Distinguishing between Platforms and Ecosystems: Complementarities, Value Creation, and Coordination Mechanisms

Michael G. Jacobides (London Business School)[1]
Carmelo Cennamo (Copenhagen Business School)
Annabelle Gawer (University of Surrey)

October 14, 2020

Under Review

Abstract

Platforms and ecosystems have emerged as new constructs that describe how economic actors engage and aggregate as they seek to create and capture value. We argue that while ecosystems often tend to be based on platforms, the two are distinct concepts, operating at different levels, with distinct value-creation and -coordination mechanisms. We elucidate and elaborate on these differences. We draw the boundaries between platforms and ecosystems, and identify the sources of value in each, distinguishing between value exchange in transactions and value creation in production. We argue that platforms rely on supermodular complementarities in either consumption or production, but do not necessarily require those complementarities to be non-generic. Ecosystems, in contrast, do rely on non-generic complementarities, be they unique or supermodular. We elucidate the mechanisms each form uses for value creation (how value is created in the first place) and coordination (how "alignment" among platforms' and ecosystems' members is achieved). We also introduce the distinction between multi-actor and multi-product ecosystems, and consider the way different sorts of platforms and ecosystems interact. We conclude with implications for theory and practice.

Keywords: Platforms, ecosystems, unique / supermodular complementarities, value co-creation, inter-firm coordination

[1] Corresponding author. Please email mjacobides@london.edu London Business School, Sussex Place, Regents Park, London NW1 4SA, UK

1 INTRODUCTION

Platforms and ecosystems have emerged as new constructs that describe how economic actors engage and aggregate as they seek to create and capture value. Motivated by the staggering growth of Big Tech, and the profound impact of firms such as Google, Apple, Microsoft, Amazon, Tencent, and Alibaba in the competitive environment (see Crémer et al., 2019; Furman et al., 2019; Stigler, 2019), a great deal of attention has been focused on both platforms (Cusumano et al., 2019) and ecosystems (Jacobides, 2019b). Yet, where does one construct end and the other begin? The two are sometimes considered interchangeably—or, more often, jointly—in the literature. So while each draws on distinct literatures, the question arises: Are they just different words for the same thing? Are the distinctions between them rooted only in intellectual history and canonical citations, or do they reflect a phenomenological differentiation, which is also analytically useful? And, even if we *can* establish conceptual differences, do we really need two closely related constructs—or should we drop one to keep things simple?

These questions are, we believe, both profound and unresolved, and our paper attempts to address them. We offer positive views on the different structural features of platforms and ecosystems, and provide a pragmatic, phenomenological distinction between the key types of each, drawing on real-world examples. This clarification leads us to emphasize a hitherto neglected distinction between *multi-actor* and *multi-product* ecosystems, and consider the empirical nature of platforms and ecosystems. Finally, we consider the implications of our analysis for theoretical and empirical research, in the hope that this will further the debate and help clarify this intensely researched topic (see Shipilov & Gawer, 2020; Thomas & Autio, 2020; Kapoor, 2018).

2 UNDERSTANDING AND BRIDGING TRADITIONS

2.1 Platforms: From engineering and economics to strategy

The first use of the concept of *platform* in the management literature was that of the "product platform," which came from engineering design (Jiao et al., 2007; Krishnan & Gupta, 2001; Meyer

& Lehnerd, 1997). In that perspective, platforms were defined as specific modular product architectures[2] (Ulrich, 1995) that help firms develop product families (Sanderson & Uzumeri, 1995), thus enabling the systematic re-use of common assets or activities (Krishnan & Gupta, 2001). Firms using platforms could then benefit from the recombination options afforded by modular designs[3] (Baldwin & Clark, 2000; Schilling, 2000; Garud & Kumaraswamy, 1995) and innovate more quickly and cheaply. The benefits of platforms (like the "chassis platform" that an automotive manufacturer could use across multiple models) related to the economies of re-use and scope, facilitating interdependent innovation—like that enabled by the modular architecture of products, such as IBM's System/360. Studies developed the construct by exploring the innovation implications of the concept of "design hierarchy" (Clark, 1985) on methods of product development and production.[4]

In parallel, another distinct understanding developed in the economics literature. In this view, platforms facilitate exchange, allowing direct transactions between different types of consumers (members of the so-called platform "sides") who could not otherwise transact. Such platforms have been variously referred to as "two-sided markets," "multi-sided markets," or "multi-sided platforms" (MSPs) (Armstrong, 2006; Evans et al., 2008; Evans, 2003; Rochet & Tirole, 2003, 2006; Rysman, 2009), subject to network effects, as exemplified by digital marketplaces such as

[2] Ulrich (1995) defines *product architecture* as "the scheme by which the function of a product is allocated to physical components" (Ulrich, 1995: 419), and more precisely as: (1) the arrangement of functional elements; (2) the mapping from functional elements to physical components; and (3) the specification of the interfaces among interacting physical components (Ulrich, 1995: 422).

[3] Gawer & Cusumano (2002) developed the concept of *platform leadership*, with platform owners exerting influence over external innovators, stimulating the development of complementary products alongside innovation trajectories that would be beneficial to the platform. They called these types of platforms "industry platforms" to contrast them with product platforms developed entirely in-house. These industry platforms were principally designed to stimulate external innovation.

[4] For Wheelwright & Clark (1992, p.73), the earliest management scholars to refer explicitly to platforms, platforms are products that meet the needs of a core group of customers, but can be modified through the addition, substitution, or removal of features. For McGrath (1995), Meyer & Lehnerd (1997), and Krishnan & Gupta (2001), platforms are collections of common elements, defined as sets of subsystems and interfaces, forming a common structure from which a stream of products can be developed. This literature is heavily inspired by the modularity literature (Baldwin & Clark, 2000; and Robertson & Langlois, 1995, Huang *et al.*, 2005; Jiao *et al.*, 2007), but with a twist: a platform is a particularly important and central module (Baldwin & Woodard, 2009).

eBay, which matches buyers and sellers; Tinder, which matches daters; and Uber, which matches drivers and passengers.

Economics, with its focus on network effects, sees the multi-sided structure of a market as largely exogenous and fixed. In other words, network consumption externalities between the sides of the platform simply "exist"; subsequently, the platform offers a way to internalize them and thus facilitate exchange. Accordingly, research documents the self-reinforcing feedback loop that magnifies incumbents' early advantages. Strong network effects can, under certain conditions, drive competition between platforms to a "winner takes all" outcome (Eisenmann et al., 2006; Lee et al., 2006).

Some initial strategy papers have advocated a "unified view" of the economics and engineering-design perspectives (Baldwin & Woodard, 2009). Gawer (2014) made a first-a systematic attempt to do so by indicating that all platforms create value through economies of scope, whether in production, consumption, or innovation. She suggests that platforms are organizations or meta-organizations that exist along a continuum, and distinguishes between *internal platforms*, *supply-chain platforms*, and *industry platforms*. The main difference between these lies in the location of developers of complementary innovation: within the firm, across a supply chain, or within an ecosystem (Gawer, 2014). Recent work (Anderson et al., 2014; Boudreau, 2010, 2012; Ceccagnoli et al., 2012; Eisenmann et al., 2011; McIntyre et al., 2020; Parker et al., 2017) uses operationalizations of platforms that are consistent with both the economics and the engineering-design view.

More recently, Cusumano, Gawer and Yoffie (2019) clarify the distinction between *innovation platforms*—those that facilitate innovation on a foundation offered by a central actor—and *transaction platforms*—those that link buyers and sellers. Both types of platforms are subject to network externalities. For innovation platforms, one side always consists of developers of complementary products or services. The authors also suggest that today's most successful platform

firms operate *hybrid platforms*, encompassing both the innovation and transaction aspects. These include companies such as Apple, Google, and Facebook, with their interconnected sets of technologies and services. Consider how Apple iOS (an innovation platform) is necessary for the App Store (a transaction platform) to operate.

2.2 Ecosystems: From metaphor to concept

In parallel, the concept of *ecosystem* has developed separately in the management literature, where scholars have focused on communities or aggregations of economic actors whose activities need to be coordinated to achieve a collective outcome that creates value for the final consumer. Hence, the image of an ecosystem, where actors depend on each other to succeed, is sometimes used more for metaphorical color than for analytical rigor (e.g., Iansiti & Levien, 2004; Moore, 1993; Teece, 2007). Depending on the analytical angle, the ecosystem has been conceived in one of three ways. First, it can be a *business ecosystem*—that is, a community affecting a firm's ability to adapt to its environment (e.g., Moore, 1993; Pierce, 2009; Williamson & DeMeyer, 2012; Teece, 2007; Zahra & Nambisan, 2012). Second, it can be an *innovation ecosystem*, aggregating all actors who make contributions that are essential to delivering a valuable innovation to the final customer (Adner & Kapoor, 2010, 2015; Alexy et al., 2013; Frankort, 2013; Iyer et al., 2006; Kapoor & Lee, 2013; Leten et al., 2013; West & Wood 2013). Third and finally, it can be a *platform ecosystem*, aggregating developers of complementary products required to extend the value of a core platform technology (Ceccagnoli et al., 2012; Cennamo & Santaló, 2013, 2019; Gawer & Cusumano 2002; 2008; Parker et al., 2017; Wareham et al., 2014; Jacobides et al., 2019).[5]

[5] Another literature looks at *regional ecosystems*, where the term "ecosystem" is conceptually close to the "clusters" of yesteryear (see Porter, 1990; Saxenian, 1996), and where the term often used is *entrepreneurial ecosystems*, meaning the loosely related firms that all participate in entrepreneurial activities in one place, and as such complement each other *latu sensu.* This "looser" use of the term has led us to exclude regional ecosystems from our own analysis in related previous research. However, as recent papers suggest, there is a kinship in terms of the structures that operate in such entrepreneurial ecosystems and those in other varieties. See Thomas and Autio (2020) for a discussion.

More recently, a unifying and more discriminating structural view of ecosystems has been put forward (Adner, 2017; Jacobides et al., 2018). This aimed to bring some order and analytical clarity to a literature that was quickly becoming rich in claims and metaphors, but weaker in its analytical foundations and its links to related literatures. Additional reviews of the concept have been offered by Kapoor (2018), Bogers, Sims, and West (2019), and Baldwin (2020), discussing how ecosystem research relates to other streams in strategy and innovation. Table 1 below presents a comparative summary of these papers.

The focus in Adner (2017) is on alignment structures—i.e., what allows firms that collaborate in ecosystems, often to build a joint value proposition, to be aligned (Adner, 2017). The focus in Jacobides et al. (2018) is on the reasons why such structures emerge and require alignment, highlighting the role of *modularity* and, perhaps more importantly, the nature and strength of *complementarities* as defining features. For Jacobides et al. (2018: 2264), ecosystems consist of "a set of actors with varying degrees of multi-lateral, non-generic complementarities that are not fully hierarchically controlled." A distinguishing feature of Jacobides et al. (2018) is to clarify that not all complementarities necessarily give rise to ecosystems, and that ecosystems comprise sets of interdependent firms that are not unilaterally hierarchically driven—a view shared by Baldwin (2020).[6] Complementarities can be either generic (like those between kettles and tea bags) or non-generic (between necessarily co-specialized components, such as Nespresso's coffee machines and own-brand capsules, which together define the ecosystem—as in Jacobides (2019b).

Such complementarities can operate either in production (where two components work together to deliver a product or service, like types of silicon wafers and masks in semiconductors—Ganco et al., 2020) or in consumption (where two components work together to benefit the customer, like a

[6] As Baldwin puts it, "For an ecosystem to be sustained, the complementarities among products and/or actions must be strong enough to require coordination but not so strong as to need unified governance" (2020: 7).

wearable fitness tracker and a smartphone). These complementarities can also be unique (A needs B in fixed proportions) or supermodular (A is more valuable when B is present).

The emphasis on such distinguishing features clarifies how ecosystem research relates to existing streams (also, see Adner, 2017; Thomas & Autio, 2020). Shipilov & Gawer (2020) have clarified the relationships between *networks* and ecosystems, highlighting complementarities and cross-sectoral links as distinguishing features. They point to future avenues of research that could leverage "techniques" developed in the field of organizational networks (including DSMs[7]) and ecosystems. All these views agree that complementarities among a multilateral actors' activities and offers for joint value creation are a defining feature of ecosystems. While Adner (2017) and Kapoor (2018) emphasize the focal value proposition as the determinant of the level of complementarities among activities and actors' interdependence, Jacobides et al. (2018) focus on the extent to which complementarities are generic, determining whether actors can repurpose their goods and services in alternative value applications. In this view, the fungibility of members' offerings becomes a key demarcating element of an ecosystem's boundaries. Baldwin's (2020) characterization of ecosystems is close to that of Jacobides et al. (2018), with an emphasis on the role of modularity and technological interfaces ("design rules") for the different parts supplied by independent firms and individuals to arrive at a complete product system offering value to the customer.

Bogers et al. (2019) take a broader view of the concept of ecosystem to integrate different streams of related research (such as open innovation, entrepreneurial and regional ecosystems, or value networks), emphasizing interdependence, network, and self-interested actors as core operational elements. Thus, we see that, despite significant commonalities between researchers, there is still significant variance in ecosystem research, leading some (e.g., Thomas & Autio, 2020) to argue that ecosystems should be considered as a concept, rather than a construct, as it is as of yet not

[7] A Design Structure Matrix (DSM) is a modelling technique to model interdependencies between elements of a system (Eppinger and Browning, 2012).

operationalized enough to allow for robust measurement and testing. Table 1 summarizes these broadly consistent, but distinct, views.

Insert Table 1 here

Most strategy literature implicitly or explicitly considers that ecosystems are often based on platforms, which enable the connections between ecosystem actors and possibly end users.[8] This obvious kinship leaves a number of questions unresolved. Are these concepts merely referring to distinct nested elements operating at different levels within a layered modular structure of economic relationships? Are platforms necessary for ecosystems to operate? And do platforms always entail an ecosystem? What is it that distinguishes them, analytically speaking? What are their defining features, and the coordination mechanisms and value creation mechanisms for each?

2.3 Breaking down the silos

While *platform* differs from *ecosystem*, the two concepts are closely interrelated. Despite that, the two literatures have developed along a number of fairly independent trajectories of knowledge accumulation (Dosi, 1982), each with different origins, journals of reference, and main foci of interest. Both the platform literature and the newer ecosystem literature have not fully converged on construct definitions, and although greater clarity has emerged of late (Gawer, 2014; Thomas & Autio, 2020), relating these two literatures remains challenging. Yet, as ecosystems continue their ascendance in the business world and trigger regulatory activity (Crémer et al., 2019; Furman et al., 2019), we need to transcend these academic silos, since only conceptual precision will allow our discourse to advance. Putting these two concepts to the test, and exploring their connections, will

[8] Thus, as maintained in Kapoor (2018: 8), "Many ecosystems are organized around a central platform-based architecture that serves as a foundation for firms to offer complementary products or services." Adner (2017) is the exception to this rule, as he distinguishes ecosystems and MSPs as distinct phenomena.

sharpen our understanding both of the real world (what does each concept capture?) and theory (what does each concept elucidates, and what mechanisms does it shed light on?).

To do so, we propose a brief discussion of some foundational pieces, in terms of both complementarities (a key definitional aspect of ecosystems, which can be usefully applied to platforms) and network externalities, which have historically been associated with platforms. We also consider the question of *focus* for each concept, and as such, provide a set of distinguishing phenomenological and theoretical characteristics that help us put platforms and ecosystems in context. We then shift to *mechanisms,* looking at how coordination and value creation happens in platforms vs ecosystems, which leads to a proposal on how to unpack these concepts and consider the key issues in practice.

3 BACK TO BASICS: STRUCTURE, COMPLEMENTARITIES, AND NETWORK EXTERNALITIES AS DRIVERS OF PLATFORMS VS ECOSYSTEMS

To define our terms, we must start with *what each concept aims to explain.* Platforms tend to be associated with the "infrastructure" that offers a technological foundation. This basis can be used by many parties, within or between organizations, to connect and either transact (as in a marketplace) or engage and support innovation (as with Tensorflow in AI, which provides a basis for developers). Platform scholars are concerned with the *specific medium offered* that allows participants to engage, whether for production or consumption.[9] Ecosystems, on the other hand, tend to focus on the sets of interorganizational arrangements that allow different organizational participants (and/or individual actors) to collaborate, and jointly produce, or to allow the consumer to jointly consume compatible products or services that have value. Thus, while ecosystems may rest on platforms, they do not require them; conversely, platforms do not necessarily engender ecosystems. Before going into examples, we first address the conceptual differences between the

[9] Companies that have *platform strategies* are those that use platforms to underpin their competitive positioning. More often than not, the focus is on companies that own or sponsor platforms. Yet, the literature also considers the plight of smaller complementors who need to decide either which platform to join, or how to compete within it—even if this is a less prominent theme. See, e.g., Boudreau and Jeppesen, 2015; Cennamo et al., 2018; Rietveld and Eggers, 2018; Tavalaei and Cennamo, 2020.

two, expanding on the distinction introduced by Jacobides et al. (2018: 2266, Figure 2) in terms of complementarities in production and consumption. As exemplified in Figure 1, the key difference rests on the type of complementarities (whether they are supermodular or not) and extent they are generic (or specific).

Insert Figure 1 about here

Figure 1 summarizes our views on how platforms and ecosystems relate, on the basis of the structure of complementarities that characterize multi-actor relationships, whether in production or in consumption, can be either supermodular or non-supermodular. A and B have a *supermodular* complementarity when the value of A increases in the presence of B.[10] Each of these two categories can further entail either generic or non-generic ("specific") complementarities. In a *specific* (i.e. non-generic) complementarity, A requires a specific, non-fungible investment to make it complementary to B. Platforms exhibit supermodularity in either production or consumption.[11]

The upshot of Figure 1 is that *if this supermodularity is generic, then a platform would not be classified as, or lead to, an ecosystem*. Consider, for instance, the role of multi-sided platforms that are marketplaces, where the participants are not co-specialized—they do not need to tailor, redesign, or customize their products to the specificities of the platform architecture in order for their products to offer value to customers. For instance, in dating marketplaces such as Tinder, the value of the match increases in line with the availability of potential matches, which implies

[10] Supermodularities in production imply that, the more items A are produced, the more of B items are produced (or, the higher their value in production); or, the more activities A are conducted, the more productive (i.e., the greater the production benefits from) activities B and C that are performed. Supermodularities in consumption imply that there are increasing returns to joint consumption of complements: the more A is consumed, the more B becomes valuable (in consumption), and the more it gets consumed.

[11] In the case of digital platforms such as social networks, which link advertisers (on one side of the platform) to end users (who generate content, on the other side of the platform), complementarities are not symmetric: while the advertisers find the platform more valuable if there are more users, the converse is not the case (unless users find some benefit in advertising content). Facebook's end users do not find the core experience more valuable if there are more adverts on their feed; however, they might find value in following some of their favourite brands and joining their campaigns to interact with those companies and other followers.

supermodularity (in this case, in consumption). However, the complementarity between the individuals and the platform is generic. While match-seekers will give their personal characteristics in their profile, there is nothing really locking them in, in the sense of having to specifically design or customize to the platform (which is why each individual tends to list on 2.7 dating platforms, on average; see Jacobides, 2020). This, in our view, means that an online matchmaking service neither constitutes an ecosystem, nor engenders one. Inasmuch as supermodularity is generic, there is no need to set up specific inter-organizational arrangements to enable value creation. Thus, platforms do not necessarily entail ecosystems. Furthermore, there could be ecosystems (characterized by non-generic and non-supermodular complementarities) that are not based on platforms, as we shall detail below in the example of the Michelin PAX tyre.

To consider whether and when a platform entails an ecosystem, we have to consider whether it requires non-generic—i.e., non-fungible—investment. To the extent that Facebook enables companies to build applications on top of its platform and target users with marketing campaigns, some non-generic, platform-specific complementarities can be created that will involve complementors tailoring their activities to Facebook's unique dynamics, to some extent. That is, these activities will find limited or no value when ported to a different social network, and this creates the dependencies which, to use our terminology, constitute a true ecosystem.

That said, supermodular complementarities and concomitant network effects do not necessarily imply that the complementarities involved are specific. Consider an app developer who needs to develop for a given platform. Since more end users increase the value of the developer's effort, they benefit from network externalities. Yet, if we wish to consider dependencies—i.e., between the developer and the platform owner—we must also assess how *generic or specific* the complementarity is. If the interface connecting the platform and its complementors is generic—for example, if all platforms have to follow the same open standard—then app developers could leverage all the work they have undertaken and apply it to a different platform at low or no cost

(that is, they could "multihome"). Since their investment is non-platform-specific, they are not beholden to any one platform owner. As such, it is worth understanding, *separately*, the platform dynamics and associated network externalities on one hand, and the structure, dependencies, and relative power within the ecosystem on the other.

3.1 Illustrations distinguishing between platforms and ecosystems

This section details examples of platforms that do not entail ecosystems, and ecosystems that are not based on platforms. It also shows how platforms can sit at the heart of ecosystems.

Platforms without ecosystems

Under our definitions, SIM cards and 4G smartphones are platforms that do not entail ecosystems. Consider a user who has an Apple iPhone and a contract with a network provider. At the end of her contract, she wishes to purchase an Android-compatible phone. She can re-use her SIM card in her new phone, and may also be able to keep her phone number if she changes network provider. 4G technology requires the makers of network equipment, smartphones, and SIMs to make specific investments to create compatible products—but these actors need not coordinate with each other to do so; all they need do is adhere to open 4G standards. As such, 4G is a platform technology, giving rise to many complementary products and services, but it does not engender an ecosystem, as all dependencies are managed through *open standards*. There are no specific complementarities that bind together a particular set of actors, or their shared fortunes. There is a platform, and it has network externalities—but there are few interdependencies that have to be managed. Thus, in a setting such as this, when complementarities across products are codified in free open standards, and/or resources or assets are freely fungible between platforms, we see no "real" ecosystem.

Consider, in contrast, the case of 5G technology. 5G is an innovation platform at the heart of the Internet of Things, expected to connect people, devices, data, applications, transport systems, and cities in smart networked communication environments. Precisely because the standards for 5G are

in the process of being developed, but have not yet been fully standardized, we see multiple 5G ecosystems emerging, each with its coalition of firms who coordinate amongst themselves to provide mutually compatible parts of an overarching system. Other coalitions, meanwhile, offer rival solutions and services. One such example is the OpenRAN coalition, which includes Microsoft, AT&T, Intel, Google, Telefonica, and Samsung. 5G, therefore, is a platform around which multiple, competing ecosystems are emerging.

Platforms without ecosystems can also arise when they involve generic supermodular complementarities on the demand side. Consider, for example, sellers on Amazon Marketplace, hosts on Airbnb, and drivers on Uber, all of whom are "demand-side" in the sense that they adopt or "consume" the platform. For these platform adopters, there is no significant co-specialization involved in delivering the service; the asset being exchanged remains the same. Having signed up to Uber, a driver may affix an Uber sticker to his car, but he does not have to customize his vehicle, or fundamentally change the way he drives, to deliver the Uber service. If, later on, he decides to join Lyft, all he must do is replace the Uber sticker with its Lyft counterpart and comply with the membership and transaction rules of that platform. Of course, there are significant complementarities *across* the sides of the platform. Therefore, we do consider these as platforms, but not as ecosystems. That said, we consider that firms such as Uber aim to transform generic complementarities into specific ones, by providing incentives aimed at locking drivers in, such as health insurance and fuel refill cards. These make the arrangement more akin to a "true" ecosystem and increase their complementors' dependence, be they drivers or customers. Thus, we should rather assess how "ecosystemic" a specific collaborative arrangement is in specific cases, with "ecosystemicity" being a matter of degree, defined by the extent to which investments required to join a group of collaborating firms are fungible.

Ecosystems without platforms

There are also ecosystems that are not based on platforms. Consider the Michelin PAX tire ecosystem described by Adner (2013). In the 1990s, Michelin developed PAX, a revolutionary new tire that could run almost perfectly for 125 miles following a puncture. PAX promised to make customers' lives easier and safer, and generate revenue for Michelin. The company duly built a powerful alliance with Goodyear and signed up major auto brands to install PAX on new cars. Yet Michelin had not considered the entire ecosystem that PAX would rely on, because it had overlooked the service stations that repair punctured tires. They would need to invest in expensive new equipment that they had neither money nor space for, long before it would get heavy use—and they saw no reason to do so. By 2007, the product was such a failure that Michelin had to abandon it. PAX was neither an innovation platform nor a transaction platform; instead, it was a technology that depended on an ecosystem that needed to be managed—which Michelin failed to do (Adner, 2013).

4 FROM MULTI-ACTOR TO MULTI-PRODUCT ECOSYSTEMS

As noted above, in the management literature, the term "ecosystem" has been taken to denote a form of governance of multi-actor relationships, as distinct from traditional multi-actor forms such as supply chains or alliances. Researchers have defined ecosystems as the "alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize" (Adner, 2017); as the "set of actors with varying degrees of multilateral, non-generic complementarities that are not fully hierarchically controlled" (Jacobides et al., 2018); or as "a set of actors that contribute to the focal offer's user value proposition" (Kapoor, 2018). Common to these definitions is the emphasis on ecosystems as a governance mode—that is, as a mode of organizing that is distinct from both full integration and the use of arm's-length contracts.

This stream has helped put ecosystems in theoretical context, and has also drawn on illustrations, often from the realm of technology, to illustrate them. The quintessential example is iOS, where a

focal firm (Apple) engages a number of complementors (app developers) who abide by iOS rules in exchange for the right to sell through this ecosystem.

Yet, if we look at the use of ecosystems in practice, a different notion emerges that responds both to common parlance and to the emerging debate on regulation (esp. Stigler, 2019). Here, "ecosystem" denotes a family of mutually compatible, often mutually enhancing products or services that come together to create an attractive solution; hence, this is a *multi-product ecosystem*. So, one would often refer to "the Google ecosystem" (including Android, Google Search, Google Docs, Google Drive, Gmail, Google Maps, etc.); or "the Apple ecosystem" (iOS, iPhone, iPad, MacBook, Apple TV, etc.). In this view, the term "ecosystem" reflects the way in which *multiple and interconnected services and products are offered to the end user.* The ecosystem owner derives their competitive advantage either from the way the products interact, or from how data is combined, which can allow them to lock in end users. However, we would posit that multi-actor and multi-product ecosystems are not entirely distinct, because the kind of complementarities that emerge between products have their roots in a broader multi-actor ecosystem. In other words, firms exploit multi-product ecosystems by leveraging their existing multi-actor ecosystems.

Insert Figures 2a, 2b, 2c and 2d about here

To showcase the distinctions, consider Figures 2a, b, and c. On one axis, we consider each of the different products, for which a firm may use one or more governance choices—integration, supply chain, or (multi-actor) ecosystems. On the other axis, we consider how all the different verticals combine into a unified bundle. We can thus specify the multi-product ecosystems that are relevant for the customer, but also for strategy, policy, and regulation.

These two types of ecosystem might best be seen as different analytical angles to examine specific sets of interdependencies and linkages. The more a firm wants to cover a broad range of customers

through interconnected products or services, the more likely it will have to go beyond its own internal capabilities, and even its supply chain, and resort to other firms. Looking at multi-product or multi-service ecosystems also helps us understand how firms may use (proprietary) platforms to both link different parts of their overall offering, or interface with various participants.

To illustrate, consider AntFinancial (now AntGroup), which is heading for a $225B IPO, making it the most valuable IPO on record. Its focus, is on multi-product ecosystems, and its strategy, shown in Figure 3, is to create interconnected data flows linking products and services that will mediate the consumer and their needs, customizing offers around the (increasingly broad) set of value propositions. To support its multi-product ecosystem, the firm may use multi-actor ecosystems, which it does by using platforms that are often consistent between certain offerings.

Returning to our earlier analytical distinctions, the multi-product angle could help us focus on the specific and generally supermodular complementarities among a firm's products and services, which make them more distinct than say, bundles of horizontally related products. (For instance, Pepsico offers soft drinks and snacks through its subsidiaries snack.com and pantryhouse.com—but this does not make them ecosystems, as there is no specific complementarity that ties the value of these products to the value of a connected product system.)

In most Big Tech ecosystems, non-generic complementarities are based on some account information, such as a device ID or a login, that serves as a unified source of information that cuts across different product lines. This then allows for greater customization, identification, and product access.[12] For AntFinancial (and its competitor, Chinese insurer PingAn), this type of common account makes it easier for a customer to get (for example) insurance or a loan, provided they have

[12] There are a number of ways in which multi-product ecosystems can be created and sustained. In addition to common login and identification, they can refer to product bundling (Apple preinstalling its Safari browser on devices), ensuring interoperability only with their own services (Apple Pay denying third parties access to NFC chip); vertical integration with self-preferencing elements (Apple charging Spotify an App store fee, while Apple Music essentially doesn't bear any such related costs); and personalization that emerges from composite information about a client, used to cross-sell, price-discriminate, or sell targeted advertisements—practices that have been challenged by major reports on digital competition as potentially anticompetitive (Furman, 2019; Crémer et al., 2019; Stigler, 2019).

at least one other AntFinancial product. This type of vertical-traversing account information makes it cheaper for the firm to engage with users and lock them in.

Big Tech multi-product ecosystems often create value for the customer—with or without their knowledge—through personalization. Google, for instance, collects browsing history and Android app usage data, granting it hyper-personalized information on each user and their habits. This insight then allows Google to charge advertisers higher fees for highly targeted leads. Facebook draws information from the usage patterns at its main site and its subsidiaries WhatsApp and Instagram, using a device identifier, to customize advertising or content for its users.

Often, customers simply go with the recommendations they are offered, which could take advantage of their behavioural predisposition to stick with the default (Thaler, 2015). Be that as it may, the "lock in" that multi-product ecosystems create has been noted by students of antitrust. In the words of the Stigler report (2019), "The increased scale and scope of control has provided modern digital platform owners with increased power over their ecosystems. Today's platforms understand that they can obtain higher margins if they either make all of the necessary complements themselves or position themselves as a mandatory bottleneck between partners and customers" (2019: 49).

This quote also highlights the connections between multi-actor and multi-product ecosystems. Big Tech focuses on creating multi-product ecosystems that lock customers in, while establishing multi-actor ecosystems to make them more enticing. More "stickiness" for users serves to increase value creation and enable superior value capture. While the two dimensions are connected, we should keep them conceptually separate, both to help set strategy and to provide a sounder basis for regulatory intervention. A multi-product ecosystem strategy that locks customers in (such as Apple's iOS-based multiple devices, described in Jacobides, 2020), can allow a firm to dominate its multi-actor ecosystem.

Armed with these distinctions, we can better understand what firms do, and why they engage in various types of ecosystems. While Apple or Google may be well known for some of their multi-

actor ecosystems, they do not use them as a governance mode invariably or indiscriminately. As Gawer (2020) notes, we should focus on how platform firms shape their overall boundaries, including firm scope, platform sides, and digital interfaces. While both the platform and ecosystem literatures have primarily focused on the way different parties interact, a whole different agenda—brought to life by regulatory attention on Big Tech (Crémer et al., 2019; Furman et al., 2019; Stigler, 2019) and strategy prescriptions (Jacobides, 2019)—suggests we need to take the firm-based perspective more seriously, and understand how these choices interact to drive firm strategy and customer welfare.

A firm-based focus also helps us understand how firms use platforms to support their ecosystems. For example, firms may use transaction platforms to attract customers, then use the information they gain to build multi-product ecosystems. This appears, for instance, to be the strategy of Grab, the South-East Asian rival to Uber. Grab built a platform that matches drivers and riders, and, having gotten access to customers, is building a multi-product ecosystem including food delivery and financial services—the latter being expected to create lock-in (see Teng & Jacobides, 2020). Uber, too, seems to be trying a similar strategy of late. As noted earlier, what makes these strategies something more than simple cross-selling is the supermodular complementarities for the user, so that the value of A (food ordering) increases in the presence of B (the existence of a ride-sharing account), usually because of convenience.

It is precisely the existence of real benefits to the customer, and the ability to leverage information from multiple activities to increase customization (whether for the benefit of the customer, or the benefit of other participants like advertisers who can then target the customer) that differentiates a multi-product ecosystem from horizontally diversified firms that cross-sell. Firms like AntFinancial are able to provide service and increase customization (or also price discriminate, in addition to targeting) drawing on their information, enhanced by the use of AI tools (Iansiti & Lakhani, 2020). This is in contrast with traditional financial service firms who have traditionally been engaged in

cross-selling, which only leverages customer access or back-office synergies. The strength of an ecosystem is based on the value generated by the specific complementarities, directly or indirectly. Whether this value is appropriated by the customer, or by the ecosystem orchestrator and their partners benefiting from customer lock-in due to the customer preferring convenience and customization over price and quality, is another point; and one for regulators to consider.

The importance of specific complementarities can be seen in the setting of financial services, which, in the EU, have had to follow the Payment Services Directive 2 (PSD2).[13] This mandates that all financial service firms have data for their customers which are fully transferrable, and also mandates a fully open architecture so that no firm can create lock-ins for their customers in any products. In essence, this directive nullifies the opportunity for financial firms to form multi-product ecosystems, as the only complementarities are wholly generic.

The multi-product perspective can also show us how platforms and ecosystems interact. Facebook and Google, for instance, offer Software Development Kits (SDKs) and APIs to app developers, offering features such as the "like" button. While this makes it easy for a user to embed the app in their daily practice, it also sends usage information to Facebook, so that its innovation platform ends up strengthening its ecosystem. This analysis also helps us understand the dynamics of competition between ecosystems. Apple, for instance, via "technical" changes in iOS14, has removed app makers' ability to share information on the basis of the unique device or user identifier, making it much harder for them to customize their experiences.[14] So, while an app

[13] See The European Union Payment services (PSD 2) at https://ec.europa.eu/info/law/payment-services-psd-2-directive-eu-2015-2366_en.

[14] IDFA, which stands for Identifier for Advertisers, is a unique, anonymous device identifier used in digital advertising to allow the personalization of ads, as well as the tracking of analytics. It is what allows advertisers to target their audience and track performance to see if their ad campaigns are working. While IDFA was meant to be used solely for marketing purposes, it became increasingly associated with breaches of privacy and started to be used for nefarious purposes, as unscrupulous actors using IDFAs can track individuals and identify them, using these identifiers as a way to carry out electronic surveillance. iOS14 makes the Identifier for Advertiser (IDFA, which used to be on by default) into an option that users must opt into, in effect forcing app developers to request permission for tracking. For app developers that used to rely on IDFA to personalize their campaigns, and track their performance, Apple proposes as a replacement its own SKAdNetwork API.

developer could previously build a solid ecosystem regardless of device, now Apple has favored its own multi-product ecosystem (see Jacobides, 2020).

Summing up, multi-product ecosystems are sets of product and service offerings characterized by specific supermodular complementarities, where the value of consuming one product or service increases if the customer already participates in, and consumes, another product or service of the ecosystem.[15] Multi-actor ecosystems refer to groups of firms tied by specific supply-side complementarities, be they supermodular or unique, that collaborate to offer products and services that jointly create value for the customer. Multi-product ecosystems often entail multi-actor ecosystems; and multi-actor ecosystems can provide the customer base and complementary services for expanding multi-product ecosystems. Platforms, which bring together different users through generic supermodular complementarities, are often used in both types of ecosystems, to support innovation and facilitate transactions and matching (for MSPs).

5 VALUE CREATION AND COORDINATION IN PLATFORMS AND ECOSYSTEMS

Having clarified the basic differences between platforms and ecosystems, we now delve more deeply into the mechanisms used by various types of platform to create value and coordinate, and compare these with ecosystems.

5.1 Value creation in platforms

The basis of value creation in innovation platforms comes from the possibility to attract and align complementors, who use the connectors provided by the platform owner to develop complementary innovation—such as e.g., Application Programming Interfaces (APIs). The design of the interfaces around the platform, and the extent to which they are "open" or "closed" (West, 2007), have a

[15] Note that the constituent parts of a product ecosystem can (at least potentially) each stand on their own, sold or monetized separately -- one might own an iPhone, iPad and Mac but not iWatch. Nonetheless, their value increases with the presence of other devices. Alternatively, the value to advertisers of a customer who uses Facebook increases if they also use WhatsApp and Instagram. The value to customers can potentially be considered to increase as well, inasmuch as this allows them to be exposed to the "rightly" targeted advertisement (for consumers who value such advertisements, that is).

direct effect on the facilitation of complementary innovation at the industry level (Langlois & Robertson, 1992). In this regard, platform scholars discuss extensively how value emerges from *design*—in particular, "product design" and "platform design." Platforms create value by providing access to critical complementary assets for production and the use of system components in innovation. This is what underpins the idea of "generativity"—i.e., the capacity to enable the continual creation of variant system components that offer new affordances to the user of the technology (Yoo et al., 2010; Wareham et al., 2014: 1195).

The benefit of platform design is the enabling of (modular) components to extend the core product or service. The design has a deliberate and inherent "incompleteness," which is a "trigger for the creation of many diverse ideas on how a design can be extended and further developed" (Garud et al., 2008: 358). This opens up new avenues for ongoing engagement with different sets of innovators. This benefit tends to be contrasted with "traditional" product design, which is usually conceived as having predefined functionalities and "closed" architectures, intended to offer standalone value in the market (Attour & Peruta, 2016; Gawer & Henderson, 2007). Thus, the main value-creation mechanism in innovation platforms is the enabling of complementarities in innovation: The platform affords the collaboration, but it is participants who offer supermodular complementarities in production, and the value of what each one does increases in the presence of the other(s).[16]

In the economics and strategy literature on platforms, which tends to focus on transaction platforms, the value to platform users is seen to arise from the access of "one side" of a market to the "other." In other words, value comes from supermodular complementarities, primarily in consumption (where the value to the participants on one side increases with the number of participants on

[16] As Ceccagnoli and colleagues (2012: 266) note, engagement with the platform "is a way to access a key complementary asset, certification of software compatibility, that increases a start-up's ability to appropriate the returns from its innovation. This kind of alliance, therefore, co-creates value by avoiding investments in hard-to-duplicate complementary assets (e.g., investments needed to integrate complementary products with the platform and gain a reputation for quality and reliability)."

another). Thus, much of the literature has focused on how to bring multiple sides on board, given that none would have an incentive to join without the other(s) (Caillaud & Jullien, 2003; Evans, 2003; Rochet & Tirole, 2006). Studies in this stream draw from examples in ICT, media advertising, videogames, mobile apps, or the payment industry (see for example Evans et al., 2008; Seamans & Zhu, 2014; Wilbur, 2008; Zhu & Iansiti, 2012).

This network-effects characteristic has led to much of the excitement over platforms, including stratospheric valuations of heavily loss-making companies. The fact that the stock market values growth over margins, and will even fund patently unprofitable platform businesses, suggests that investors may be expecting that at some stage, network effects will kick in and allow the platform to capture most of the market (Khan, 2017). Earlier research underscored the point, focusing on the prevalence of "winner takes all" dynamics (Eisenmann et al., 2006, 2006). However, more recent work (Boudreau & Jeppesen, 2015; Cennamo & Santalo, 2013; Cennamo, 2018) has introduced more nuanced views.[17]

All studies in this stream recognize that the coordination of the market by the platform provider is a critical condition for enhancing interactions and transactions between end-users and complement providers, and thus increasing value-creation opportunities by limiting the problem of free-riding (e.g., Cennamo and Santaló 2019; Tajedin et al. 2019). Also, from the regulatory side, drawing on economics research, the possibility of multi-homing and the portability of information are seen as crucial features that limit lock-in, and attenuate the ability of the platform owner to capture the value that they create (see Crémer et al., 2019; Furman et al., 2019).[18]

[17] Some studies have looked not just at one platform in isolation, but at the factors such as multi-homing, first-party complements, and within-platform market competition, which may limit "winner takes all" dynamics and lead to the coexistence of multiple platforms (Cennamo & Santaló, 2013; Cennamo 2018; Corts & Lederman 2009). This may affect the incentives and strategies of various players, particularly complementors, for co-creating value (Landsman & Stremersch, 2011; Mantena et al., 2010).

[18] Note, however, that there is some evidence that practices such as exclusivity tie-in agreements with complementors (e.g., Lee, 2013) or technology-based switching costs for users (e.g., Grzybowski & Nicolle, 2020) might be pro-competitive in that they favor smaller platforms to create differentiation and compete with dominant platforms.

5.2 Coordination in Platforms

Beyond the mechanisms of value creation and value capture, another question arises: How can multiple, dispersed, and *ex-ante* uncoordinated actors converge around the platform to connect and interact, and what coordination mechanisms are in play?

In the "innovation literature" stream (e.g., Anderson et al. 2014; Gawer and Henderson 2007; Tiwana 2015; West and Wood, 2013), the focus is on establishing technological standards and interfaces to attract and coordinate a set of producers of modular components around a key technology system that benefits its users (Bresnahan & Greenstein, 1999)—such as, for instance, the case of enterprise software systems (e.g., Ceccagnoli et al. 2012). The economics and strategy tradition, however, is more concerned with the coordination of diverse agents across different platform sides (Armstrong & Wright, 2007; Boudreau, 2012; Cennamo & Santalo, 2013; Hagiu 2006; Rochet & Tirole, 2006; Parker et al., 2017).

The focus in the innovation platform stream emphasizes the role of the platform orchestrator as an architect who needs to ensure the "production and adoption of different components of the system by external actors" (West & Kuk, 2016: 170), aiming to "preserve the design's dynamic qualities, i.e., one which allows elements of a system to inform but not determine one another" Garud et al. (2008: 365). This focuses on technological interfaces ("design rules") as a central object of study (Anderson et al. 2014; Gawer and Henderson 2007; Gawer 2014, 2020; Tiwana, 2015). Coordination failures constrain the innovation capacity of the system and its overall value for the innovation user (West & Wood, 2013).

To achieve coordination in a platform, an important foundation is platform governance. Van Alstyne et al. (2016: 60) argue that maximizing value creation requires platform owners to make "smart choices about access (whom to let onto the platform) and governance (or "control"—what consumers, producers, providers, and even competitors are allowed to do there)." Accordingly, the literature focuses on the market-coordination or "orchestration" strategies used by the platform

owner, as well as their effects on market competitiveness, complementors' incentives to join the platform or provide higher-quality complements, user utility, and platform competition and market structure (e.g., Armstrong & Wright, 2007; Cennamo & Santaló, 2013, 2019; Corts & Lederman, 2009; Hagiu, 2006; Hagiu & Spulber, 2013; Rochet & Tirole, 2003, 2006). Another aspect of governance relates to "search rules"—enacted through algorithms, user interfaces, or policies for user-complementor engagement—that are intended to direct user attention toward what to search for (Claussen et al., 2013; Hagiu & Jullien, 2011). This drives coordination, value creation, and value capture.[19]

A syncretic approach on how best to govern platforms is offered mostly in applied literature, such as in the book by Parker et al. (2016), which considers some key prescriptive aspects of participation and ownership rights (including voting rights for participants, legal ownership of the platform, data and IP ownership and access, competition rules within and between platforms), revenue management (including price-setting rules, revenue and profit sharing and other incentives-and their control), and conflict resolution.[20]

5.3 Value Creation in Ecosystems

As one might expect, the literature on (multi-actor) ecosystems focuses, in terms of value creation, on how organizations can come together to provide a collective outcome. The emphasis is on the

[19] Platform governance also considers "membership rules," including exclusivity to one platform versus multi-homing (Cennamo & Santaló, 2013; Corts & Lederman, 2009; Lee, 2013). Such rules also relate to platform owner roles—partly participating on the platform, but also partly opening up to complementors, which has underpinned work on the strategic and welfare analysis of the provision of first-party complements by the platform owner (e.g., Cennamo, 2018; Hagiu & Spulber, 2013; Zhu & Liu, 2018), the regulation of platform competition intensity (Armstrong, 2006; Casadesus-Masanell & Halaburda, 2014; Cennamo & Santaló, 2013, 2019; Panico & Cennamo 2020), or the provision of additional information signals that can augment price signals (Tajedin et al., 2020). These topics have also been picked up by recent regulatory studies, which are particularly interested in the possibility that a platform that benefits from network externalities—and, as such, undue power—can leverage its position to favor its own products (see Furman et al., 2019; Crémer et al., 2019).

[20] Research has recently started exploring aspects of platform governance (Cennamo & Santaló, 2019; O'Mahony & Karp, 2020; Wareham et al., 2014; Zhu & Liu, 2018), and the rules of platforms have also attracted interest from regulators (Crémer et al., 2019). Thus, research is starting to examine how platform governance and, in particular rules such as search algorithms, self-preferencing on platforms, and pricing help both to resolve the coordination issue and also allow for joint value creation—with important distribution effects (Hagiu & Wright, 2020; O'Mahony & Karp, 2020; Panico & Cennamo, 2020; Zhu & Liu, 2018).

cooperation of diverse entities as they try to interoperate, and either use each other's services or usefully combine so that the customer can benefit from a coherent and well-integrated whole (e.g., different digital health services, from devices to receptors to health-service provision). Value creation comes through different means. In the realm of production, benefit comes from having sets of cospecialized firms that can interchangeably produce and consume, so that the ecosystem allows for more opportunities to either source an input or place an output, and reduce both frictional transaction costs and the need for ad hoc arrangements that might be uneconomical. For a firm that buys services through an ecosystem, the existence of variety in potential supply-chain partners is beneficial; for those selling through ecosystems, this flexible option may be more attractive than traditional captive arrangements (Adner & Kapoor, 2010; Kapoor & Lee, 2013; Ganco et al., 2020). As for ecosystems that are focused on new innovations, their emphasis is on ensuring that there can be an effective, organizationally distributed way of seeking new advancements: Ecosystems create value *through* the coordination they offer—a topic to which we return later (also see Jacobides et al., 2019).

In terms of ecosystems in consumption, which is a rapidly growing area of interest, value comes from services, usually digitally connected, that can operate together to satisfy user needs. The adherence to some rules in the ecosystem ensures compatibility and a good experience for the end user. Ecosystems, in this regard, allow for "bundles" of offerings with appeal for users (Jacobides, 2019b). Research has also pointed out that production and consumption benefits may be joined, so that value comes from combining the two.[21] The analytical point here is that customers have a say in the choice of complements, unlike in supply chains (Jacobides et al., 2018; 2019), which drives value for them and for participating firms.

[21] Consider, for instance, your smartphone. The value you get from it comes primarily through the apps you use. Apps are dependent on the operating system your phone runs, but the phone manufacturer cannot dictate which ones you use; instead, they merely provide the contours of free choice.

Ecosystems often provide opportunities by broadening out choice, while requiring (or at least enabling) specific links. This brings us to the mechanisms of value creation of multi-product ecosystems. The growth of today's Big Tech is predicated on an ever-growing array of services that increase convenience for the customers, even as they potentially restrict some forms of competition. In this regard, information and access—often enabled by a single platform—can unlock new sources of value. Consider, for instance, the growth of PingAn, China's most successful insurance firm (Catlin et al., 2018), which decided to expand into healthcare (with its venture GoodDoctor) and lifestyle (in conjunction with Grab), engaging a number of a different ecosystem partners.[22]

The value created for the customers is convenience from the one-stop shop, single-login, and unified-account function. Yet, what offers convenience also restricts choice, reduces competition, and creates the risk that ecosystem orchestrators, especially in such multi-product settings, take undue advantage of their position, particularly if they have a "gatekeeper" role (see Furman et a, 2019; Jacobides, 2020; Stigler, 2019).

While much research has focused on the value that flows to orchestrators, we believe that not enough attention has been paid to the strategic questions that other potential members face—such as which ecosystems to join, and with what role (for exceptions, see Fuller et al., 2019; Jacobides et al., 2018). This line could build on research on value distribution and value capture, including the question of who owns the bottleneck (Baldwin, 2018; Hannah & Eisenhardt, 2019; Jacobides et al., 2006).[23]

[22] It is interesting to note that much of the pervasive use of the term "ecosystems" in China regards *multi-product* ecosystems, and not multi-actor ecosystems. Thus, Alibaba and Tencent in their corporate communications focus on "ecosystem strategy" denoting scope, i.e., covering increasingly digitally interconnected needs. A fascinating topic for future research is the comparison of models that tend to rely multi-product ecosystems, offered by in-house capabilities, often acquired when needed, with those that rely on a supply chain, and those, like JD.com—one of Alibaba's competitors—that grow by relying on multi-actor ecosystems and leveraging other firms' skills.

[23] Clearly, questions of power of orchestrators are also important in platform research, especially for those from an economics background, who have also made significant strides in the evaluation of welfare and potentially non-competitive aspects in platforms, a topic of great and yet mounting interest. See Lianos and Ivanov (2019).

Finally, research on ecosystems, through its focus on organizations, has also looked at how organizations need to change to adapt to ecosystems, and how ecosystem-focused structures may change the orientation of the firm (Jacobides, 2019). This follows up on earlier research that connects porous organizational boundaries with positive growth dynamics (Jacobides & Billinger, 2006).

Consider, for instance, Haier, the world's largest appliance manufacturer. Zhang Ruimin, Haier's CEO, acknowledging that the world of white goods is becoming digitized, has recently reshaped his entire organization into "Ecosystem Micro-enterprise Communities" (see Jacobides & Duke, 2020). The question of the correspondence between organizational changes and ecosystem orientation as a means to add value is an area of growing future interest.

5.4 Coordination in Ecosystems

Coordination mechanisms in ecosystems are analogous to, but distinct from, those in platforms. The emphasis in multi-actor ecosystems is more on alignment at the level of organization overall, and the literature suggests that, over and above adjustment via arm's-length transactions (often on a standardized basis), coordination is achieved through common assets or the platform of a central orchestrator (e.g. Iansiti & Levien 2004; Zahra & Nambisan 2012). The benefit of modular structures enable firms to adjust to the actions of other members (e.g., Pierce, 2009; Zacharakis et al., 2003), to the "smart power" of the lead firm (Williamson & De Meyer 2012; Iansiti & Levien 2004) or, and perhaps fundamentally, to the choices that final users make between ecosystems. For multi-product ecosystems, the emphasis is on interoperability and the value they create, either to the end users or to other actors (e.g., advertisers).

More particularly, for platform-based ecosystems, coordination mechanisms include sharing product-development resources made available by the orchestrator (such as APIs and SDKs); standardized rules of access to and use of platform resources; self-selection incentives to participate based on pricing structure (Panico & Cennamo, 2020) or other screening rules (Wareham et al.

2014); within-platform ecosystem competition (Tiwana 2015; Cennamo & Santaló 2013, 2015); platform–complementor coopetition (Gawer & Henderson 2007; Ceccagnoli et al., 2012); and feedback from ecosystem generativity (Cennamo & Santaló, 2019; Yoo et al., 2010; Tiwana, 2015).

These coordination mechanisms bring up another important topic, which parallels the discussion in platforms: governance. In this instance, it is even more important, as it addresses the potentially contentious issues of how ecosystems themselves are run.[24]

5.5 Synthesis

Our analysis of value creation and coordination in platforms and ecosystems is, by its nature, incomplete. Its purpose was to provide a sense of what each stream of literature focuses on, and, together with our analytical clarification of the differences between platforms and ecosystems, help us better explore the links and relationships between these two connected yet distinct constructs—or concepts.

First, both platforms and ecosystems encompass a broad set of manifestations. Despite greater terminological clarity over the last few years, the answer to how value is created and how coordination takes place in platforms vs ecosystems depends on the particular connotation that we provide to the term. Despite this proviso, there seems to be a fair amount of consistency within the platform and ecosystem literatures, and the differences reveal that they focus on related yet distinct phenomena. Platforms are the technological and institutional manifestations of the infrastructure

[24] Jansen (2020), in his exhaustive and fascinating analysis of software ecosystems, draws on and substantially expands on the analysis from Parker et al. (2016) on platform governance and recent ecosystem research to develop a model of (software) ecosystem governance and management. The study looks at each of the dimensions of a particular ecosystem, focusing implicitly on what the author considers to be the right practices. He identifies, beyond the rules for ecosystems, some other key features that are predictive of ecosystem success, and which collectively explain ecosystem health. This brings in the underlying structural features of an ecosystem, with the practices that are necessary for the ecosystem to be successful. They include platform governance and its openness (as one of the components), software governance, the openness of innovation and of markets, the nature of associate models, and the monitoring of ecosystem health. This applied empirical project, which looks at how different ecosystems fare (and, as such, what they look like), along with ways to measure each dimension, helps to illustrate the necessary complexity of coordination once we shift from the simpler question of a particular platform and the interaction between its members, to the webs of connections that ecosystems entail, and the capabilities that firms (be they orchestrators or participants) need to be effective.

that allows firms, institutions, or individuals to connect to each other. Platforms, we submit, primarily rely on (or are defined by) supermodular complementarities and the direct or indirect, supply or demand network externalities that they engender. Ecosystems, meanwhile, are defined by the extent to which interdependencies, be they supermodular or unique, production or consumption-based, are specific—whether they be in relation to multi-actor or multi-product ecosystems.[25]

This observation raises another important point: Ecosystem discussions tend to be as concerned with value capture as it is with value creation. Empirically speaking, there seems to be greater concern about who controls the bottleneck (Baldwin, 2018; Hannah & Eisenhardt, 2019), and how value-capture dynamics affect the incentives to create value (Khanaga et al., 2020; O'Mahony & Karp, 2020; Panico & Cennamo 2020). Overall, ecosystems often, but not always, draw on platforms to link their members. Ecosystem research is much more concerned with the interorganizational dynamics that permeate these arrangements, and can even focus on the ways in which organizations are able to respond to new demands imposed by their environment.

6 DISCUSSION

The literatures on platforms and ecosystems address a fascinating range of topics, and are growing very rapidly (Shipilov & Gawer, 2020). As often happens during such times, reality pushes researchers to explore new topics, but the cost is that terms emerge without the necessary clarity. Now, we have reached a point at which we need to take stock and move ahead. Grappling with the similarities and differences between platforms and ecosystems, and considering how to combine the two, is overdue. We hope that this paper will enrich the dialogue that will follow.

[25] Multi-homing, or data portability, which has received significant attention of late (Furman et al., 2019; Crémer et al., 2019), illustrates this distinction. The imposition on a platform owner of the requirement to make a consumer's data fully portable, and to allow their complementors to multi-home, technically speaking, does not change the network dynamics, the way value is created, or the network externalities (or the supermodular complementarities that give rise to these externalities). What changes is not at the level of the platform, but, rather at the level of the ecosystem that sits atop of it—since this change allows, say, an app developer or service provider to switch from one platform to another. In our parlance, multi-homing and data portability make a specific supermodular complementarity (i.e., one where there are ties to specific groups of players that cannot be redeployed) into a more generic one, since data portability and multi-homing take an ecosystem with strong multi-lateral dependencies and "reduce its hold" on its members. Policies aimed at protecting complementors from potentially greedy orchestrators relate to *ecosystem* structures.

We argue that when we take a step back and consider what these new constructs have to say in terms of our existing theory, we need to introduce a new distinction: multi-actor vs multi-product ecosystems. We do not propose this to create more theoretical jargon, but because we genuinely need to clarify the complex reality before us. Such clarity will help us describe, understand, and prescribe—potentially helping both strategy and policy.

To take a broader perspective, the very way firms organize is changing, which poses some new and exciting challenges to the theory of the firm. Let us not forget that Coase (1937) based his theory on the empirical observation of American industry after his trip from England. Armed with similar curiosity—or heeding Herbert Simon (1991), who exhorted us to see "what the visitor from Mars" would observe—we have to report a shift in the patterns of organization of economic activity, with Big Tech, platforms, and ecosystems all moving centre-stage. This change requires us to update our terminology and analytical arsenal, and to get our hands dirty by grappling with shifting and sometimes murky phenomena. Doing so will not only enrich our empirical understanding of the world; it will also help us understand the essence of organization.

As regulatory interest in Europe and the US is picking up pace, with regulation on "gatekeeper" firms becoming ever more relevant, we have a great opportunity to contribute by helping anchor what is becoming an increasingly polarized policy debate. The competitive structure and industry architecture for a number of industries is being transformed, and we hope that our framework will help clarify some of the ongoing debates on the power of firms using platforms and ecosystems. As we need to ascertain where customer convenience ends and where anticompetitive lock-in begins, and where competition on merits risks being confused with ecosystem hegemony and platform dominance, we hope that our paper offer some definitional and conceptual clarity that allows us to better comprehend this shifting context.

References

Adner R. 2013. *The Wide Lens: What Successful Innovators See that Others Miss*. Penguin Random House.

Adner R, Kapoor R. 2010. Value creation in innovation ecosystems: how the structure of technological interdependence affects firm performance in new technology generations. *Strategic Management Journal* **31**(3): 306-333.

Adner R, Kapoor R. 2016. Innovation ecosystems and the pace of substitution: Re-examining technology S-curves. *Strategic Management Journal* **37**: 625-648.

Adner R. 2017. Ecosystem as structure: An actionable construct for strategy, *Journal of Management* **43**(1): 39–58.

Alexy O, George G, Salter AJ. 2013. Cui bono? The selective revealing of knowledge and its implications for innovative activity. *Academy of Management Review* **38**: 270–291.

Anderson Jr EG, Parker GG, Tan B. 2014. Platform performance investment in the presence of network externalities. *Information Systems Research* **25**(1):152-72.

Armstrong M. 2006. Competition in Two-Sided Markets. *RAND Journal of Economics* **37**: 668-691.

Armstrong M, Wright J. 2007. Two-sided markets, competitive bottlenecks and exclusive contracts. *Economic Theory* **32**: 353–380.

Attour A, Peruta MD. 2016 Architectural knowledge: key flows and processes in designing an inter-organizational technological platform. *Knowledge Management Research & Practice*. **14**(1):27-34.

Baldwin CY, Clark KB. 2000. *Design Rules: The Power of Modularity*. Vol. 1. MIT Press: Cambridge, MA.

Baldwin CY. 2012. Organization design for business ecosystems, *Journal of Organization Design* **1**(1): 20-23.

Baldwin CY. 2018. *Design Rules: How Technology Shapes Organizations.* Vol. 2: The value structure of technologies: Technical and strategic bottlenecks as guides for action. *Harvard Business School Research Paper Series*.

Baldwin CY, Woodard J. 2009. The architecture of platforms: A unified view, in: Gawer, A. (Ed), *Platforms, Markets and Innovation*. Edward Elgar, Cheltenham, UK and Northampton, Mass, 19-44.

Baldwin CY. 2020. *Design rules, volume 2: How technologies shape organizations, chapter 14, introducing open platforms and ecosystems.* Working paper 19-035, Harvard Business School.

Bogers M, Sims J, West J. 2019. *What is an ecosystem? Incorporating 25 years of ecosystem research*. Working Paper. DOI: 10.5465/AMBPP.2019.11080abstract.

Boudreau K. 2010. Open platform strategies and innovation: Granting access vs. devolving control. *Management Science* **56**(10): 1849–1872.

Boudreau KJ. 2012. Let a thousand flowers bloom? An early look at large numbers of software app developers and patterns of innovation. *Organization Science* **23**(5):1409-27.

Boudreau KJ, Jeppesen LB. 2015 Unpaid crowd complementors: The platform network effect mirage. *Strategic Management Journal* **36**(12):1761-77.

Bresnahan T, Greenstein S. 1999. Technological competition and the structure of the computer industry. *Journal of Industrial Economics*, vol. 47: 1-40.

Caillaud B, Jullien B. 2003. Chicken-and-egg: competition among intermediation service providers. *RAND Journal of Economics* **34**: 309–328.

Casadesus-Masanell R, Halaburda H. 2014. When does a platform create value by limiting choice? *Journal of Economics and Management Strategy* **23**: 259-293.

Catlin T, Lorenz JT, Nandan J, Sharma S, Waschto A. 2018. Insurance beyond digital: The rise of ecosystems and platforms. McKinsey & Company.

Ceccagnoli M, Forman C, Huang P, Wu DJ. 2012. Co-creation of value in a platform ecosystem: The case of enterprise software. *MIS Quarterly* **36**(1): 263-290.

Cennamo C. 2019. Competing in digital markets: A platform-based perspective. *Academy of Management Perspectives* https://doi.org/10.5465/amp.2016.0048

Cennamo C. 2018. Building the value of next-generation platforms: The paradox of diminishing returns. *Journal of Management* **44**: 3038-3069.

Cennamo C, Ozalp H, Kretschmer T. 2018. Platform architecture and quality tradeoffs of multihoming complements. *Information Systems Research* 29(2):461–478.

Cennamo C, Santaló J. 2013. Platform competition: strategic trade-offs in platform markets. *Strategic Management Journal* **34**(11): 1331-1350.

Cennamo C, Santaló J. 2019. Generativity tension and value creation in platform ecosystems. *Organization Science* **30**(3): 617-41.

Clark KB. 1985. The interaction of design hierarchies and market concepts in technological evolution. *Research Policy* **14**(5): 235-251.

Claussen J., Kretschmer T., Mayrhofer P. 2013. The effects of rewarding user Engagement: The case of Facebook apps. *Information Systems Research*, 24. https://doi.org/10.1287/isre.1120.0467

Coase RN. 1937. *The Nature of the Firm* Economica

Corts KS, Lederman M. 2009. Software exclusivity and the scope of indirect network effects in the US home video game market. *International Journal of Industrial Organization* **27**: 121-136.

Crémer J, de Montjoye YA, Schweitzer H. 2019. Competition policy for the digital era. Report for the European Commission. Apr.

Cusumano, MA., Gawer A, Yoffie, DB. 2019. *The Business of Platforms: Strategy in the Age of Digital Competition, Innovation, and Power*. HarperBusiness.

Dosi G. 1982. Technological paradigms and technological trajectories. *Research Policy* **11**: 147-62.

Eisenmann TR, Parker G, Alstyne M. 2006. Strategies for two-sided markets. *Harvard Business Review* **84**(10): 92–101.

Eisenmann T, Parker G, Van Alstyne M. 2011. Platform envelopment. *Strategic Management Journal* **32**(12): 1270–1285.

Evans DS. 2003. Some empirical aspects of multi-sided platform industries. *Review of Network Economics* 2: 191–209.

Evans DS, Hagiu A, Schmalensee R. 2008. *Invisible Engines: How Software Platforms Drive Innovation and Transform Industries.* MIT Press: Cambridge, MA.

Eppinger SD, Browning TR. 2012. *Design Structure Matrix: Methods and Applications*. MIT Press.

Frankort HTW. 2013. Open innovation norms and knowledge transfer in interfirm technology alliances: Evidence from information technology, 1980-1999. *Advances in Strategic Management* **30**: 239–282.

Fuller J, Jacobides MG, Reeves M, 2019. The myths and realities of business ecosystems, *Sloan Management Review* Digital Article, February.

Furman J, Coyle D, Fletcher A, McAuley D, Marsden P. 2019 Unlocking digital competition: Report of the digital competition expert panel. Report prepared for the Government of the United Kingdom, March. https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/785547/unlocking_digital_competition_furman_review_web.pdf.

Ganco M, Kapoor R, Lee G. 2020. From rugged landscapes to rugged ecosystems: Structure of interdependencies and firms' innovative search. *Academy of Management Review*. Forthcoming.

Garud R, Jain S, Tuertscher P. 2008. Incomplete by design and designing for incompleteness. *Organization Studies* **29**(3): 351-71.

Garud R, Kumaraswamy A. 1995. Technological and organizational designs to achieve economies of substitution. *Strategic Management Journal* **16**: 93-110.

Gawer A. 2014. Bridging differing perspectives on technological platforms: Toward an integrative framework. *Research Policy* **43**(7): 1239-1249.

Gawer, A. 2020. Digital platforms' boundaries: The interplay of firm scope, platform sides, an digital interfaces. *Long Range Planning*. https://doi.org/10.1016/j.lrp.2020.102045

Gawer A, Cusumano MA. 2002. *Platform Leadership: How Intel, Microsoft, and Cisco Drive Industry Innovation*. Harvard Business School Press: Boston, MA.

Gawer A, Cusumano MA. 2008. How companies become platform leaders. *MIT Sloan Management Review* **49**(2): 28-35.

Gawer A, Henderson R. 2007. Platform owner entry and innovation in complementary markets: Evidence from Intel. *Journal of Economics and Management Strategy* **16**(1): 1–34.

Grzybowski L, Nicolle A. 2020. Estimating consumer inertia in repeated choices of smartphones. *Journal of Industrial Economics*. Forthcoming.

Hagiu A. 2006. Pricing and commitment by two-sided platforms. *RAND Journal of Economics* **37**(3): 720-737.

Hagiu A, Spulber D. 2013. First-party content and coordination in two-sided markets. *Management Science* **59**(4): 933-949.

Hagiu A, Wright J. 2015. Multi-sided platforms. *International Journal of Industrial Organization* **43**:162-74.

Hagiu A, Wright J. 2020. Controlling vs. Enabling, *Management Science* **65**(2): 459-954.

Hagiu A, Jullien B. 2011. Why do intermediaries divert search? *The RAND Journal of Economics* **42**(2): 337-362.

Hannah D, Eisenhardt, KM. 2019. Bottlenecks, cooperation, and competition in nascent ecosystems. *Strategic Management Journal* **40**(9): 1333-1335.

Hayek FA. 1945. The Use of Knowledge in Society. *American Economic Review* **35**(4): 519-530.

Huang GQ, Zhang XY, Liang L. 2005. Towards integrated optimal configuration of platform products, manufacturing processes, and supply chains. *Journal of Operations Management* **23**(3-4): 267-290.

Iansiti M, Levien R. 2004. *The Keystone Advantage: What the New Dynamics of Business Ecosystems Mean for Strategy, Innovation, and Sustainability*. Harvard Business School Press: Boston, MA.

Iansiti, M. and Lakhani, K.R., 2020. *Competing in the Age of AI*. Harvard University Press.

Iyer B, Lee CH, Venkatraman N. 2006. Managing in a small world ecosystem: some lessons from the software sector. *California Management Review* **48**(3): 28-47.

Jacobides MG, 2019a, Goodbye Business as Usual, *Think!*, May.

Jacobides MG, 2019b, In the ecosystem economy, what's your strategy? *Harvard Business Review*, September-October.

Jacobides MG 2020. What Drives and Defines Digital Platform Power? A framework, and why Apple's strategic success should stop resting on competitive dominance. Working Paper, LBS.

Jacobides MG, Knudsen T, Augier M. 2006. Benefiting from innovation: value creation, value appropriation and the role of industry architectures. *Research Policy* **35**: 1200–1221.

Jacobides MG, Billinger S. 2006. Designing the boundaries of the firm. *Organization Science* **17**(2): 249–261.

Jacobides MG, Duke L. 2020. Haier: An ecosystem revolution, case-studies, number pending, LBS/HBS case repository.

Jacobides MG, Cennamo C, Gawer A. 2018. Towards a theory of ecosystems. *Strategic Management Journal* **39**: 2255-2276.

Jacobides M, Sundararajan A, Van Alstyne M. 2019. *Platforms and Ecosystems: Enabling the Digital Economy*, World Economic Forum White Paper 1-32.

Jansen S. 2020. A focus area maturity model for software ecosystem governance. *Information and Software Technology* **118**(2): 106-219.

Jiao JR, Simpson TW, Siddique Z. 2007. Product family design and platform-based product development: A state-of-the-art review. *Journal of Intelligent Manufacturing* **18**(1): 5-29.

Khan, L. (2017). Amazon's Antitrust Paradox. *Yale Law Journal*, Vol. 126, 712-805.

Khanaga S, Ansari S, Paroutis S, Oviedo L. 2020. Mutualism and the dynamics of new platform creation: A study of Cisco and Fog computing. *Strategic Management Journal.* Forthcoming.

Kapoor R, Lee JM. 2013. Coordinating and competing in ecosystems: how organizational forms shape new technology investments. *Strategic Management Journal* **34**(3): 274-296.

Kapoor R. 2013. Collaborating with complementors: what do firms do? *Advances in Strategic Management* **30**: 3–25.

Kapoor R. 2018. Ecosystems: broadening the locus of value creation. *Journal of Organization Design* **7**(1): 12.

Krishnan V, Gupta, G. 2001. Appropriateness and impact of platform-based product development. *Management Science* **47**(1), 52–68.

Landsman V, Stremersch S. 2011 Multihoming in two-sided markets: An empirical inquiry in the video game console industry. *Journal of Marketing* **75**(6): 39–54.

Langlois RN, Robertson PL. 1992. Networks and innovation in a modular system: Lessons from the microcomputer and stereo component industries. *Research Policy* **21**(4):297-313.

Lee RS. 2013. Vertical integration and exclusivity in platform and two-sided markets. *American Economic Review* 103(7): 2960–3000.

Lee E, Lee J, Lee J. 2006. Reconsideration of the winner-take-all hypothesis: Complex networks and local bias. *Management Science* **52**(12): 1838-48.

Leten B, Vanhaverbeke W, Roijakkers N, Clerix A, Van Helleputte J. 2013. IP models to orchestrate innovation ecosystems. *California Management Review* **55**(4): 51-64.

Lianos I, Ivanov, A, 2019, *Digital Era Competition: A BRICS Review*, accessed at http://bricscompetition.org/upload/iblock/6a1/brics%20book%20full.pdf

Mantena R, Sankaranarayanan R, Viswanathan S. 2010. Platform-based information goods: The economics of exclusivity. *Decision Support Systems* **50**(1): 79–92.

McIntyre D, Srinivasan A, Afuah A, Gawer A, Kretschmer T. 2020. Multi-sided platforms as new organizational forms. *Academy of Management Perspectives.* In Press.

Meyer MH, Lehnerd, AP. 1997. *The Power of Product Platforms: Building Value and Cost Leadership*. Free Press, New York.

Moore JF. 1993. Predators and prey: a new ecology of competition. *Harvard Business Review* **71**(3): 75-86.

O'Mahony S, Karp R. 2020. From proprietary to collective governance: How platform participation strategies evolve. *Strategic Management Journal.* 1– 33. https://onlinelibrary.wiley.com/doi/abs/10.1002/smj.3150

Panico C, Cennamo C. 2020. User preferences and strategic interactions in platform ecosystems. Forthcoming in *Strategic Management Journal.* DOI: 10.1002/smj.3149

Parker G, Van Alstyne M. 2005. Two-sided network effects: A theory of information product design. *Management Science* **51**(10): 1494–1504.

Parker G, Van Alstyne M, Choudary SP 2016. *Platform revolution: How networked markets are transforming the economy – and how to make them work for you.* Norton & Company Inc: New York.

Parker G, Van Alstyne M, Jiang X. 2017. Platform ecosystems: how developers invert the firm. *MIS Quarterly* **41**(1): 255-266.

Pierce L. 2009. Big losses in ecosystem niches: how core firm decisions drive complementary product shakeouts. *Strategic Management Journal* **30**: 323–347.

Porter ME. 1990. *The Competitive Advantage of Nations*. New York: Free Press.

Rietveld J, Eggers JP. 2018 Demand heterogeneity in platform markets: Implications for complementors. *Organization Science* **29**(2): 304-22.

Rochet JC, Tirole J. 2003. Platform competition in two-sided markets. *Journal of the European Economic Association* **1**(4): 990-1029.

Rochet JC, Tirole J. 2006. Two-sided markets: a progress report. *RAND Journal of Economics* **37**: 645–667.

Rysman M, 2009. The economics of two-sided markets. *Journal of Economic Perspectives* **23**(3): 125-143.

Sanderson SW, Uzumeri M. 1995. Managing product families: The case of the Sony Walkman. *Research Policy* **24**(5): 761–782.

Saxenian AL. 1996. *Regional Advantage: Culture and Competition in Silicon Valley and Route 128*. Harvard University Press.

Schilling MA, 2000. Towards a general modular system theory and its application to interfirm product modularity. *Academy of Management Review* **25**(2): 312-334.

Seamans R, Zhu F. 2014. Responses to entry in multi-sided markets: The impact of craigslist on local newspapers. *Management Science* **60**(2): 476–493.

Simon HA. 1991. Organizations and Markets. *Journal of Economic Perspectives*, **5**(2): 25-44.

Shipilov A, Gawer A. 2020. Integrating research on interorganizational networks and ecosystems. *Academy of Management Annals* **14**(1): 92-121.

Stigler. 2019. Scott Morton F, Bouvier P, Ezrachi A, Jullien A, Katz R, Kimmelman G, Melamed AD, Morgenstern J. Committee for the Study of Digital Platforms, Market Structure and Antitrust Subcommittee, Stigler Center for the Study of the Economy and the State. https://www.judiciary.senate.gov/imo/media/doc/market-structure-report%20-15-may-2019.pdf.

Tajedin H., Madhok A, Keyhani M. 2019. A theory of digital firm-designed markets: Defying knowledge constraints with crowds and marketplaces. *Strategy Science* **4**(4): 323-342.

Tavalaei M, Cennamo C. 2020. In search of complementarities within and across platform ecosystems: Complementors' relative standing and performance in mobile apps ecosystems. *Long Range Planning.* In Press. https://doi.org/10.1016/j.lrp.2020.101994

Teece DJ. 2007. Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal* **28(**13): 1319-1350.

Teng N, Jacobides MG. 2020. *Turning the tables in digital platform ecosystems: How and why innovative complementors outshine established incumbents*. IIE Working Paper, London Business School.

Thaler RH. 2015. Misbehaving: The Making of Behavioral Economics, New York: WW Norton.

Thomas L, Autio E. 2020. Innovation ecosystems in management: An organizing typology, in *Oxford Encyclopedia of Business and Management*. Oxford University Press.

Tiwana A. 2015. Evolutionary competition in platform ecosystems. *Information Systems Research* **26**(2): 266-81.

Ulrich K. 1995. The role of product architecture in the manufacturing firm. *Research Policy* **24**(3): 419-440.

Van Alstyne M, Parker G, Choudary S. 2016. Pipelines, platforms and the new rules of strategy. *Harvard Business Review* (April).

Wareham J, Fox PB, Cano Giner JL 2014. Technology ecosystem governance. *Organization Science* **25**(4): 1195–1215.

West J, Wood D. 2013. Evolving an open ecosystem: the rise and fall of the Symbian platform. *Advances in Strategic Management* **30**: 27-67.

West J. 2007. The economic realities of open standards: Black, white and many shades of gray. *Standards and Public Policy*. 87:122.

West J, Kuk G. 2016. The complementarity of openness: How MakerBot leveraged Thingiverse in 3D printing. *Technological Forecasting and Social Change*. 102:169-81.

Wheelwright S, Clark K. 1992. *Revolutionizing Product development: Quantum Leaps in Speed, Efficiency and Quality*. The Free Press: New York.

Wilbur KC. 2008. A two-sided, empirical model of television advertising and viewing markets. *Marketing Science* **27**(3): 356-378.

Williamson PJ, De Meyer A. 2012. Ecosystem advantage: How to successfully harness the power of partners. *California Management Review* **55**(1): 24-46.

Yoo Y, Henfridsson O, Lyytinen K. 2010. Research commentary—the new organizing logic of digital innovation: an agenda for information systems research. *Information Systems Research.* **21**(4):724-35.

Zacharakis AL, Shepherd DA, Coombs, JE. 2003. The development of venture-capital-backed internet companies: An ecosystem perspective. *Journal of Business Venturing* **18**(2): 217–231.

Zahra SA, Nambisan S. 2012. Entrepreneurship and strategic thinking in business ecosystems. *Business Horizons* **55**(3): 219-229.

Zhu F, Iansiti, M. 2012. Entry into platform-based markets. *Strategic Management Journal* **33**: 88-106.

Zhu F, Liu Q. 2018. Competing with complementors: An empirical look at Amazon.com. *Strategic Management Journal* **39**(10): 2618-2642.

Figure 1: Types of complementarities, platforms, and ecosystems

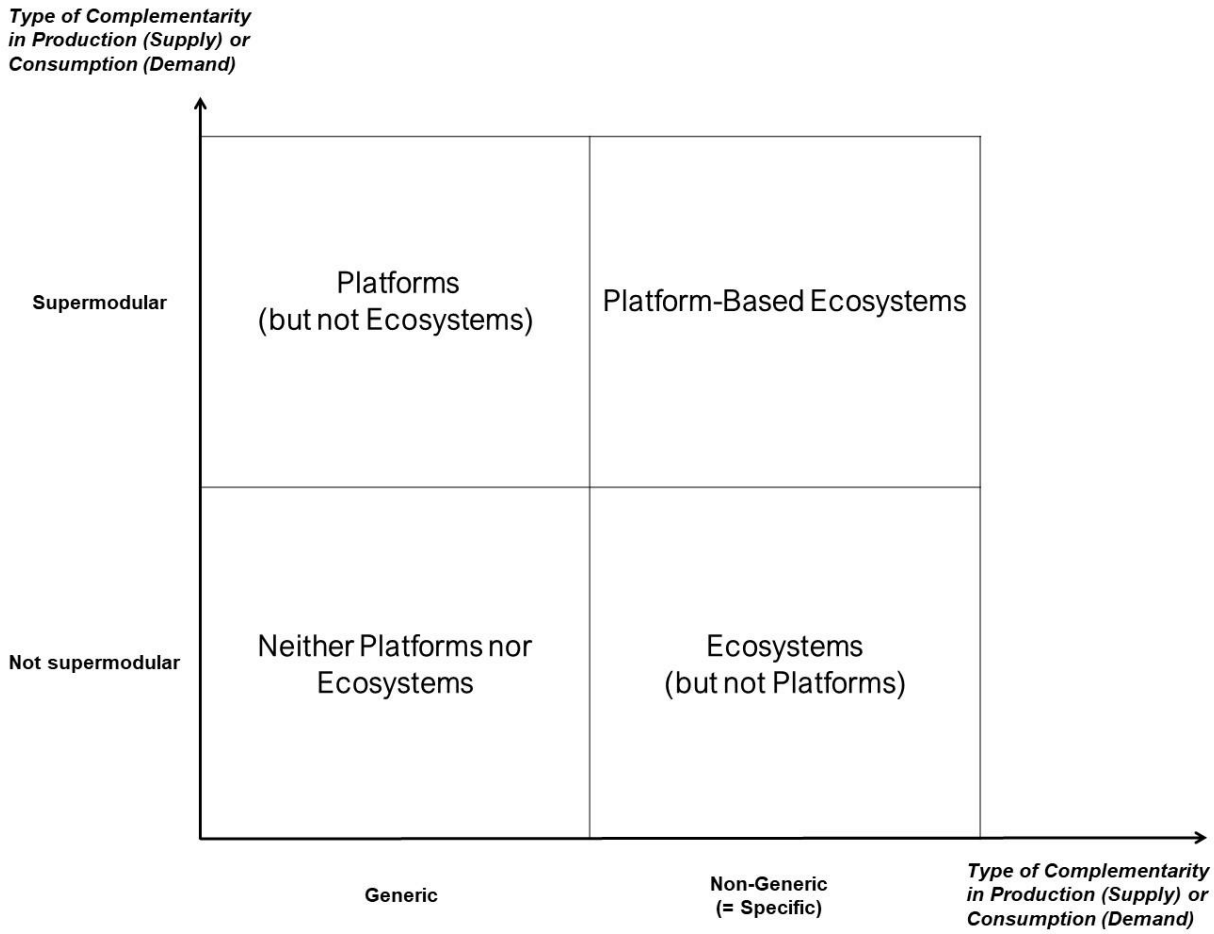

Figure 2a: (Multi-firm) and Multi-Product Ecosystem for Google

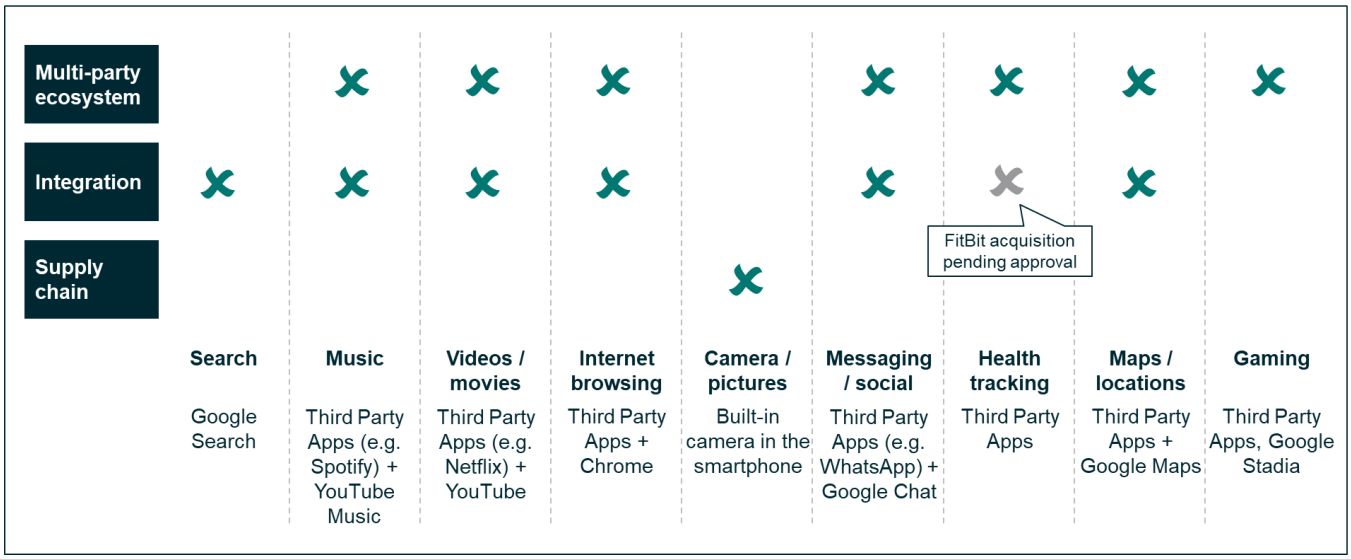

Figure 2b: (Multi-firm) and Multi-Product Ecosystem for Apple

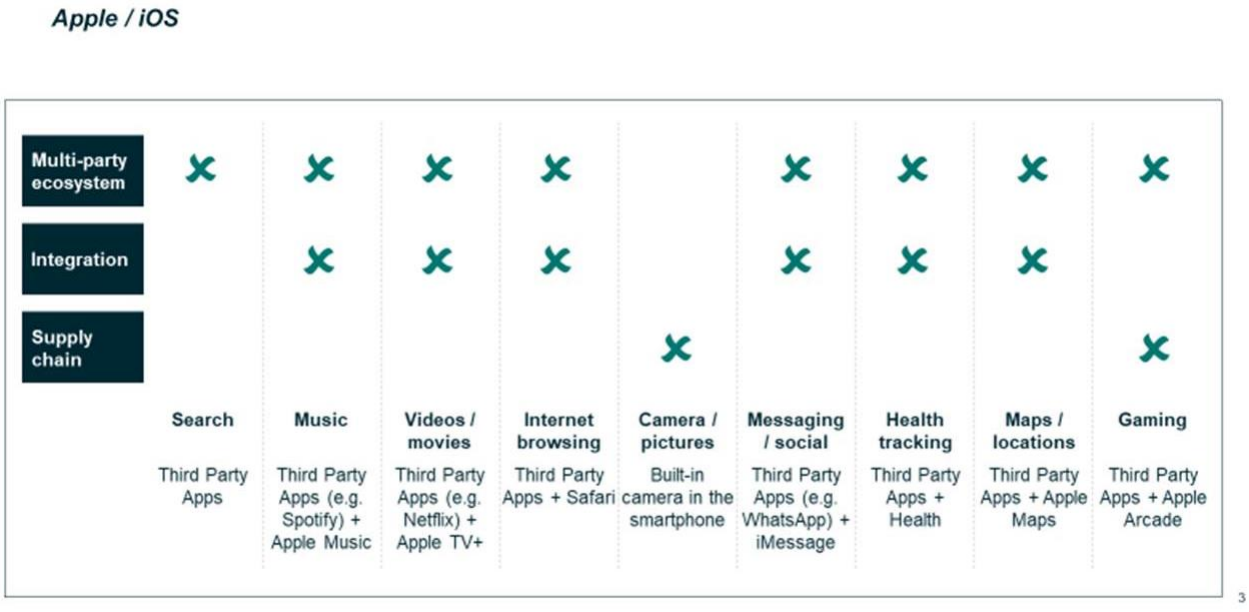

Figure 2c: Facebook Multi-Service Ecosystem

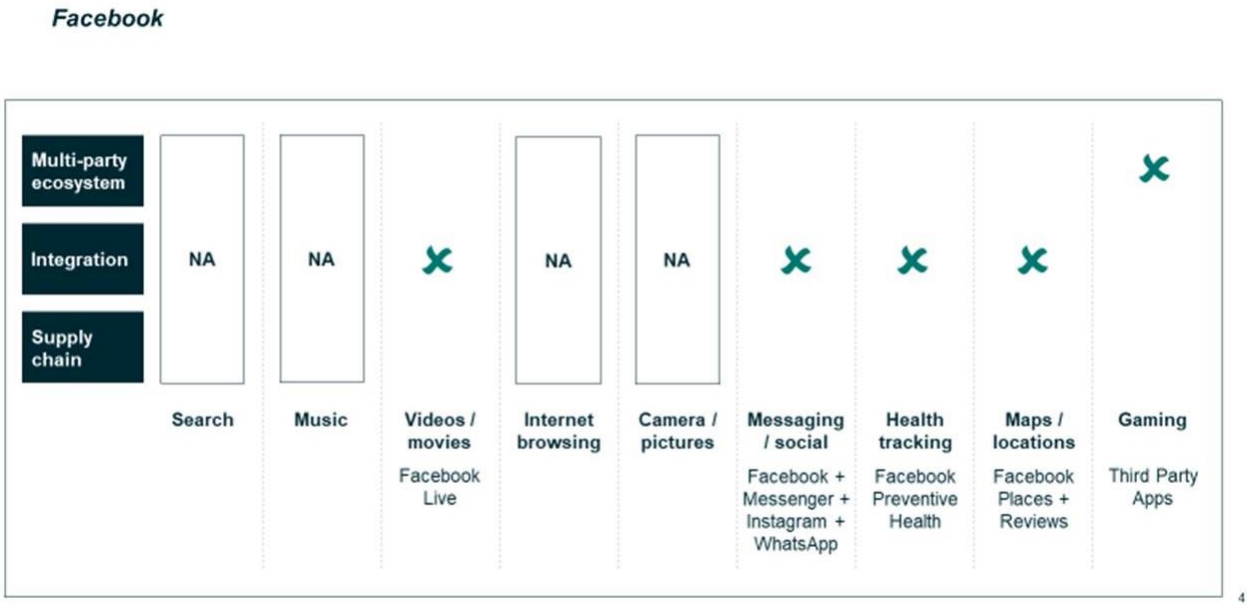

Figure 2d: Ant Financial Multi-Product Ecosystem

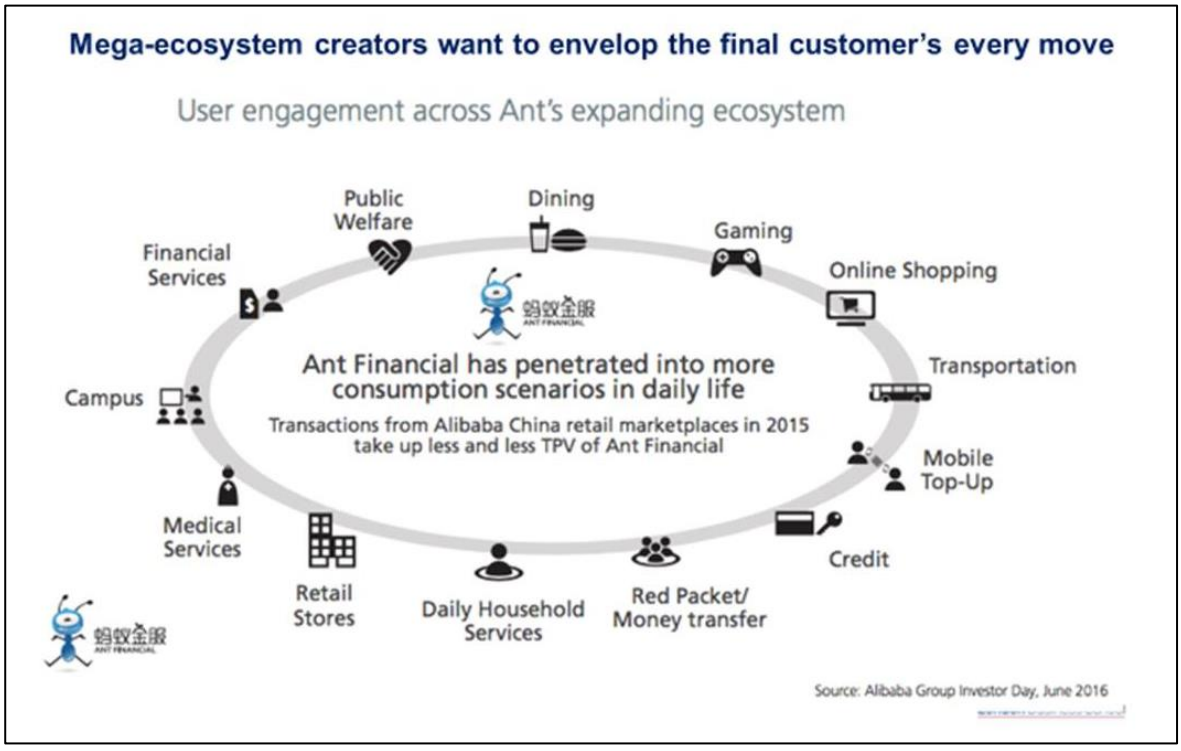

Table 1 – Ecosystem Definitions (and relation to Platforms): A selective Comparison

Article	Adner (2017)	Jacobides, Cennamo & Gawer (2018)	Kapoor (2018)	Baldwin (2020)	Bogers, Sims & West (2019)
Ecosystem definition	"The alignment structure of the multilateral set of partners that need to interact in order for a focal value proposition to materialize" (p.40)	"A set of actors with varying degrees of multilateral, nongeneric complementarities that are not fully hierarchically controlled" (p.2264)	"An ecosystem encompasses a set of actors that contribute to the focal offer's user value proposition" (p.2)	"A network of autonomous firms and individuals whose products or actions are complementary" (p.7)	"An interdependent network of self-interested actors jointly creating value" (p.2)
Analytical elements of focus	(joint) value proposition	Type of complementarities (supermodular vs. unique) and fungibility (generic vs. specific complementarities)	user value proposition	modularity (of components and complements)	members' goals
	members alignment (compatible incentives and motives)	(Need for) multilateral coordination at the group-level	complementarities between actors' offers (in terms of the potential for user value creation)	"design rules" (interfaces enabling connections and innovation)	members' network of relations and interdependence with goals
Representative example(s)	Michelin's run-flat tire technology (and connected actors)	Android system and connected apps; competing 5G-compatible IoT product systems; Sony videogame console and compatible videogames	Electric car (as "product ecosystem"); Apple's iPhone (as "platform-based ecosystem")	Apple mobile OS and apps developers; PC computer system and external developers	N.A.
How ecosystems and platforms relate	Platforms are outside the scope of ecosystems - "Whereas platforms are concerned with the governance of interfaces, ecosystems are concerned with the structure of interdependence." (p.54)	Platforms offers specific way to coordinate non-generic complementarities in ecosystems; not all platforms entail ecosystems.	Some ecosystems ("platform-based ecosystems") build on top of platforms which offer specific technological architectures connecting actors and offers	"Open platforms of all types rely on ecosystems of firms and individuals to supply many parts and perform many of the tasks needed to arrive at a complete product" (p.7)	Platforms (through their interfaces) can help structure relationships and interdependence of members' network