BUSINESS ECOSYSTEMS

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Many industries are characterized by networks of interdependent firms. Often termed ecosystems, these networks consist of firms that offer discrete products or services that collectively form a valuable solution (Adner, 2012; Iansiti and Levien, 2004; Moore, 1996). The smartphone ecosystem, for example, includes handset manufacturers, operating system platforms, application developers, and network carriers—each of which provides an integral component of the smartphone. Ecosystem firms sometimes work together in formal and even exclusive alliances while at other times they collaborate in informal and loose relationships. Regardless of the exact nature of the alliances, firms within the distinct components of an ecosystem have high "consumption-side" interdependence such that firms depend on their alliance partners to succeed (Hannah, Bremner, and Eisenhardt, 2016).

Prior work defines ecosystems in several ways (Jacobides, Cennamo, and Gawer, 2015). For example, early work by Moore (1993) describes ecosystems as networks of "companies work[ing] cooperatively and competitively to support new products, satisfy customer needs, and eventually incorporate the next round of innovations" (1993: 76). Consistent with this view, Jacobides and colleagues define ecosystems as "sets of firms in distinct positions that develop group-level co-specialization" (Jacobides et al, 2015: 3). In contrast, others take a broader view. For example, Adner and Kapoor (2010) explicitly incorporate both upstream suppliers and downstream complementers. Despite various definitions, however, common threads underlie the ecosystems concept.

First, ecosystem alliances occur within an industry architecture, which identifies the division of labor and allocation of value within the ecosystem (Jacobides et al 2006). By providing a 'blueprint' for the interactions among firms (Ozcan and Eisenhardt 2009: 256) and determining 'who does what and who gets what' (Ferraro and Gurses 2009: 243), industry architecture provides the context in which alliances occur and strategies are set. For example, the industry architecture of the PC ecosystem specifies roles and relationships for microprocessor, operating system software, disk drive, and printer firms while the industry architecture of the 3D printing ecosystem does the same for firms in modeling software, materials, and printing. A key point is that ecosystem partners often come from diverse industries with conflicting timing, competitive pressures, and business models that complicate their alliances (Casadesus-Mansell and Yoffie, 2007).

Second, since ecosystem firms in different components have high consumption-side interdependence, they must work together to create value. As a result, there may be a high degree of group-level, co-specialization and alignment among partner firms (Adner, 2012; Ozcan and Eisenhardt, 2009; Jacobides et al, 2015). For example, Ozcan and Eisenhardt (2009) describe how video game publishers coordinated with brand partners like Newline Cinema and platform providers like Qualcomm to provide games in the mobile device industry. Interdependence also drives the emergence of bottlenecks that impede firms' ability to create and capture value (Adner & Kapoor, 2010; Baldwin, 2015; Hannah & Eisenhardt, 2015). Following Jacobides et al. (2006), we define a bottleneck as an ecosystem component that is impeding overall growth. The literature distinguishes among technology, adoptive, and strategic bottlenecks. Technology bottlenecks exist when one component of the ecosystem limits the performance of the total solution due to technical or supply limitations (Ethiraj, 2007). Adoptive bottlenecks occur when the potential providers of a component fail to do so despite its availability (Adner, 2012). Strategic bottlenecks occur when one or a few firms control a critical component and capture disproportionate value (Baldwin, 2015; Jacobides, Knudsen & Augier, 2006; Hannah and Eisenhardt, 2015).

Third, while ecosystem partners cooperate to create value, they also compete to capture value. This simultaneous collaboration and competition among partners, as well as the importance of complementarity and co-specialization, differentiates ecosystems from concepts like industry, sector and population (Jacobides and Winger, 2012). Central to successful ecosystem strategy is envisioning the entire system of relationships (Ozcan and Eisenhardt, 2009) or what Adner (2012) terms the "wide lens".

From a theoretical perspective, ecosystem research draws on traditions including the resource-based view, industrial organization, resource dependence, and transaction cost economics. Using these lenses, research examines *value creation* such as addressing technology bottlenecks, *value capture* such as the influence of kingpin firms, and *nascent ecosystems* such as strategies for shaping industry architecture.

Value Creation

This stream seeks to understand the dynamics of collaboration among ecosystem partners as a positive-sum game that allows them to create collective value, and realize opportunities beyond the reach of a single firm. Some work examines "improving" strategies by which firms cooperate with partners in other components to create value at the component and ecosystem-levels (Hannah and Eisenhardt, 2016). This stream, however, highlights how technology and adoptive bottlenecks (both of which stifle value creation) emerge and can be addressed, particularly how partners can manage related co-innovation and adoption risks (Adner, 2012).

Technology bottlenecks occur when the performance limitations of one (or more) components constrains the entire system. For example, costly and inefficient solar panels limited the revenue growth and collective profit within the residential solar ecosystem for years (Hannah et al., 2015). The literature identifies several strategies for when and how to address technology bottlenecks. One strategy is to invest in the bottleneck component. For example, Ethiraj (2007) studies hardware producers in the PC ecosystem. The author finds that non-bottleneck component firms dedicate about 8.5% of their R&D effort toward resolving technology bottlenecks.

Alternatively, firms may motivate other firms to enter and innovate in bottleneck components. Gawer and Henderson (2007) describe how Intel motivated firms in the PC ecosystem to innovate in bottleneck components that were constraining the growth of Intel's core microprocessor business. For example, Intel operated its non-microprocessor divisions as profit centers to demonstrate that these components were economically viable, and shared intellectual property, relevant to these components, with other firms. Similarly, Boudreau (2012) studies the handheld computer ecosystem, and finds that motivating the entry of software producers to the ecosystem increased the variety of software available and enhanced the ecosystem.

Timing can play an essential role in addressing technology bottlenecks. Adner and Kapoor (2010) study how innovation timing is affected by the location of technology bottlenecks. In a longitudinal study of the semiconductor lithography ecosystem, the authors examine 33 focal firms—lithography tool producers—operating across 9 technology generations. A key implication is that firms should innovate quickly when upstream technology bottlenecks occur, and delay to innovate until downstream complementor bottlenecks are cleared. In other words, upstream technology bottlenecks represent opportunities for firms to get ahead of rivals and so favor quick innovation, while downstream technology bottlenecks simply stifle value creation. In a related study (Adner and Kapoor, 2015), the authors find that technical improvements in complementary components can extend the life of existing components, also making delay advantageous.

Timing can also prevent technology bottlenecks such as by releasing innovations simultaneously across ecosystem components (Adner & Kapoor, 2010; Milgrom, Quian & Roberts, 1991). In support, Davis (2013) uses simulation to show that firms with strong and dense alliances with their ecosystem partners are more likely to coordinate their innovation efforts and achieve mutually advantageous synchrony across the system.

Finally, firms can mitigate technology bottlenecks by participating in a more complete set of components. Hannah and Eisenhardt (2015) examine 5 entrants into the residential solar industry. They observe a particularly successful firm that followed a systems strategy of occupying most relevant components through organic expansion and acquisition. This firm was thus assured of having access to the all ecosystem components. The firm not only grew, but also stimulated the growth and thus value creation of the entire ecosystem. Others note that the effectiveness of such a systems strategy is greatest when products are highly complex (Almirall & Casadesus-Masanell, 2010), and when firms seek to change the ecosystem architecture rather than improve individual components (Kapoor, 2013). For example, integrated memory producers in the PC ecosystem were faster to new technology generations, especially when they changed the product architecture (Kapoor and Adner, 2012).

In contrast with technology bottlenecks, adoptive bottlenecks occur when the necessary technology exists but has not been adopted. Adner (2012) illustrates an adoptive bottleneck in the case of Michelin's failure to successfully commercialize its PAX run-flat tire in the automotive ecosystem. Even after Michelin secured buy-in from automakers to include the tire in their new automobiles, garages were slow to adopt the equipment necessary to service the tires. Consequently, garages became an adoptive bottleneck making consumers reluctant to purchase these superior tires given the incomplete ecosystem.

Since incentives are critical to relieving adoptive bottlenecks (Adner, 2012), several studies focus on them. Adner (2012), for example, describes how Amazon crafted incentives for book publishers to participate in the e-reader ecosystem. In related work, Kapoor and Lee (2013) examine the healthcare ecosystem, and find that hospitals engaging in alliances with doctors had more incentive to adopt new technologies that improved performance than did hospitals in which doctors were either fully integrated as employees or at arms-length. A particularly interesting approach to adoptive bottlenecks is the switchback strategy as noted by Marx and colleagues (forthcoming). Studying the speech recognition industry, these authors find that introducing a stand-alone product to demonstrate commercial viability to potential partners, and then later allying to grow the ecosystem can be an effective approach to adoptive bottlenecks.

Value Capture

This stream explores how firms capture value in ecosystems such as by increasing their relative bargaining power and exploiting their position within the industry architecture. The emphasis is on competing to control the ecosystem by dominating rivals and appropriating value from partners. A key thread seeks to understand how some firms—known as "keystones" (Iansiti & Levien, 2004) or "kingpins" (Jacobides & Tae, 2015)—emerge.

A central concept is the strategic bottleneck, defined as the critical ecosystem position that enables firms to capture a disproportionate value (Jacobides & Tae, 2015). Often identified by their performance (e.g., profitability, market share), firms that occupy strategic bottlenecks have been termed "kingpins", and are seen as the "least replaceable players" (Jacobides & MacDuffie, 2013, p. 4). For example, when consumer finance was the strategic bottleneck in the resurgent residential solar industry, consumer finance firms (particularly the most skilled) could drive advantageous terms with their partners (Hannah et al., 2015). Similarly, Intel occupied a strategic bottleneck in the PC ecosystem, and thus captured (with Microsoft, occupant of another strategic bottleneck) the majority of PC ecosystem value (Jacobides et al., 2006).

To create a strategic bottleneck, firms should actively build encourage competition in other components while building entry barriers to their components (Jacobides et al., 2006). One strategy to build entry barriers is innovation. For example, Jacobides and Tae (2015) study 33 PC ecosystem components, and find that firms enhanced their value capture through innovation. Specifically, firms with higher R&D expenditures and market capitalization established strategic bottlenecks and had the highest profitability in the ecosystem.

Another approach to create a strategic bottleneck is to develop architectural control.

Ethiraj and Posen (2013) sample 106 firms across four PC ecosystem components, and indicate that maintaining architectural control is associated with more patenting and value capture. Fixson and Park (2008) also illustrate the role of architectural control in their study of Shimano and the bicycle drivetrain ecosystem. By introducing superior product architecture, the firm nullified the existing division of labor across the ecosystem to its advantage. In the automotive ecosystem, Jacobides, MacDuffie and Tae (2015) find that, since OEM automakers control much of the architectural R&D, these firms are able to retain disproportionate value despite attempts at modularizing the industry. Ferraro and Gurses (2009) detail Music Corporation of America's rise to dominance by taking advantage of an industry disruption such that the firm re-shaped the industry architecture in a way that exploited its advantages in creative talent.

Firms can also occupy a strategic bottleneck because of luck. Using simulation, Jacobides, Veloso and Wolter (2014) illustrate how value can shift from one component to another such that profit can migrate downstream as a result of upstream innovation. Alternatively, firms may suffer as a result of innovation in other ecosystem components. Kapoor and Agarwal (2015) study the iOS platform ecosystem, and find that application developers are less likely to be top performers when they must contend with generational transitions and complexity that are driven by ecosystems partners.

Nascent Ecosystems

A third stream emphasizes nascent ecosystems which are those ecosystems in an early state of formation or reformation (Santos & Eisenhardt, 2009). Ecosystems can emerge through the recombination of existing industries (e.g., mobile payments; Ozcan & Santos, 2014), new opportunities driven by entrepreneurial firms (e.g., residential solar; Hannah & Eisenhardt, 2015) or a combination of entrepreneurial and incumbent actions (e.g., Pay TV in television; Gurses & Ozcan, 2014). The central strategic challenges arise because the winning industry architecture is often ambiguous, it is usually unclear whether the ecosystem will ultimately create sufficient value to survive, bottlenecks are difficult to anticipate, and substantial technical, regulatory and competitive uncertainties exist (Ozcan and Eisenhardt, 2009; Hannah and Eisenhardt, 2015).

Since nascent ecosystems are in flux, agency plays a critical role as firms jockey to create and capture value. An important source of agency is soft-power tactics - i.e., employing subtle persuasion, rather than tactics involving coercion and dominance (Santos & Eisenhardt, 2009). One such tactic is framing by which firms attempt to shape the collective vision of the ecosystem roles and relationships to attract partners. For example, Gurses and Ozcan (2014) study how entrepreneurs introduced Pay TV into the US television broadcasting industry. The authors find that entrepreneurs used multiple frames to appear non-threatening to incumbents. Similarly, both entrepreneurs and incumbent broadcasters used framing to make their products appear to align with public interests (e.g., incumbents - "keep TV free", entrepreneurs – "extended coverage").

Santos and Eisenhardt (2009) describe a broader set of soft-power tactics in their study of firms that all successfully shaped their nascent ecosystems using alliances. In addition to framing, these firms all developed alliances with would-be rivals that were essential to their success. They did so by offering incentives such as equity positions and revenue-sharing to motivate these partners to remain in their current businesses and out of the focal component.

Ozcan and Eisenhardt's (2009) study of firms in the nascent mobile gaming ecosystem reveals additional tactics for shaping nascent ecosystems through alliances. In particular, they find that firms that formed alliances with multiple actors at once, rather than in a series of dyadic ties, were more successful within the ecosystem. A pattern emerged whereby firms advocated a unique industry architecture that created a motivating vision which attracted multiple potential partners. Another partnering approach was to act as an intermediary in connecting would-be partners together, and thereby also connecting themselves in a series of triads.

More broadly, research also explores strategies to succeed in nascent ecosystems. In their study of 5 entrants into the nascent residential solar ecosystem, Hannah and Eisenhardt (2015) find that high-performing firms move to occupy strategic bottlenecks rather than simply entering an ecosystem component based on pre-existing capabilities or component competition. One successful firm followed a "systems" strategy in which it avoided alliances and simply entered all components. In contrast, another successful firm used a "bottleneck strategy" whereby it entered components only as they become bottlenecks and relied on alliances to create a complete ecosystem. This bottleneck strategy was less costly than the systems strategy but required substantial foresight and alliances with firms in non-bottleneck components. Finally, firms following a "component" strategy (which relies on alliances) were less successful except when they happened, by luck, to occupy the strategic bottleneck.

Finally, firms are sometimes simply unable to form the alliances necessary for a nascent ecosystem to emerge. Ozcan and Santos (2014) study mobile payments, an ecosystem that struggled to emerge from the convergence of the financial and telecommunications industries. They find that powerful incumbents from these industries could not agree on an industry architecture. Furthermore, the longer they disagreed, the more likely they were to invest in their own vision of the ecosystem, creating a negative feedback loop, further inhibiting ecosystem emergence. Only in countries with a dominant central government (Singapore) or an incumbent who could employ a system strategy (Japan) did a mobile payments ecosystem emerge.

Future Research

Among many avenues for future research, we note three. One is to examine how firms manage the trade-off between value creation vs. value capture. The value creation stream illustrates that relieving bottlenecks increases value, but often neglects how these actions affect value capture relative to firms in other ecosystem components. The value capture stream emphasizes dominance and control, but pays limited attention to how firms attract the partners necessary for the ecosystem to succeed. Yet to be successful, firms need to address both value creation and capture.

A second avenue is to explore the bottlenecks that are central to ecosystems. For example, what exactly are strategic bottlenecks, how do they relate to technical and adoptive bottlenecks, and how do firms come to occupy such bottlenecks? High R&D expenditures (Jacobides & Tae, 2015) and astute architectural innovation (Adner & Kapoor, 2012; Fixson & Park, 2008; Jacobides et al., 2015) may be useful for creating strategic bottlenecks. But are these approaches more effective than employing soft-power strategies to shape the ecosystem (Ozcan & Eisenhardt, 2009), or simply being lucky (Jacobides et al., 2014)?

A third avenue is to examine the research on biological ecosystems more closely for insights into business ecosystems. For example, how do "kingpins" in business ecosystems compare with "keystones" in biological ones. Similarly, does the biological concept of "mutualism" have a business ecosystem corollary? More broadly, it is likely fruitful to compare biological strategies for succeeding in ecosystems with business strategies such as component, systems, and bottleneck. Biological research might also offer insights into how ecosystems evolve or even collapse.

Conclusion

Many firms compete in ecosystems in which firms both cooperate in alliances to create value and compete with one another to capture value. We organize the ecosystem research into three streams: value creation, value capture, and nascent ecosystems. While each offers insights such as approaches to mitigate technology bottlenecks, tactics to become a "kingpin" and the pros and cons of a component strategy, much remains to understand about these ubiquitous and strategically complex contexts in which alliances are central.

REFERENCES

Adner, R. (2012). *The wide lens: A new strategy for innovation*. Portfolio/Penguin, New York.

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

Adner, R., & Kapoor, R. (2014). Innovation Ecosystems and the Pace of Substitution: Re-examining Technology S-curves. *Strategic Management Journal*.

Almirall, E., & Casadesus-Masanell, R. (2010). Open versus closed innovation: A model of discovery and divergence. *Academy of management review*, *35*(1), 27-47.

Ansari, S., Garud, R., & Kumaraswamy, A. (2015). The disruptor's dilemma: TiVo and the US television ecosystem. *Strategic Management Journal*.

Baldwin, C. (2015). Bottlenecks, modules, and dynamic architectural capabilities. *The Handbook of Dynamic Capabilities*. Oxford University Press, New York.

Baldwin, C., & von Hippel, E. (2011). Modeling a paradigm shift: From producer innovation to user and open collaborative innovation. *Organization Science*, *22*(6), 1399-1417.

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

Brandenburger, A. M., & Nalebuff, B. J. (1995). The right game: Use game theory to shape strategy. *Harvard business review*, *73*(4), 57-71.

Brown, S. L., & Eisenhardt, K. M. (1997). The art of continuous change: Linking complexity theory and time-paced evolution in relentlessly shifting organizations. *Administrative science quarterly*, 1-34.

Casadesus-Masanell, R., & Yoffie, D. B. (2007). Wintel: Cooperation and conflict. *Management Science*, *53*(4), 584-598.

Davis, J. P. (2013). The Emergence and Coordination of Synchrony in Organizational Ecosystems. Advances in Strategic Management, 30, 197-237.

Ethiraj, S. K. (2007). Allocation of inventive effort in complex product systems. *Strategic Management Journal,* 28(6), 563–584.

Ethiraj, S. K., & Posen, H. E. (2013). Do product architectures affect innovation productivity in complex product ecosystems? *Advances in Strategic Management*, *30*, 127-166.

Ferraro, F., & Gurses, K. (2009). Building architectural advantage in the US motion picture industry: Lew Wasserman and the Music Corporation of America. *European Management*

Review, *6*(4), 233-249.

Fixson, S. K., & Park, J. K. (2008). The power of integrality: Linkages between product architecture, innovation, and industry structure. *Research Policy*, *37*(8), 1296-1316.

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

Gurses, K., & Ozcan, P. (2014). Entrepreneurship in regulated markets: framing contests and collective action to introduce pay TV in the US. *Academy of Management Journal*, amj-2013.

Hagiu, A., & Wright, J. (2015). Multi-sided platforms. *International Journal of Industrial Organization*.

Hannah, D., Bremner, R., Eisenhardt, K. M. (2016). Resource Redeployment in Business Ecosystems. *Forthcoming, Advances in Strategic Management.*(T. B. Folta, C. E. Helfat, and S. Karim, Eds).

Hannah, D., & Eisenhardt, K. M. (2015). Origins and Outcomes of Firm Strategy in Nascent Ecosystems. *Working paper.*

Hannah, D.P. and Eisenhardt, K.M. (2016). Value creation and capture in a world of bottlenecks, *Working paper.*

Iansiti, M., & Levien, R. (2004). *The keystone advantage: what the new dynamics of business ecosystems mean for strategy, innovation, and sustainability*. Harvard Business Press.

Jacobides, M., Cennamo, C., & Gawer, A. (2015). Industries, Ecosystems, Platforms, and Architectures: Rethinking our Strategy Constructs at the Aggregate Level. *Working paper.*

Jacobides, M., Knudsen, T., & Augier, M. (2006). Benefiting from innovation: Value creation, value appropriation and the role of industry architectures. *Research policy*, *35*(8), 1200-1221.

Jacobides, M., MacDuffie, J. P., & Tae, J. (2012). When value sticks around: Why automobile OEMs still rule their sector. In *Industry Studies Association Conference* (pp. 29-31).

Jacobides, M., & Tae, C. J. (2015). Kingpins, Bottlenecks, and Value Dynamics Along a Sector. *Organization Science*.

Jacobides M., Veloso F., & Wolter C. (2014). Ripples through the value chain and positional bottlenecks: Innovation and profit evolution in a competitive setting. Working paper, London Business School, London.

Kapoor, R. (2013). Persistence of integration in the face of specialization: How firms navigated the winds of disintegration and shaped the architecture of the semiconductor industry. *Organization Science*, *24*(4), 1195-1213.

Kapoor, R., & Adner, R. (2012). What firms make vs. what they know: how firms' production and knowledge boundaries affect competitive advantage in the face of technological change. *Organization Science*, *23*(5), 1227-1248.

Kapoor, R., & Agarwal, S. (2015). Sustaining Superior Performance in Business Ecosystems: Evidence from Application Software Developers in the iOS and Android Smartphone Ecosystems**.** *Forthcoming in Strategic Management Journal.*

Kapoor, R., & Furr, N. R. (2014). Complementarities and competition: Unpacking the drivers of entrants' technology choices in the solar photovoltaic industry. *Strategic Management Journal*.

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

Kapoor, R., & McGrath, P. J. (2014). Unmasking the interplay between technology evolution and R&D collaboration: Evidence from the global semiconductor manufacturing industry, 1990–2010. *Research Policy*, *43*(3), 555-569.

Milgrom, P., Qian, Y., & Roberts, J. (1991). Complementarities, momentum, and the evolution of modern manufacturing. *The American Economic Review*, 84-88.

Moore, J. (1996). The death of competition: leadership and strategy in the age of business ecosystems. HarperCollins, New York.

Musk, E. (2014). All Our Patent Are Belong To You. Retrieved from https://www.teslamotors.com/blog/all-our-patent-are-belong-you

Ozcan, P., & Eisenhardt, K. M. (2009). Origin of alliance portfolios: Entrepreneurs, network strategies, and firm performance. *Academy of Management Journal*, *52*(2), 246-279.

Ozcan, P., & Santos, F. M. (2015). The market that never was: Turf wars and failed alliances in mobile payments. *Strategic Management Journal*.

Pierce, L. (2009). Big losses in ecosystem niches: How core firm decisions drive complementary product shakeouts. *Strategic Management Journal*, *30*(3), 323-347.

Ranganathan, R., & Rosenkopf, L. (2013). Do ties really bind? The effect of knowledge & commercialization networks on opposition to standards. *Academy of Management Journal*, amj-2011.

Rosenberg, N. (1969). The direction of technological change: inducement mechanisms and focusing devices. *Economic Development and Cultural Change*, 1-24.

Santos, F. M., & Eisenhardt, K. M. (2009). Constructing markets and shaping boundaries: Entrepreneurial power in nascent fields. *Academy of Management Journal*, *52*(4), 643-

671.

Teece, D. J. (1986). Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research policy*, *15*(6), 285-305.