. From solution 7a (Table 1.4), we find that the ecosystem structure remains the same as in the incipient stage (solution 3a in Table 1.3) with the exception that complement category now becomes significant. This may be attributed to the presence of generic complementarity and open interfaces that attract more participation of complementors. The marketplace ecosystems with this configuration (e.g., Coursera and edX) leveraged complementors' contributions extensively through less restrictive ecosystem structure but orchestrated the value co-creation efforts for coherence in value proposition and their own benefit.

From solution 7b (Table 1.4), we find that the configuration of platform sponsor scope is similar to the one in the incipient stage (solution 3b in Table 1.3). The ecosystem structure depicts high levels of access control and generic complementarity as core conditions. The platform interfaces are more closed, and consequently, the ecosystem exhibits few complement categories. In the mature stages, such a choice of a restrictive ecosystem structure may be explained by the platform sponsor's goal to maintain the quality of the ecosystem through access control and closed interfaces. Moreover, the platform sponsors seek to leverage the growth from the incipient stage when the ecosystem structure was less restrictive. The marketplace ecosystems with this configuration (e.g., Facebook and Tumblr) have leveraged the ecosystem growth from the earlier stages and focused on quality of the ecosystem in the mature stage.

Solution 8 (Table 1.4) depict the configurations for information ecosystems. We find that the configuration of platform sponsor scope and ecosystem structure remains the same as in incipient stage (solution 4 in Table 1.4) except for the choice of a narrow scope of orchestration. In the mature stage, as the platform grows, the sponsor is required to assume a more neutral role in order to signal fairness in matching and transactions. In other words, the ecosystem tends closer to an ideal market, diminishing the centrality of the platform sponsor. However, this is not to imply that the platform sponsor ceases to capture the value and rather the use of market forces to accomplish the same goals.

Finally, we conducted the negation of outcome and a number of sensitivity analyses to examine the robustness of our findings. The negation analysis examines the configurations for non-occurrence of the outcome to rule out any overlap with the configurations for occurrence of the outcome. We considered alternative crossover points by varying the crossover points for all measures by +/- 25 percent. Although minor changes appear in the solution in the form of the number of solutions and sub-solutions, the interpretation of the results remains unchanged, indicating the robustness of the findings.

Interpretation of Results

The fsQCA results described above across the incipient and mature stages highlight three broad insights that capture the importance of (i) ecosystem heterogeneity, (ii) alignment between scope and ecosystem structure, and (iii) ecosystem lifecycle stages.

Ecosystem Continuum: An Organizing Framework for Ecosystem Heterogeneity

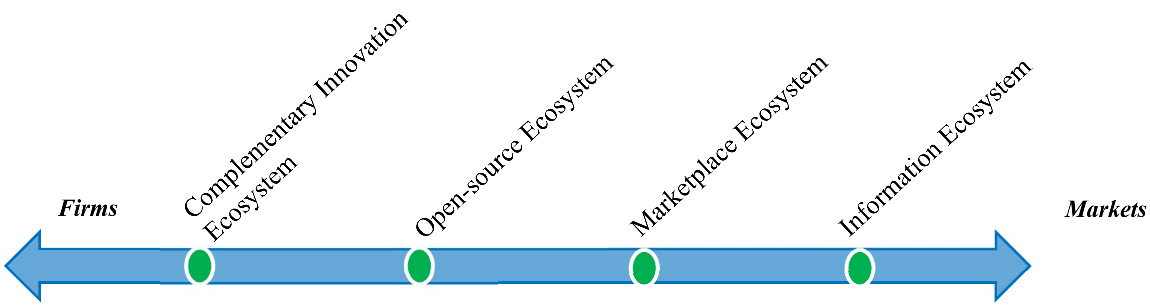
The fsQCA results depict distinct configurations of platform sponsor scope and ecosystem structure that map onto the different types of ecosystems. This finding supports our fundamental argument that ecosystems are heterogeneous in terms of their platform sponsor scope and ecosystem structure. Such heterogeneity is seen in both the incipient and mature stages, indicating that the differences endure the lifecycle stages.

In comparing the configurations across the different ecosystem types (solutions 1a through 4 for incipient stage and solutions 5a through 8 for mature stage), we find that there exists a pattern in the configuration of platform sponsor scope elements. The complementary innovation ecosystems (solution 1a, 1b, 5a and 5b) depict a broad platform sponsor scope owing to choices such as a broad scope of activities to perform internally, hold complement decision rights, and a broad scope of orchestration within the ecosystem. In contrast, the information ecosystems (solution 4 and 8) depict a narrow platform sponsor scope due to choices such as a narrow scope of activities to perform internally, no decision rights over the complements and minimal orchestration within the ecosystem. Furthermore, the configurations of the open-source ecosystems depict a narrower platform sponsor scope compared to complementary innovation ecosystems. The configurations of the marketplace ecosystems depict a broader platform sponsor scope compared to the information ecosystem.

We build on the above findings and extant literature to propose an organizing framework in the form of an *ecosystem continuum* to understand ecosystem heterogeneity. Ecosystems are argued to be distinct from hierarchies and markets because of the presence of modularity that allows distinct structural configuration as well as coordination mechanisms (Jacobides et al., 2018). On the one hand, modularity allows the platform provider to set overarching architectural parameters and forego some degree of coordination among value cocreators; on the other hand, it leads to the emergence of markets (Baldwin & Clark, 2006). Thus, the value creation systems comprise elements of both hierarchies and markets yet remain distinct from both. Jacobides et al. (2018) place ecosystems in between the hierarchy-based and market-based value systems.

We propose that the differences among ecosystems can be explained by the degree of market attributes employed in an ecosystem, which itself is a result of the choice of platform sponsor scope. The differences in platform sponsor scope manifest as different types of ecosystems that can be placed on a continuum between *firm*s on one end and *the market* on the other end (Figure 1.2). The position of an ecosystem on the continuum is defined by the platform sponsor scope such that a broad platform sponsor scope places the ecosystem closer to the firm end and a narrow scope moves it closer to the market end. In Figure 1.2, we have placed the complementary innovation ecosystem closer to the firm end as the configurations depict a broad scope of the sponsor. In contrast, we have placed the information ecosystem with a narrow sponsor scope closer to the market end of the continuum. This argument is consistent with the placement of ecosystems in between hierarchical and market-based value systems but brings more granularity by differentiating the different ecosystems based on platform sponsor scope.

Figure 1. 2: Ecosystem Continuum - Platform Sponsor Scope-based Organizing Framework



Platform Sponsor Scope and Ecosystem Structure Alignment

As stated earlier, one of the key advantages of a configurational approach is its ability to conduct a holistic and systemic analysis (Meyer et al., 1993). As a consequence of using such an approach, we find that there exist multiple pathways for ecosystems to attain high popularity in the form of distinct configurations of platform sponsor scope and ecosystem structure. The results depict a configurational alignment between scope and ecosystem structure. As the platform sponsor scope narrows, corresponding changes are found in the ecosystem structure to balance the change in value co-creation processes such that the ecosystem structure supports the complementors to create most of the value. When the sponsor scope is broad, the ecosystem structure supports the sponsor to create most of the value even as it attracts complementors.

The first set of configurations for the complementary innovation ecosystems (solution 1a and 5a) show that a broad platform sponsor scope is aligned with a restricted ecosystem structure. However, in the second set of configurations for these ecosystems (solution1b and 5b), we find that a less restrictive ecosystem structure is aligned with a narrower platform sponsor scope. The configurations for open-source ecosystems (solution 2 and 6) show that whereas a broader scope is aligned with a more restrictive ecosystem structure in the incipient stage, a narrower scope is aligned with a less restrictive ecosystem structure in the mature stage. In the marketplace and information ecosystems, a narrow scope is aligned with a moderate to less restrictive ecosystem structure. These findings show that high popularity ecosystems preserve the alignment between scope and ecosystem structure across the incipient and mature stages.

The alignment between the platform sponsor scope and ecosystem structure attracts participation on all sides of the platform as it helps the complementing actors and users perceive fair and beneficial outcomes from participation. More broadly, our basic thesis is that there is no one dominant path for superior performance but rather the alignment between the type of ecosystem and configurational characteristics in terms of scope and ecosystem structure as defined by the platform sponsors. The configurational alignment manifests as tradeoffs between the different elements of scope and ecosystem structure as discussed in the results section.

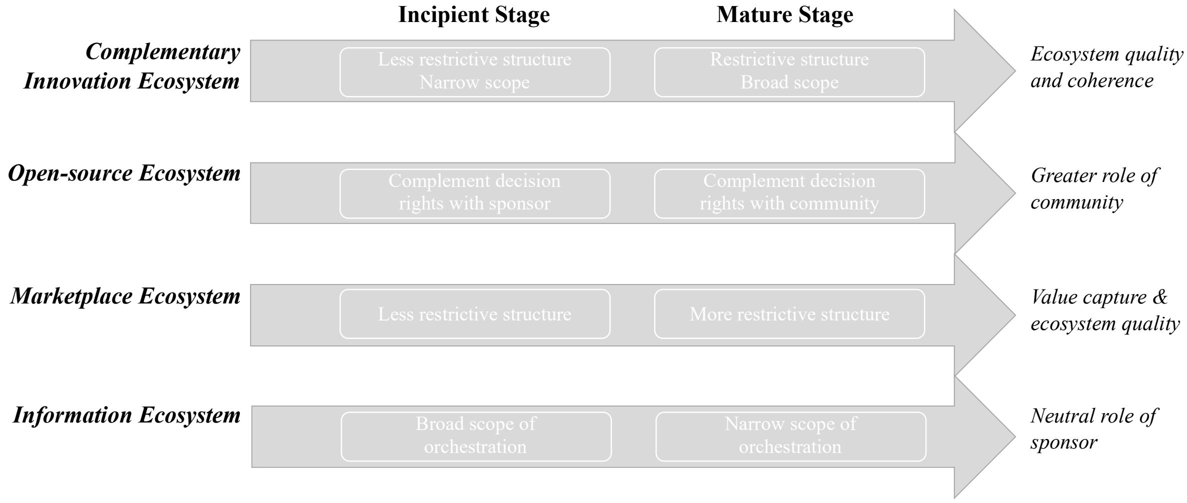
Ecosystem Lifecycle Stages

The network effects dynamics fuel the growth of platform ecosystems (Katz & Shapiro, 1994; Rochet & Tirole, 2006) and are argued to result in winner-take-all dynamics (Arthur, 1989) once the market tips in favor of the ecosystem with the strongest network effects (Gawer, 2020; McIntyre & Srinivasan, 2017). In the incipient stage, i.e., before the market tips, the platform sponsor is focused on attracting participation and thereby leveraging network effects. In the mature stages, i.e., after the market tips, the platform sponsor is focused on capturing the value created. Our results show how the ecosystem structure and platform sponsor scope span out in response to the above goals of the platform sponsor. For each type of ecosystem, the configurations depict a change in one or more elements of platform sponsor scope and ecosystem structure across the incipient and mature stages. This finding demonstrates that the lifecycle stage is a key factor to be considered in studying ecosystems. We now delve deeper into the change in configurations across the incipient and mature stages for each type of ecosystem (summarized in Figure 1.3).

From the configurations for complementary innovation ecosystems (solution 1b and 5b in the incipient and mature stages respectively), we find that the elements of both ecosystem structure and platform sponsor scope change from the incipient to mature stages (see Figure 1.3). Whereas the ecosystem structure changes from being less restrictive in the incipient stage to more restrictive in the mature stage, the platform sponsor scope changes from a narrower scope in the incipient stage to a broader scope in the mature stage. The less restrictive ecosystem structure coupled with a narrower scope attracts complementors with attractive opportunities to create and capture value in the incipient stages. The shift in the mature stage may be attributed to the need to manage the ecosystem quality, enable coherence in value co-creation in the mature stage and counter the effects of open interfaces and complement variety in the initial stages. Such an approach was seen in Google's Android ecosystem, where Google increasingly made its app review procedures more stringent in an effort to maintain the quality and integrity of the ecosystem during the mature stage. In terms of ecosystem structure, the sponsors continued to impose non-generic complementary requirements and not exercise high control. However, they pivoted to a more closed interface and restricted variety configuration in the mature stage.

In the open-source ecosystems, the platform sponsor’s hold decision rights over complements in the incipient stage but no longer exert such decision rights in the mature stages. This shift may be explained by the emergence of a strong community that substitutes for the platform sponsor in maintaining the quality and integrity of the ecosystem. For the same reason, the platform sponsor no longer exercises high levels of control in the ecosystem. This change in configuration from the incipient stage to the mature stage depicts the important role the community plays in facilitating value co-creation in open-source ecosystems.

Figure 1. 3: Ecosystem Lifecycle Stages



From the configurations for marketplace ecosystems (solution 3b and 7b in the incipient and mature stages respectively), we find that whereas the platform sponsor scope remains similar across the lifecycle stages, the ecosystem structure changes from being less restrictive in the incipient stage to being more restrictive in the mature stage. Specifically, in the mature stage the interface becomes more closed, and the complement categories reduce compared to the incipient stage. The less restrictive ecosystem structure in the incipient stage attracts complementors' participation. With a high popularity in the mature stage, the platform sponsor may adopt the above changes to capture value as well as maintain ecosystem quality.

Finally, in the information ecosystems (solution 4 and 8 in the incipient and mature stages respectively), we find that although the ecosystem structure remains similar across the stages, the platform sponsor moves from having a broad scope of orchestration to a narrow scope of orchestration. There are two plausible explanations to this change. First, the shift to a narrow scope of orchestration in the mature stage may be attributed to the need for the platform sponsor to assume a neutral role of market facilitator. Second, it is plausible that in the incipient stages, the platform sponsor faced with uncertainty had to maneuver value creation in response to evolving value propositions (Dattée et al., 2018) but in the mature stages with reduced uncertainty such orchestration was unnecessary.

Overall, the above configurations depict that for each type of ecosystem, the configuration of ecosystem structure and platform sponsor scope changes from the incipient stage to mature stages in response to both the platform sponsor's goals before and after market tipping point as well as the emerging dynamics and value propositions of the ecosystem.

Concluding Remarks

To recapitulate, in this paper, we developed a typology of platform ecosystems and a configurational model of ecosystem structure and platform sponsor scope. We inductively identified configurations of ecosystem structure and scope across four different types of ecosystems and found that an alignment between ecosystem structure and scope exist in high-performing ecosystems. We explicated how the configurations change temporally between the incipient and mature stages. We also developed an organizing framework in the form of ecosystem continuum with traditional firms and markets as its endpoints. This framework serves to better understand ecosystem heterogeneity.

Our paper makes several related contributions to the literature. First, we provide an empirically validated typology and bring more granularity to the distinction between innovation and transaction ecosystem and identify four types of ecosystems. In doing so, we demonstrate that ecosystems may differ despite having similar functionality (innovation or transaction), and thus an organizing framework in the form of an ecosystem continuum based on platform sponsor scope provides a better way to consider ecosystem heterogeneity. The platform sponsor scope-based organizing framework that we provide enables us to understand in a fresh and novel manner the differences across distinct ecosystems in the co-creation of value by the participants. By focusing on ecosystem heterogeneity, our study responds to calls to diversify the empirical context of platform research (McIntyre et al., 2020).

Second, using a configurational approach, we show the importance of alignment between the platform sponsor scope and ecosystem structure for superior performance. In doing so, we respond to calls to consider a comprehensive approach to studying platform ecosystems (McIntyre & Srinivasan, 2017). We demonstrate that high popularity ecosystems depict an alignment of narrow scope with less restrictive ecosystem structure and broad scope with more restrictive ecosystem structure regardless of the presence or absence of individual attributes in a configuration. These findings underscore the importance and benefits of using a configurational approach that highlights the combined effect of the attributes. Furthermore, the configurations show that the alignment is achieved when tradeoffs between individual attributes are managed appropriately. For instance, ecosystems with more complement categories also exhibit open interfaces whereas those with few complement categories exhibit closed interfaces.

Finally, we explicate how the alignment and the configuration of the ecosystem structure and scope span out before and after the market tipping point. This study brings fresh insights into the temporal aspect of ecosystems by demonstrating that ecosystem structure and platform sponsor scope are not static decisions made at the outset rather are choices made in consideration of the market tipping point. Except for a few studies (Cennamo, 2018; Kretschmer & Claussen, 2016; Tiwana, 2015), the temporal aspect, especially in relation to ecosystem structure, has not received enough attention in the literature. Our study fills this gap in the literature. Furthermore, we highlight how the platform sponsor's goals before and after the market tips takes shape through the choices in scope and ecosystem structure.

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