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POINT OF VIEW

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Digital ecosystems and their implications for competitive strategy

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Abstract

This paper discusses some implications for competitive strategy when business environments are framed as digital ecosystems. Digital ecosystems are ecosystems shaped by interdependencies initiated through data connectivity, galvanized by technologies such as sensors and the Internet of Things (IoT). They are composed of two parts: production and consumption ecosystems. Production ecosystems are founded upon interdependencies associated with value chains. Although their underlying interdependencies are traditional, they gain fresh impetus because of data connectivity. Consumption ecosystems on the other hand are spawned by interdependencies among entities that complement the data generated by product usage. These are largely new interdependencies that did not exist before modern digital technologies enabled connectivity. Taken together, digital ecosystems influence a firm's strategic landscape. I discuss three implications of digital ecosystems for competitive strategy: (1) the scope of value creation, (2) the scope of competition, and (3) the rise of digital monopoly power. I also discuss the implications of digital ecosystems for organizational design and suggest how studies can assess the processes driving the digitization of ecosystems.

Keywords: Digital ecosystems, Competitive strategy, Platforms

Introduction

Industry characteristics have framed a firm's competitive business environment for a generation of strategy scholars. And for good reasons, studies show that industries and their structural attributes influence firm performance (e.g., Rumelt 1991; McGahan and Porter 2003). Also, framing competitive strategy as ways firms shape industry structure for differential competitive advantage is not only founded upon sound conceptual and empirical underpinnings of industrial organization economics (Demsetz 1973; Mancke 1974; Shapiro 1989), but is pragmatically appealing to managers as well (Porter, 1996). Managing value chain activities to occupy attractive positions within industries, building barriers to entry, and jockeying with industry rivals have thus remained some of the underlying tenets of competitive strategy (e.g., Caves and Porter 1977; Hatten and Hatten 1987; Gimeno 1999).

Recently, however, business environments are increasingly referred to as ecosystems (Teece 2014; Jacobides et al. 2018; Subramaniam et al. 2019). They are seen as a system of interlinkages and interdependencies, such as among business activities, business units, and firms (Moore 1993). Although such interdependencies per se are not new (Thompson 1967), modern digital technologies are enriching and expanding their underlying interlinkages. The pervasiveness of smartphones, cloud connectivity, sensors, the Internet of Things (IoT), 3D printing, and other such related developments offer evidence. Managers also associate ecosystems with digital platforms such as of Uber, Alibaba or Amazon, and the app economies built by Apple, Microsoft, or Google, because of the digital interlinkages they generate and leverage. The growing influence of such digital natives in recent years further bolsters their view of business environments as ecosystems.

Strategy scholars too are paying attention to ecosystems with a view that focusing on interdependencies can shed new light on various organizational phenomena (Kapoor 2018). For many thus the construct of ecosystems has been useful to extend their traditional work such as on networks and alliances (e.g., Venkatraman and Lee 2004; Gulati et al. 2012) or on technology and innovation (e.g., Dhanraj and Parkhe 2006; Adner and Kapoor 2010). Others have focused on the underlying nature of interdependencies among firms to propose reasons for the emergence of ecosystems (Jacobides et al. 2018) or to suggest new governance systems to manage them (e.g., Wareham et al. 2014). A few studies that have more directly addressed competitive strategy within ecosystems (e.g., Iansiti and Levien 2004; Kapoor 2018) have yet to expressly incorporate the context of digital connectivity, a significant force driving interdependencies in modern business environments. On the other hand, studies examining ecosystems emerging from digital interdependencies such as in software companies or technology platforms (e.g., Gawer and Henderson 2007; Gawer and Cusumano 2014) have yet to apply their gleaned insights to the general population of firms that are of broader interest to strategic management (Kopalle et al. 2020).

The purpose of this article is to address how digital ecosystems influence competitive strategy. Digital ecosystems are ecosystems where interdependencies are driven by digital connectivity. They are an outcome of various technological forces that create a network of data recipients—with whom firms can share data and co-create value. To benefit from digital ecosystems, a firm needs products[1] that generate and share data within this network of data recipients. In doing so, they can compete not just with products but with the data their products generate. More broadly, digital ecosystems influence the way products are produced, sold, and consumed. These attributes of digital ecosystems thereby more pointedly reveal ramifications to competitive strategy in ways that generic notions of ecosystems do not. This article develops the concept of digital ecosystems and presents some of its implications for competitive strategy.

Parallels between ecosystems and industries

To understand what is different about digital ecosystems and how they may influence competitive strategy, it is useful to first acknowledge some parallels between the generic construct of ecosystems built upon traditional business interdependencies and industries. Parallels are to be expected, as interdependencies that epitomize the modern construct of ecosystems are not a new notion for firms. Indeed, competing in industries

[1] I use the term "product" for both products and services.

necessitates managing a myriad of interdependencies that firms have traditionally accomplished through their value chains (Porter 1985). In its industry, a manufacturing firm for example manages numerous interdependencies across its supplier network, production and assembly units, R&D, Marketing, and its distribution and after-sales service network. A service company such as a bank similarly manages interdependencies across several branches in the process of attracting deposits and selling loans. The specific ways by which firms do so differentiate their respective competitive positions (Rivkin 2000).

Firms can further enlarge their value chain interdependencies by attracting alliance partners to shore up select facets of its activities such as operations or sales (Yu et al. 2013). Firms also confront interdependencies with its industry rivals as each of their competitive actions invariably attracts competitive responses (Chen and Miller 1994). To deter rivalry and maintain profitability, firms maneuver their value chain activities such as marketing and sales to establish stronger multi-market-contact (Gimeno 1999; Yu et al. 2009), or coordinate other activities such as plant locations, product introductions, or pricing in ways that minimize competitive retaliation (Brandenburger and Nalebuff 1995). An industry from this perspective is an ecosystem. Its underlying interdependencies help us anchor our understanding of competitive strategy. It also offers a reference point to assess how this understanding can be refined through the lens of digital ecosystems.

Digital ecosystems

Ecosystems become digital when their underlying interdependencies are propelled by digital technologies and associated data connectivity. “Digital” per se is not new to firms, as its applications go back to the era of mainframe computers. Neither is data new, as firms are accustomed to capturing and utilizing data on markets, products or operations, and integrating them within their value chains. However, the current enthusiasm with digital technologies and their association with digital ecosystems is because of new possibilities they engender for generating and utilizing data.

Data and digital ecosystems

One facet of modern digital technologies relates to how they enable real-time and archived data to be combined and strategically harnessed in new ways (Subramaniam et al. 2019). Real-time data can turn into archived data over time. Yet, they exhibit different attributes (Kopalle et al. 2020). Real-time data provides real-time insights. Sensors on an athletic shoe for example can provide insights specific to each particular time the shoe is used. Archived data on the other hand accumulates insights over time to develop profiles of each user’s running habits or skills. Notably, it is possible to archive insights on each individual provider of sensor data separately (such as for each shoe user) and refine each provider’s profile over time with continuing streams of real-time data. Such combinations of real-time and archived data, that I define here as “sensing units”, can continue to grow in intelligence. Over time, they develop more intricate insights on individual customers and help firms develop products that are more customized to their preferences. Knowing how often an athletic shoe customer uses her shoe for running or walking for example can help the producer offer shoes that more closely meets her needs.

Advancements in data storage such as the cloud (or high capacity centralized data servers) allow firms to maintain vast repositories of profiles and ongoing real-time data sourcing for each sensing unit. Technologies such as artificial intelligence (AI) further amplify insight building processes for each profile. Select facets of real-time and archived data can also be shared across various other connected assets linked through IoT. Sensing units can hence not only communicate with one another with real-time data, but shape their communications based on intelligence garnered by its archived data. McKinsey estimates thirty to fifty billion of such connected assets in the coming years[2]. These advances in modern technologies have catalyzed data and data connectivity to both enrich traditional interdependencies and expand them beyond their industry parallels into digital ecosystems. I describe digital ecosystems by elaborating on its two components: production and consumption ecosystems.

Production ecosystems: enriching traditional interdependencies

Production ecosystems arise from digitally connected sensing units embedded in an amalgamation of interdependent activities, units, and entities that contribute to a firm's value proposition through its value chain (Subramaniam et al. 2019). The construct allows firms to frame and visualize how digital technologies can infuse new impetus into their traditional value chain interdependencies.

Firms for instance can achieve tighter coordination among suppliers based on real-time status of inventory usage or synchronization in smart factories where machines, robots, or production and assembly units communicate to streamline workflows (Porter and Heppelmann 2015). Each sensing unit in a firm's operational network can offer early alerts on various workflow obstacles: such as quality issues at a supplier, impending machine stoppages, or credit problems with customers. Sensing units can even take corrective actions on their own; machines anticipating a stoppage for a quality issue for example can automatically shift their workloads to those machines that optimally reduce interruptions.

With sensing units in products, a firm can track every individual product-customer interface. With data on the running habits or skills of each individual user for example, Nike can fine tune its marketing and sales efforts with greater precision. Products can also be designed to adapt their attributes to individual customer needs. GE's jet engines for example, reacting to data generated during each flight, inform pilots on flying altitudes and speeds to optimize fuel consumption. GE can thus "mass-customize" every flight. Similarly, after-sales services can be designed to predict breakdowns before they happen and even customize timely spare parts delivery through 3D printing. Firms can play an important role in digitizing their value chain. The more intricate the sensing unit network a firm embeds into various activities within its value chain, the more enriched its production ecosystems.

Consumption ecosystems: expanding traditional interdependencies

Consider however a different facet of digital ecosystems triggered by real-time data on a driver's locations which Ford can use to connect a driver with various third-party

[2]McKinsey's estimates: https://www.mckinsey.com/industries/semiconductors/our-insights/the-internet-of-things-sizing-up-the-opportunity and https://www.mckinsey.com/business-functions/digital-mckinsey/our-insights/the-internet-of-things-the-value-of-digitizing-the-physical-world

entities such as Starbucks, Amazon, banks, and an array of app developers[3]. Through voice-activated technology, a driver orders Starbucks coffee through Alexa. Through weather and traffic information apps, the car predicts the precise time the driver reaches Starbucks ensuring prompt availability for pick up without waiting in line. In the meantime, Ford's MyPass app automatically completes the transaction through a connected bank.

Such digitally driven ecosystems that emerge because of interdependencies between various objects or third-party entities that complement data generated by a product when used or consumed are consumption ecosystems (Subramaniam et al. 2019). These new complementor-based interdependencies are different from value chain interdependencies (Kapoor 2018; Gawer and Cusumano 2014). Consequently, unlike production ecosystems that enrich traditional value chain interdependencies, consumption ecosystems are an outcome of a proliferation of a different set of interdependencies beyond value chains that did not exist for a vast majority of firms before modern digital connectivity (Kopalle et al. 2020).

A light bulb for example can initiate consumption ecosystems in multiple domains depending on the kinds of complementors it attracts for the data it generates. By sensing motion in homes supposed to be empty, it initiates a security service ecosystem of alarms and mobile apps. By tracking inventory in warehouses, it creates an ecosystem of entities to improve logistics. By detecting gunshots, it generates an ecosystem of camera feeds, 911 operators, and ambulances to improve street safety (Subramaniam et al. 2019).

Previous studies have highlighted the concept of complements and their associated downstream demand-side interdependencies (Priem et al. 2013; Jacobidies et al. 2018; Kapoor 2018). Even before the advance of modern digital connectivity, Ford cars for example had gas stations as complements; light bulbs had sockets and electrical wiring as complements. Interdependencies among such complements are managed through modularity in component and product designs or trading off the costs and benefits of proprietary versus open standards (Baldwin and Clark 2000). Consumption ecosystems however are founded upon new kinds of complementarities and demand related interdependencies. As it is data generated by the product—not the product itself—that attracts complements and generates their interdependencies. Such data-related complementarities, akin to the app economies of the digital natives, have a far broader scope than product complementarities.

Implications of digital ecosystems for competitive strategy

Data and its connectivity thus is a common thread running through digital ecosystems, whether production or consumption. Product-generated data is shared and utilized within the value chain in one case and outside in the other, thus channeled into different kinds of interdependencies. Both engender new opportunities to transform a firm's interactions with customers. However, as I will elaborate below, they shape a competitive strategy differently and provide different strategic options for firms. I discuss three broad implications that digital ecosystems have for competitive strategy.

[3]https://www.geekwire.com/2017/starbucks-partners-ford-amazon-allow-car-orders-via-alexa/

Scope of value creation

At a basic level, by infusing digital connectivity into value chain interdependencies, production ecosystems strengthen a firm's prevailing competitive position. For instance, by enabling smart workflows in operations they can help firms improve on their low-cost positions (Porter 1980). More than that however, production ecosystems can expand value for a firm beyond what it achieves from its prevailing product positions by harnessing the value of product generated data. One such approach entails channeling product-generated data to drive new product performance-related services. This is possible when, as highlighted earlier, products adapt their attributes to individual customers' usage data and their outcomes can be tracked, improved upon, and displayed through tangible metrics.

GE introduced "outcome-based" services based on assurances of reduced fuel costs in addition to jet engine sales (Iansiti and Lakhani 2014). Mattress companies can similarly offer services related to sleep quality or toothbrushes related to dental health. Insurance companies offer new policies where premiums vary with drivers' driving performances. To achieve such expanded value, firms continue to rely on their core value chain activities such as product design, marketing, and sales. However, they may need new resources and capabilities to channel these activities into delivering data-driven services in addition to selling their traditional products.

Consumption ecosystems too leverage product-generated data. To benefit from this approach however, a firm needs to identify external entities that complement this data and co-create new services. Ford's coffee ordering-procuring-while-driving feature is one example of such a service. The more complements Ford identifies and attracts, the greater the scope of its services and the more its value to users through network effects (McKintyre and Srinivasan 2017). Like app economies, the boundaries of such complements are open-ended. They could be retailers other than Starbucks who offer what the driver desires. They could be connected parking spots for helping the driver find optimal parking or a host of other such possible objects or entities that complement the data generated by the car while driving. Ford also needs to set the rules for how various complementors coordinate their inputs while executing these services. In so doing, Ford expands its value as a multisided platform (Hagiu 2014; Hagiu and Wright 2015), using data to orchestrate exchanges across the complementary entities that exist within its consumption ecosystems.

Production and consumption ecosystems thus offer distinct approaches to expand a firm's value creation scope. With the former, a firm stays within its value-chain structure; with the latter, it extends into a multi-sided platform. The underlying business models in each case are different and so are the capabilities required to build and manage them (Van Alstyne et al. 2016). Firms coming from value chain heritages can learn about multisided platforms; however, fusing prevailing produce-and-sell business models with new ones associated with platforms require fresh strategic thinking (see Subramaniam and Piskorski 2020). Managing such new value-creating options within digital ecosystems is an important implication for competitive strategy.

Scope of competition

As the scope of value expands because of new opportunities with data, so does the scope of competition. Digital ecosystems add data-based competition into the mix of product-based competition, leading to new competitive scenarios and dynamics. For example, when Caterpillar, Komatsu and Hitachi add predictive maintenance services to their respective portfolios, they compete both with their excavators and associated excavator-generated data. They may face other rivals contesting for the predictive maintenance service space with excavators of their own. They may also face new rivals in this space who do not produce or have excavators, but who retrofit sensors onto older excavators already operating in the construction site (Subramaniam and Piskorski 2020). These rivals can gain access to the same data Caterpillar, Komatsu and Hitachi use for their data-driven services. Similarly, light bulbs entering the home security space with motion sensing data will find the same data also accessible to a host of other objects in the home such as cameras or thermostats. Competition within products and competition within associated data-driven services thus may not overlap.

A different scenario is where traditional companies compete with companies drawing their strengths from digital ecosystems. Consider Chinese banks such as the Bank of China and the Agricultural Bank of China facing competition from Alibaba and Tencent since the last few years (Subramaniam and Rajagopal 2019). With their dominant e-commerce platforms and apps that millions of consumers use for almost every facet of their day to day lives, Alibaba and Tencent have an intricate understanding of the interdependencies entailed in the use of money. They have real-time data on, for instance, when a consumer plans to buy a car, what kind of car she is interested in, her credit history, her location, and the appropriate dealer from who she may get a good price. The competitive edge they gain from understanding the intricacies related to the need of a loan, for servicing that loan, is apparent. Not surprisingly, Tencent and Alibaba have made notable forays into the consumer and small and medium enterprise loans business in China.

This kind of competitive battle can also be framed as one between firms positioned within production and consumption ecosystems. Alibaba and Tencent are firmly positioned in the consumption ecosystems of banks as their platforms draw strengths from an array of different entities that complement the use of loans. Even if the traditional Chinese banks galvanize their deposit collection-loan selling value chains with modern digital connectivity, and thereby gain new impetus with production ecosystems, they would find it difficult to match the strengths that Alibaba and Tencent have garnered.

We may see more such asymmetric competitive battles with digital natives such as Google, Apple, and Amazon entering different traditional industries. A digital native for example, harnessing data on interdependencies entailed in the consumption of groceries by digitally tapping into facets that complement our grocery usage behaviors, can commoditize grocery stores. They may relegate grocery stores into warehouses for storage and delivery, while their platform-based services that seamlessly and conveniently orchestrate grocery availability in homes, gain differentiated value. Such expansion in the scope of competition and its associated new competitive dynamics thus represent another implication of digital ecosystems for competitive strategy.

Digital monopoly power

Monopoly power is the grand objective of competitive strategy. It reflects the strength of a firm's competitive advantage and drives superior profits or rents (Jacobsen 1988).

Our traditional understanding of monopoly power is one that is tied to industry structure, where we infer its existence through concentration ratios or relative market shares of products (Demsetz 1973). However, if the locus of value creation shifts to data, relative market shares of products may not remain the only indicators of monopoly power. Traditional product-based monopoly power also may be blunted when firms compete in digital ecosystems (Iyer et al. 2017).

Barriers to entry from dominant market shares of products become less daunting when competitive attacks are based on dominance in data within digital ecosystems. The leading Chinese banks illustrated earlier could not protect their turfs from Alibaba and Tencent despite a long history of enjoying high concentration ratios in their industry through their traditional products. Monopoly rents associated with dominant product-market shares may also erode if new data-driven digital ecosystem services commoditize product-based offerings. Dominance through products thus may not be enough when competing in digital ecosystems; firms have to seek new kinds of dominance through data orchestration. Put differently, digital monopoly power may replace product-driven monopoly power as the grand objective of competitive strategy.

What is digital monopoly power? How does a firm attain it? One way to approach these questions is to associate digital monopoly power with dominance in digital ecosystems, just as we associate traditional monopoly power with dominance in industries. We may also assess digital monopoly power based on relative market shares of a firm's data-driven services within digital ecosystems, just as we assess monopoly power based on relative market shares of products within industries. Such trends represent yet another set of implications for competitive strategy.

Implications of digital ecosystems for organizational design

In addition to competitive strategy, digital ecosystems also have implications for organizational design, as firms try new approaches to organize and optimally harness the powers of data and its connectivity. For firms competing in production ecosystems, optimizing the sensory network within the value chain and across its activities becomes a guiding principle. Organizations may need to manage centralization and decentralization tradeoffs accordingly, to structure the relationships between units related to digital technology/software and other value chain activities. Firms competing in consumption ecosystems have to find design structures that tie their value chains to new platforms. Subramaniam and Piskorski (2020) describe such new entities as tethered digital platforms that not only draw scale-based strengths from value chains, but also create network effects through their platforms.

Conclusions

As interest in ecosystems has grown, several studies have offered perspectives on this construct. In this article, I offer an added perspective with a specific focus on digital ecosystems. I show how framing business environments as digital ecosystems enable us to recognize new facets of competitive strategy, in terms of how firms can expand their value-creating scope, how they face expanded competition and new competitive dynamics, and how they could build a new kind of monopoly power. Underlying each of these developments is the fact that, within digital ecosystems, firms compete not just with products but with the data their products generate.

There may be other implications of digital ecosystems for a competitive strategy that future studies can identify, discuss, and examine. One such aspect is about the processes entailed in the "digitization" of ecosystems. Firms certainly have a role in digitizing their value chains and creating production ecosystems. Here, the process concerns digitizing existing ecosystems (or value chain interdependencies). Consumption ecosystems on the other hand entail interdependencies outside prevailing value chains. These ecosystems evolve because of "connected" entities and assets that complement the data generated by-products. An individual firm has a much smaller role in its digitization; rather, it benefits from an evolving network of such entities created by larger technological forces. Understanding the digitization of consumption ecosystems may hence require a different approach from that of examining the digitization of production ecosystems.

Digital ecosystems also have implications for organizational design, especially as data rather than products take a central role in value creation. Such new organizational designs that empower traditional firms to effectively compete in digital ecosystems are in part the goals of what is broadly referred to as digital transformation.

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