Industries, Ecosystems, Platforms, and Architectures:

Rethinking our Strategy Constructs at the Aggregate Level

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ABSTRACT

We have recently seen a proliferation of new terms such as "platforms" and "ecosystems" that reflect strategic dynamics at the aggregate level, motivated by changes in the nature of competition and the desire for theoretical differentiation. But what is really new about these terms, and how can they help us better understand the world? What are their comparative strengths, and how do they complement or contradict each other? To improve terminological clarity and consistency, we offer a tighter definition of "ecosystem", and discuss this concept's relationship to industry and multi-sided "platforms" and "industry architectures", as well as supply networks and sectors. We conclude by exploring promising paths for future research on these topics, and implications for mainstream strategy research.

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INTRODUCTION

How do we, in the field of strategy, think about the business context within which firms are embedded? As our field has matured, the constructs we use at the aggregate level of analysis have evolved considerably. During the 1980s, Michael Porter legitimized industry analysis just as industry studies were falling out of favour in economics (Schmalensee, 1989). For the next decade, significant attention was paid to industry conditions and the profit variance they could explain (McGahan and Porter, 1997, Rumelt, 1991). However, this interest in the nature of aggregate level did not last, and soon enough the pendulum swung back again. With the emergence of the Resource-Based View (Barney, 1991, 1996; Wernerfelt, 1984), the analysis of capabilities (Prahalad and Hamel, 1990), and the influence of evolutionary analysis (Nelson and Winter, 1982) on strategy, the focus returned to the firm. While new sub-fields examined the evolution of technologies (Tushman and Anderson, 1990), life-cycles (Klepper, 1997), and populations (Hannan and Freeman, 1977) at the level of the industry, the *nature* of the aggregate level – the definition of a "sector" or "industry", or even the "population" – was largely taken for granted (Jacobides and Winter, 2012).

The last few years, though, have seen a development that may have profound implications for how we think about firms in their environment. It is the concept of "ecosystems": webs of collaborating and competing firms that offer connected products and services (Adner 2006; Iansiti and Levien 2004; Moore 1993). In parallel, a fast-growing stream of research on "platforms" has emerged, and moved well beyond the traditional confines of network industries such as telecommunications and the narrow interpretation economists have opted for (Gawer, 2009; Gawer, 2014). Also, research on "industry architectures" (Jacobides, Knudsen and Augier, 2006) has suggested that industries are actually fluid entities, hotly contested by firms who aspire to manipulate the division of labour and profit.

All three of these streams, though originating from distinct traditions, share an interest in re-examining the nature of the aggregate level. They exhort us to move beyond the assumption of “a sector”, and use new constructs to explain firms’ actions and the results of their collective effort. In parallel, management practitioners and authors are increasingly using similar concepts (Adner, 2012; Autio and Thomas 2014; Boudreau and Lakhani 2009; Iansiti and Levien, 2004; Williamson and De Meyer 2012).

The added value of this emerging research, though, is jeopardised by a profusion of term definitions and the effort to be all-encompassing. This is especially true for “ecosystem”, which is increasingly used simply to denote the competitive context. Yet the question remains of what we actually mean by “ecosystem”, and how it differs from other constructs.

We start with a bibliometric analysis showing the rapid growth of the terms “ecosystem” and “platform”. We then consider the institutional, economic, and technological reasons to expect a greater interest in these new constructs, and present a literature review. Next, we look at the role of these new constructs as rhetorical devices that can illuminate features that existing constructs miss. We then explore the analytical and conceptual issues: Are these constructs really new? Can we demarcate what *is* or *is not* an ecosystem or a platform? This brings us to our intended contribution, as we propose a tighter definition for “ecosystem”, and identify the extent to which the concepts of “platform” and “ecosystem” compare and overlap, as well as explain how they relate to “industry architectures” and the traditional idea of industries or sectors.

We argue that *ecosystems are sets of firms in distinct positions that develop group-level co-specialization.* Then, drawing on the accepted definitions of multi-sided and industry platforms, we explain how these two concepts relate to each other and how they (partially) overlap with ecosystems. We then explore how both “ecosystems” and “platforms” relate to “industry architectures” (IA) and to traditional conceptions of industries, and suggest links with the analysis of industry standards. This allows us to suggest boundary conditions reflecting whether and when these new concepts are analytically helpful and distinct from existing constructs. We conclude by identifying promising areas for research on these "new aggregate level" analyses, and link back to the mainstream strategy literature.

THE "NEW AGGREGATE" IN STRATEGY RESEARCH: DOCUMENTING THE EMERGENCE OF "ECOSYSTEM" AND "PLATFORMS"

Emergent constructs: A bird's-eye view

Over the last few years, there has been a surge of research interest in "alternative" constructs at the aggregate level of analysis. Figures 1a and 1b below show the growth of papers featuring the terms "ecosystem" and "platform" respectively[1]. The growth in the use of "ecosystem" is significant in practice (*Economist*, 2014) as well as in research (Autio and Thomas 2014; Yoo *et al.* 2012), and its proliferation has been so extensive that there have been growing calls for theoretical consistency and clarity – as well as exhortations for more research (Autio and Thomas 2014; Teece, 2012).[2] The concept of "platform" has also blossomed, with strands of research looking at the dynamics of Multi-Sided Platforms (MSPs). The study of MSPs originated with studies of credit-card companies and ad-subsidized free newspapers, and was further invigorated by the dramatic growth of examples such as eBay, Amazon, and Google (Armstrong 2006; Farrell and Klemperer 2007; Parker and Van Alstyne 2005; Rochet and Tirole 2003, 2006). Over time, this literature has become more technical, so as to explore the growth of digital platforms (Boudreau 2012; Yoo *et al.* 2012) – but it has also broadened the definition of "platform" from the purely technological to include

[1] These figures refer to the number of articles with the term "ecosystem" or "platform" appearing in the titles, abstracts, or keywords in business outlets, as returned by ISI Web of Science (Social Sciences). To ensure that only relevant management research articles were captured through the ISI database, we excluded papers that only use these terms in their generic meaning. This gives a total of 398 of articles.

[2] "Ecosystem", in particular, has almost always been used with a positive connotation (Williamson and DeMeyer, 2012; Teece, 2012). Almost all papers published in management journals extoll ecosystems' ability to create value, contradistinguishing them from "old-fashioned" constructs or modes of organizing – a feature to which we return later.

the support of businesses and their environment (Ceccagnoli *et al.* 2012; Hagiu and Wright 2013). Finally, "industry architecture" (Jacobides *et al.*, 2006) has emerged as a potentially unifying concept, as it is explicitly focused on *structural* features, and considers how firms shape rules and roles that may or may not involve "platforms" or "ecosystems" (Ferraro and Gurses, 2009; Gurses and Ozcan, 2014; Pon *et al.* 2014; Pisano and Teece, 2007).

Insert Figures 1a and 1b around here

So what drove this shift away from "industries" as the key level of analysis? First, the real economy underwent a massive transformation. From the 1990s, the technological possibilities offered by IT, in conjunction with competitive forces, paved the way for dis-integration in sectors such as computers (Baldwin and Clark, 2000), and industrial production overall (Sturgeon, 2002). Regulators also attempted to vertically separate formerly integrated monopolies such as electricity, telecommunications, and government services, leading to the creation of diverse and often quite idiosyncratic ways to organize sectors, with significant differences across time and space (Jacobides, 2008). The financial services sector, starting with mortgages, ended up unbundling too, paving the way for the financial crisis (Jacobides, Drexler and Rico, 2014). Outsourcing grew as India and China flourished, with work shifting across both organizational and geographical boundaries, leading to the "dis-integration of production and integration of trade" (Gereffi, Humphrey and Sturgeon, 2005; Feenstra, 1998).

All this meant that the nature of industries, in terms of their boundaries and organization, could no longer be taken for granted. It led to a much greater variety of combinations between collaborating and competing firms. It also raised new design issues, as firms could use new ways of collaborating and co-creating that were not feasible in the past.

Literature followed these trends. Economic sociologists were already studying the way firms connect and how their networks are structured. Institutional sociologists were interested in the evolution of "institutional fields" (Fligstein and McAdam, 2011; Phillips, Lawrence and

Hardy, 2000) and arrangements that link different firms together, while institutional and evolutionary economists (Langlois 1992, 2007; Jacobides and Winter, 2005, 2012) considered how sectors change, and how new institutional arrangements emerge. Such was the context for the emergence of new constructs, which we now examine in turn.

Ecosystems: Origin, definitions, key attributes

Borrowed from biology, "ecosystem" generally refers to a set of organizations that are highly interdependent upon each other's input and output (Adner and Kapoor 2010; Iansiti and Levien 2004; Moore 1996; Teece 2007) or to a system of technologies that are related to one another in a specific context of use (Adomavicius *et al.* 2007, 2008; Ceccagnoli *et al.* 2012; Wareham *et al.* 2014). These two variations reflect the distinct focus of studies in strategic management and technology management, respectively.

Ecosystems in strategic management research. Under different labels such as "business ecosystem" (e.g., Moore 1993; Teece 2007), "innovation ecosystem" (e.g., Adner and Kapoor 2010), or "product ecosystem" (e.g., Ethiraj and Posen 2013), studies in the strategic management tradition have been motivated by the question of how firms can outcompete rivals by creating more value, particularly in contexts where other organizations influence the creation and delivery of a firm's product (Iansiti and Levien 2004; Moore 1993).

This research stream stresses that a firm must "be viewed not as a member of a single industry but as part of a business ecosystem" (Moore 1993: 76), defined as an economic community supported by a foundation of interacting organizations and individuals (Moore 1996). Some have highlighted the collective behaviour of the ecosystem by stressing the "shared fate" of the network as a whole (Iansiti and Levien 2004: 69), or the alignment of investments across ecosystem members to create value (Williamson and DeMeyer 2012). Others highlight the interdependence of innovations in production (components) and use (complements) in generating value for final customers (e.g., Adner 2006; Adner and Kapoor

2010; Autio and Thomas 2014) and conceive an innovation ecosystem as a set of "functionally related though often loosely coordinated actors" (Brusoni and Prencipe 2013: 169), or as a "small world network" characterized by a high degree of clustering and short path length between any two nodes (Iyer *et al.* 2006).

A fundamental characteristic of ecosystems as presented in these studies is value *co-creation* between parties, and the intensity of inter-firm relations. Uniquely, this results from coordination of firms' activities that is usually not governed by contractual, bilateral agreements (Brusoni and Prencipe 2013; Gulati *et al.* 2012; Williamson and DeMeyer 2012). Another ostensibly differentiating attribute of ecosystems is members' *co-evolution* of capabilities and roles (Fang and Wu 2006; Kapoor and Lee 2013; Kapoor 2013), with firms working cooperatively and competitively to develop new products and satisfy customer needs (Moore 1993, 2006; Williamson and DeMeyer 2012; Teece 2012).

Ecosystems in the technology management perspective. Research in this literature stream has been primarily interested in the adoption and evolution of technology. Under labels such as "technology ecosystems" (Adomavicius *et al.* 2007), "digital ecosystems" (Yoo *et al.* 2012), or "platform ecosystems" (Gawer and Cusumano 2008; Ceccagnoli *et al.* 2012), ecosystems have been conceptualized as complex systems of interrelated technologies. Adomavicius and colleagues (2007: 185) propose that technology evolution is best viewed as a "dynamic system or ecosystem that includes a variety of interrelated technologies". They suggest that different ecosystems can be identified on the basis of the context where the focal technology is used.

Within this research stream, ecosystems are studied as complex systems that are interesting for their inherent properties. They exhibit *generativity* – the ability to create new content, structure, or behaviour without additional input from the original creators (Tiwana *et al.* 2010; Yoo *et al.* 2012; Wareham *et al.* 2014) – and follow a *self-organizing* process, such that system-level order arises from the action of interdependent agents adapting to feedback from each other's actions (Dougherty and Dunne 2011).

Governance and Hierarchy in Ecosystems

Ecosystems' structures, their governance, and the (often implicit) role of hierarchy constitute important themes of ecosystem studies. Studies in the strategic management research stream focus on the role of a central firm, often referred to as the "lead firm" (Williamson and De Meyer 2012) or "keystone" organization (Iansiti and Levien 2004), in shaping the structure and workings of the ecosystem (Moore 1993, Teece 2007). According to Gulati *et al.* (2012), the presence of an "architect", who sets a system-level goal and defines the hierarchical differentiation of members' roles, is an essential and distinguishing feature of an ecosystem.

Iansiti and Levien (2004) maintain that keystone members create and regulate connections by providing a stable set of shared assets upon which other members can build their own offerings. However, others contend that the lead firm is not necessarily the largest or most resource-rich member of the ecosystem, but rather the one that uses "smart power" (Williamson and De Meyer 2012), "problem framing" (Brusoni and Prencipe, 2013), or "informal authority" based on knowledge, status, or control over key resources or technology (Gulati *et al.* 2012). These studies tend to agree that ecosystems are not subject to formal authority, but few have specifically looked at the rules governing membership and relationships within an ecosystem. Gulati and colleagues (2012) consider membership of ecosystems to be "open" – i.e., not granted bilaterally between the architect and the prospective member, but rather based on self-selection. Open membership has also been identified by studies that draw from open innovation strategy (e.g., Chesbrough, 2003; Chesbrough *et al.* 2014; West and Wood 2013).

Studies from the technology management research stream tend to see the core technology as the foundation of the ecosystem (Adomavicius *et al.* 2007; Baldwin 2014;

Gawer and Cusumano 2008). They also consider how technological features such as interfaces (and the question of which part of the technology is "open" and which is "closed") or governance rules (such as membership and participation rules) shape collective outcomes (Boudreau 2010; Gawer and Cusumano 2002; Gawer and Henderson 2007; Tiwana *et al.* 2010). Relatedly, a number of studies have considered the trade-offs of exercising too much or too little control over the core technology: too much control may limit the generativity of the system, reducing its ability to evolve; too little may render the system fragmented and unstable, and equally limit its capacity to evolve (Yoo *et al.* 2012). Balancing these tensions is one of the main goals of technology ecosystem governance (Wareham *et al.* 2014).

What's new? Key Hypotheses or Findings on Value Creation and Value Capture

To assess the contribution of these concepts to strategy research, we should examine how each one models value creation and capture. In the strategic management stream, ecosystems are seen as structures that enable firms to connect and create new products or markets by combining individual products and services into customer-facing solutions (Adner 2006; Williamson and DeMeyer 2012; Teece 2012). Value is then captured by gaining control over the configuration of the ecosystem (Teece 2007; Williamson and De Meyer 2012).

Research in this stream has shown how different collaborative arrangements for complementary innovations affect investment in, and the production of, innovations (Alexy *et al.* 2013; Chesbrough *et al.* 2014; Kapoor and Lee 2013; Kapoor 2013); how firms can mobilize tacit knowledge and leverage ecosystem members' heterogeneous competencies to deliver more complex solutions (Williamson and De Meyer 2012) or generate new knowledge (Brusoni and Prencipe 2013); how technical and behavioural uncertainty about firms' interdependent innovations may limit coordination and hamper the keystone's capacity to create value (Adner 2006; Adner and Kapoor 2010); and how changes in product design affect firms' innovation performance (Ethiraj and Posen 2013; Pierce 2009).

This stream holds that keystones or orchestrators shape the structure and pattern of interactions within the ecosystem to create and capture value (Brusoni and Prencipe 2013; Teece 2007, 2012), a position that also draws on IA research (Jacobides et al, 2006). In this view, firms aspiring to shape the ecosystem should create product designs, technological assets, or problem-framing processes that stimulate complementary partner investments and unleash value creation by reducing the complexity, ambiguity, and uncertainty surrounding collaboration (e.g., Ethiraj and Posen 2013; Brusoni and Prencipe 2013; Adner and Kapoor 2010, 2014; Pierce 2009; West and Wood 2013; Williamson and DeMeyer 2012).

Studies in the technology management research stream have highlighted that technology ecosystems create value by solving a technological problem within a given context of use, and enabling complementors to leverage the core product, service, or technology (Baldwin 2014; Ceccagnoli *et al.* 2012; Gawer and Cusumano 2008; Yoo *et al.* 2012). Value is captured at the ecosystem level through competition with rival technology ecosystems, and by controlling the core technology solution (Gawer and Cusumano 2008; Adomavicious *et al.* 2008).

Studies have looked at factors affecting firms' ability to develop the technology infrastructure that binds the ecosystem together. Gawer and Cusumano (2008) discuss "coring" and "tipping"; Baldwin (2014) discusses the role of technological bottlenecks[3]; others focus on the combinatorial attributes of the technology (Adamovicious *et al.* 2007, 2008), the convergence of mobile technologies (Basole 2009), the generative capacity of the system (Yoo *et al.* 2012) or "technological clockspeed" – the time required for a particular sub-industry to utilize the level of technological performance that is provisioned by another, interdependent sub-industry (Makinen and Dedehayir 2013), and how interdependencies between technology providers change releases of a core technology (Adomavicius *et al.* 2012)

[3] Baldwin defines technological bottlenecks in terms of the way components interact to create value for users. A technological bottleneck is a component in a complex system whose performance significantly limits the performance of the system. This is consistent with earlier work by Ethiraj (2007) and Jacobides *et al.* (2006).

Platforms: Conceptualization and Key Attributes

The construct of "platform", while related, is separate from that of "ecosystem". It developed in parallel in the literatures of engineering design and economics – without, until recently, much cross-fertilization. While the word "platform" has been used in both streams, the defining characteristics of the construct only partially overlap. Key examples in recent contributions, however, have been strikingly similar across these streams, and include Google, Facebook, Amazon, and Apple.

The engineering-design perspective (Jiao *et al.*, 2007; Krishnan and Gupta, 2001; Meyer and Lehnerd, 1997) views product platforms as technological designs that help firms generate modular product innovation. In the economics view, platforms are seen as special kinds of markets that facilitate exchange by allowing direct transactions between different types of consumers who could not otherwise transact. In this view, platforms have been variously referred to as "two-sided markets", "multi-sided markets", or "multi-sided platforms" (MSPs) (Armstrong, 2006; Evans and Schmalensee, 2008; Evans, 2003; Rochet and Tirole, 2003, 2006; Rysman, 2009). Network effects between the "two sides" of the market are seen as central in this tradition – so much so that Rysman (2009: 127) states that "in a technical sense, the literature on two-sided markets could be seen as a subset of the literature on network effects".

Scholars have tried to bridge these two streams by working toward a "unified view" (Baldwin and Woodard, 2009) or "integrative framework" (Gawer, 2014). Also, recent work (Anderson *et al.* 2014; Boudreau, 2010, 2012; Ceccagnoli *et al.* 2012; Eisenmann, Parker and Van Alstyne, 2011) uses operationalizations of platforms that are consistent with both the economics and the engineering-design view.

In the economics-based research, with its focus on network effects, the multi-sided structure of a market is seen as exogenous and fixed. Research documents the self-reinforcing feedback loop that magnifies incumbents' early advantages, and strong network effects can, under certain conditions, drive competition between platforms to a "winner takes all" outcome (Eisenmann, Parker and Van Alstyne, 2006; Lee, Lee, and Lee, 2006).

By contrast, in the engineering-design stream, platforms are technological designs of *product* architectures[4] (Ulrich, 1995) that help firms develop product families (Sanderson and Uzumeri, 1995) and innovate more quickly and systematically by re-using common assets (Krishnan and Gupta, 2001), and where firms can benefit from the recombination options afforded by modular designs (Baldwin and Clark, 2000; Schilling, 2000; Garud and Kumaraswamy, 1995). These studies developed the construct of "platforms" by exploring the innovation implications of the concept of "design hierarchy" (Clark, 1985) on methods of product development and production.[5]

Platforms: Key Hypotheses or Findings on Value Creation and Appropriation

In economic models, value is captured through platform competition, driven by the adoption of the platform by multiple consumer constituencies. As the value of the platform stems principally from the access of "one side" to the "other side", adoption is a question of "how to bring multiple sides on board" (Evans, 2003; Rochet and Tirole, 2006) while avoiding the "chicken-and-egg problem"[6] (Caillaud and Jullien, 2003). Parker and Van Alstyne (2005), Rochet and Tirole (2003 and 2006), and most others suggest that appropriate pricing,

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[4] 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; (3) the specification of the interfaces among interacting physical components (Ulrich, 1995: 422).

[5] For Wheelwright and 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 and Lehnerd (1997), and Krishnan and 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 andand Clark, 2000; and Robertson and Langlois, 1995, Huang *et al.*, 2005; Simpson *et al.*, 2006; Jiao *et al.*, 2007), but with a twist: a platform is a particularly important and central module (Baldwin and Woodard, 2009).

[6] This problem relates to the key dilemma platforms face when building the market: users on one side would not have interest in joining the platform unless there are complementors on the other side to transact with; at the same time, complementors would have limited incentives to affiliate to a platform that has no users.

involving the subsidizing of "one side" of the platform in order to attract the "other side" to join, is the solution.

Studies in this stream tend to support economics-based views on variation in pricing and business models, drawing from examples in ICT, media advertising, videogames, or the payment industry (see for example Evans *et al.*, 2006; Rysman, 2004; Seamans and Zhu, 2013; Wilbur, 2008; Zhu and Iansiti, 2012). While earlier research focused on the prevalence of "winner takes all" dynamics (Eisenmann *et al.* 2006, 2006), more recent work (Cennamo and Santalo, 2013; Boudreau and Jeppesen, 2014) has introduced more nuanced views. In particular, a few studies have looked not just at one platform in isolation, but at the factors that may limit "winner takes all" dynamics and lead to the co-existence of multiple platforms, and how this may affect the incentives and strategies of various players, particularly complementors (Corts and Lederman 2009; Landsman and Stremersch 2011; Mantena *et al.* 2010).

By contrast, in the engineering-design literature, platforms create value by allowing various economic agents to innovate more rapidly and cheaply. Potential complementary innovators self-identify to the platform owner, and can use codified information on platform connectors[7]. The design of the interfaces around the platform, and the extent to which they are "open" or "closed" (West, 2007), have a direct effect on the facilitation of complementary innovation at the industry level (Langlois and Robertson, 1992).

ASSESSING THE VALUE-ADD OF THE "NEW AGGREGATE" CONSTRUCTS

The concepts of "ecosystems" and "platforms", then, have helped identify some important interconnections between actors, and helped reinvigorate research that focuses on the "aggregate environment", summarized in Tables 1a and 1b. The excitement in the literature, documented in our second section, is matched by that of practitioners: innovation ecosystems

[7] For example, Application Programming Interfaces (APIs) are the ubiquitous connectors created to allow third-party programmers to connect to software platforms.

are becoming part of the political agenda (e.g., The European Innovation Ecosystem Initiative), while others have gone so far as to talk about the "platformization" of the entire economy (*Economist* 2014). Google's Chairman, in his latest book, says that "in the twenty-first century, The Corporation as a hub of economic activity is challenged by The Platform" (Schmidt and Rosenberg, 2014: 245).

While such enthusiasm may aid our scholarly cause, it can also cloud our critical view. Perhaps existing constructs could work just as well, and "ecosystem" (or even "platform") is just the new word for what we used to call an "industry", "web of alliances", or "industry cluster". To assess the potential value-add of our new concepts, we take a two-step approach. First, we look at how these new terms might help us see reality in a new light. Second, we consider issues with the definitions-in-use, before turning to our proposed solution.

Insert Tables 1 and 2 about here

New Constructs as Framing Devices

What do these new constructs help us "see better" compared with established ideas? To answer this question, we use the example of an "old-economy" business, a supermarket, to see what a "platform" or "ecosystem" perspective might offer, summarized in Table 2.

In the traditional strategic vocabulary and worldview, supermarkets can be seen as resellers of goods, partly integrated and partly specialized, with supply chains that may be transactional or organized as a managed network. Strategic analysis would thus focus on input procurement and transactional alignment, as well as supply-chain and supplier management, and of course competition with other supermarkets, and the associated resources and capabilities needed.

Taking a multi-sided platform perspective would shift the focus to lateral transactions, with supermarkets seen as marketplaces for direct or facilitated transactions between customers and suppliers of goods. These goods would be seen as complements whose availability would increase the “value” of the platform (i.e. the supermarket) to customers, which in turn would increase its value to sellers as a marketplace. These sellers are no longer seen as suppliers, but as complementors with whom the platform attracts and cooperates to co-create a market.

This perspective also implies a rethink of business logic. Value is created by involving sellers and customers to increase variety and reduce search and transaction costs. Value can be captured by increasing the volume of transactions and locking in customers and/or providers, allowing the supermarket to charge a higher margin, or a lower margin on a higher volume.

An “ecosystem” perspective would see the supermarket as an economic agent embedded in a web of interdependent relationships with other agents. Such a view can help us focus on symbiosis, and identify ways in which traditional competitors along a sector might find ways to collaborate and add joint value. Goods can be seen as complements that “extend” the value and appeal of the supermarket to final customers. On the other hand, since it has “links” with both final customers and complementors, the supermarket can position itself as an “orchestrator”, coordinating complementary activities to best satisfy customers’ needs. In this sense, a supermarket, as well as letting goods-producers sell through its stores, also collaborates with some of them to create special editions of products that are sold under its own brand.

In this perspective, suppliers of goods and services are potential bottlenecks for value creation or value delivery to customers, and for providing co-creation opportunities of new goods and services. Value is created by designing and managing the ecosystem in order to minimize bottleneck risks and/or facilitate opportunities for co-creation, while value capture may be achieved by gaining control over the critical assets that other members need to generate complementary value.

How are “Ecosystems” and “Platforms” distinct and useful?

The example above suggests that our new concepts might help us by providing new, suggestive analogies and identifying analytical options that dominant frameworks might obscure. However, a new theoretical construct needs to do more than reframe issues we already know; it should reflect phenomena that cannot otherwise be named and described.

To provide a concrete example in the supermarket case, firms forging relationships with producers to sell under their own brand may be characteristic of what we call an “ecosystem”, but it is not a new phenomenon. Most supermarkets both compete with FMCG producers, and also collaborate with them to create their own-branded product lines through a practice known as white-labelling. The “traditional” analytical framework allows for this, considering it an effort to reduce the power of suppliers by reducing their ability to differentiate (Porter, 1980). Shifting from “industry” to “ecosystem” might colour our analysis and, without a clear set of definitions and boundary conditions, we may end up missing insights we would otherwise have retained from existing frameworks. The question then becomes, what is *special and unique* about these new ways of studying the aggregate level – particularly “ecosystems”?

The literature seems to single out interdependence, co-creation beyond the dyadic level, and co-evolution as the distinguishing features of ecosystems (Moore 1993; Williamson and DeMeyer 2012; Autio and Thomas, 2014). Yet interaction *per se* is not new: studies of it abound in the analysis of industrial districts and clusters (Saxenian, 1994), and the co-evolution of population has been an important topic for many years (Baum and Singh, 1994), and more recently has been explored quantitatively (de Figuerido and Silverman, 2012; Negro and Sorenson, 2012). That said, ecosystem analysis does provide a more direct focus on complementarity and cross-industry coordination complexity (Brusoni and Prencipe 2013; Kapoor and Lee 2013; Teece 2012), helping to advance research on co-evolution and value co-creation (Brusoni and Prencipe 2013; Iansiti and Levien 2004; Kapoor 2013; Moore 1993; Teece 2012).

What does seem to be novel here is the examination of the nature of interdependence between ecosystem members, with a focus on profit and value, as opposed to survival or growth alone. The ecosystem literature of the last decade has eschewed traditional conceptions of "industry", "sector", or "market", where the main modality of interaction between firms is competition, to shift our attention to the nature of co-dependent firm groupings that co-create value through complex modes of interaction that combine competition and collaboration.

However, definitions centred on interdependence may not help, as they describe an *outcome* rather than a structural feature. More to the point, as they do not explain how this interdependence differs from existing constructs, including "value nets" (Nalebuff and Brandenburger, 1997), "value networks" (Allee, 2000; Norman and Ramirez, 1993) or even supply chains (Womack *et al.*, 1990). Table 3 provides further examples, including "strategic groups", "strategic networks", and "clusters".

Insert Tables 3, 4 and 5 about here

Exacerbating the challenge of novelty, much recent work has been increasingly ambitious, especially in terms of the definition of "ecosystem". This intellectually expansionist tendency is entirely understandable in an emerging field that wants to maximize its applicability, but potentially hampers its value-add. As Tables 4 and 5 show, definitions are diverse and sometimes divergent (especially for "ecosystem"), and the conceptual relationship between "ecosystems" and "platforms", however the latter are defined, is not clear. Since the two terms are often used interchangeably, it is essential that we clarify their definitions and boundary conditions – which is what we now turn to.

DEFINING ECOSYSTEMS AND THEIR RELATIONSHIP WITH PLATFORMS AND INDUSTRY ARCHITECTURES

A tighter definition of "ecosystem"

Everything is interdependent, to a greater or smaller degree. So the emphasis on interdependence, central as it may be, cannot provide a definitional boundary for "ecosystem". A definition might be better directed to *structural* features that *entail* a particular type of interdependence. Therefore, we propose that:

> An ecosystem is *a set of firms in distinct positions along a sector or set of sectors that have group-level, mutual co-specialization, and are not unilaterally hierarchically managed.*

This encapsulates three crucial attributes of an ecosystem. First, "group-level, mutual co-specialization". The notion of co-specialization draws on Transaction Cost Economics (Williamson, 1985). However, unlike TCE, we look not at the relationship within *dyads*, but rather between *groups*. From TCE we retain the economic foundations of co-dependence, and from the ecosystem analysis we look at the dynamics of groups of firms whose fortunes are tied together (hence "mutual").

"Co-specialization", as we define it, means that in order to join an ecosystem, there must be some investment that is *not fully fungible.* That is, the investment, or assets in place, cannot be used elsewhere without cost. This is, in our view, the fundamental structural feature that creates the strategically distinct nature of ecosystem interaction.

Second, our definition points out that an ecosystem comprises firms "in distinct positions along a sector or set of sectors". This distinguishes ecosystems from horizontal alliances (e.g., StarAlliance or OneWorld in terms of airlines). While such alliances may decide to create ecosystems around them, they are not ecosystems in themselves. However, while the existence of firms in different parts of a value-added system is a *necessary* condition for us to confirm that an ecosystem is present, it is not *sufficient.*

Third, our definition points out that ecosystems are "not unilaterally hierarchically managed". For all the power of the "keystone" or "orchestrator", ecosystems lack hierarchical controls such as those found in traditional firm groupings such as *Keiretsus* or *Chaebols*. This suggests that there is no party that can unilaterally set the terms for prices and quantities. That is, we posit that ecosystems need to be both *de jure* and *de facto* run with decision-making that is *to some extent* distributed, and without all decisions (especially on both prices and quantities) being hierarchically set. This also allows us to distinguish between ecosystems and supply chains, since in supply chains the "hub" (OEM, or buying firm) has hierarchical control – not by owning its suppliers, but by fully determining what is supplied and at what cost. Thus Toyota, which is at the centre of a group of co-dependent suppliers that occupy different parts of the value chain and co-specialize with it (Nishiguchi, 1994), unilaterally decides what it will procure, from whom, and at what cost. Toyota is not, by our definition, the keystone of an ecosystem. Apple, on the other hand, with its App Store, *is* a keystone. It manages participation criteria, standards, and rules, but does not decide how many apps will be published or downloaded; nor does it set prices, beyond setting an acceptable range.

MSPs and industry platforms and their link to ecosystems

Unlike "ecosystem", "platform" has been defined more narrowly in its literature. That said, as the economics- and engineering design-based streams have developed independently, the link between their respective definitions (and with that of "ecosystem") has not been clarified.

To reiterate, *multi-sided platforms* (MSPs) are markets enabling direct transactions across different customer groups, characterized by network effects between these groups (Armstrong, 2006; Evans *et al.* 2006; Eisenmann *et al.* 2011; Rochet and Tirole, 2003, 2006;). In contradistinction, *industry platforms* are technological designs that facilitate autonomous agents' innovation on complementary products and services (Gawer, 2009a; Krishnan and Gupta, 2001; Sanderson and Uzumeri, 1995; Ulrich, 1995).

Clarifying these definitions is tricky, because they focus on different aspects of partially similar phenomena. Adding to this complexity, some authors even discuss them as if they were synonymous or interrelated concepts. For instance, Wareham and colleagues (2014: 1197) define technology ecosystems as "product platforms defined by core components made by the platform owner and complements made by autonomous companies in the periphery". Gawer (2009: 2) claims that the [industry] platform "acts as a foundation upon which other firms, loosely organized in an innovation ecosystem, can develop complementary products, technologies or services".

A clear point of differentiation however, is that, while MSPs focus on the transactional aspects of modalities of interaction between agents, industry platforms focus on innovation. Ecosystems, meanwhile, focus on various kinds of interdependences between agents.

The Venn diagram in Figure 2 examines whether there any MSPs that are not industry platforms, or whether there can be platforms that are not ecosystems, or vice versa. As it shows, the constructs do not completely overlap – which suggests that they are not substitutable. For instance, there are MSPs that are not industry platforms, such as AirBnB, Match.com, the Apple App Store, Amazon Marketplace, and net-based taxi services such as Uber or Hailo. Each of these platforms clearly facilitates connections and/or transactions between sets of agents, in the context of network effects, but they do not particularly facilitate autonomous agents' innovation on complementary products or services.

On the other hand, there are industry platforms – such as AUTOSAR, ARM, Qualcomm, or Intel – that are not MSPs: while they do enable other firms to innovate "on top of" their technology design, these platforms do not create multi-sided markets within which these complementors transact directly with final customers. We also find that there are MSPs that are at the same time industry platforms, such as Facebook for developers and SAP NetWeaver: not only do they facilitate transactions between agents who could not otherwise connect with each other, but they also provide the core technology upon which an array of firms can develop complementary technologies, products, or services. Also, companies including Apple, Google, and Facebook offer interconnected sets of technologies and services that combine characteristics of MSPs and industry platforms, such as Apple iOS, an industry platform that is necessary for the App Store (an MSP) to operate, and Google Android, an industry platform that is necessary for the Google Play store (another MSP) to operate.

Some examples of MSPs and industry platforms are also ecosystems in our tighter definition. However, there are pure transactional platforms, such as Match.com, AirBnB, eBay, or Amazon marketplace, that do not have group-level co-specialization. There are also ecosystems that are neither MSPs nor industry platforms, such as Apple's iTunes.

Illustration: Unpacking Apple's ecosystem and platforms

We can use our clearer definition to provide a more precise characterization of Apple, the one firm above all others that has become synonymous with ecosystem and platform leadership. The first thing that becomes apparent is that different aspects of Apple fall into different categories. The App Store, iOS, and iTunes all appear in different regions of our Venn diagram, while others, such as the manufacturing of its hardware, are outside it completely. More specifically, the App Store *is* an MSP, and also an ecosystem, but it is *not* an industry platform. Third-party App developers need to work specifically on Apple specs, and they depend on Apple's success to succeed themselves, but Apple has no unilateral control to set prices *and* quantities, even if it does retain significant control in terms of accreditation and pricing guidelines. This contrasts sharply with Apple's hardware production, where it is unequivocally in charge of a tightly managed supply chain.

Apple's iTunes, by contrast, is an ecosystem by our definition, but it is neither an industry platform nor an MSP. The iTunes application allows digital media to be bought from the iTunes Store, downloaded, and synced to the end customer's own devices. But unlike the App Store, the iTunes Store is *not* an MSP, since it does not allow *direct* transactions between final customers and digital media publishers. Instead, Apple mediates these transactions, functioning *de facto* as a traditional reseller (see Boudreau and Lakhani, 2009; Hagiu and Wright, 2013). In addition, the iTunes Store is not an industry platform, because it does not facilitate innovation on complementary products or services by agents in distinct segments of the industry. We do, however, contend that iTunes (media content and Store) constitutes an ecosystem, as it requires mutual, group-level co-specialization between sets of firms that occupy different parts of the value-adding process, and media publishers cannot generally repurpose files made for iTunes for other ecosystems.[8]

ECOSYSTEMS AND PLATFORMS IN CONTEXT

Armed with our tighter definition, we move to relating ecosystems and platforms to industry architectures and previous work on standards, before turning to promising avenues for future work and implications for mainstream research.

Ecosystems, Platforms, and Industry Architectures

Ecosystem and platform research, as we noted earlier, has several links with the growing literature on industry architectures (IA). IA research focuses on the rules and roles that pertain to the division of labour (Jacobides et al, 2006) in a sector, as they shape the division of profit. Its contribution is to explain how firms benefit through their efforts to shape the architecture of their sector (Ferraro and Gurses, 2009; Gurses and Ozcan, 2014; Jacobides and MacDuffie,

[8] Music or video content is limited by the technical and legal standards defined by Apple (the Apple proprietary MP4 format /AAC standard and proprietary Digital Rights Management, which Apple had created to create non-fungibility, which has been upheld with varying degrees of success.)

2013; Pisano and Teece, 2007; Pon *et al.*, 2014; Tee and Gawer, 2009). IA research suggests that the structure of a sector, or of a related set of sectors, should not be taken for granted; in this sense, it allows for ecosystems or platforms but does not assume their existence. In the context of our comparative map in Figure 2, the IA would describe how labour is organized, and would include the potential existence of ecosystems, platforms, or more traditional supply chains, or independent (and interdependent) segments.

Ecosystem and platform research might benefit by considering the broader IA context (Tee and Gawer, 2009); conversely, IA research might benefit from the analysis of how ecosystems and platforms allow particular firms, or segments, to become "bottlenecks" and retain value (Dedrick et al, 2010). Jacobides and Tae (2015), for instance, tracked the profitability of each of the different value-adding steps in the computer sector, focusing on different vertical segments and the presence of strong firms ("kingpins") who shape the sector to their advantage, and the advantage of others in their segments. They explicitly shied away from the analysis of competing groupings that bring together different parts of the value chain (i.e. platforms or ecosystems) – e.g., the Apple iOS ecosystem vs the IBM-compatible ecosystem. However, both dimensions (vertical competition between segments, and competition between ecosystems that span segments) seem important to us. Thus, IA could both benefit from a clearer focus on ecosystems and platforms *within* architectures; conversely, ecosystem and platform analysis should include the IA context.

Ecosystems, Co-specialization, and Standards

Ecosystems, in our definition, are defined by group-level co-specialization. Actors in one part of an industry (e.g. app developers, infrastructure providers, or mall participants) commit resources, build assets, invest in capabilities, or create products and services that would not have value in a different context. This highlights the importance of *fungibility:* the harder it is to transplant investments and products to a different ecosystem, the more dependent a firm will be on the ecosystem it occupies. Conversely, the easier it is to switch, the less interested a firm will be in a *given* ecosystem. At the limit, when switching is effortless and costless, we no longer have an ecosystem, but rather a set of interdependent segments.

This is best illustrated by an example. Consider the ecosystems around Google's Android, and Apple's iOS. Inasmuch as products, services, and technical assets are *ecosystem-specific and non-fungible,* there is a significant degree of ecosystem dependence. This can be seen through the distinction between apps, which are platform-specific, and other products (such as speakers or accessories) that can be used with many platforms.[9]

Given that ecosystems (whether or not they are based on platforms) are based on group-level co-specialization, it follows that this will be based on a specific set of specifications or standards. Some ecosystems might have clear, possibly *de jure* defined standards, especially if they have many members. Others, especially those not based on technology, might have *de facto* expectations in terms of the rules of engagement.

Seen from this perspective, early contributions in the standards literature (see Cusumano, Mylonadis and Rosenbloom, 1992) have important implications. The battle between VHS and Betamax discussed by Cusumano *et al.* (1992), for example, can be seen as a struggle between rival ecosystems. Within an industry, we may have one or more ecosystems, and standards battles (David and Greenstein, 1990; Farrell and Saloner, 1985; Garud, Jain and Kumaraswamy, 2002; Shapiro and Varian, 1999) are often ecosystem battles in disguise – since the outcome will affect firms' non-fungible investments.

We should, however, clearly distinguish between *industry-wide standards,* i.e. standards used by all firms, and *ecosystem-specific standards,* which support group-level co-specialization. Consider audio codecs: MP3 and MP4 are industry-wide standards that are not

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[9] Individual firms, of course, can choose to participate in more than one ecosystems – e.g. to write apps for Android, Apple, but also Blackberry. This doesn't mean the firm would not be a part of an ecosystem; as a matter of fact, provided the writing of the code or the App isn't fungible, it may be part of *many* ecosystems, and its choice may be constrained by the rules each ecosystem has on participation, or the firms' appetite to invest.

connected to any firm or group of firms, whereas Apple's AAC system, bundled with DRM, ties firms to a specific ecosystem.[10]

This also suggests that the creation of a series of technological standards – such as 3G or 4G in mobile telecommunications – does not necessarily qualify as an ecosystem. Firms that collaborated on 3G or 4G were creating the landscape in which different ecosystems could compete, but rules, roles, and technical specifications that apply to *all* players are not "ecosystems" by our definition, because they do not necessarily create mutual co-dependencies. Rather, they are aspects of industry architecture: they provide the foundations, which affects how labour will be divided. Put simply, ecosystems are a special case of standardization in which firms mutually co-specialize.

Of course, rules that affect all firms may still have implications for ecosystems.[11] Overall, it is clear that groups of firms collaborate and compete to shape the IA, partly through standards wars – conflicts which, as Besen and Farrell (1994), Shapiro and Varian (1999), and Rosenkopf and Tushman (1994) have pointed out, have substantial strategic implications. These wars impact the distribution of profit along a sector, but also the possibility for successfully launching or sustaining ecosystems and platforms. Finally, our analysis suggests that while ecosystems largely require standards, the emergence of standards in itself does not signify the existence of an ecosystem – and standards (and standards conflicts) can emerge outside an ecosystem context.

[10] The distinction between open and closed standards is closely related, but not identical. Usually, ecosystem keystones will want to control some of the key standards, but even open (but competing) standards can create the group-level co-specialization that defines an ecosystem.

[11] For instance, in the financial services sector, recent changes in terms of regulations linking different types of actors (such as the "Retail Distribution Review in Financial Services" in the UK) shape the ways in which firms who operate in different parts of the sector can connect, how they can charge commissions, how they report, etc. This affects *all* firms and as such shapes the IA, but it also shapes the potential benefits and shortcomings of non-captive, non-fully-hierarchically run groups of firms, as well as the extent to which group-level co-specialization is or is not allowed or encouraged by law.

DISCUSSION AND IMPLICATIONS FOR RESEARCH

To conclude our analysis, we now turn to the research areas we think can yield the greatest insight in helping us better understand ecosystems, and more broadly the shifting nature of aggregate constructs in strategy research.

Rethinking the nature, structure, and evolution of platforms and ecosystems

For "ecosystem" to become more than an evocative term, the birth, growth, and decline of ecosystems must be studied with impartiality. Otherwise, there is a risk that the excitement of novelty will hamper our critical sense of when such terms are appropriate.

There are some important questions to answer in terms of operationalization. For instance, how granular should we be as we define the boundaries of an ecosystem? Should we speak generally of a firm's ecosystem (e.g., Moore 1993) – for example, "the Google ecosystem" – or rather of contextual ecosystems (see Adomovicius *et al.* 2007) such as "Google's search-engine ecosystem", "the Android ecosystem", "the Google Maps ecosystem", and so on? The problem here is that both the variety of participants and the variety of involvement of one firm in many related realms makes it difficult to define the boundaries of ecosystems. While we take comfort from the appreciation of some authors for open and permeable boundaries (Gulati *et al*., 2012: 576), we feel that in order to build a cumulative body of knowledge, we need rules on how to set the scope of our analyses, and our suggestion is to look separately at each of the individual ecosystems that a firm belongs to (as we did in our analysis of Apple's App Store and iTunes). This suggests that we must *resist the temptation to align ecosystems with companies or brands,* as this can obfuscate the analysis by conflating entirely distinct elements.

To make progress in our understanding of ecosystems, platforms, and IAs, we suggest a three-pronged approach. First, a focus at the context in which ecosystems (or platforms) emerge, grow, and decline; second, a more robust analysis of their structural and governance features; and third, a firm-based approach to better understand how one organization can manage the interactions between its actions in (or even sponsorship of) different ecosystems or, especially for complementors, how they cope with the dilemmas of participating in different ecosystems and platforms.

First, taking the perspective of context, we can use the tighter definition we put forth to create a map of the way sectors are organized, so as to understand when and how ecosystems, industry platforms, or multi-sided platforms emerge. Only by looking at the historical context of the shift from interdependent segments to groups of mutually dependent, sector-spanning ecosystems will we be able to better appreciate the real-world value-add of particular types of ecosystems and platforms, and the features that enable or constrain them. Also, as well as documenting how ecosystems and platforms originate and evolve, we should look at how they decline and wither.

There are several exciting questions to consider. What factors may allow or hinder the creation of an initial, or contender ecosystem? Under which conditions, and how, do tightly managed ecosystems unbundle through the adoption of universal standards? What factors may lead an ecosystem keystone to decide to become more integrated, turning an ecosystem into a supply chain – and, conversely, when does a keystone switch from a managed hierarchy to a more open structure? What is the role of internal factors, as opposed to the state of the competitive environment? To address these questions, we need to understand and distinguish the roles of technology, strategic choice, and regulation in enabling platforms or ecosystems to emerge, grow, decline, and dissipate. We also need to understand the dynamics in nascent sectors or ecosystems, which have received a fair amount of attention of late (e.g., Gurses and Ozcan, 2014; Hannah, 2014) and contrast them with more mature settings.

Second, we need to better understand the way ecosystems and platforms are structured and governed. Our definition of ecosystems, for instance, suggest that they may be hierarchically managed, but not unilaterally so. While we consider iTunes to be an ecosystem, Apple still manages it quite aggressively, for example by determining the price of music. (In 2003, CEO Steve Jobs famously agreed a payment of 99¢ per track with the major labels – in contrast to Apple eBooks, which have a more flexible pricing strategy.) The App store gives Apple the right to determine what applications are "off brand", and also how to charge (Boudreau and Lakhani, 2009). At the other end of the spectrum, Amazon allows its Marketplace partners to set prices for the items they sell, and then takes a cut. Uber has two ways of interacting with taxi drivers: one where it sets the price itself, and another (UberX) where the driver sets the price following Uber guidelines. Several questions arise. What determines the level and form of control in an ecosystem? Which control mechanisms can a keystone use? How do they relate to group-level co-specialization? At what point does the exercise of power transform an ecosystem into a supply chain?

More broadly, we need to better understand the extent to which ecosystems are hierarchically structured, or centred around a "keystone" (Iansiti and Levien, 2004), "platform leader" (Gawer and Cusumano, 2002), "hub" (Dhanaraj and Parkhe, 2006), or "innovation integrator" (Nambisan and Sawhney, 2011). Much of the literature has implicitly assumed, or explicitly argued, that ecosystems are centred around an individual firm, which takes care of both its own interests and the health of the ecosystem (or should do so). But we need more research into the circumstances under which more distributed governance can emerge, such as in the open source movement (O'Mahony and Ferraro, 2007; O'Mahony and Bechky, 2008).

Another related area to explore is the nature of participation in an ecosystem, its drivers, and its consequences. Here we can distinguish between open and closed ecosystems, with several shades of grey in between. Some ecosystems accept any participants who agree to a minimal set of rules, whereas elsewhere membership is strictly controlled, whether by committee, or by the "keystone", if one exists. Consider, for instance, different videogame consoles' ecosystems. Historically, Nintendo has set strict rules for participation, imposing exclusivity clauses and limiting the number of complements members can develop for its systems. Rival ecosystems, such as those sponsored by Sony or Microsoft, have adopted rather more *laissez-faire* policies. Also, in some ecosystems, rules may change over time, as in the case of Facebook (Claussen *et al.* 2013). We need to understand how membership rules vary, what drives this variation (and its competitive impact), and how this relates to standards (open vs. closed, proprietary or sector-wide).

Finally, we need to complement our analysis of context, and the in-depth understanding of individual ecosystems and platforms, with the way in which individual firms combine their positions across multiple ecosystems. With the growth of firms like Google, Amazon, Facebook, Microsoft, and Apple, and their increasing webs of influence, illustrated in Figure 3, we need tools of analysis that examine the strategic logic through which one firm manages many different ecosystem or platform positions; and the way in which less privileged complementors decide how to participate in one or many ecosystems and platforms, moving beyond the analyses of multi-homing (Ceccagnoli *et al.* 2012; Kenney *et al.* 2014).

Include Figure 3 around here

In doing so, we need to move beyond strategic outcomes, and look at welfare, corporate control, and the dynamics of innovation. Such a systematic view might challenge the fervour of research that promotes the operational benefits of platforms and ecosystems in innovation, and identify the societal risk from some of the giants shown in Figure 3 controlling the business environment.

Value Creation and Appropriation in Ecosystems and Platforms

The enthusiasm in much of the field about ecosystems may draw on the perspective of the prospects of a strong hub firm such as Apple, which can leverage a unique skill, brand, technology, or set of capabilities to enlist complementors and expand its value-adding processes without committing capital. But there are risks in applying this perspective too widely. When, exactly, should a firm become a “hub”? Looking past the shiny success stories, the question becomes, what are the features of a good “hub” or “keystone”, and what can we learn from firms that tried to become one, but failed? And, for the keystones that do make it, should they try to tie complementors exclusively to their ecosystem, as Nintendo used to? How does this affect the value of complementarity of activities and products within the ecosystem, and differentiation across rival ecosystems?

Second, Googles, Apples, or Amazons are few and far between. Most ecosystem members are complementors (for instance, in July 2014 there were 2.3 million individuals working as App developers), with very limited power. While research has started to consider their plight (Ceccagnoli *et al.* 2012; Huang *et al.* 2014; Kapoor 2013; Selander *et al.* 2013), it has mostly examined firms facing tactical decisions such as multi-homing (Bresnahan *et al.* 2014; Landsman and Stremersch 2011; Mantena *et al.* 2010). Many “big ticket” questions remain, and research has only just begun to address the strategic dilemmas of ecosystem participants (Hannah, 2014).

Third, questions of value creation and value capture tend to focus on one ecosystem at a time – Apple’s iOS or Google’s Android, for instance, and not the interaction of the two. While this is entirely understandable as a research strategy, it may be flawed inasmuch as the actions of the potential participants in either ecosystem will depend on the *relative options offered by the alternative ecosystem.* Thus, we will find it hard to understand one ecosystem and its rules without direct reference to the other: to understand Hailo, we need to understand Uber and local taxi despatch structures.

Finally, there is the question of process. What capabilities are needed to set up and nurture an ecosystem or platform? There is a growing set of studies on shaping sectors (Gurses and Ozcan, 2014; Jacobides and MacDuffie, 2013), and some more appreciative research on ecosystems (Brusoni and Prencipe 2013; Nambisan and Sawhney, 2011; Teece 2007; Williamson and DeMeyer 2012). While some studies have documented tradeoffs in orchestration activities (Cennamo and Santaló 2013; Garud *et al.* 2002; Wareham *et al.* 2014), much work is needed to help us understand how firms can shape ecosystems and platforms.

Rethinking our Aggregate Level for Strategy Research

Having come full circle, we can now return to the question of how research on platforms, ecosystems, and IA may require a rethink of the constructs we use in strategy research.

First, "industry", as a level of analysis, is increasingly inadequate. The boundaries and nature of industries have been questioned for a long time (see Jacobides and Winter 2012 for a review), but current changes in the nature of the competitive environment mean that the idea of a sector may obscure more than it reveals. If we want to understand the context of competition in certain sectors, we will need new levels of analysis, in addition to existing ones. Of course, until we achieve intellectual clarity and operational ease (let alone accessible databases) on ecosystems, platforms, and architectures, industry-based analysis will remain. But we must be mindful of its limitations, and consider whether there are platforms and ecosystems at play, and whether it is worth specifying and measuring them. The question will be a practical one: how significantly is viability, innovation potential, or value distribution affected by the existence of ecosystems or platforms?

Second, we will need to refocus our attention on capabilities and resources that pertain to ecosystems, platforms, and their management. We will need to extend some of the tenets of the Resource-Based View (Barney 1996) by ascribing some of the value extracted by the "hub" or "orchestrator" to their management of their ecosystem, which appears to be a very idiosyncratic resource or capability.

Third, we should rethink the classical, firm-specific mechanisms for value capture, such as patents, intellectual property, and other well-documented sources of firms' bargaining power (Porter, 1980), or complementary assets (Teece, 1986). One important question will be whether there are *ecosystem*-specific complementary assets, for instance, that may prove more valuable to the firm controlling them vis-à-vis other firms within the ecosystem (see Pisano and Teece, 2007). Work on IA has already highlighted the importance of controlling assets that appreciate in value because they become central to the new IA (Jacobides *et al.* 2006). On the other hand, firm-specific complementary assets may grant the firm more flexibility to play across ecosystems and lower the risk of being locked in to any particular one. Yet, this may reduce the potential strategic value of the firm within any given ecosystem, and thus its value-capture potential.

Fourth, it is becoming clear that the success of a firm's product is tied to the success of the ecosystem (Adner, 2012). How, then, should we think about firms' competitive strategy? Is it about deciding which ecosystem to engage with, and which role to play within it? (Hannah, 2014). Concepts such as product differentiation, for instance, lose their clear meaning if the degree of vertical or horizontal differentiation of a product depends on the complements produced by other members of the ecosystem. Also, and importantly, differentiation must be defined in contrast to alternative product-complement bundles that could be generated not only by other members of the given ecosystem, but by members of competing ecosystems. Firms should consider their differentiation value within the ecosystem vis-à-vis other complementors, and how the ecosystem compares to rival ecosystems.

Sixth, this research can help us rethink how firms innovate. Strategy researchers have already acknowledged that the sources of innovation do not lie necessarily within the firm, but may be with users (Von Hippel, 2005) and external collaborators (Chesbrough, 2003). A better understanding not only of the promise but also of the potential boundary conditions of platforms and ecosystems can help inform this research, and help us understand the factors that underpin such more "open" or ecosystem-/platform-based arrangements.

Strategy as a Science of Design, and the Promise of Ecosystems, Platforms, and IA

Our objective in this paper was to critically examine the new constructs that describe the aggregate level in strategy research. All share a strong emphasis on the *structure* of competition and collaboration, and on the nature of interactions and interdependencies. In other words, these are all constructs that draw our attention to the design of economic systems, and to the endogeneity of these designs. Mobile telecommunications, for example, can be structured in myriad ways: with different rules, roles, and relationships; with or without platforms; with fewer or more ecosystems, which may be open or closed, hierarchical or more democratic; or managed through traditional supply-chain structures. Previous constructs that looked at "industries" did not pay much attention to these structures – or, if they did, they focused on the immediate, segment-level economic dynamics they produced. The new wave of research considers the design features that *drive* these aggregate features, which, in turn, shape profitability dynamics. As long as we don't allow loose definitions to restrict its potential, this is research that could take strategy closer to a "science of design".

We believe this is a hugely promising area, with many theoretical and empirical contributions waiting to be made. Research practice, and the parlance of executives, already suggests that the design perspective is taking off. Our review clearly suggests that the structured analysis of ecosystems, platforms, and IA should play a key role in this trend, and we hope that this paper will help speed this exciting journey.

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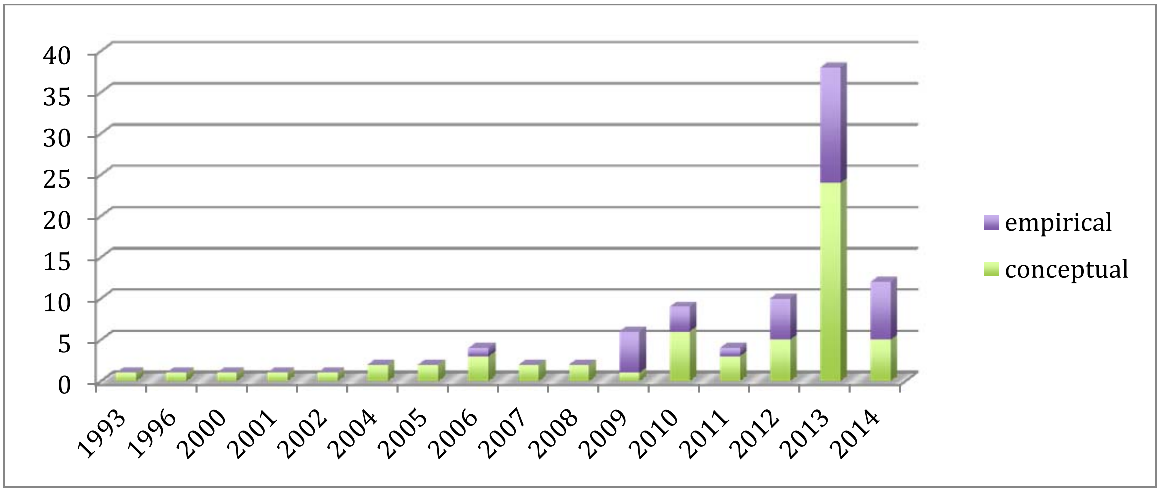
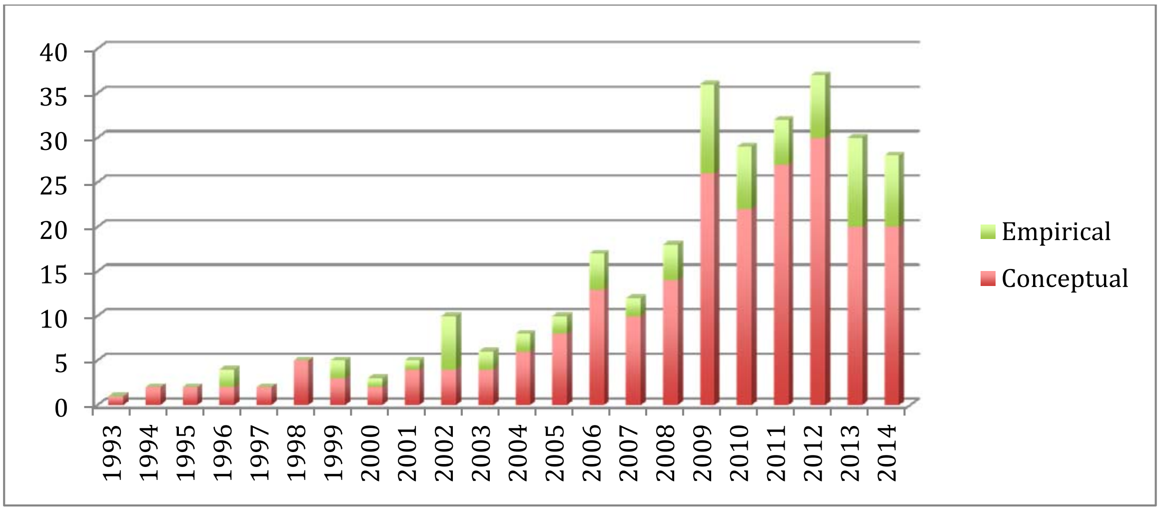


Note: Published items containing the term "ecosystem" in the title, abstract, or keywords in business outlets returned by ISI Web of Science (Social Sciences). Total N = 96 records. 2014 is a partial count.

Figure 1a. Ecosystem articles in the Social Science literature



Note: Published items containing the term "platform" in the title, abstract, or keywords in business outlets returned by ISI Web of Science (Social Sciences). Total N = 302 records. 2014 is a partial count.

Figure 1b. Platform articles in the Social Science literature

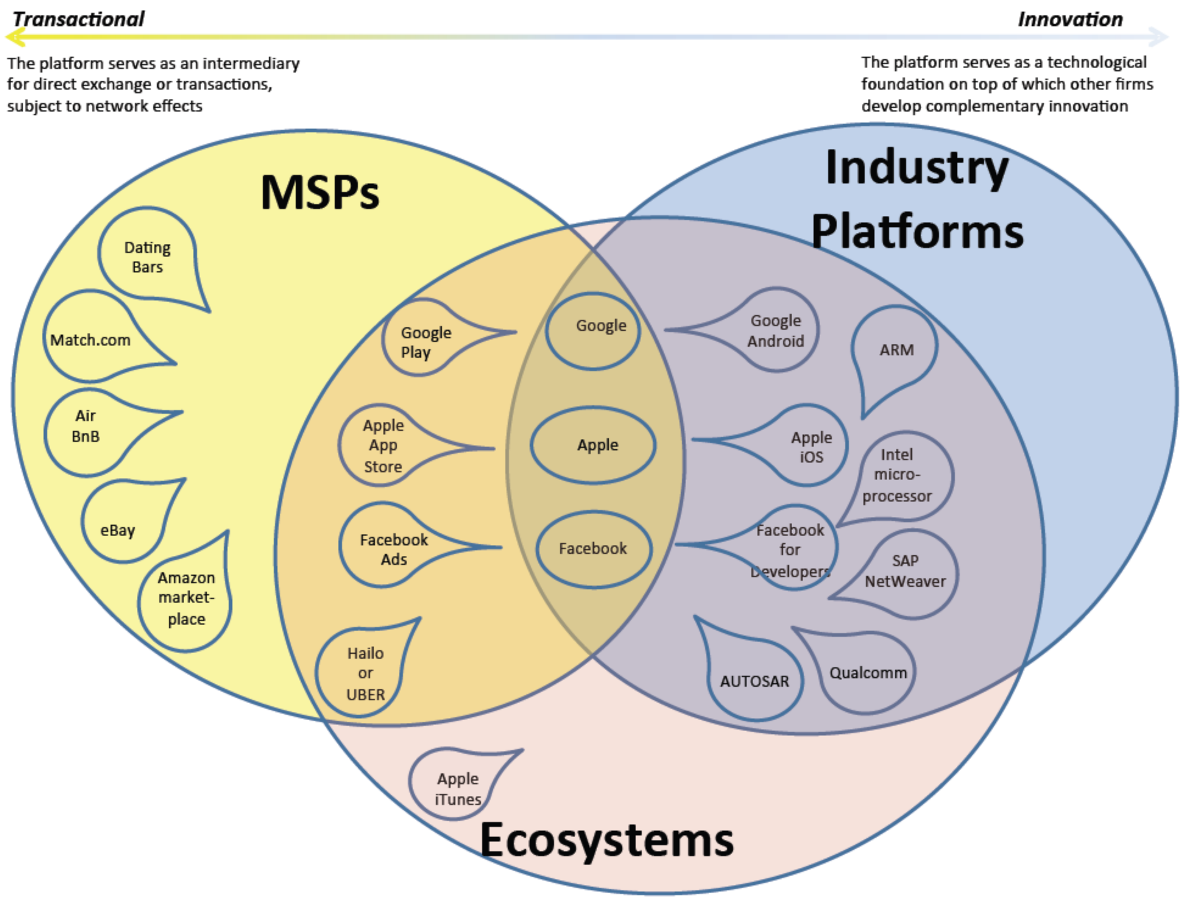
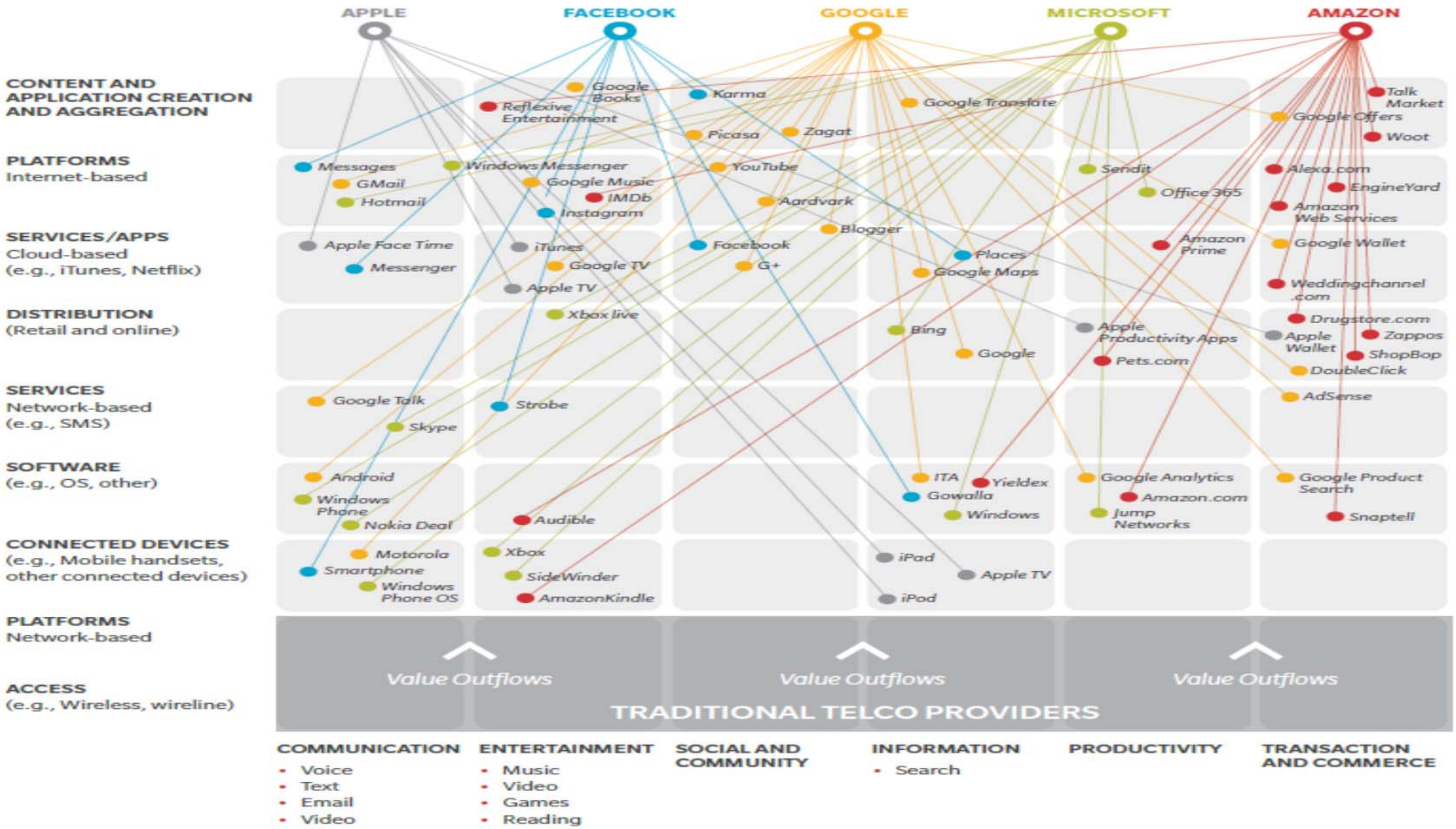


Figure 2. Mapping ecosystems, industry platforms and multi-sided platforms



Source: Oliver Wyman Communications, Media and Technology practice.

Figure 3. Webs of influence across ecosystems

Table 1a. Overview of ecosystem research

Perspective	Strategic management	Technology management
Ecosystem conceptualization	Set of interconnected firms	System of interrelated technologies
Ecosystem characteristics	Keystone; lead firm Co-evolution of firms' capabilities	Core technology; technological standard; platform Technology generativity, self-organizing
Value creation	Co-creation of new products/technology/markets	Complementary technologies; leveraging complementary assets
Value capture	Control over ecosystem architecture	Competition between ecosystems; Control over technical bottleneck(s)/platform(s)/standard setting bodies

Table 1b. Overview of platform research

Perspective	Economics	Engineering design
Platform conceptualization	Market that enables direct transactions among distinct groups, subject to network effects	Technological design that enables complementary innovation
Platform characteristics	Two-/multi-sidedness; Indirect network effects	Core and periphery modules
Value creation	Conduit of direct value-exchange transactions that would otherwise not be feasible	Enabler of more innovation from a larger pool of innovators
Value capture	Platform competition; winner-take-all; lock-in	Not a focus in this perspective

Table 2. A platform and ecosystem view of supermarkets

	Traditional view	Multi-sided platform view	Ecosystem view
Main conceptualization	Reseller of Goods	Marketplace	System Player
Focus and level of analysis	Transactional/Networked supply-chain Supermarkets competition	Lateral, direct transactions Complements/complementors	Inter-firms interdependent activities Multilateral links
Key strategic issues	Input procurement Transactional alignment Suppliers management Strategic resources and capabilities	Reseller or Marketplace? Cooperative and competitive relationships with complementors Market creation & network externalities	How to co-create value? Bottleneck risks Complementary activities orchestration
Value creation-capture	Superior resources/capabilities Bargaining power with suppliers Competitive positioning	Greater variety Lower search and transaction costs Greater volume of transactions and lock-in	Increase product/services co-creation opportunities Reduce bottleneck risks Gain keystone position

Table 3. Related aggregate constructs in strategy research

Research stream	Conceptualization of the aggregate	Value of the aggregate	Key Concepts
Strategic groups			
(e.g., Caves and Porter 1977; Newman 1978; Porter 1979; Hatten *et al.* 1978; Dess and Davis 1984)	Set of firms in an industry implementing similar strategies	Define competition structure in an industry; Group membership affects performance of individual firms by protecting from profit-reducing entry of other firms	Firms homogeneity within group; Firm heterogeneity across groups; Mobility barriers; Intra-industry oligopolies
Population ecology			
(e.g., Hannan and Freeman, 1977; Uzzi 1997; Carrol and Hannan 2000)	Community of mutual-dependent firms	Constrains firm behaviour; Determines firm evolution and survival; Resources dependence	Path-dependency; Legitimacy; Social embeddedness
Clusters			
(e.g., Porter 1998, 2000; Breschi and Malerba 2001; Alcacer 2006; Whittington *et al.* 2009)	Groups of interconnected firms, co-located in a particular district, region or community	Container' of ideas, knowledge, skilled labor and resources; Foster innovation due to ideas contamination and its commercialization; Enhance collaboration and reduce transaction costs due to trust and social embeddedness	Collective resources; knowledge spillovers; social embeddedness; coopetition;
Strategic networks			
(e.g., Kogut 1988; Jarillo 1988; Zaheer and Venkatraman 1995; Dyer and Singh 1998; Gulati 1999; Gulati *et al.* 2000)	Firm is embedded in 'network of relationships' with other organizations	Influences firm conduct and performance; Provides firm with critical resources (access to information, resources, markets, technologies); Allows firms to share risks and outsource value-chain stages and organizational functions; May lock firms in unproductive relationships	Co-opetition; dyadic co-specialization; network resources; joint creation;

Table 4. Definitions of "ecosystem" in the literature

Perspective	Strategic management	Technology management
Conceptualization	Set of interconnected firms	System of interrelated technologies
Sample of definitions	Innovation ecosystems - the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution (Adner 2006: 98)	Technology ecosystem – "System of interrelated technologies and the interdependent technological advances that influence evolution" (Adomavicius *et al.* 2007: 186);
	Business ecosystems –Loose networks of suppliers, distributors, outsourcing firms, makers of related products or services, technology providers, and a host of other organizations [that] affect, and are affected by, the creation and delivery of a company's own offerings (Iansiti and Levien 2004: 69)	Technology ecosystem – "Product platforms defined by core components made by the platform owner and complements made by autonomous companies in the periphery" (Wareham *et al.* 2014:1197)
	Business ecosystem—the community of organizations, institutions, and individuals that impact the enterprise and the enterprise's customers and supplies (Teece 2007: 1325)	Platform ecosystem – The network of innovation to produce complements that make a platform more valuable (Ceccagnoli *et al.* 2012: 263)
	Business ecosystem –Interdependent activities carried out by [firm's] customers, complementors, and suppliers (Kapoor and Lee 2013: 276)	Platform ecosystem – The collection of the platform and the modules specific to that platform (Tiwana *et al.* 2010)
	A network of interconnected organisations, connected to a focal firm or a platform, that incorporates both production and use side participants and creates and appropriates new value through innovation (Autio and Thomas 2014)	Mobile ecosystem – A large and complex network of companies interacting with each other, directly and indirectly, to provide a broad array of mobile products and services to end-customers (Basole 2009)
	A business ecosystem – A group of companies—–and other entities including individuals, too, perhaps—–that interacts and shares a set of dependencies as it produces the goods, technologies, and services customers need (Zahra and Nambisan 2012: 220)	Core industry technology and its complements produced by a variety of businesses (Gawer and Cusumano 2008)

Table 5. Definitions of "platform" in the literature

Perspective	Economics	Engineering design
Conceptualization	Conduit of transactions across distinct groups of users	Technology components enabling firms' innovation
Sample of definitions	An intermediary for two or more groups of customers who are linked by indirect network effects. (Evans and Noel 2006)	The platform consists of those elements that are used in common or reused across implementations. A platform may include physical components, tools and rules to facilitate development, a collection of technical standards to support interoperability, or any combination of these things (Boudreau 2010)
	A platform providing goods and services to two distinct end-users where the platform attempts to set the price for each type of end-user to "get both sides on board (Chakravorti and Roson 2006)	Platforms are technological building blocks, providing an essential function to a technological system (Gawer 2009)
	Platforms provide infrastructure and rules that facilitate the two groups' transactions (Eisenmann *et al.* 2006)	Technology platforms are the hubs of the value chains in technology industries. (Economides and Katsamakas 2006)
	Multi-sided platforms coordinate the demand of distinct groups of customers who need each other in some way. (Evans 2003)	Products that meet the needs of a core group of customers, but can be modified through the addition, substitution, or removal of features (Wheelwright and Clark 1992, p.73)
	Platforms enable consumers to access, purchase and/or use a great variety of products (Hagiu 2009)	A set of subsystems and interfaces forming a common structure from which a stream of products can be developed (Meyer and Lehnerd 1997)