Paper to be presented at

DRUID15, Rome, June 15-17, 2015

(Coorganized with LUISS)

Ecosystem Dynamic Capabilities: Enabling Co-innovation & Growth

Tammy L Madsen
Santa Clara University
Management Dept., Leavey School of Business
tmadsen@scu.edu

David Cruickshank
SAP
Co-Innovation Lab Palo Alto
david.cruickshank@sap.com

Abstract

Our study adds to the growing literature on open innovation and mechanisms for platform-based ecosystem growth by identifying an alternative approach to ecosystem growth -- a platform provisioning both supply- and demand-side resources to external parties (complements) for co-innovation projects. Studies emphasize the importance of demand-side resources in promoting partner relationships in platform-based ecosystems. Unaddressed is the role of other types of resources, capabilities, and processes in shaping and growing an ecosystem. Studying a novel context, a platform with a high degree of resource-openness that is governed and controlled by a single firm, we address this gap. The findings demonstrate how a platform?s degree of resource openness gives rise to a dynamic capability that yields outcomes vital to building and sustaining an ecosystem?s evolution and durability.

Jelcodes:Z00,-

Approaches to developing platform-based ecosystems are becoming increasingly important in shaping and growing industries and markets (Adner, 2006; Chesbrough and Appleyard, 2007; Iansiti and Levien, 2004; Teece, 2007). The industry ecosystem concept captures "the collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution" (Adner, 2006: 2; Iansiti and Levien, 2004). Firms often use a platform-based approach to advance an ecosystem's development (Boudreau, 2010; Eisenmann, Parker and Van Alstyne, 2009; Iansiti and Levien, 2004). Platform-based ecosystems typically revolve around a core service, tool or technology where the functionality of the platform's products and services can be enhanced or extended by other members of, or entrants to, the ecosystem (Boudreau, 2007, 2010; Williamson and De Meyer, 2012; Gawer and Cusumano, 2002, 2008; Gawer, 2009). It follows that how a platform's leader[1] develops and promotes enduring relationships with other actors (entrepreneurs, customers, complementors, suppliers, competitors, institutional actors and systems) is vital to a platform-based ecosystem's growth.

Although research highlights methods used to manage an ecosystem (e.g., Boudreau, 2010; Gawer, 2009; Gawer and Cusumano, 2002; Willamson and De Meyer, 2012; West and Wood, 2013), less attention has been directed at how these methods vary in their ability to facilitate and support co-innovation or coupled forms of open innovation. Yet, if success in these contexts depends on both the platform leader's actions as well as the willingness and ability of external parties to generate meaningful, complementary innovation (Adner, 2006; Iansiti and Levien, 2004), then examining how platform leaders develop and employ capabilities specific to fostering co-innovation and ecosystem growth merits study. We define co-innovation projects as

1. Studies refer to the developer of a platform's core technology and driver of innovation within a platform-based ecosystem as a keystone firm (Iansiti and Levien, 2004), platform leader (Gawer and Cusumano, 2002, 2008), or core firm (Wareham, Fox, and Cano Giner, 2014).

collaborative arrangements where two or more firms agree to invest in, and share, resources and capabilities to create products or services involving novel content.

Over the last few decades, platform leaders have varied in the scope of resources they open up to external parties -- in their degree of resource openness -- to support complementary innovation and growth. Differences in the degree of access granted to complementary firms affects how value is created and distributed and in turn, contributes to variance in the nature and pace of development within an ecosystem (Bourdreau, 2010). Traditional methods involve a "hands-off" approach[2] to collaboration, where a platform leader provides complementary external parties resources to support demand-side or downstream value creation activities (for example, see Ceccagnoli et. al., 2012; Chellappa and Saraf, 2010; Huang et. al., 2009). Partner certification programs provide one example of this "hands-off" approach. By establishing rules and restrictions for participation, these programs focus attention on ensuring a new product or service is compatible with its associated platform technology, signaling the legitimacy and value-add of a new partner's offering, and providing access to downstream resources to support market exposure and sales (see Chellappa and Saraf, 2010)[3]. For example, Cisco offers a variety of programs to serve potential partners including an online hub for finding a partner, a formal process for becoming a certified Cisco partner, and a pathway for benefitting from Cisco's market access.[4] Google offers a somewhat similar certified partner program to grow their analytics business. Approved partners gain a certification badge, access to information regarding Google's product roadmap, technical support, points of contact in Google's Analytics' product management and marketing teams, and possible client referrals.[5]

2. Hands-off refers to the platform or host's degree of involvement in collaborative arrangements.
3. Building on Teece (1980), these types of contractual arrangements support scalability and in turn, dampen the needs for other types of investments in promoting enterprise scale and scope.
4. http://www.cisco.com/web/partners/pr11/index.html#~2
5. Android App Developer page: http://developer.android.com/design/index.html; Google Analytics Certified Partner Program: http://www.google.com/analytics/partners/partners-criteria.html (accessed: 11/20/12).

This "hands-off", one-to-many, approach to platform-based ecosystem growth leverages the outside-in form of open innovation rather than an inside-out or co-innovation form (2003, 2006, 2011). As a result, these partnership programs focus less on co-development or supply-side activities and more on market development and promotion (demand-side activities). However, research indicates that 30% to 70% of partnership arrangements fail to create economic value (Bamford et. al., 2004; Duysters et. al., 1999; Kale et. al., 2002). Studies frequently site governance and management problems as a one of the primary sources of alliance failures (e.g., Park and Ungson, 2001). Other work argues that a firm's ability to identify and manage "bottleneck assets" or "choke points" in the innovation process, from ideation to commercialization, is critical to the firm's ability to create and capture value from innovation (Teece, 1986). These conditions suggest that in platform-based ecosystems, firms relying on more "hands-off" approaches to promote innovation-focused partnerships may be disadvantaged.

One approach to address this challenge involves a platform leader opening up both its supply-side (upstream) and demand-side (downstream) resources and capabilities to external parties. This resource open, "hands in", approach involves granting external parties access to resources and capabilities that assist them in forming and managing innovation-focused partnerships. By expanding the degree of resource-openness to support the co-development of complementary innovative offerings, a platform leader develops a specific and repeatable ability to shape and extend its ecosystem (Chesbrough, 2006, 2014; Teece, 2007; Teece, et al., 1997). This dynamic capability fuels ecosystem growth in a manner distinctive from purely demand-side approaches to growth.

Firms adopting more "hands in" approaches vary in the type and amount of supply-side resources and capabilities made accessible to external parties and how those resources are shared or distributed (see Figure 1). In other words, they vary in the degree of resource openness

employed to support co-innovation. SAP, the world's largest business software company, provides one example of an ecosystem growth (dynamic) capability with its Co-Innovation Lab (COIL). COIL provides supply- and demand-side resources to organizations interested in pursuing co-innovation projects (the supply and demand side resources include knowledge brokers, subject matter experts and project managers; tools and managers to support alliance formation, project planning, and IP management; a virtual collaborative workspace and cloud-based resources; and marketing resources). Intel's Developer Zone and Microsoft's Technology Centers provide additional examples, albeit with more streamlined resource provisions.[6] Table 1 details the different approaches and offers examples of firms employing each approach.

[Insert Figure 1 & Tables 1 & 2 about here]

While studies have explored various approaches to ecosystem growth (i.e., Boudreau, 2010; Cecagnoli et. al., 2012; Gawer and Cusumano, 2002, 2008; Huang et. al., 2009; Iansiti and Levien, 2004), scholars lack a theory of *how a platform's degree of resource openness affects* its ability to promote co-innovation and in turn, ecosystem growth. We address this gap in the literature using a theory building approach (Eisenhardt, 1989). We begin by reviewing concepts that set the stage for our theory development. Our study focuses on contexts where a single firm sponsors and controls a platform's core technology and interfaces. Next, we discuss our methods and introduce the data context for our study, SAP's Co-Innovation Lab (COIL). SAP introduced its first co-innovation lab in spring, 2007 in Palo Alto, California and now operates labs in ten countries (Brazil, China, Germany, India, Japan, Korea, Russia, Singapore, Switzerland, United States). The lab supported a few projects in 2007 but began ramp up in 2008; since 2008, the

6. http://www.microsoft.com/en-us/mtc/default.aspx; Intel's Developer Zone provides a variety of resources but with little asked of Intel in return:L http://software.intel.com/en-us/partner-resources?&paneltab[tabs-453-main]=pid-4690-453#pid-4690-453.

program has supported 644 co-innovation projects and 147 of these projects are affiliated with the Palo Alto lab (see Table 2 for the annual number of co-innovation projects by COIL location from 2008 to 2014). Qualitative and archival data allow us to conduct a deep analysis of fifteen co-innovation projects developed in the Palo Alto lab, from formation to completion. We then offer theory and propositions regarding how a more resource open or "hands in" approach to ecosystem development promotes co-innovation and growth as well as the development of a distinctive ecosystem growth capability. The paper concludes with the implications for theory and future research.

THEORETICAL BACKGROUND

Platforms & Resource Openness

Tapping into the knowledge and creativity of parties external to a firm is a central tenet of the open innovation concept (Chesbrough, 2003, 2006; von Hipple, 2005). Since platform leaders seek to stimulate complementary innovation by external parties that advance the platform's attractiveness to customers (Gawer and Cusumano, 2002; Iansiti and Levien, 2004), the links to open innovation appear obvious (Chesbrough, West and Van Haverbeke, 2006; West, 2003). Work shows that opening a platform's market to third party complementors increases the rate of new development (Boudreau, 2010) while also exposing the platform to diverse sources of ideas and knowledge. Since interactions among diverse actors facilitate the sharing and exchange of complementary knowledge and in turn, foster knowledge creation and experimentation (Jacobs, 1969), granting broad access can yield agglomeration benefits that promote innovation and growth (Jacobs, 1969; Saxenian, 1994).

However, identifying the appropriate degree of openness or access involves crucial tradeoffs (Eisenmann et. al., 2009; West, 2003). For instance, employing an open innovation

approach may stimulate the broad adoption of a technology but also reduce an innovator's ability to appropriate or capture value from its investments (West, 2003). Scholars suggest that this tradeoff plays a weaker role in contexts involving platforms granting market access to complementors (Boudreau, 2010). Second, when a platform's viability thrives on ongoing innovation, an open approach promotes diversity while also giving up some control (Boudreau, 2010). Our study focuses on one crucial tradeoff, the degree to which a platform leader opens its resource base to external parties developing complementary services or products. We define a platform's degree of resource openness using the scope of resources that the platform makes available to third party complements. A high degree of resource openness involves the provisioning of both demand and supply side resources in both virtual and physical forms whereas the low end involves provisioning purely demand side resources in only virtual or online forms (see Table 2). Importantly, throughout the continuum, the platform leader does not forfeit control over the resources but instead, manages and coordinates their use. For instance, when COIL provides a project with access to the lab's IT infrastructure, they work with the project's partners to ensure the system fulfills the project's needs but SAP maintains control over the provisioned infrastructure and its operation. Each approved project is provisioned as a Virtual Local Area Network (VLAN). The software resources (i.e., application servers, platforms, middleware, etc.) inside the VLAN are managed by the project team.

Ecosystem Attributes and Capability Development

As noted in the introduction, broadly defined, ecosystems involve "collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution" (Adner, 2006: 2; Iansiti and Levien, 2004). Scholars have explored the ecosystem concept from different but complementary angles – platform-based (i.e., Ceccagnoli et. al., 2012; Gawer and Cusumano, 2002, 2008; Huang et. al., 2009; Iansiti and Levien, 2004),

network-related (Eisenmann et. al., 2009), ecology-based (McKelvey, 1982; Moore, 1993), and industry-focused (Adner and Kapoor, 2010; Kapoor and Furr, 2014). Despite this diversity, the prior work identifies several common and critical attributes that characterize business ecosystems. First, ecosystems are multi-lateral and thrive on the engagement of many different types of organizations and actors (i.e., entrepreneurs, customers, complementors, suppliers, competitors, institutional actors). For instance, in the smartphone space, the actions of Apple and Google motivated a wide variety of entrepreneurs to develop complementary capabilities to support the generation of new applications. Second, and analogous to ecological ecosystems (Pianka, 1974, 2011), multiple direct and indirect interactions among diverse, loosely connected actors support the sharing, creation and recombination of ideas and knowledge and in turn, the scale and scope of entrepreneurship and innovation in an ecosystem. Relatedly, and similar to a complex adaptive system, the reciprocal interactions among these diverse actors ensures the joint evolution of their capabilities. For instance, interactions among heterogeneous actors facilitate the sharing and exchange of complementary knowledge. This third attribute is particularly critical for the identification of new or adjacent niches associated with an ecosystem and in turn, the development of innovations that support the ecosystem. In combination, the strength of these characteristics underlies the durability and continuous evolution of an ecosystem.

It follows that a capability that promotes these characteristics is critical shaping and extending innovation in platform-based ecosystems. Mapping the dimensions noted above to the different approaches to ecosystem growth suggests that platform leaders may develop different types of dynamic capabilities to support growth. As background, "a dynamic capability is one that enables a firm to alter how it currently makes its living" (Helfat and Winter, 2011: 1244; Eisenhardt and Martin, 2000; Helfat et. al., 2007; Teece et. al., 1997(4); Teece, 2007; Winter,

2000, 2003). First, a demand-side approach provides complementary external parties the opportunity to engage with many different types of actors in the ecosystem. Through partner certification, the demand-side approach signals a partner's legitimacy to the network of actors in the ecosystem. Once certified, partners typically are provided access to an ecosystem's network of actors and in turn, opportunities for interactions with different actors. However, although demand-side resources may help partners fine- tune their skills in building market awareness and sales, they do not contribute to the joint development of partners' supply-side capabilities. Since the latter inform how a firm creates products or services, they play a critical role in the joint evolution of firms within an ecosystem and in the identification of new or adjacent niches associated with the ecosystem. This logic suggests that platform leaders that provide partners with access to supply and demand side resources develop a dynamic capability that helps them not only extend their ecosystem's market scope but also, shape innovation critical to their ecosystem's future (Helfat and Winter, 2011; Teece, 2007). In contrast, approaches focused solely on demand-side resources give rise to a dynamic capability focused on extending an ecosystem rather than co-creating and shaping its innovation trajectory.

Ecosystem Growth

Scholars have explored the growth of platform-based ecosystems from different vantage points. Taking a more macro view, one stream of studies examines how competition and network conditions affect the evolution of platform-based markets (for example, Cennamo and Santalo, 2013; Eisenmann, 2007; Shapiro and Varian, 1999; Zhu and Iansiti, 2012).[7] For instance, studies explore the conditions under which a platform-based market is more likely to become a monopoly or oligopoly (Zhu and Iansiti, 2012). Shifting attention to the lead firm or focal

7. While relevant to the general study of platforms, much of this work is tangential to our focus -- understanding how a platform's provisioning of supply- and demand-side resources affects innovation and ecosystem growth. As a result, rather than provide a comprehensive review of the research on platforms, platform based markets and network effects, we draw on this work to help set the stage and boundary conditions for exploring our study.

platform, other work offers guidance regarding firm-specific tactics, practices and tradeoffs that differentially affect the growth and leadership of new or late-mover platforms (for example, Caillaud and Jullien, 2003; Gawer and Cusumano, 2002, 2008; Gawer, Hagiu and Eisenmann, 2007[8]; Iansiti and Levien, 2004). For instance, some prior work has focused on positioning a platform relative to customers, complements, entrants and competing platforms, including how the leader uses its internal process to manage and promote relationships with complementors (Gawer and Cusumano, 2002).[9] Other work demonstrates that granting access to complementary developers accelerates the rate of new device development but the rate may be conditioned on the amount of control given up by the platform leader (Boudreau, 2010). A third stream of studies focused on value creation considers the influence of complementary firms on ecosystem growth and the conditions that influence the likelihood that a firm will join, and benefit from, a platform-based ecosystem. For example, Huang et. al. (2009) show that competition between an ISV and a platform owner in downstream markets reduces the likelihood of an ISV partnership whereas Ceccagnoli et. al., (2012) find that after joining a platform-based ecosystem, complements, such as independent software vendors, benefit from increased sales.[10] A consistent theme across these studies is that one path to ecosystem growth involves continuously building relationships with external parties to advance a platform's offerings to customers.

8. For instance, one view suggests that platform owners should initially direct attention to customers whose value capture is not dependent on the existence of the complement side of the platform (Hagiu and Eisenmann, 2007). After building a strong customer base, the platform can then shift attention to growing the complement side of the platform.

9. For example, in a detailed study of Intel, Gawer and Cusumano (2002) identified various actions Intel took to develop a platform leadership position. Some actions, such as granting access to software development kits, were oriented toward managing relationships with external complements by provisioning demand side resources.

10. Ceccagnoli et. al. (2012) leverage a unique data set that includes 1,210 independent software vendors that could potentially partner with SAP (the observation period is 1996 to 2004). A key independent variable is whether an ISV is certified by SAP through SAP's integration and certification centers (ICC, http://scn.sap.com/community/icc). SAP's ICC is an example of a hands-off (demand-side) program and is independent from SAP's COIL program; the two programs have different charters.

In sum, the literature on ecosystem attributes, ecosystem growth, and resource openness informs our understanding of the relationships between external parties, a platform's capabilities and an ecosystem's development. Nonetheless, critical issues remain overlooked. First, work in strategy emphasizes that understanding both demand-side and supply-side drivers of value creation is crucial to developing an advantage (Hoopes, Madsen and Walker, 2003; Barney and Peteraf, 2003). Yet, studies of platform-based ecosystems predominately focus on demand-side sources of value creation. This is surprising given resources and capabilities underlie a firm's innovative capacity (Teece, 1986, 2007; Winter, 2000, 2003) and that consistently providing innovative complementary offerings to customers is crucial to sustaining the growth of a platform-based ecosystem. In addition, although the notion that platforms benefit from enabling enduring relationships with external actors is not new, we lack systematic evidence regarding how a platform's degree of resource openness affects its ability to shape and extend its ecosystem. Our study addresses this gap.

RESEARCH SETTING

As noted above, our research setting is a Co-Innovation Lab (COIL) operated by one of the world's largest business software providers, SAP. COIL is an organizational form that provides upstream and downstream complementary resources and capabilities to organizational actors in order to facilitate the formation, design, and implementation of co-innovation projects in a platform-based ecosystem. Recall that a co-innovation project is a collaborative arrangement where two or more firms agree to invest in, and share, resources and capabilities to develop products or services involving novel content. Projects supported by a COIL form should extend the value created by services or products offered within the focal platform's ecosystem. In this model, the firm that created a platform's core technology typically serves as the lab's host but a

host may be any firm interested in promoting innovation within an ecosystem.[11] In addition, the host may, or may not, serve as an alliance partner for co-innovation projects.

As noted above, a COIL provides external parties engaging in a co-innovation project access to both supply-side (upstream) and demand-side (downstream) resources and capabilities. Supply-side resources provisioned by SAP's COIL include: a knowledge broker and network resources, subject matter experts, resources and capabilities specific to intellectual property management, project and operation management templates and managers, IT infrastructure and cloud-based resources and support capabilities, and project workspace (physical and digital). Demand side resources include opportunities to market and showcase project outcomes to SAP's ecosystem of partners and customers using multiple types of communication channels (for example, events; product/service demonstrations; online forums, podcasts & videos; online postings of project reports such as white papers, case studies, etc.). COIL also provides pathways into SAP's other demand-side programs.

A COIL project involves four phases: Proposal (Formation), Enablement, Project Work, and Project Output. First, a project begins with a proposal to COIL by one or more firms. Each COIL facility has a finite set of resources so proposals require support from a senior Vice President (VP) at SAP. When a firm lacks the appropriate SAP contact or support and a COIL lead or finds merit in the proposed project, the lead will facilitate a connection to a senior VP in SAP to determine if there is broader interest in the project. In this way, a COIL lab acts as a bit of a clearinghouse, it is open but with controls or restrictions for use (Boudreau, 2010)[12]. Second, in many instances, a firm proposing a project seeks collaborators. A COIL lead operates as a knowledge broker, assisting the firm in identifying complementary partners within or outside the

11. For instance, predicated upon some very early stage discussions, a university is investigating how they might apply lessons from COIL and is building a platform that includes supply- and demand-side attributes.
12. Over time, COIL has evolved to a membership type organization.

platform's ecosystem. Once partners are identified, the COIL team works with all parties to complete a statement of work (SOW) and develop a formal project agreement. COIL's legal and IP resources and capabilities support this stage of the process. The SOW and agreement include a project timeline and also, identify the types of COIL resources and capabilities needed to support the project. With the SOW and agreements in place, the project's enablement phase begins and primarily involves provisioning the appropriate resources and capabilities to support the subsequent project work phase. Throughout the project's work process, COIL's support team monitors the project and provides additional support when needed. For instance, as a project evolves, a project's partners may find that they need subject matter experts to solve a particular problem. In this case, a COIL lead will connect the partners with subject matter experts in SAP to assist in problem solving. At completion, the partners have the opportunity to showcase and market the project output using the various COIL demand-side resources noted above. Figure 2 provides a snapshot of the process.[13]

[Insert Figure 2 about here]

METHODS

Given limited theory on how a platform's degree of resource openness contributes to co-innovation, capability development and ecosystem growth, we employ a multi-case study approach (Eisenhardt, 1989; Yin, 1994). Several factors motivate our approach. First, we explore a relatively new phenomenon, a co-innovation lab with a high degree of resource-openness. Second, in depth, qualitative analysis allows us to reveal relationships among different actors and constructs that span different levels of analysis in a context where quantitative data is not readily accessible. As such, it is not our intent to describe all of the different aspects of platform-based

13. COIL issues a Value Received Survey (VRS) to project participants at the conclusion of a project and captures participants' views, assessments and quotes regarding the project, the COIL experience and the benefits for engaging with COIL.

ecosystems. Instead, our focus lies with identifying a core set of theoretical concepts and how they inform our research question.

The research setting, SAP's Co-innovation Lab, is attractive for several reasons. For one, innovation oriented collaboration is pervasive in the software industry, SAP's core business (Ceccagnoli et. al., 2012; Gawer and Cusumano, 2002; Martin and Eisenhardt, 2010). The fast-paced nature of the industry (Brown and Eisenhardt, 1997; Baldwin and Clark, 2000; Lee et. al., 2010) also increases the likelihood that firms will pursue collaborative arrangements to support innovation. Third, SAP is one of the world's largest business software firms, making it an attractive global platform for potential alliance partners. Fourth, the characteristics of SAP's core software platform are similar to platforms in other contexts, lending to the generalizability of our findings.

We studied fifteen co-innovation projects originating in SAP's Co-innovation Lab located in Palo Alto, California (see Table 3). We focused on co-innovation projects from the Palo Alto facility because it was the first COIL facility and its practices served as the template for the other nine COIL facilities. The study includes projects from each cohort year beginning in 2009; the analysis omits the 2008 cohort due to a lack of data availability. The firms participating in the projects range from large, established public firms, such as Intel, to small private firms such as BlueCoat Systems.

[Insert Table 3 about here]

Data sources

Several data sources inform our analysis: 1) quantitative and qualitative data from interviews with senior staff members of SAP's Coinnovation Lab (COIL) and with executives and managers that have participated in partnerships with COIL; 2) archival data including white papers, press releases, podcasts, video interviews, presentations, project specific documents, and

corporate documents; and 3) follow up interviews to fill in data gaps. The primary data source includes semi-structured interviews with the Director and Assistant Director of SAP's Co-innovation Lab (COIL) located in Palo Alto, CA. Approximately 12 interviews, ranging from 60 minutes to 3 hours, were conducted. These interviews focused on COIL's operations. We also conducted semi-structured interviews with firms involved in the fifteen co-innovation projects. These interviews ranged from 30 minutes to 1 hour and occurred at the completion of a co-innovation project. In these engagements, we directed our attention to each project's objectives, the co-innovation alliance process, and the project's outcomes. The second author also observed each co-innovation project from initiation to completion and interacted with members of a co-innovation project as the project evolved. The interview data coupled with archival data on each project allowed us to develop project profiles for each co-innovation project. We triangulated the interview data with the various other data sources noted above to ensure accuracy.

Data Analysis

Drawing on the methods for theory building from multiple cases (Eisenhardt, 1989; Eisenhardt and Graebner, 2007; Mitchell, 2014), our study employs within-case and cross-case analysis with no prior hypotheses. The analysis began by building individual cases for each co-innovation project that triangulated our data. To ensure independent appraisals, each author reviewed the data. We then synthesized the data into case write-ups. We analyzed a large number of cases, fifteen (as compared to the recommended range four to twelve), in order to strengthen our understanding of the emergent theory and enhance its generalizability (Eisenhardt, 1989).

We used the case write-ups for the within- and cross-case analyses. The within-case analysis focused on revealing a COIL project's experiences and outcomes. We evaluated the various effects from informants' statements as well as from archival data sources. We then shifted our attention to cross-case analysis, using tables to identify similar themes and patterns.

From these themes and patterns, we developed preliminary theoretical constructs and propositions regarding relationships among the constructs. The next step involved using replication logic to refine and validate the emerging theory. This process involved systematically reviewing the data to compare and verify themes, constructs and patterns while also paying attention to unexpected types of relationships. Next, iterating between theory and data sharpened our findings and theoretical arguments (Eisenhardt, 1989). For example, studies in proximate research streams added to our understanding of the emerging relationships and in turn, helped us refine the theory and develop propositions. Collectively, the various activities yielded the theory that follows.

[Insert Table 4 about here]

ECOSYSTEM GROWTH AND CAPABILITY DEVELOPMENT

Ecosystem Growth

Despite the knowledge that combining upstream and downstream resources and capabilities is critical to the successful development and commercialization of innovations (Teece, 1986, 2006), the dominant approach to growth in platform-based ecosystems involves provisioning demand-side resources to advance the introduction of complementary offerings. In this hands-off approach, external parties work to become certified partners of the platform. Our findings suggest that by providing resources and capabilities to support supply-side activities, COIL's more "hands-in" approach yields additional outcomes. There are three findings. First, interactions and knowledge spillovers among project partners and COIL's network resources (other partners, subject matter experts, contacts within SAP's internal network) are generative -- spawning additional co-innovation projects, often with new or different partners relative to a firm's existing or current project. Some additional projects extend the innovation trajectory of existing projects but others fuel the development of adjacent niches and novel products or

services. In this way, COIL, the platform leader, supports the joint evolution of capabilities among members of its ecosystem while also facilitating interactions among different, loosely connected actors in its ecosystem. Second, COIL projects not only lead to additional COIL partnerships by participating firms but often stimulate the formation of partnerships outside of the ecosystem. Third, the above findings suggest that provisioning both supply and demand side resources to support co-innovation, a platform leader develops a dynamic capability that shapes and extends its innovation in products and services.

Platform leaders grow their ecosystems by collaborating with external actors to extend the value of the platform to end-users. We define ecosystem growth using two metrics. The first metric, growth in platform-specific partnerships, considers whether a partner that initiated a co-innovation project engaged in additional co-innovation projects in COIL; the projects may be related or unrelated to the partner's first co-innovation project. We coded this growth by counting the number of co-innovation projects an initiating partner participated in after its first COIL project. This metric provides an indicator of whether a platform leader is able to promote, shape and extend innovation in the ecosystem. Growth in non-platform-specific partnerships is coded as occurring when an initiating partner engaged in at least one additional partnership outside of the ecosystem based on connections the partner made through COIL. Since ecosystems thrive on a diversity of actors, a critical question is whether growth in projects contributes to diversity. As a result, we also examined whether a firm's other COIL projects involved different partners. Diversity in project partners is coded as occurring when an initiating (non-SAP) firm's other projects involved a different partner or different set of partners.

Among the firms initiating the fifteen projects, three were not involved in other COIL projects either before or after the project under analysis whereas eight contributed to two or more future projects. Intel provides a good example of a project that spawned additional COIL

projects. Intel pursued its first project with COIL in 2009 and participated in twelve more co-innovation projects from 2010 to 2014. As background, outside of COIL, SAP and Intel collaborated to build functionality for a new core platform innovation, SAP HANA. This effort and the SAP HANA platform fueled a variety of related, COIL co-innovation projects that added additional value to the overall platform.[14] An Alliance Manager at Intel commented on one of the related projects that occurred in 2014: This project outcome is the result of companies working cooperatively in a true co-innovation style that was built on the backbone of the COIL *at SAP." "I can't wait to see what we do next."* Reinforcing the growth in platform and non-platform-specific partnerships, an Alliance Manager, Citrix, stated: *"*COIL offers us the unique combination of collaboration with SAP and other partners, working with them on customer-driven solutions, projects and proof-of-concepts and hence extending and creating new partner*ships beyond an already existing ecosystem."* By the end of 2013, Citrix had participated in five co-innovation projects at COIL.

Another key finding is that among the fifiteen co-innovation projects studied, nine contributed to additional partnerships outside of the platform. When noting COIL's supply-side resource benefits, several project participants mentioned that a byproduct of engaging with COIL participants and COIL's knowledge broker was the development of additional partnerships outside of COIL. Nine of the fifteen projects examined resulted in the initiating firm developing a partnership with an external party based on connections made through COIL. For example, one project involving collaboration with SAP NS2 (SAP's US proxy entity), spawned several COIL projects as well as projects external to COIL. The firm's CTO stated:

14. SAP HANA converges platform, database, data processing capabilities, spatial and textual data analysis and provides libraries for predictive planning and business analytics all in a single platform with a built in application and web server. It blends together innovations in hardware architectures, columnar and row databases, text analytics and parallel processing, in a real time data processing platform.

> *"Our work in COIL started in 2013 based on collaboration with SAP NS2 focused* on building an engineered solution on SAP HANA that specifically leverages the HANA Spatial engine. This work has led to additional projects within COIL to leverage more SAP HANA spatial capability, SAP Mobile, and SAP BI; all aimed at accelerating adoption of the emerging spatial technologies across the SAP stack within the SAP customer base. It has also resulted in expanded relationships with other key SAP Partners and SIs. Without the collaborative work in SAP COIL, this extension and creation of new partnerships as well as marketplace adoption of *these technologies would have taken much longer."*

Reinforcing these effects, another executive noted, *"The COIL has provided more than sustained* infrastructure. The COIL has opened doors that helped [my firm] build enduring relationships *internal to SAP and with external SAP partners."* A Principal Enterprise Architect at Red Hat stated: *"Working with SAP COIL enables Red Hat to participate in world leading innovative projects, in collaboration with not only SAP but also other partners."* The findings show that participating in COIL assisted partners and the platform leader in "sensing" and "seizing" opportunities, two entrepreneurial activities viewed as critical to building and maintaining dynamic capabilities that support enterprise growth (Teece, 2007: 1346). We discuss related activities, such as reconfiguration, in a subsequent section of the paper.

To understand whether COIL promotes a critical attribute of productive ecosystems, the interactions of many different types of loosely connected actors, we identified the firms involved in multiple COIL projects and reviewed the partners they worked with after their first COIL partnership. Since several firms were involved in more than one of the fifteen project cases, we focused this analysis at the firm versus project level. We also restricted the analysis to cases where SAP was not the sole initiator of a project. The findings indicate that four firms worked with different partners or sets of partners to support nineteen additional COIL projects. One executive at Intel reinforced this observation: *"Intel* has the unique opportunity to partner with SAP and other innovators to drive rich SAP HANA based enterprise solutions with customers, *and proof of concepts result in new industry partnerships."*

This part of the analysis revealed that COIL's knowledge broker capability was instrumental in connecting a COIL participant to new or distant partners or actors. These connections emerged in both formal and informal ways. For instance, when discussing a project with a COIL lead or manager, a project participant might mention an idea, problem or opportunity that emerged during the project and that required new or different capabilities. The COIL lead would then connect the participant with a firm in the ecosystem's network that held the capabilities required for the potential project. To provide one example, in 2010, a project, Monsta, was formed to examine concurrent use levels of an SAP product (SAP BI 4.0). At the time, Supermicro, a tertiary server provider, considered the notion of joining COIL as one beach head in its efforts to build a broader relationship with SAP. However, supporting Supermicro's initial project required additional computing capacity. To ensure that Supermicro could gain the necessary components (semiconductor processors with the appropriate capacity) to provide the servers for the project, COIL brokered a deal between Supermicro and Intel. This connection enabled Supermicro to engage in the Monsta project. Once the first stage of the project was completed, COIL demonstrated the project outcomes to Intel which legitimated Intel's collaboration with Supermicro. The next phase of the project required additional technical equipment and COIL facilitated a connection with a third firm, F5. The project, documented in a white paper, demonstrated the ability to achieve 10K concurrent users on the SAP business intelligence 4 platform, achieving performance superior to previous testing and validation, and establishing a new threshold.

The project involving Intel, Vormetric, and Virtustream provides another example, motivated by a challenge facing Vormetric, a provider of an encryption solution for cloud deployments (in particular, with SAP's HANA platform). Vormetric was not certified with SAP and thus, faced a common challenge: If a customer using SAP's HANA platform also employed

Vormetric's solution for encryption and subseqently needed to trouble shoot a problem, Vormetric's lack of certification meant that the customer would have to remove Vormetric's software from their system before SAP would assist in the trouble shooting process. As a result, Vormetric is working with COIL to make the necessary connections within SAP to certify the encryption solution and ensure that the appropriate processes are in place to make back end support possible. Once its encryption solution becomes certified, COIL will assist Vormetric in developing relationships with other parties at SAP, as well as parties external to the ecosystem, to further legitimize their role in a deployment with SAP. In sum, the supply-side resources provisioned by the platform promote the formation of ties among different actors in the ecosystem.

Taken together, the findings suggest that platforms with a high degree of resource openness, those granting external parties or partners access to both supply and demand side resources, promote growth in different ways. First, they spawn additional co-innovation projects (partnerships) which extend the value of the platform's offerings for end users and in turn, promote the growth of the ecosystem. Second, the observation that the COIL process and resources assisted participants in developing partnerships outside of the ecosystem demonstrates that a platform's high degree of resource openness creates unique value for its partners. While research shows that granting access to a platform's market increases the rate of product development (Boudreau, 2010) and that providing access to demand-side resources promotes market exposure and sales (Chellappa and Saraf, 2010), prior work devotes less attention to how growth is influenced by opening up access to a platform's supply-side resources. By provisioning supply-side resources, a resource-open platform provides foundational resources critical to knoweldge creation. However, resource openness does simply increase the count of platform based parternships but affects the diversity of participants, offering another dimension of growth.

This diversity is critical to fueling the creation and recombination of ideas and knowledge among loosely connected actors and in turn, the joint evolution of their capabilities. A critical byproduct of this evolution is ongoing innovation for the ecosystem. In sum, we propose:

Proposition 1: Co-innovation partnerships formed through platforms that provide both supply- and demand-side resources (a high degree of resource openness) spawn the formation of additional platform-specific partnerships.

Proposition 2: Co-innovation partnerships formed through platforms that provide both supply and demand side resources (a high degree of resource openness) spawn the formation of additional non-platform partnerships.

Resource Openness & Capability Development

Research in strategy and innovation highlights the importance of both supply-side and demand-side resources and capabilities in value creation (Hoopes et. al., 2003; Barney and Peteraf, 2003; Teece, 1986, 2007). Supply-side factors are vital to the creation of products and services whereas demand-side factors are critical to understanding customer preferences and use value. In combination, they inform a firm's strategic position relative to customers and competitors (Hoopes et. al., 2003). It follows that accessing these different categories through COIL should have implications for a project's participants. Several results emerged when exploring the cases from the partner's perspective. Not surprisingly, we found that external parties value a platform with a high degree of resource openness -- e.g., a platform that provides access to both supply- and demand-side resources. However, and unexpectedly, we also found that many firms chose to leverage only the platform's supply-side resources, ignoring the traditional demand-side resources. In addition, firms using only COIL's supply-side resources contributed differently to the diversity of actors participating in the platform's ecosystem and to the platform's growth as compared to firms that tapped COIL's supply- and demand-side resources. Third, using the platform's supply-side resources facilitated learning and in turn, provided a path for strengthening a partner's innovation oriented capabilities. In addition,

regardless of whether partners used both sets of resources or only supply-side resources, they experienced a faster time to project completion relative to non-platform based projects.

As noted in the theory section, we define a platform's degree of resource openness using the scope of resources that a platform leader makes available to firms that develop complementary goods or services. In our construal, platforms providing a full range of supply- and demand-side resources to external parties are characterized as employing a high degree of resource openness (see Figure 1 and Table 1). Our interest lies in understanding: 1) how heterogeneity in the types of resources accessed by a co-innovation project influences platform-specific outcomes of diversity and growth discussed above; and 2) how a platform's high degree of resource openness affects the learning and innovation capabilities of firms (partners) participating in co-innovation projects. We coded the type of resources tapped by each co-innovation project. Projects that accessed all resources, supply- and demand-side) available at COIL are coded as "both". Projects that only used COIL's supply side resources are classified as "supply-side only" whereas projects that only used COIL's demand-side resources are classified as "demand-side only". Among the fifteen co-innovation projects studied, six used both sets of resources and ten used only supply-side resources. Next, we coded the type of learning identified by a project's participants. Projects where participants identified demand-side learning benefits such as learning about the market or customer needs were coded as "demand-side" whereas projects where participants identified learning related to deeper knowledge about the innovation process, problem solving and capabilities were coded as "supply-side". Projects benefitting from both resource categories were coded as "both".

Since firms in the projects studied did not always take advantage of both sets of resources offered by COIL, we compared the growth and diversity outcomes associated with each project. Six project cases leveraged all of the resources provided by COIL. All of the initiating firms in

these projects engaged in multiple COIL projects, the majority of which involved different partners. In contrast, nine projects opted to only use COIL's supply-side resources. In these cases, five of the initiating firms engaged in multiple other COIL projects but only three firms worked with different partners in their other projects. This findings suggest that heterogeneity in resources accessed by co-innovation partners contributes to differences in the diversity of actors participating in the platform's ecosystem and leads us to propose:

Proposition 3: In platforms with a high degree of resource openness, heterogeneity in the resources accessed by complementary firms contributes to variance in the diversity of actors participating in the platform's ecosystem.

Proposition 4: In platforms with a high degree of resource openness, heterogeneity in the resources accessed by complementary firms contributes to variance in the platform's growth.

Regarding resource-openness, firms identified a variety of benefits associated with gaining access to COIL's supply-side resources and capabilities or entire resource bundle. Not surprisingly, several participants stressed the functional benefits of COIL's resources and capabilities in the context of co-innovation. For example:

> *"COIL provides me the key infrastructure."* Project Lead

> *"The co*-innovation piece provides additional context and frameworks to assist the *innovation process."* Vice President and General Manager

> *"*Leveraging internal SAP resources we were able to validate the approach and compatibility with t*he core product and processes."* CEO and CTO

> *"Given the hugely disruptive nature of technology innovation driving business* change, truly useful innovation cannot exist in a vacuum. Working with COIL and their global team enables innovation to be delivered within the partner ecosystem on a global basis, addressing customer scenari*os and real world requirements."* Alliance Manager

Other project participants voiced benefits associated with specific types of supply-side resources or capabilities:

> "The most valuable aspects of our engagement with COIL is access to the products *and experienced engineers."* Solutions Architect

> *"There is support available in key areas of SAP technologies when it is needed.* COIL provides a great environment to showcase a model architecture and *implementation."* Project Lead

> *"Not only is COIL providing the infrastructure and logistics for projects* getting done successfully, it also offers services for legal agreements, business development opportunities and joint go-to-market activities which makes the COIL services a complete package for SAP partners being interested to deliver new innovative solut*ions to customers."* Director, Strategic Alliances

> *"Working with SAP COIL enables [our firm] to engage SAP product experts and* access the latest SAP solutions in a robust environment managed by SAP *professionals."* Senior Product Manager

Given the above, it is not surprising that learning and honing a firm's innovation capabilities emerged as a common theme. Many project participants explicitly identified COIL, the COIL process (proposal, project formation, project enablement) and/or COIL's knowledge broker capability as primary sources of learning. For example, considering projects that tapped both demand- and supply-side resources, a Global Vice President stated: *"The COIL lab gave us* a framework for drawing out customer needs; helping us learn from our *customers."* Another Vice President noted: "Through our work at the Co-Innovation Lab we have been able to demonstrate customer benefits that extend beyond the recognized project acceleration and *hardware cost savings…"*. A third executive remarked that the partnership at COIL helped us *"learn a lot about our assumptions that will help us in our product development."* In this case, the partners indicated that several assumptions might not have surfaced in their traditional approaches to product development. Further, as noted above, COIL resources also include connections to subject matter experts. For instance, in the Monsta project discussed above, knowledge sharing occurred among the firms but learning also occurred through interactions among project participants and COIL's network of subject matter experts.

Partners in co-innovation projects that only used COIL's supply-side resources also identified learning benefits. In particular, COIL's resources and process helped firms gain unique

insight into their projects. As stated by one Global Vice President and General Manager: *"We didn't just validate the product but came up with some unknowns and surprises and can (use* those) to plan for this during the pilot phase; we learned things that we might have learned *months later in our regular process."* Similarly, a Senior Director of Worldwide Corporate Business Development, noted that his firm: *"*has found that its technical engagement has deepened through its interactions with the SAP Co-Innovation Lab, its own engineering and product management departments have been able to make further SAP app-specific *optimizations and performance gains."* Project participants also noted that accessing COIL's resource base allowed them to focus their attention, as noted by a Senior Product Manager: *"Working with SAP COIL… allowed our software engineering team to concentrate on the job at hand, reducing the time to market."* Such focused attention tends to strengthen an individual's task orientation (Nambisan, 2002) and the quality of his contributions to a project. These observations suggest the COIL resources and capabilities that support project formation and enablement help in problem solving and capability development, a benefit that may be difficult to achieve with demand-side resources alone. In sum, in addition to extending the ecosystem's scope through partnerships and diversity (as proposed in P1, P2 and P3), platforms with high degrees of resource openness help to modify and shape the knowledge base and capabilities of a project's partners, a hallmark of a dynamic capability (Helfat and Winter, 2011; Teece, 2007). Considering these effects in combination, we propose:

Proposition 5: Platforms employing a high degree of resources openness to support co-innovation develop a dynamic capability that fuels ecosystem growth.

DISCUSSION

Our study adds to the growing literature on open innovation and mechanisms for platform-based ecosystem growth by identifying an alternative approach to ecosystem growth --

a platform provisioning both supply- and demand-side resources to external parties (complements) for co-innovation projects. Prior work emphasizes the importance of demand-side resources in promoting partner relationships in platform-based ecosystems. Unaddressed is the role of other types of resources, capabilities, and processes in shaping and growing an ecosystem. Using a novel context, a platform with a high degree of resource-openness that is governed and controlled by a single firm, we address this gap. A central contribution is a theoretical framework mapping how a platform's degree of resource openness gives rise to a dynamic capability that that yields outcomes vital to building and sustaining a durable ecosystem.

Implications for Theory

Resource Openness, Dynamic Capabilities & Ecosystem Durability

Research on open innovation in the context of platform-based ecosystems spans a host of topics. For instance, studies compare platforms on their general degree of openness based on whether the platform is open or closed to different participants (platform provider, platform sponsor) and users (end users, third party complements) (for instance, see Eisenmann et. al., 2009). Other studies emphasize issues of control, defining openness based on the degree of "restrictions on the use, development and commercialization of a technology" and the tension between fostering diversity and giving up control of a platform (Boudreau, 2010: 1851). Related work identifies the tradeoff of promoting widespread adoption (openness) at the risk of distributing value versus capturing it (West, 2003). Finally, other studies identify tactics and actions that platform leaders adopt to develop their ecosystems (for example, Adner, 2006; Gawer and Cusumano, 2002). Despite the fact that supply-side resources are crucial to knowledge creation and innovation, few studies of ecosystems with a single platform leader

explicitly apply the open innovation concept at the micro or resource level to understand ecosystem growth.[15]

Addressing this void, we define a platform's degree of resource openness based on the scope of resources it makes available to potential partners. The findings demonstrate that a platform with a high degree of resource openness advances and shapes an ecosystem by: 1) engaging many different types of actors; 2) facilitating direct and indirect interactions among loosely connected actors; and 3) enabling reciprocal interactions among actors to support the joint evolution of their capabilities. Co-innovation projects in COIL spawned additional partnerships and the diversity of actors within the ecosystem as well as innovation oriented partnerships outside of the ecosystem. During project engagements, a partner's interactions with its project partners, COIL's team, COIL's resources and network ties (such as subject matter experts or ecosystem members), facilitated learning at the project level. Pursuing additional co-innovation projects with different partners also exposed a partner to heterogeneous knowledge sources and in turn, provided opportunities for learning and capability development. As a result, the findings demonstrate that platforms with high degrees of resource openness help to modify and shape the knowledge base and capabilities of partners (Helfat and Winter, 2011; Teece, 2007). In combination, the findings provide robust evidence of a dynamic capability that fuels ongoing innovation in an ecosystem, promoting its growth, durability and evolution.

Ecosystem: Attributes, Growth, and Durability

It is also important to note that studies frequently leverage the ecosystem concept with disregard for its conceptual roots and attributes (exceptions, Iansiti and Levien, 2004; Wareham

15. Several case studies identify actions or tactics platform leaders have used to grow their ecosystems. We exclude studies that provide anecdotal descriptions of any type of platform. Alexy and West's (2014) recent study explores the tension between the resource-based view's emphasis on controlling valuable, rare and inimitable resources in order to gain competitive advantage and open innovation's emphasis on surrendering some degree of control to gain advantage.

et. al., 2014). Building on work in evolutionary ecology and biology, we address this issue by explicitly calling attention to the core attributes (noted above) required to ensure an ecosystem's durability. The implications are twofold. First, increasing the number of participants in an ecosystem supports growth but persistent or durable growth requires additional mechanisms that facilitate direct and indirect interactions among actors and enable reciprocal interactions that support joint learning and capability development. Prior work focuses on growth in complementary firms serving the platform but devotes less attention to the second two features noted above. Second, durable platform-based ecosystems are generative and sticky (Wareham et. al., 2014). Lacking an ability to propagate enduring relationships with and among heterogeneous actors and, in turn, generate ongoing innovation, a platform-based ecosystem's evolution stalls. Yet, this evolution is crucial to sustaining an ecosystem's innovative capacity and in turn, its value. It follows that future research on platform-based ecosystem growth should not only consider mechanisms that advance an ecosystem's size and scope but also, those that promote and maintain its durability. Our study illustrates one approach to ecosystem durability -- a partially controlled platform with a high degree of resource openness. This ecosystem-specific dynamic capability that is, by definition, generative.

Resource Openness and Appropriability

While work suggests that the tradeoff between adoption and appropriability plays a weaker role in platform-based ecosystems (Jacobides et. al., 2006), opening up a platform's supply-side resources challenges this assertion: Will external parties be able to appropriate more value from the platform's supply-side resources than the platform itself? Prior work emphasizes that, under certain conditions, the value created by third party complements is often exploited and appropriated by a platform leader or sponsor. On the flipside, in contexts with a single platform sponsor and provider, will a high degree of resource-openness promote greater value

appropriation by third parties? In the case of COIL, supply-side resources include project agreement templates and legal staff to support the development of bilateral alliance agreements, including terms for managing foreground and background intellectual property. In a separate survey conducted by COIL, project participants identified these contract oriented and legal resources as invaluable. It follows that platforms considering granting third parties access to both supply- and demand-side resources should consider including resources and/or capabilities that address risks of value distribution.

Limitations

This study is not without limitations. Many of the co-innovation projects we studied only used COIL's supply side resources. This was surprising given the projects include firms that are well established in their industries as well as firms that lack experience with a partner program. We investigated this issue in more depth through additional interviews with partners and the COIL Director. Several explanations emerged. First, several well established firms, such as Intel and Cisco, already hold SAP partner certification status by the time they arrive at COIL. Second, these firms also have robust downstream resources to support their own marketing activities. Third, a firm may first attempt to join SAP's PartnerEdge Program. But, if it lacks an SAP product certification or technical suitability review, the firm might approach COIL for assistance in characterizing the features or performance of their product and developing the necessary requirements for qualifying for certification. Regardless of the reasons, we also found that several large established firms opted to access both sets of resources. As a result, the story is likely more complex and presents an opportunity for future research. Last, our study focused on a specific type of platform, and how its resource-openness affected co-innovation projects, project participants (partners), and its ecosystem. Other sources of unobserved heterogeneity such as partners' behaviors, intentions, and strategies could yield unanticipated consequences.

Our interactions with participants involved in the fifteen cases suggest that our findings are not biased by unobserved heterogeneity. Nonetheless, future work will explore the COIL engagements by unbundling the partner side of the picture in more detail.

Conclusion

Integrating research on open innovation, dynamic capabilities and platforms with ecological views of ecosystems, our study advances theory by demonstrating how a platform's degree of resource openness affects co-innovation, partner learning and an ecosystem's growth and durability. By provisioning both supply- and demand-side resources with partial control, a platform-leader develops an ecosystem-specific dynamic capability that shapes and promotes ongoing innovation and in turn, the value of the ecosystem. This approach takes us one step closer to understanding what explains heterogeneity in the development and evolution of platform-based ecosystems.

REFERENCES

Adner, R., 2006. Match your innovation strategy to your innovation ecosystem. Harvard Business Review, 84: 98-107 (2006: 2).

Adner, R., and 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: 306-333.

Alexy O, West J. 2014. The Resource-based View of Openness. Working paper, presented at Santa Clara University.

Baldwin CY, Clark KM. 2000. Design Rules: The Power of Modularity. MIT Press: Cambridge, MA.

Bamford, J., Gomes-Casseres, B., Robinson, M. 2004. Mastering Alliance Strategy: A Comprehensive Guide to Design, Management, and Organization. Jossey-Bass: San Francisco, CA.

Barney JB, Peteraf MA. 2003. Unraveling the resource-based tangle. Managerial and Decision Economics, 24: 309-323.

Boudreau, KJ. 2010. Open Platform Strategies and Innovation: Granting Access vs. Devolving Control. Management Science, 56: 1849-1872.

Boudreau KJ. 2007. Does Opening a Platform Stimulate Innovation? The Effect on Systemic and Modular Innovations. MIT Sloan Research Paper No. 4611-06.

Brown SL, Eisenhardt KM. 1997. The art of continuous change: linking complexity theory and time-paced evolution in relentlessly shifting organizations. Administrative Science Quarterly, 42(1): 1–34.

Callaud B, Jullien B. 2003. Chicken & Egg: Competition among intermediation service providers. RAND Journal of Economics, 34: 309-328.

Ceccagnoli M, Forman, C, Huang P, Wu, DJ. 2012. Co-Creation of Value in a Platform Ecosystem: The Case of Enterprise Software. MIS Quarterly, 36: 263-290.

Cennamo C, Santalo J. 2013. Platform Competition: Strategic trade-offs in platform markets. Strategic Management Journal, 34: 1331-1350.

Chellappa, RK, Saraf, N. 2010. Alliances, Rivalry, and Firm Performance in Enterprise Systems Software Markets: A Social Network Approach. Information Systems Research, 21: 849-871.

Chesbrough, H.W., Appleyard, M. A. 2007. Open Innovation and Strategy. California Management Review. 50: 57-76.

Chesbrough HW. 2011. Bringing Open Innovation to Services. MIT Sloan Management Review, 52: 85-90.

Chesbrough HW. 2006. Open Business Models: How to Thrive in the New Innovation Landscape. Harvard Business School Press: Boston, MA.

Chesbrough HW, West J, Vanhaverbeke W. 2006. Open Innovation: Researching a New Paradigm. UK: Oxford University Press.

Chesbrough HW. 2003. Open Innovation: The new imperative for creating and profiting from technology. Harvard Business School Press: Boston, MA.

Eisenhardt KM, Martin JA. 2000. Dynamic Capabilities: What are they? Strategic Management Journal, 21: 1105-1121.

Eisenhardt KM. 1989. Building theories from case study research. Academy of Management Review, 14: 532-550.

Eisenmann T, Parker G, Van Alstyne M. 2009. Opening Platforms: How, when, and why? In Gawer A. (ed.), Platforms, Markets and Innovation, 131-162. Cheltenham, UK and Northampton, MA, US: Edward Elgar.

Eisenmann T. 2007. Managing Networked Businesses: Course overview for educators. Harvard Business School note 807-104.

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

Gawer A, Cusumano M. 2008. How companies become platform leaders. Sloan Management Review, 49(2): 28–35.

Gawer, A. 2009. Platforms, Markets and Innovation. Edward Elgar Publishing.

Hagiu A. 2007. Merchant or two-sided platform? Review of Network Economics, 6: 115-133.

Hagiu A, Eisenmann TR. 2007. A staged solution to the catch-22. Harvard Business Review, 85(11).

Helfat CE, Winter SG. 2011. Untangling dynamic and operational capabilities: Strategy for the [n]ever-changing world. Strategic Management Journal, 32: 1243-1250.

Helfat CE, Finkelstein S, Mitchell W, Peteraf MA, Singh H, Teece DJ, Winter SG. 2007. Dynamic Capabilities: Understanding Strategic Change in Organizations. Blackwell Publishing: Malden, MA.

Hicks DA, Brody G, Skelton MD. 2014. A Rapid Application Development Center for High-Speed Networks. Presented at SAP's Co-Innovation Lab, Palo Alto, CA, October, 2014.

Huang, P., Ceccagnoli, M., Forman, C., and Wu, D. J. 2009. When Do ISVs Join a Platform Ecosystem? Evidence from the Enterprise Software Industry. ICIS Proceedings, Association for Information Systems, 1-1-2009.

Hoopes D, Madsen TL, Walker G. 2003. Why is there a resource-based view: Toward a theory of competitive heterogeneity. Strategic Management Journal, 24:889-902.

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

Jacobides MT, Knudsen M, Augier. 2006. Benefiting from innovation: Value creation, value appropriation and the role of industry architectures. Researh Policy, 35(8):1200–1221.

Jacobs J. 1969. The Economy of Cities. Random House, New York.

Kale, P., Dyer, J., Singh, H. 2002. Alliance capability, stock market response, and long-term alliance success: the role of the alliance function. Strategic Management Journal, 23, 747–767.

Kapoor R, Furr NR. 2014. Complentarities and Competition: Unpaking the Drivers of Entrants' Technology Choices in the Solar Photovoltaic Industry. Strategic Management Journal, forthcoming.

Lee C, Venkatraman N, Tanriverdi H, Iyer B. 2010. Complementarity-based Hypercompetition in the Software Industry: Theory and Empirical Test, 1990-2002. Strategic Management Journal, 31: 1431-1456.

Madsen TL, Leiblein MJ. 2014. What Factors Affect the Persistence of an Innovation Advantage? Working Paper, SCU and OSU.

McKelvey B. 1982. Organizational Systematics: Taxonomy, Evolution, Classification. Berkeley and Los Angeless, CA, University of California Press.

Moore JH. 1993. Predators and Prey: A New Ecology of Competition. Harvard Business Review, 71: 75-86.

Pianka, E. R. 1994 (2011). Evolutionary Ecology. New York, NY: Harper Collins Publisher.

Saxenian A. 1994. Regional Advantage: Culture and Competition in Silicon Valley and Route 128. Cambridge, MA: Harvard University Press.

Shapiro, C., H. Varian. 1998. Information Rules: A Strategic Guide to the Network Economy. Harvard Business School Press, Boston.

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

Teece DJ, Pisano G, Shuen A. 1997. Dynamic capabilities and strategic management. Strategic Management Journal 18(7): 509–533.

Teece DJ. 1986. Profiting from technological innovation: implications for integration, collaboration, licensing and public policy. Research Policy, 15: 285–305.

Teece DJ. 1980. Economies of scope and the scope of the enterprise. Journal of Economic Behavior and Organization. 1: 223-247.

Wareham J, Fox PB, Cano Giner JL. 2014. Technology Ecosystem Governance. Organization Science, 25: 1195-1215.

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

West J. 2003. How open is open enough? Melding proprietary and open source platform strategies. Research Policy, 32: 1259-1285.

Williamson, P.J. and De Meyer, A. 2012, Ecosystem Advantage: How to Successfully Harness the Power of Partners. California Management Review, 55: 24-46.

Winter SG. 2003. Understanding dynamic capabilities. Strategic Management J., 24: 991-996.

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

Figure 1. Supporting vs. Enabling Ecosystem Growth: Examples of Variation in Resource Openness

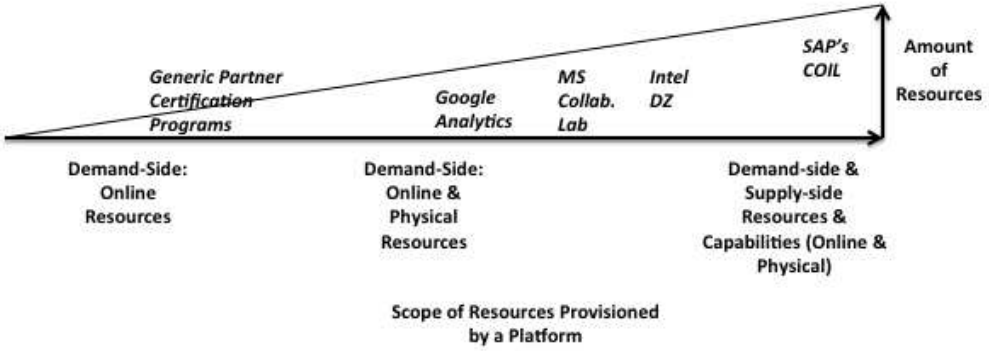
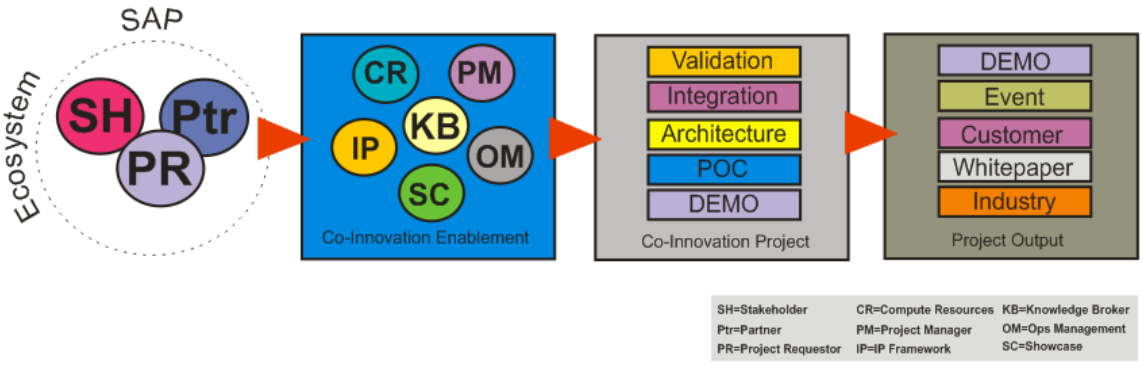
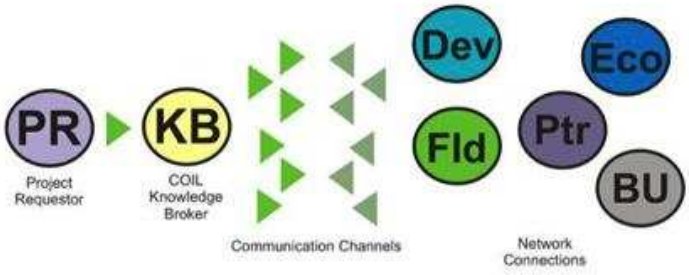


Figure 2. SAP's COIL: Snapshot of the COIL Process & Resources





Acroynms: Network connections include field (Fld) representatives (sales, pre-sales, acct. executives, service, consulting, etc.), partners (Ptr), and subject matter experts in SAP's ecosystem (Eco) and SAP's technology and business development groups (Dev, Biz).

Table 1. Summary and Examples of Resources provided by Hands-Off and Hands-In Approaches to Ecosystem Growth

	Supply-side (Upstream) Resources & Activities							Demand-side (Downstream,Outbound Facing) Resources & Activities
Hands-in Forms	Concept Evaluation	Identifying &/or Facilitating Connections to Partners for Co-Innovation	Opportunity Assessment	Project SOW	Project Contracts & IP Agreements: Templates, Legal Staff	Network Resources: Knowledge Brokers, Subject Matter Experts, & Host's online services (Partner Hubs)	Project Execution	Marketing: Product Launch; Activities specific to Demonstrating Proof of Value
SAP - COIL	COIL Staff review concepts & engage actors to define the scope & desired outcomes	Knowledge Broker used to identify appropriate partners	Managers work with all parties to refine project terms, scope & timeline	Managers work with all parties to formalize the SOW. Resources include project managers, SOW templates, & planning tools	Contract Templates & IP Agreements; Legal Staff Support to facilitate contract development	Access to Knowledge Brokers; Subject Matter Experts	Provision of Project & Ops Managers as needed; Access to IT Infrastructure & virtual collaborative workspace; Planning tools	Product demonstrations; Showcasing Functionality/interoperability to Ecosystem; Whitepapers. Focus: Proof of value demonstration
Intel DZ				Access to Project Planning Templates		Access to online resources: Developer Community &Knowledge database	Access to s/w assessment tools.	Access to online guides specific to marketing and product launch
MS Collaboration Lab	Kickoff with Strategy Workshop to clarify customer needs.					Training Workshops	Collaboration (design & development) in lab to support customized needs.	Assistance with deployment/rollout.
Hands-Off Forms		Partner Certification Processes				Online Technology, Project &/or Community Resources		Outbound activities specific to marketing & launch
Google Analytics Partner Network		Partner Certification Process				Online Technical Support; Access to point of contact in Google's Product Mgmt. Team & Information on Google's Roadmap		Access to point of contact in Google's Marketing Team; Possible client referrals
Cisco Partner Network		Partner Certification Process				Access to Partner Hub; Partner Certification Process		Pathway for benefiting from Cisco's market access.

Table 2. Annual Number of Co-Innovation Projects by COIL Facility (location)

	Year						
COIL Facility (by location)	***2008***	***2009***	***2010***	***2011***	***2012***	***2013***	***2014***
Brazil			6	32	33	28	15
China					1	21	8
Walldorf Germany	1	12	14	6	9	9	5
Dresden Germany						6	
India	6	9	6	19	25	7	4
Japan	3	15	26	27	26	41	8
Korea		2	5	0	5	7	3
Russia					2	10	
Singapore					7	6	
Switzerland					8	7	4
United States (Palo Alto)	5	34	33	21	17	28	9
United States NSQ						2	1
Annual Project Counts	***15***	***72***	***90***	***105***	***133***	***172***	***57 (ytd)****

Table 3. Overview of the Focal Co-Innovation Projects (Cases)

Co-Innovation Project (Alliance	Cohort Year	# of Partners Involved	Project Duration	Number of Informants	Informants	Outcome: Goals Achieved
Processor Performance Validation	2009	3	12 mos.	4	Alliance Manager, SAP; Architect, VMWare; Project Manager, COIL; Alliance Manager, VMWare	Yes
Teradata & SAP Integration (stalled project)	2009	2	6 mos.	3	Vice President, Teradata; Alliance Manager, SAP; Project Manager, Teradata	No; stalled project
Global Deployment Solution	2010	2	2 mos.	3	Aliance Manager, Blue Coat; Alliance Marketing, Blue Coat; Manager - Blue Coat Services, SAP	Yes
OSI Energy Mgmt. Showcase & Integration Development	2010	2		2	Account Executive, OSIsoft; Architect and Project Manager, OSIsoft	Yes
Vistex HANA Solution	2011	2	11 mos.	2	Project Manager, COIL; Partner Manager, SAP	No; stalled project
OSIsoft & HANA Integration	2012	2	6 mos.	2	Account Executive, OSIsoft; Architect, and Project Manager, OSIsoft	Yes
Monsta BOE - BI4 on Sybase perf/scale- P186	2012	5	11 mos.	6	SAP HANA Services; SAP Development; Alliance Manager, Intel; Manager, Supermicro; Alliance Manager, F5; Executive Vice President & GM, Global Database Technology, SAP	Yes
Case Study	2012	4	4 mos.	2	SAP HANA Services; SAP Development	No
Managing and enforcing security policies on SAP Mobile Platform with CA SiteMinder®	2013	3	3 mos.	2	Alliance Manager for CA, SAP; Alliance Manager for CA, SAP	Yes
Virtualized HANA technology	2013	2	8 mos.	4	Project Manager, VMWare; Project Manager, COIL SAP; Partner Manager to VMWare, SAP; Vice President, VMWare, Alliance to SAP	No
SAP Hana Encryption – Phase 1 Feasibility Testing	2013	4	4 mos.	3	Vice President, Product, Vormetric; Alliance Management, Intel; Data Center Systems Product Manager, Intel	Yes
SAP 3D Visual Enterprise - Phase 1	2013	3	9 mos.	2	Director, Strategic Alliances; SAP Visual Enterprise 3d team	Yes
Intel Ivybridge E7 launch Analyst workshop for HANA, big data, and security	2014	2	2 mos.	2	Alliance Management, Intel; Project Manager, COIL	Yes
Development of Red Hat OpenShift Cartridge for Sybase IQ and SQL Anywhere	2014	2	4 mos.	2	Alliance Mgr, Red Hat; Architect, Red Hat	Yes
HANA & Big Data Fusion - Phase I - Real Time Situational Awareness Reference Architecture	2013	4	8 mos.	5	Chief Technology Officer, SAP; Database Architect, SAP; Development, SAP; Encryptics Project Manager; Chief Technology Officer, Critigen	Yes

Table 4. Shaping and Growing the Platform-based Ecosystem

Co-Innovation Project	Partners (*=initiating partner)	Initiating Partner new to SAP?	Resources used from Platform (Supply side; Demand side; Both)	Platform-specific Outcome: Spawns Co-innovation Projects Yes & # of additional projects; or No	Diversity: Initiating firm's other Co-innovation projects involve different partners?	Non-Platform-specific Outcome: Spawns Partnerships outside of COIL?	Learning: Demand-side (Market-based); Supply-side (Capability-based; Innovation Process); Both	Representative Quote
Processor Performance Validation	Intel *, VmWare, SAP	No	Both	Yes: 12	Yes	Yes	Both	"Through our work at the Co-Innovation Lab we have been able to demonstrate customer benefits that extend beyond the recognized project acceleration and hardware cost savings of SAP in VMware virtualized environments." VP Global Partners and Solutions, VMWare
Integration	Teradata *, SAP	Yes	Supply-side	Yes: 1	No	No	Supply-side	"Combining SAP Business Warehouse with Teradata on a single scalable enterprise data warehouse platform will improve companies' operating efficiencies and information infrastructures." President and CEO, Teradata Corp.
Global Deployment Solution	Blue Coat*, SAP	Yes	Both	Yes: 3	Yes	No	Supply-side	"Blue Coat has found that its technical engagement has deepened through its interactions with the SAP Co-Innovation Lab, its own engineering and product management departments have been able to make further SAP app-specific optimizations and performance gains." Sr. Director, WW Corporate Business Development, Bluecoat Systems
OSI Energy Mgmt. Showcase & Integration Development	OSIsoft*, SAP		Supply-side	Yes: 2	No	Yes	Supply-side	"[COIL] has allowed our software engineering team to concentrate on the job at hand, reducing the time to market." Senior Product Manager, OSIsoft
Vistex HANA Solution	Vistex *, SAP	Yes	Supply-side	No	No	No	Supply-side	"When we embarked on this project, HANA was still an immature product. COIL resources helped us work through many product issues that could have stopped the project. This was invaluable and allowed the partner (Vistex) to meet its goal ... We at SAP have also

								learned much about HANA by having to work with it in its initial release. Again - this has proven to be invaluable." Partner Manager, SAP
OSIsoft & HANA Integration	OSIsoft *, SAP	No	Supply-side	No	No	Unknown	Supply-side	"Working with SAP COIL enables OSIsoft to engage SAP product experts and access the latest SAP solutions in a robust environment managed by SAP professionals." Senior Product Manager, OSIsoft
Monsta BOE - BI4 on Sybase perf/scale-P186	Supermicro, RH Intel, F5, SOASTA, OSIsoft (initiated by SAP COIL)	No but 2 new partners in the project	Both	Yes: 3	Yes	Yes	Both	"COIL has been strategic in creating a network and community of experts who can develop content, drive projects and help us achieve our goals. Without this stellar and necessary support, the sales team and I could not do what we do—identify and develop opportunities, and close deals." Executive VP & GM, Global Database & Technology, SAP
Case Study	Intel, Supermicro, Soasta, F5 RH	No	Supply-side	No	No	No	Both	"The SAP COIL lab is such a value add to our partnership with SAP. We conducted the project with the experts from the SAP product team and other high profile partners and delivered outstanding results which gave us tremendous visibilities and go to market opportunities. The lead and staff at COIL demonstrated great leadership, professionalism, technical skills, and excellence in project management. It was a pleasure and valuable experience working with COIL" Executive, Red Hat
Managing and enforcing security policies on SAP Mobile Platform with CA SiteMinder®	Computer Associates, SAP*, Cisco	No	Both	Yes: 2 Prior projects: 1	No	Yes (2 with GTM)	Demand-side	"SAP COIL allows CA Technologies and Cisco to showcase a solution that goes beyond monitoring by adapting your SAP HANA IT environment to the changing needs of business." VP, CA Technologies
Virtualized HANA Technology	VMWare*, SAP*	No	Both	No Prior projects: 2	Yes	Yes	Supply-side	"Great facilities, equipment and great people all around helped to make this one a successful project." Project Lead, VMWare

SAP HANA Encryption – Phase 1 Feasibility Testing	Vormetric, Virtustream, Intel*, SAP	No	Supply-side	Yes: 1	Yes	Yes	Supply-side	"The resources within the COIL group allowed us to jumpstart and deliver a practical solution to a real world problem facing all Hana Enterprise Cloud customers. Leveraging internal SAP resources we were able to validate the approach and compatibility with the core product and processes." CEO & CTO, Virtustream "Our joint goal is to ensure customers always control their data, deny third-party administrators access to sensitive data, and give customers the visibility they need for security and compliance. Vormetric is excited to be part of the technology leadership team that COIL has brought together to foster innovative cloud solutions that are secure and have high performance at scale." VP of Product Development, Vormetric
SAP 3D Visual Enterprise - Phase 1	Citrix*, NVidia, SAP	Yes	Supply-side	No Prior projects: 4	No	Yes	Supply-side	"The SAP Co-Innovation Lab is a unique place where SAP and partners can come together to create new innovative solutions for customers. Not only is COIL providing the infrastructure and logistics for projects getting done successfully, it also offers services for legal agreements, business development opportunities and joint go-to-market activities which makes the COIL services a complete package for SAP partners being interested to deliver new innovative solutions to customers." Director Strategic Alliances, Citrix Systems, Inc.
Intel Ivybridge E7 launch Analyst workshop for HANA, big data, and security	Intel*, SAP*	No	Supply-side	Yes: 1	Yes	Yes	Supply-side	"This project outcome is the result of companies working cooperatively in a true co-innovation style that was *built on the backbone of the COIL* at SAP. Thank you everyone for all your work and dedication to this project. I can't wait to see what we do next." Alliance Manager, Intel

Development of Red Hat OpenShift Cartridge for Sybase IQ and SQL Anywhere	Redhat*, SAP	Yes	Supply-side	Prior projects: 1	Yes	Yes	Both	"Working with SAP COIL enables Red Hat to participate in world leading innovative projects, in collaboration with not only SAP but also other partners. It provides a robust infrastructure environment where the latest technologies are applied to high profile projects and as a result, superior results are made possible to customers. The streamlined Go-To-Market program provides highest visibility for partners to demonstrate the results and solutions. SAP COIL has become the go-to place for joint projects." Principal Enterprise Architect, Red Hat, Inc.
HANA & Big Data Fusion - Phase I - Real Time Situational Awareness Reference Architecture	Cisco, SAP*, Critigen, SAP NS2	No	Both	Yes: 3 Prior projects: 3	Yes	Unknown	Both	"We could have not made the progress we have in developing the Real Time Situational Awareness RDS without the COIL. The COIL provides technical outreach to development, marketing and other internal SAP organizations critical for implementing innovative solutions for customer business problems." CTO, SAP NS2