ORIGINS AND OUTCOMES OF FIRM STRATEGY IN NASCENT ECOSYSTEMS

DOUGLAS P. HANNAH

Department of Management Science and Engineering

Stanford University

473 Via Ortega, Stanford, CA, 94110

dphannah@stanford.edu

KATHLEEN M. EISENHARDT

Department of Management Science and Engineering

Stanford University

473 Via Ortega, Stanford, CA, 94110

kme@stanford.edu

February 12, 2015

We are grateful for the insightful comments and generous support of the students and faculty of the Stanford Technology Ventures Program. Support for this research was provided by the Stanford Technology Ventures Program and the Stanford Gerald J. Lieberman Fellowship, and the Mackenzie Family Fellowship Fund.

ORIGINS AND OUTCOMES OF FIRM STRATEGY IN NASCENT ECOSYSTEMS

Prior research examines firm strategy within the context of established ecosystems. This study investigates nascent ecosystems. Through an in-depth, multiple-case study of firms in the US residential solar industry, we develop a theoretical framework to explain how firms successfully navigate nascent ecosystems over time. We identify three distinct strategies, each driven by a unique strategic logic and carrying its own unique advantages and disadvantages. In contrast to prior research, we find that the strategies of high-performing firms are motivated neither by their own preexisting capabilities nor rivalry between partners. Instead, high-performing firms are motivated to create value in collaboration with their partners, and enact strategies that allow them to do so despite the uncertain and dynamic structure of nascent ecosystems. The resultant theory has implications for research on strategy within ecosystems, as well as the relationship between strategy, capabilities, and industry structure.

Many industries consist of networks of interdependent firms. Often termed ecosystems, these networks consist of firms that offer discrete products and services that together comprise, and might be assembled by customers into, a coherent solution (Adner, 2006; Kapoor and Lee, 2013; Langlois and Robertson, 1992). Examples include personal computers (hardware and software), mobile phones (handsets, networks, and operating systems), and 3D printers (printers, software, and scanners). But despite their practical and theoretical significance (Ozcan and Santos, 2014; Jacobides, 2005), little is known about how firms navigate ecosystems over time.

Ecosystems are characterized by simultaneous cooperation and competition. To create value, firms depend on one another to collectively provide the components that comprise the final product (Adner and Kapoor, 2010; Afuah, 2000). To capture value, individual firms must ensure their own bargaining power relative to firms in other components (Jacobides, Knudsen, and Augier, 2006; Hannah and Eisenhardt, 2014). Performance is driven by both value creation and value capture, and thus requires that firms succeed in both respects. Within ecosystems, firms thus face a critical strategic question: which piece(s) of the puzzle should they provide?

Two streams of research offer insight into the factors that might govern this choice. One perspective emphasizes firm characteristics. In particular, research on capabilities suggests the importance of prior experience, which determines the set of relevant organizational skills and technical knowledge the firm can bring to bear (Helfat and Lieberman, 2002; Kapoor, 2013). In this perspective, firms create value by entering components that are consistent with their preexisting capabilities (Gawer and Henderson, 2007; Qian, Agarwal, and Hoetker, 2012). In contrast, a second stream of research prioritizes industry characteristics. According to this perspective, firms succeed by maintaining bargaining power, and thus the ability to capture value, relative to other industry participants (Porter, 1980; Chatain and Zemsky, 2011). In this

view, firms should thus enter components in which they face little rivalry (Jacobides, Knudsen, and Augier, 2006). Overall, prior research thus suggests two governing logics – capabilities and rivalry – that are understood to guide firm strategy in ecosystems.

But the applicability of these logics to strategy within *nascent* ecosystems is not clear. Nascent ecosystems are those that are in an early state of formation or reformation (Santos and Eisenhardt, 2009). They may be completely new industries like quantitative fitness, or re-booted industries in which substantial shocks trigger new dynamics, as in the residential solar industry that we study here. Nascent ecosystems differ from established ecosystems in ways that are likely to affect the choice of which components to enter in several critical ways. First, nascent ecosystems often exhibit undefined industry structures, with unclear product or component definitions, rapidly changing innovation in one or more components, and uncertainty about potential rivals (Navis and Glynn, 2010; Santos and Eisenhardt, 2009; Hargadon and Douglas, 2001). As a result, it is not clear how rivalry- or capability-based logics might guide firm strategy. For example, while entering low rivalry components may be effective in established ecosystems, executives in nascent ecosystems may not be able to identify which components exhibit low rivalry. Similarly, although the relationship between capabilities and components may be clear in established ecosystems, executives in nascent ecosystems may not be able to predict what capabilities are required to compete successfully within a given component.

A related issue is that within nascent ecosystems, the availability of the components required to create value cannot be taken for granted (Hughes, 1983; Hannah and Eisenhardt, 2014). For example, there may be no partners available to provide a particular component, and the firm may lack the capability to provide that component on its own (Collis, 1992; Ozcan and Santos, 2014). As a result, a firm's ability to successfully produce its own component (capability

logic) or to dominate other firms (rivalry logic) may be insufficient to guarantee its success.

A third issue is that unlike established ecosystems, nascent ecosystems are dynamic. That is, the location of technological challenges and the relationship between components is likely to change over time due to unanticipated firm actions and unexpected innovation (Staudenmayer, Tripsas, and Tucci, 2005; Ferraro and Gurses, 2009; Adner and Kapoor, 2010). But it is not clear how firms respond to changes in the ecosystem that affect the value of different capabilities, or change the location of attractive positions. As a result, existing perspectives are unlikely to generalize fully to nascent ecosystems. With this in mind, we thus ask, *how do firms successfully navigate nascent ecosystems?*

To address this question, we conducted an inductive multiple case study (Eisenhardt and Graebner, 2007) of five early entrepreneurial firms in the US residential solar industry. We selected entrepreneurial firms because we could track their strategies from founding and thus avoid left censoring the data. Moreover, entrepreneurial firms are often pioneers in nascent ecosystems, and having an effective ecosystem strategy is critical because they typically have fewer resources than established firms (Katila, Rosenberger, and Eisenhardt, 2008; Chatterji, 2009). Using extensive interview and archival data, we tracked five entrepreneurial firms that entered the residential solar industry at the same time during a major upheaval in the industry. We then examined how they changed their positions within the ecosystem over time, thus creating an unusually close comparison of rival ecosystem strategies and performance outcomes.

Our study contributes to research on strategy, entrepreneurship, and organization theory. We find that that there are multiple, distinct strategies for navigating nascent ecosystems, each of which carries its own advantages and disadvantages and each of which is driven by a unique strategic logic. At the same time, we also find that the strategies of high-performing firms share a

number of characteristics that belie their apparent dissimilarity. Building on this insight, we propose a theoretical framework that explains how successful firms navigate nascent ecosystems over time. This framework clarifies how strategy in nascent ecosystems differs from strategy in established ecosystems and examines specific actions by which firms ensure their own ability to both create and capture value within nascent ecosystems. It contrasts with both capability- and rivalry-based logics (Porter, 1980; Argyres, 1996), and suggests that in nascent ecosystems these logics lead, at best, to mediocre performance. We note contributions to existing perspectives in strategy and extend work on industry structure, capabilities, and strategy within ecosystems.

THEORETICAL BACKGROUND

Multiple streams of research shed light on how firms successfully navigate ecosystems. First, according to the capabilities perspective, firms enter components for which they possess relevant capabilities, and rely on partners to produce those for which they have relatively inferior capabilities (Helfat and Lieberman, 2002; Jacobides and Hitt, 2005). In this view, possessing the resources, experience, and organizational skills required by a given component allows firms to create value by ensuring their ability to succeed within that component (Argyres, 1996; Bayus and Agarwal, 2007; Farrell, Monroe, and Saloner, 1998). Studies have shown that such behavior is common. For example, in a study of 90 entrepreneurial entrants into the US biofuels industry, Qian et al (2012) find that firms were more likely to enter components in which their founders had prior experience. Similarly, Gawer and Henderson (2007) track Intel's decisions with respect to the various components in the semiconductor industry, and find that Intel was more than twice as likely to enter components deemed by managers to be consistent with its existing capabilities. Collectively, this stream answers our research question with a *capability logic*: by doing what they know how to do well, firms are better able to create value. Over time, doing so will then

allow the firms to continue to develop expertise and advantage in a particular set of components (Mayer, Somaya, and Williamson, 2013; Helfat and Lieberman, 2002). In nascent ecosystems, this implies that successful firms will benefit from entering components that are consistent with their capabilities, and from relying on partners to produce those that are not.

In contrast, the industry structure perspective examines ecosystem strategy as a function of rivalry between firms. In this view, the ability of firms to capture value is a function of their bargaining power relative to other industry participants (Porter, 1980; Chatain and Zemsky, 2011). Firms thus ensure their ability to capture value by entering components in which rivalry is low, and by promoting rivalry within the other components (Jacobides, Knudsen, and Augier, 2006).[1] Research finds that firms that do so can achieve superior performance (Hannah and Eisenhardt, 2014; Dedrick, Kraemer, and Lindon, 2010). For example, Jacobides, MacDuffie, and Tae (2014) demonstrate that the American automakers (OEMs) capture a disproportionate share the value in the automotive ecosystem by limiting entry into their own components while requiring upstream suppliers to compete ferociously with one another. This minimizes the bargaining power of individual suppliers and allows the OEMs to 'play' their partners off one another. This research gives rise to a *rivalry logic*: by increasing their own relative bargaining power, firms are able to capture a greater share of jointly created value. Within the context of nascent ecosystems, this logic implies that successful firms will enter components that are low in rivalry, and will attempt to increase rivalry in other components of the ecosystem.

Overall, these theoretical lenses clarify the factors thought to govern firm strategy within established ecosystems. But their implications for nascent ecosystems are not clear. For example,

[1] Consistent with Porter (1980), this literature conceptualizes rivalry as the degree to which firms in a component exert competitive pressure on one another. Rivalry is influenced by a variety of factors, including the number and size of participants, the presence of fixed costs, and industry growth rates.

nascent ecosystems are characterized by uncertainty regarding potential competitors and entrants (Rindova, Ferrier, and Wiltbank, 2010; Santos and Eisenhardt, 2009), and may draw potential entrants from a wide variety of different sources (Qian, Agarwal, and Hoetker, 2012; Klepper and Simons, 2000). As a result, executives in nascent ecosystems may not be able to identify who their competitors are or will be, as well as which components are or will continue to be low rivalry. Similarly, nascent ecosystems may exhibit substantial uncertainty regarding product definitions, underlying technologies, and component boundaries (Staudenmayer, Tripsas, and Tucci, 2005; Hargadon and Douglas, 2001). As a result, executives may not be able to predict the relationship between their own capabilities and those required to enter a given component. Moreover, nascent ecosystems are often dynamic, so that all of these factors may change over time due to firm actions and technological innovation (Jacobides, 2008; Fixson and Park, 2008).

A smaller body of research has recently begun to explore firm strategy within nascent ecosystems. For example, Hannah and Eisenhardt (2014) develop a formal model to show that within nascent ecosystems, a lack of available partners in other components may prevent firms from creating value in their own. Similarly, Ozcan and Santos (2014) show that firms within the (failed) mobile payments industry were unable to jointly create value because of their inability to determine an underlying component ecosystem. This research suggests that nascent ecosystems may present unique strategic challenges relative to established ecosystems. At the same time, other research suggests that firms within nascent ecosystems may also have a broader strategic repertoire. For example, scholars have examined how firms can create value by coordinating novel relationships among existing participants (Ozcan and Eisenhardt, 2009; Ferraro and Gurses, 2009), or by modifying the boundaries between components (Fixson and Park, 2008). Overall, research thus suggests that firms in nascent ecosystems face a different set of challenges

and have a different set of feasible strategies than those in established ecosystems.

But while this work is promising, prior research has not addressed when these strategies are viable, or how firm strategy unfolds within nascent ecosystems over time. For example, it is not clear how firms respond to changes that affect the value of their capabilities, or alter the location of attractive positions. Nor is it clear how firms simultaneously create and capture value when the structure of the industry, and perhaps its underlying viability, are unknown. Examining how firms successfully navigate nascent ecosystems over time is thus important and our focus.

METHODS

Given the limited theory about how firms navigate nascent ecosystems, we conducted an inductive multiple case study (Eisenhardt, 1989; Yin, 1994). Inductive studies are particularly useful when existing theory provides limited insight into the focal question, and for process questions such as ours. Multiple case studies are effective because they allow for comparison across cases, which often results in more robust, generalizable theory than analysis of single cases (Eisenhardt and Graebner, 2007; Langley, 1999).

The research setting is the US residential solar photovoltaic industry from 2007 to 2014. This is an attractive setting for our study for several reasons. First, the residential solar industry was highly uncertain and dynamic throughout the study period. One major contributor to this uncertainty was the federal Energy Policy Act of 2005, which allowed firms to claim a 30% investment tax credit on the installation of residential solar systems. This policy prompted a rapid and sustained growth in the residential solar market – 15,000% cumulative growth in installations over the course of the study period – while at the same time shuffling and clouding the residential solar ecosystem. For example, rapid growth prompted expectations of entry by a variety of actors from different industries, many of whom were new to the solar industry and

thus threatened to substantially change the existing competitive dynamics. The policy also introduced a new component (consumer finance), which had not previously been part of the ecosystem. The new finance component introduced new actors to the ecosystem (e.g., investment banks), introduced the possibility of new business models, and allowed the market to grow by dramatically lowering the up-front costs faced by consumers. At the same time, a spectrum of new solar photovoltaic technologies emerged (e.g., thin film panels and micro-inverters), which generated substantial uncertainty regarding which would win and how the economics of the industry would change over time. The cumulative effect of these changes was to "reboot" what had previously been a relatively staid industry, such that the ecosystem and competitive dynamics from 2007 onward were unlike what had existed previously.

Residential solar is also attractive because after the changes in 2007 it exhibited a rich ecosystem composed of five distinct components: (1) solar photovoltaic panels, (2) racking, which is a structural component on which panels are mounted, (3) sales and system design, (4) installation, and (5) consumer finance. Each of these components drew on distinct capabilities and had little value in isolation, thus making the ecosystem logic particularly salient to managers (See Figure 1). Finally, the industry is very well documented in the technology and popular press throughout the study period. This facilitates study of its emergence and evolution over time.

We studied entrepreneurial firms. We chose entrepreneurial firms because we could track their strategy from founding and thus avoid left-censoring the data. Moreover, entrepreneurial firms are frequently pioneers in nascent ecosystems (Ozcan and Eisenhardt, 2009), and having an effective ecosystem strategy is essential because entrepreneurial firms typically have fewer resources than established firms (Chen, Williams, and Agarwal, 2012; Chatterji, 2009).

The sample is five entrepreneurial firms founded as the market emerged in 2007 (See

Table 1). We use pseudonyms for the firms in order to ensure the anonymity of our informants. Firms were sampled from archival publications dating to the emergence of the industry, and were corroborated by informants as being among the important "first frontier companies." One key advantage of this study is that the firms began at the same time in the same initial markets, with similar resources and founder characteristics. Moreover, all founders shared the goal of building a significant and profitable firm. These similarities are important because they suggest that firms faced similar starting conditions and had a similar range of feasible strategies, and thus help to mitigate alternative explanations for performance like founding economic conditions. We track the firms from 2007 until 2014, at which point the performance outcomes were clear and one prominent industry analyst declared, *"the winners have emerged*."

Data Sources

We rely on several data sources: (1) semi-structured interviews with firm executives, (2) interviews with industry experts, journalists, and competitors, (3) informal follow-up interviews with key respondents via phone and email, and (4) archival materials, including press releases, corporate documents, recorded interviews, books written by executives, internet resources, and analyst reports. This varied data allowed triangulation among multiple sources, strengthening the accuracy of the data and the quality of the resulting inferences. One particularly valuable source of information was a wealth of archival written and recorded interviews with firm executives from 2007 to 2012, which provided real-time data free of retrospective bias.

A primary data source was semi-structured interviews. In 2013 and 2014 we conducted two waves of interviews with company executives about their firms' history, strategy, and the motivations for key strategic actions (See Table 2). We rely on two types of informants. Internal informants were the executives most familiar with firm history and strategy. This set included

founders, CEOs, board members, and functional area managers like VPs of marketing and operations. External informants consisted of both individuals directly connected to specific firms (e.g., investors) as well as those with more general industry expertise (e.g., analysts, technology journalists, and executives at other firms in the industry). External informants provided an expert outsider perspective on the firms and verified the chronology of events and their implications.

The goal of these interviews was to "get inside executives heads" and glean information directly from the managers making and implementing strategic decisions (Smith et al, 2001). The interviews had three sections. The first covered informants' background, work history, and role within the firm. The second consisted of a detailed narrative of the firm's history from founding to the time of the interview. This section of the interview focused on the specific actions the firm took with respect to each component of the ecosystem, as well as motivations and implications of each. The goal was to understand how and why the focal firm addressed each component at each point in time (e.g., entry into a component, or formation of a partnership). In this section, we also explored entry and partnership decisions that were contemplated but not executed, as well as more general aspects of firm strategy. The third section explored specific details and decisions that arose during the interview or in archival research, as well as the informant's performance assessment of their own firm and of competitors. Each interview lasted between 45 minutes and two hours, and were recorded and transcribed within a day. In many cases, follow-up interviews and emails were used to examine specific events in greater detail and to fill in gaps.

We took multiple steps to ensure data validity and minimize informant bias. Interviews were structured to gather specific information, and were conducted using techniques such as non-directive questioning and event tracking, methods that prior research has shown to yield accurate information from informants (Huber, 1985; Huber and Power, 1985). For non-directive

questioning, informants were asked to focus on facts and events, rather than speculation. For example, informants were asked about specific partnerships, hires, and product releases. We avoided leading questions (e.g., "was the opportunity attractive?"). For event tracking, informants were guided through the history of the firm in order to produce a step-by-step chronology of events (Eisenhardt, 1989). For example, informants stepped through when and how they approached potential partners, what the relationship consisted of, and when and why it was terminated. Second, we interviewed a wide range of informants inside and outside the firms, including representatives from various functional areas and hierarchical levels. This diversity of viewpoints provides a more complete and accurate perspective than single informants (Kumar, Stern, and Anderson, 1993). Moreover, these informants were ensured anonymity, which allowed them to speak candidly about motivations and failures. Third, we triangulated between interview and archival data, a particularly rich source of real-time information.

We collected in-depth archival data from a variety of sources to complement the interview data. This included secondary materials such as popular press articles, company press releases, technology blogs, conference presentations, and analyst reports. The residential solar industry benefited from unusually rich press coverage throughout the study period, due to both public awareness around climate change as well as a number of widely publicized events during the study period (e.g., the failure of Solyndra). One particularly valuable source was the large number of media interviews and conference presentations performed by firm executives. This archival data usually confirmed the interview-based histories, but also generated new insights. In combination, the data yield a comprehensive and accurate history of the firms in the sample.

Data Analysis

We began the data analysis process by synthesizing the interview and archival data into a

comprehensive case history for each firm. Each case focused in particular on the firms' position within the ecosystem at each point in time; including what components they produced internally, relationships (e.g., alliances or contracts) with other firms, and their assessment of the competitive landscape (e.g., technological uncertainty, degree of competition, etc). We focused on information that could be corroborated from multiple data sources and was emphasized by multiple informants (Jick, 1979). Whenever details were missing or unclear we obtained additional archival information or conducted follow-up interviews with informants. Although we took advantage of opportunities to collect unique data, we completed most data collection prior to beginning cross-case analysis in order to preserve the integrity of the replication logic across cases (Eisenhardt, 1989; Yin, 1994). After the first researcher wrote all of the initial cases, the second researcher revisited the original data to ensure accuracy and comprehensiveness. We then identified emergent patterns by analyzing each case through the lens of the research question.

After completing this within-case analysis, we conducted a cross-case analysis in order to examine and compare emergent themes and constructs (Eisenhardt and Graebner, 2007). Using tables and charts (Miles and Huberman, 1994), we listed tentative theoretical constructs and compared them across the cases. We then cycled between emergent theory and case data to clarify the key constructs, develop measures, and strengthen the associated logical arguments. As theoretical insights clarified, we referred to prior literature to compare these nascent insights with existing research. We then returned to the data, thus following an iterative process of refining insights and relating them to existing theory in order to clarify the contribution. The result is the following midrange theory on how firms successfully navigate nascent ecosystems.

Measures

This research asks, how do firms navigate nascent ecosystems? By navigation, we are

referring to which components firms enter directly (e.g., which components they make), whether and how they interact with firms in other components (e.g., alliances or contracts, or other means of coordination), and how these actions change over time. The firms in our sample navigated the solar ecosystem, from founding, with very different strategies. Before describing our theoretical framework, however, we present the firm performance measures.

We assessed firm performance at various points during the study period and at the study conclusion in mid-2014 (Table 3), at which point firms' performance had clarified and there was widespread agreement that the initial phase of industry emergence had ended. We measured firm performance using several quantitative measures deemed to be relevant by both analysts and firm executives: (1) *Annual installations* were compiled from firm press releases and verified in state-level databases such as that maintained by the California Solar Initiative. We also measured (2) the *number of states* in which each firm was operating, (3) the *number of employees* at each point in time, and (4) the *amount of project financing* raised, with data drawn from interviews and press releases. Together, these measures capture the likely revenue as well as the scale of each firm at various points in time including post-study.

We also used multiple qualitative measures. For example, we compiled (5) relevant quotes providing *qualitative assessments* from the industry press that reflect public perception of the firms, and internal informants that provided evaluations of their own and their competitors' performance over time. We also interviewed industry experts to obtain (6) their subjective *industry ranking* of the firms. Overall, there was a high level of consistency between informants and across these measures, which clearly show the rise and fall of the individual firms over time.

Despite similar initial starting points, by the end of the study, the firms' performance had diverged tremendously. Jupiter and Saturn were the highest performing. Each had performed or

financed over 60,000 installations, had raised billions in project financing, and was operating in over a dozen states across the country. Informants described Jupiter as "*the clear number one*," and Saturn as "*easily the next best*." Venus and Mars were moderately successful. In 2011 Mars had peaked as one of the top solar firms in the country, and Venus had been the fastest growing solar firm in the country for a time, but by 2014 their stars had faded. Despite having completed 10,000 to 20,000 sales each, Venus was described as "*not taken very seriously by competitors*" and Mars as having "*nothing about them that's special*." Finally, the lowest performing firm, Pluto, had failed. Its assets were sold in an asset sale in 2013, and a founder told us that the firm would be "*the first to be forgotten*" among the first frontier of entrants.

EMERGENT THEORETICAL FRAMEWORK

Rise of an Ecosystem, 2007 – 2010

According to the capabilities perspective, firms are likely to enter those components for which they or their founders possess relevant capabilities and applicable experience, and rely on partners to produce those for which they have inferior capabilities (Jacobides and Hitt, 2005; Qian, Agarwal, and Hoetker, 2012). Underlying this argument is the assumption that entering components consistent with preexisting capabilities will enhance the likelihood of success in that particular component, and will increase performance by allowing the firm to create value.

Consistent with this perspective, the data show that some firms did rely on their capabilities to determine which components to enter. Yet unexpectedly, these firms often had modest or even poor performance. Instead, the more successful firms entered the bottleneck component. In line with prior work (Jacobides, Knudsen, and Augier, 2006; Jacobides and Tae, forthcoming), we define a *bottleneck* as a component of the ecosystem that is blocking growth because of poor quality, high cost, short supply, or other limiting factors. Bottlenecks are crucial

to the functioning of ecosystems because they can dictate firm profitability, shape power relationships, and constrain overall industry growth. We also find that high-performing firms explicitly assembled the additional components required to create value. Thus, they assembled a complete set of relevant components *and* occupied the bottleneck.

We determined the existence of a bottleneck component using interview data with solar industry executives and experts, and corroborated this designation with our archival data. We found a shared consensus that the bottleneck from 2007 until 2010 was providing end-user finance. At this time, residential solar systems cost about $20,000 to $40,000, and homeowners paid these costs upfront. There were few, if any, dedicated providers of solar financing. In contrast, the other components of the ecosystem were more readily available. The sales and installation components were provided by many local firms, which were often small and family-owned, and operated on a zip code level. Most markets were thus served by a few "mom-and-pop" firms, and these competitors were often relatively unsophisticated: as a result, the sales and installation components were considered to be low rivalry. In contrast, the panels and racking components were understood to be high rivalry. These components were populated by a small number of large manufacturers, with high fixed costs, undifferentiated products, and excess production capacity. Brutal competition and low margins were thus the norm. But despite sharing this common understanding of the industry, the founders varied in the components they chose to enter and their strategies for doing so.

The highest performing firms, Saturn and Jupiter, both entered the finance bottleneck (See Table 4). The first, Saturn, was founded by three recent business school graduates. They decided to exploit the arbitrage opportunity afforded by the 2005 Energy Policy Act. This law enabled commercial entities to gain substantial tax savings from investment in solar systems, but

did not extend these savings to residential owners of solar equipment. These founders recognized that they could change the prevailing business model by owning a homeowner's solar equipment and taking the tax credit. For homeowners, this would reduce the overall cost of solar ownership, eliminate its upfront cost, and ease the hassle of arranging financing. The founders also believed that financing would be difficult for many firms to master because of its financial and legal technicalities. By overcoming these challenges themselves, they would be able to remove the primary constraint on the growth of the industry. Saturn executives thus aligned their entry to take advantage of this bottleneck. As one executive noted, *"We were very deliberate about what parts of the [ecosystem] we entered. The goal was to do things that are hard to do but that scale really well and are high value."* In fact, Saturn continued to pursue this *bottleneck strategy* over time, and consistently aligned its position in the ecosystem with changing bottlenecks.

Saturn coupled its entry into the finance bottleneck by securing access to the other components of the ecosystem. The firm began developing partnerships with large, experienced installers to provide the sales and installation components. By recruiting high-quality partners to provide hardware and to sell and build the systems, Saturn was able to focus on building out the financing component. As one executive stated, "*there were other companies who could do the sales and do the builds well. For us, it made more sense to try to focus on getting the financing."* Developing this component required complex financial engineering to obtain capital, securitize bundles of solar leases, and organize the tax benefits, but also provided unique value to partners. Moreover, by relying on partners for sales and installation rather than participating in these components directly, Saturn was able to scale more rapidly than if they had taken the time to build or acquire the sales, installation, and hardware components themselves.

Since Saturn entered the finance component well before any other firm, the firm gained a

virtual monopoly for almost a year, and was able to dictate aggressive terms to its partners in the crowded sales and installation components. For example, they required their partners to be exclusive and to share their customer relationships with Saturn. These terms also impaired later finance entrants by locking up access to some of the best installers and investors in solar leasing. By focusing on the bottleneck component, exploiting its position, and partnering for the other components in the ecosystem, Saturn thus achieved profitability and scale in its early years.

The other high-performing firm, Jupiter, also entered the finance bottleneck. This firm was founded by a pair of software engineers who had previously started an enterprise software firm and were now drawn to a new challenge. They were attracted to residential solar by the lack of difficult competition they saw in the industry, and because of its potential for addressing global climate change. Unlike Saturn's bottleneck strategy, Jupiter's executives adopted a *system strategy*, in which they simultaneously entered multiple (and eventually all) of the components that comprised the ecosystem. The founders modeled their strategy on what they perceived to be Apple's strategy, and aspired to "*hit a grand slam*". As one executive described,

> *"We took the path that Apple took, which was to manage all the complex pieces in a way that you shield it from the customer and reduce costs… The more of the stack I control, the better customer experience and the differentiation and the lower the cost structure."*

Jupiter entered the finance component because it was consistent with its system strategy: by providing financing, Jupiter was able to outcompete rival solar firms by providing a seamless customer experience. Unlike Saturn, however, Jupiter's founders lacked finance capability and so hired finance experts to build the finance component. This building process was successful for Jupiter. But since the firm was simultaneously entering sales and installation by building and acquiring those components rather than partnering as Saturn was, Jupiter's entry into the finance component was slowed. Although the system strategy thus put the firm behind Saturn, Jupiter did

address the finance bottleneck, assembled a full set of ecosystem components, and grew rapidly.

In contrast, the moderately performing firms, Venus and Mars, did not enter the finance bottleneck. Venus is an example. Venus was founded by two environmental activists and an investment banker. These founders were passionate about the environment and saw building a successful residential solar company as a way to solve a looming environmental crisis.

Like the other founders, they perceived the sales and installation components to be low rivalry "*cottage industries*" of unsophisticated installers, and saw finance as a critical component for the growth of the industry. According to one executive, "*not being able to pay as you go was the number one most important buying obstacle for customers*." Venus's founders also believed that they had the expertise to develop this component. Yet unlike their rivals, they believed that the barriers to entering the finance component were low and that the component would rapidly commoditize. One executive asked, "*how are you going to differentiate? Dollars are fungible.*" Moreover, Venus' founders believed in the importance of focus. As one executive stated, "*We've never believed that you could build a brand and customer relations business that is also fundamentally a financial operation. Those two things are different*." Venus thus focused on sales, which they saw as the highest value component in the long run, partnered with local installers, and waited for the finance component to commoditize. As one executive explained,

> *"It's this classic mistake of industry development that people made in personal computing and other sectors as well where they fixate on the upstream, forgetting the customer, and then remembering, 'oh the customer is always right' and then having to rush downstream to them and work out what they want and do all that. We just thought we'd get ahead of that curve."*

By 2010, Venus's executives realized that they had misread the development of the finance component, and that it had not commoditized as rapidly as they had expected. Moreover, by 2010 Saturn was already dominating the component and dictating aggressive terms to partners

(e.g., ownership of the customer relationship). Unwilling to relinquish control and partner on these terms, Venus attempted to enter the finance component itself. But the entry was difficult, as sources of leasing capital were locked up by prior entrants Saturn and Jupiter. As one executive described, *"Our fundamental mistake was that even if we were right about project finance being commoditizable and not defensible over time, it was still a big deal for a minute there and it almost killed us."* Lacking finance, Venus grew more slowly than its rivals. As a journalist stated at the time, Venus is "*a smaller potato compared to its larger and buzzier counterparts."*

Like Venus, Mars followed a component strategy and did not enter the finance bottleneck. Mars was founded by two friends who had backgrounds in investment and law, respectively. The pair realized that falling panel prices and the tax law change made solar an attractive opportunity. One founder described it as "*a space where there would be a real tailwind at our back*." Surveying the ecosystem, they decided to avoid finance. Although one founder had a finance background, Mars saw the finance component as too difficult. Instead, they chose to enter the sales and installation components, which they saw as inseparable, and to do so by buying a large, local contractor. As a founder said, these components were where "*we thought we could participate"* by bringing operational excellence to highly fragmented and low rivalry "*mom and pop*" components. Like Venus, Mars' founders also prioritized focus. As another executive described, "*We looked at finance. We just didn't want to focus on that part. We have our hands full doing what we're doing."*

Mars thus focused initially on building its business in the sales component, and neglected to secure access to finance. As a result, its early growth was constrained. After three years, Mars finally partnered with Saturn for access to finance, and in doing so, ensured its access to a full set of components. At the same time, its exclusive dependence on Saturn for the finance component

allowed the latter to dictate extractive terms. A VP noted, "*with an exclusive relationship, your whole business is almost built to work with one partner*." As finance became more competitive, Saturn eased its terms and Mars added another finance partner. While this gave Mars more power, it also introduced costly operational complexity. As one executive noted, "*There was a big learning curve and a lot of adjustment."*

Finally, the lowest performer, Pluto, entered the finance bottleneck but failed to assemble the other components. Pluto was founded by two finance executives from the energy sector. Like the entrepreneurs at high-performing Saturn, they saw an opportunity to create an innovative finance component that took advantage of the federal tax policy change. But unlike Saturn, they failed to put together the rest of the ecosystem. Their primary mistake was to form non-exclusive relationships with many small providers in the sales and installation components. As one VP described them, these firms were "*real mom and pops…plowing all of their cash back into the company every quarter and that's how they were surviving*." These firms were numerous (e.g., over 800 in California alone) and clamoring for financing, but they were often low-quality partners who took a lot of time to manage and whose lack of quality made it difficult to finance their projects. Thus, while Saturn and Jupiter were successfully obtaining capital and negotiating leases, Pluto was struggling to herd its relatively weak sales and installation partners.

Why were Saturn and Jupiter successful during this period? One reason is that they both entered the bottleneck component, finance. By doing so, they grew rapidly and at the same time tempered the growth of their rivals. Interestingly, the two firms did so by following very different strategies. With its bottleneck strategy, Saturn depended on its partners to sell and install systems. Since it had addressed the bottleneck, however, it was able both to grow and to drive tough bargains that reaped handsome profits. With its system strategy, Jupiter had minimal

dependence on partners. Moreover, having mastered the finance component for itself, the firm elected not to do the same for its rivals. As one executive noted, "*Because we can do all the pieces there is no reason for us to give anybody else that business."*

In contrast, Mars and Venus followed component strategies that avoided finance. Venus believed that finance would commoditize and that sales would offer the greatest long-term value. Mars believed that finance was too difficult given their capabilities, and that instead they could succeed by out-competing "mom and pop" rivals in sales and installation. As a result, the growth of both firms was delayed by the lack of superior financing for customers. When Mars and Venus did eventually assemble the finance component (Mars by partnering partner with Saturn and others, Venus by entering itself) they occupied weak bargaining positions that allowed their finance partners to profit disproportionately from the relationships. Overall, this suggests that following a capability or rivalry logic may allow firms to succeed within a component, but may lead to limited growth because of failure to address bottlenecks elsewhere in the ecosystem.

A second reason for the success of Saturn and Jupiter is that in addition to entering the bottleneck component, they also assembled the remaining components of the ecosystem. For example, Saturn adopted a holistic perspective of the ecosystem and explicitly recruited large and high-quality installer partners, which allowed them to then attract investors on favorable terms. Thus, they were able to assemble a complete ecosystem. Suggestive of their broader understanding of the evolving ecosystem, one executive noted, "*It's not about financing systems at all, it's operating them. From our perspective the plan was always to be more than a finance company.*" In contrast, Pluto recruited many, low-quality installers who required substantial time and training, and who made it more difficult to attract investment. Pluto ended up with an incomplete ecosystem, one consistent with their narrow vision of themselves as a finance

company. As an executive stated, "*we have always wanted to be a consumer finance company".*

A Shifting Bottleneck, 2010 – 2013

The industry structure perspective argues that firms should enter components that are low in rivalry and promote rivalry in neighboring components in order to maximize their bargaining power relative to partners (Porter, 1980; Jacobides, Knudsen, and Augier, 2006). For example, Intel has few serious rivals in the microprocessor component of the personal computer ecosystem, and thus profits disproportionately relative to the firms in the other, more crowded components. But while prior research highlights the benefits of achieving relative bargaining power in this way, it neglects the fact that in nascent ecosystems the location of bottlenecks may be likely to change over time.

Our interviews and archival data reveal that such a shift did occur in the residential solar industry in 2010, as the bottleneck component moved from finance to the sales component. Several factors drove this shift. One was falling solar panel costs. While these costs had been falling steadily for some time, they dropped by 40% ($8/watt to less than $5/watt) in 2009 and by another 40% (to $3/watt) in 2012. This made purchasing a solar system without finance possible for the first time for many homeowners. Another factor was greater crowdedness in the finance component. The number of firms in the component had increased from one to more than a dozen by 2011. As one analyst stated in 2012, "*finance is becoming the norm in the industry*." Finally, even as finance was diminishing as a bottleneck, the costs associated with the sales component remained high, making sales the new bottleneck to homeowners' purchase of solar systems and so to the overall growth of the industry. For example, one executive estimated that her firm was spending $2000 to acquire a single customer, which agreed with estimates from other firms. One analyst thus described sales as "*the hot space for residential solar innovation*", while a Saturn

executive similarly stated, "*we see originations [sales] as sort of the belle of the ball right now*."

The data confirm the importance of occupying the bottleneck position for firm performance in this time period. But since the sales component was more crowded than finance, we find that high-performing firms engaged in innovative activities in this component in order to lower costs and gain an advantage over others. We also find that high-performing firms maintained a broader perspective of the overall ecosystem, which allowed them to assemble the complete set of components required to create value. Moreover, they actively worked to improve the quality of other firms in at least some of these non-bottleneck components. This contrasts to the prescription found in prior research to "stimulate ferocious competition" among partners in other components (Jacobides, Knudsen, and Augier, 2006: 1214) (See Table 5).

As the bottleneck shifted to sales, the firms that had initially eschewed finance to focus on the sales component (Mars and Venus) now prospered. For example, Venus developed an innovative online sales and design approach consistent with its founders' mission to "*use the internet to change the way solar is sold."* In fact, its founders envisioned the firm as the "Dell" of residential solar. As one executive noted, "*The high-end, low-volume business will always have a place for the premium and elite customers*, *but there also has to be a Dell*." A press headline at the time ran, "*Dell of solar seeks to make it cheap and user-friendly to get rooftop PV*." Using satellite imagery like Google Earth, Venus could produce a sales quote and solar system design for almost any U.S. residence within 24 hours, while saving the time and cost of actually visiting the home. Thus, while many small and local firms were still having lengthy "kitchen table" discussions, Venus was revolutionizing sales. Its approach simplified the process for homeowners (cost and design were a click away) and eliminated the most expensive part of the sales process, reducing costs to 20% below the industry average.

In addition, Venus also devoted explicit effort to "*professionalizing*" their partners in the installation component, as one executive stated. The executive continued, "*The whole point of Venus is to facilitate the scaling of solar by making it easier, not just for customers – that's the first innovation – but also for installers and other contractors to get into the game*." Thus, Venus created a "contractor platform" with advanced project tools for installers, carefully inspected the workmanship of its partners, and allocated subsequent jobs based on that workmanship.

Venus thus continued its component strategy. As one executive stated, "*Installers love to install, sales people love to sell. Differentiate, division of labor, do what you're good at*." With this motivation, the firm improved its own sales offering in the bottleneck component through less expensive advanced online sales (combined with design), while also relying on and helping its partners in installation to improve. With the bottleneck now in its sweet spot, Venus grew rapidly. In 2011, Venus expanded into 5 new states in just three months, and became the fastest growing solar company in California, which was the largest U.S. market at the time.

Similarly, sitting in the bottleneck sales component also allowed Mars' component strategy to pay off. As one executive described,

> "*[We are] fundamentally a consumer marketing and sales business, so it's all about cost effective lead generation and sales execution. A lot of the other solar players come at it from different perspectives. Our core DNA [is] focused on lead generation, sales execution, and operational efficiency*."

Unlike Venus, Mars did not introduce new practices in the sales component. Instead, it focused on bringing operational efficiency to the existing sales practices in the industry, such as door-to-door canvassing, purchasing sales leads from third party aggregators, and partnering with banks and community organizations to drive referrals. With sales as the bottleneck in the ecosystem, Mars did benefit from this efficiency. Its sales more than doubled each year during this period, and in 2011 the firm peaked as the largest provider of installations in California.

"*Everything was lining up for us… all of a sudden, we had a business that was in that perfect spot for that perfect wave*," said one founder.

The shift to sales as the bottleneck also benefitted Jupiter, which had entered sales early as a result of its system strategy. Via organic growth and acquisition, Jupiter expanded across twelve states. While this expansion was expensive, it also meant that Jupiter was poised to take advantage of the shift to a sales bottleneck. In addition, Jupiter also introduced novel approaches within the sales component in order to reduce its costs. For example, Jupiter allowed residential communities to receive a discounted price for committing to installations in bulk. This lowered costs in both sales and installation. As one executive stated, "*If you go to one house and you install one system, there are travelling costs, there's building permit fees… there are all these different inefficiencies that occur. But if you go to one community and do 50 or 100 homes at a time, you get tremendous efficiencies*."

All three firms (Jupiter, Venus, and Mars) were well positioned as sales became the bottleneck component, and each addressed the emerging bottleneck in a unique way. In contrast, Saturn followed its bottleneck strategy and entered into sales only as the component emerged as the bottleneck. One executive described their motivation as follows: "*Now that sales is half to two thirds of the total cost, attention shifts to doing sales and customer acquisition in a way that wasn't as important for us three or four years ago."*

Since Saturn already had partners in the sales and installation components, it entered the sales component gradually. The firm began by building a consumer brand through billboard and radio advertisements. As a rival noted, "*Saturn said forever, 'we're not going to create our own consumer brand,' but in the background they were building out that capability'*. He continued, *"Now they do the best consumer branding of anybody in the industry*." Only once they had built

out this capability did they start selling directly at scale. A VP described, "*We started small with a group to pilot sales… As you might imagine, we did some things wrong and some things right and learned… so we understood it, so we could then grow over time*." In doing so, Saturn effectively combined its existing partnering model with its own internal sales capacity.

Saturn's entry into sales meant that it was now competing directly against its own partners in many markets. Like Venus, however, Saturn viewed its relationship with its sales and installation partners as a cooperative one. As one executive described,

> *"If our partners stay relatively high cost, and can't drive their costs down in a way that they can be competitive with Jupiter, it isn't the issue of Saturn being adversarial to them, it's the issue of them not being able to keep up with the very rapid and dramatic cost reductions going on in the industry. And then they'll just be out of business."*

Saturn thus continued to devote resources to improving the capabilities of its partners. For example, it developed an extensive suite of project management and solar system design tools with which partners could manage projects from the initial sales lead through project completion. An executive described the motivation: "*if we can create these tools for installing partners and make them more efficient, that will drive their costs down.*"

In contrast to its rivals, Pluto never entered the sales component, and instead stayed with a component strategy firmly focused on finance. Although Pluto's executives realized the growing importance of the sales component, they remained committed to their original vision as a finance company. An executive said at the time, "*In 25, 30 years we'll be in the business of supporting renewable energy technology finance*." Moreover, these executives did not have an ecosystem view. For example, as they learned that their partners lacked the training required to sell finance products, they did not act as Saturn and Venus had done. As one executive noted, "*We were really going to be hands off when it came to… sales. Our pitch to the installers was that we're not going to encumber or change your existing process at all*." As a result, neither

they nor their partners effectively addressed the sales bottleneck. Looking back, a VP noted, "*At the end of the day one of our biggest challenges was that we were never able to solve the sales conundrum of how to lower acquisition costs and really ramp up the sales engine*."

Why were Venus, Mars, Jupiter, and Saturn successful during this period? One reason is that they all participated in the sales bottleneck, albeit arriving via largely different strategies. Venus and Mars were already "in position" by virtue of their component strategies that focused on sales. A Venus executive noted that their strategy was to "*get ahead of the curve*" by focusing on sales early on while a Mars executive similarly described putting themselves in "*that perfect position to catch that perfect wave*." Jupiter was already in the bottleneck by virtue of its system strategy (preemptive entry into multiple components), and Saturn moved in as a function of its bottleneck strategy (sequential entry into emerging bottlenecks). The key insight is that the bottleneck component within an ecosystem may shift over time, and that more successful firms address those bottlenecks as they emerge rather than attempting to rely on partners.

Second, the successful firms all developed innovative approaches to the bottleneck component and thus did more than just enter in the bottleneck. For example, Venus pioneered a new approach to sales with its online sales quotes and designs using satellite technology, Saturn pioneered consumer branding, and Jupiter coupled bulk selling and installation services to reduce its costs across the board. In contrast, Pluto never even entered the sales bottleneck.

Third, the successful firms all improved their ecosystem by investing in non-bottleneck components. Venus and Saturn invested in improving the skills of their partners, particularly in installation. Similarly, Jupiter and Mars expanded and improved the operational efficiency of their own installation components. In contrast, lower performing Pluto did not invest in non-bottleneck components, and instead saw the issues that arose in those components as distractions.

Overall, the successful firms participated in and improved their approaches to the bottleneck component, and enhanced their own ecosystems by investing in other components. As a result, and with sales as the bottleneck, Mars and Venus grew rapidly during this period. But while these firms closed the gap, they were unable to catch Saturn and Jupiter, which stayed in the lead by virtue of the head start they had achieved by being in the finance component when it had been the bottleneck.

Finally, Saturn and Jupiter make for an intriguing contrast given their mutual success despite their radically different strategies. Jupiter's system strategy meant that it avoided having to migrate with the shifting bottleneck because it was already participating in the sales, finance, and installation components. But this participation in multiple components was expensive. For example, by 2012, Jupiter had raised over $300M in equity finance to fund its acquisitions and organic growth in these components, while Saturn scaled by partnering with others and therefore profitably managed with the less than half that amount. The system strategy was also risky. For example, Jupiter entered the sales and installation components in states like Colorado and Texas where the residential solar industry unexpectedly failed to take off. Capital was wasted – as one executive described, it was "*a sunk cost and a lesson learned*." In contrast, Saturn's bottleneck strategy was less risky. As one Saturn executive stated, "*Let's just partner with someone and if the market ends up with no incentives that's for them to deal with, not us*." Overall, the bottleneck strategy's emphasis on partnering made it faster, less expensive, and less risky – but also required more agility, partner coordination, and foresight than the system strategy.

The Winners Emerge, 2013 – 2014

By 2013, the informants (corroborated by the archival data) agreed that the bottleneck was shifting again as the <u>installation</u> component began to eclipse the sales component. Several

factors drove this change. One was that residential solar had become widespread and relatively well established, such that customers needed less education regarding its value. As a result, many homeowners were now shopping for multiple bids, which reduced the costs of locating potential customers as customers proactively sought out solar firms. Second, more firms had entered the sales component, which thus became more crowded. Against this backdrop, the labor costs associated with installation had remained high, and other installation costs such as permitting had even increased. With cost still the primary constraint on industry growth and the major cost reductions in sales and finance having become largely exhausted, installation thus emerged as the new bottleneck component (See Table 6).

The highest performing firms, Saturn and Jupiter, both entered the new installation bottleneck. As before, Jupiter's system strategy meant that it had already developed a presence in the installation component by the time the installation bottleneck emerged. As early as 2007, for example, an executive had declared, "*Our vision is to reduce the cost of solar. The way to do this is to become more efficient at installing solar*." Jupiter had continuously and innovatively tweaked installation in order to become more efficient, for example by improving the routing of its installation crews to reduce their travel time.

Jupiter, however, took an additional step and entered the racking component. It had two motivations for doing so. The first was to interrelate racking with the rest of the ecosystem. We define *interrelation* as achieving system-level improvements by adapting one component to improve its interworking with one or more other components. Jupiter's specific action was to acquire manufacturer of a particularly innovative racking product that improved the way solar systems were installed. Prior to 2010, racking had been considered a commodity. However, in 2010 the acquired firm had introduced a technology that dramatically reduced the time required

on-site by (and thus the labor costs of) installation crews. By acquiring this firm and technology, Jupiter improved its execution and lowered its costs within the installation bottleneck.

Jupiter had a second motivation for this acquisition, which was to attempt to create a new bottleneck that would further hinder its rivals. The acquired firm had more than a 30% market share in the racking component, was generally considered to produce a superior racking product, and was a major supplier to several of Jupiter's closest rivals. By depriving those rivals of access to this technology, Jupiter thus limited the ability of its rivals to similarly reduce their own installation costs and in effect, created a racking bottleneck. As one manager noted,

> *"We had selected them as basically being the best technology out there and ended up acquiring them so that no one else could and then stop us from using them. There's kind of a battle going on in solar this year – who can acquire more of the stuff that everybody needs and cut off the supply."*

Other Jupiter executives concurred. One noted, "*Quite frankly, if we can cripple our competitors, we'll do it in a heartbeat. We're very ruthless*." This ruthlessness was driven in part by Jupiter's vast ambition to grow: executives believed that only through constant growth could they ensure that the capacity in their various components was being fully utilized and that they could achieve the founders' vision of a "grand slam" company. As another executive described, "*Acquiring more…is what's critical to drive growth, to pump the working capital into more sales and more installs*." This aggressiveness translated into direct attacks on rivals as well, which Jupiter could afford given its growing scale and geographic reach. In 2013, for example, Jupiter launched an expansion driven by cost-cutting into Mars' home territory. An executive described this expansion in these terms: *"How do I make sure that I am taking out my competition? We're constantly looking at market share reports, who's climbing up and we're putting strategies in place for them."*

The other high-performer, Saturn, continued to follow its bottleneck strategy and so

entered the installation component as it became the bottleneck. It did so by acquiring an established installer, which let Saturn quickly enter the installation component (as well as expand its sales component) in many states in which it was already operating. Saturn similarly entered the racking component as that was turning into a bottleneck, following Jupiter's lead and acquiring a racking producer of its own. Executives described the motivation for the latter acquisition in terms of (1) decreasing their installation costs by integrating specific labor-saving hardware, (2) ensuring their continued access to the component, and (3) exacerbating the shortage (that is, creating a bottleneck) for their rivals. With these acquisitions, Saturn had, like Jupiter, come to occupy almost every component in the solar ecosystem – albeit by a very different path and with a very different underlying logic.

In contrast, the moderate performers, Venus and Mars, continued to pursue their original component strategies. Venus illustrates. One executive described their ongoing commitment to the component strategy in this way:

> *"You morph and mix it as you need to, but the insight is you try not to own it because you focus on excellent customer experience and you outsource the job of working out the latest in flashing technology to really good flashing people and the latest in loan products to really good loan people."*

While remaining committed to the sales component, Venus's executives did also recognize the growing importance of the installation component. They thus took two actions to address this bottleneck. First, they shifted to partnering with higher-quality regional installation partners. This decreased the costs associated with maintaining and training their network of partners, and ensured a high level of installation quality. Second, they began experimenting with new installation technologies and methods in order to integrate the resulting insights into their own sales and design process (interrelating components) and to pass them on to their installer partners (improving partners). But while they invested in installation, Venus adhered to its

component strategy, and did not actually enter the installation component directly. At the same time, a Venus executive was candid about the limits of the component strategy: "*We're getting beaten on install efficiency*." Another executive confirmed, *"I wouldn't be surprised if we don't start buying some of our own crews again just to get some economies*."

The other moderate performer, Mars, also maintained its component strategy, but unlike Venus did not invest in its component partners or interrelate components. Although Mars was well positioned to capitalize on the growing importance of the installation component, it suffered as operational efficiency, which had been its core advantage in the sales component, became the norm. It was also hampered by the loss of the racking suppliers acquired by Saturn and Jupiter, and because Jupiter targeted it with an aggressive, price-cutting expansion into its home territory. By 2014 Mars had decided to retrench into its core markets and was seeking to be acquired.

Finally, the lowest performer, Pluto, failed. Unable to convince high-quality installers to partner, the firm decided to try providing finance to top-tier U.S. and Asian panel manufacturers, who could couple Pluto's finance product with their own in-house installers. This move was initially successful, but as panel prices continued to decrease these manufacturers started exiting the residential solar market. As one executive described, "*As the heat turned up, [our partners] folded almost one after the next over a period of six months. They dropped like flies*." Without being able to assemble the components of the ecosystem, Pluto failed.

Why was Jupiter, and to a lesser extent Saturn, so successful during this period? A key reason is that both firms occupied the bottleneck component, installation. By virtue of its system strategy, Jupiter was already in this bottleneck as it emerged. With its bottleneck strategy, Saturn was not in the installation bottleneck as it emerged, but entered by acquiring an existing installer. Being in the bottleneck allowed both firms to address the major constraint on their growth, and

to do so in an innovative way. A key insight is that although the bottleneck component within an ecosystem may shift over time, successful firms enter and innovate within the bottlenecks rather than relying on partners to do so.

A second reason that both Jupiter and Saturn were successful was that both firms also interrelated components (e.g., installation and racking) in order to reduce their overall costs and improve performance. This required more than simply occupying multiple components: it also required an explicit attention to improving performance at the *ecosystem* rather than *component* level. In contrast, the less successful Mars participated in both sales and installation but did not explore ways to interrelate those components and thus improve its overall performance. A key insight is that within the ecosystem context, successful strategy requires managers to have a rich cognitive understanding of the ecosystem and of the relationship between components and to then be able to turn that understanding into action.

Finally, a third reason that both Jupiter and Saturn were successful was that both firms in effect created a bottleneck that had not existed before by blocking access to the racking component that rivals needed to compete efficiently in the installation component. As above, these actions demonstrated a rich understanding of the residential solar ecosystem, and displayed the firms' willingness to compete against rivals by undermining their rivals' ability to form their own functioning ecosystems, rather than through head-to-head competition.

In contrast, the component strategies implemented by Venus, Mars, and Pluto were less effective. The component strategists were both unable to match the efficiency associated with interrelating sales, racking, and installation, and were also more likely to make more myopic decisions that might have been optimal at the component level but non-optimal or even detrimental at the system level. For example, as a result of remaining laissez faire with respect to

other components, both Mars and Pluto found their costs higher and their partners elsewhere in the ecosystem less effective. Indeed, the most successful component strategist (Venus) was the one that maintained the broadest view of the ecosystem – for example, taking advantage of its limited opportunities to interrelate components (e.g., by modifying its sales and design process based on experiments in installation) and to improve its partners (e.g., through the same experiments) – although in doing so it still could not match Jupiter and Saturn.

DISCUSSION

This paper contributes to research on strategy, entrepreneurship, and organization theory by inducting a framework that describes how firms navigate nascent ecosystems over time. Prior literature has examined the origins and outcomes of firm strategy in established ecosystems (Kapoor, 2013; Qian, Agarwal, and Hoetker, 2012), but has yet to explore how firms succeed in the evolving, ambiguous, and uncertain context of nascent ecosystems. We address this gap by exploring how a set of comparable rivals managed this challenge.

Our framework indicates that firms succeed in nascent ecosystems by explicitly attending to the entire ecosystem: addressing bottlenecks to growth, improving partners in other components, and entering and exiting components in tune with their changing importance in the overall ecosystem. The resulting framework sheds light on strategy within ecosystems, as well as on classic perspectives such as capabilities and industry structure.

A Framework for Navigating Nascent Ecosystems

The first contribution is a process framework that describes how firms navigate and succeed within nascent ecosystems. Prior research examines firm strategy within the context of established ecosystems, and offers two perspectives regarding ecosystem strategy (Jacobides, Knudsen, and Augier, 2006; Qian, Agarwal, and Hoetker, 2012; Gawer and Henderson, 2007).

The first perspective emphasizes the *role of capabilities*, and suggests that firms benefit from entering components for which they possess relevant experience, resources, and capabilities (Helfat and Lieberman, 2012; Kapoor and Furr, 2014). Doing so makes them more likely to succeed within a given component, and thus more likely to be able to create value for consumers. The second perspective emphasizes industry structure, and in particular the *role of rivalry* within and between components (Jacobides, Macduffie, and Tae, 2014; Porter, 1980). Here, firms are more likely to capture value when they enter components that are low in rivalry, and when they promote competition between firms in other components.

In contrast, our framework indicates that successful firms engage in related actions that are not consistent with either the capability or rivalry logics from prior work. In particular, successful firms (1) enter and innovate within bottleneck components, even as they shift over time. Bottlenecks are components whose scarcity poses the greatest constraint on the industry, and entering them allows the firms to resolve those constraints, and thus enable the industry to grow and the focal firm to capture value. Successful firms also (2) assemble the remaining components required to create value, either by entering those components directly or by improving the ability of their partners to provide them. Over time, successful firms then (3) continue to innovate and improve bottleneck and non-bottleneck components alike, even as the location of bottlenecks and the relationships between components evolve. Finally, successful firms may also (4) create new bottlenecks for rivals, thus hindering the ability of those firms to create value just as they improve their own ability to create and capture value.

This framework extends existing theory regarding ecosystem strategy in several notable ways. First, it highlights the importance of entering bottleneck components, even as they change over time. This contrasts with the prescription in prior literature to enter components that are

consistent with firms' preexisting capabilities (Qian, Agarwal, and Hoetker, 2012; Bayus and Agarwal, 2007). The underlying insight is that within nascent ecosystems, all of the components required to create value may not be available. As a result, even firms that are poised to succeed within a particular component for reasons such as better capabilities may be limited in their ability to create value (due to missing components) or to capture value (due to bottlenecks elsewhere in the ecosystem). As a result, entering components that are simply consistent with preexisting capabilities may not lead to long-term superior performance.

Second, this framework extends prior work by highlighting the importance of non-bottleneck components, and in particular the necessity of assembling the remaining components that comprise the ecosystem. Prior literature suggests that firms benefit from inciting 'ferocious rivalry' between their partners in other components (Jacobides, Knudsen, and Augier, 2006: 1214), and that doing so improves their own relative bargaining power and thus their own ability to capture value (Jacobides, Macduffie, and Tae, 2014; Ferraro and Gurses, 2009). In contrast, we find that successful firms in nascent ecosystems actively improve the remaining non-bottleneck components, often by investing in and improving the capabilities of their partners, and even at the expense of their own ability to capture value relative to these partners. A central insight is that because critical components may be either unavailable or of insufficient quality within nascent ecosystems, successful firms recognize that to capture value they must often first jointly create value with their partners.

A related insight is that while successful firms may rely on partners to provide non-bottleneck components, they do not rely on partners for bottleneck components. The underlying intuition is that occupying a bottleneck component within an ecosystem confers substantial bargaining power (Jacobides and Tae, forthcoming; Jacobides, Macduffie, and Tae, 2014). This

power provides firms with leverage over their partners, such that these firms are likely to capture a disproportionate share of any jointly create value (Pfeffer and Salancik, 1978; Michael, 2000). In contrast, firms in positions of lower bargaining power (i.e., those that do not enter bottleneck components) are unlikely to be able to protect their ability to capture value relative to their more powerful partners through contracts or other means (Shervani, Frazier, and Challagalla, 2007).

Finally, this framework extends existing theory by explicitly addressing the dynamism often present in nascent ecosystems. In contrast, prior research offers a perspective on ecosystem strategy that is fundamentally static. For example, although the literature on industry structure has examined the impact of bottlenecks on the distribution of value within industries (Jacobides, Knudsen, and Augier, 2006; Dedrick, Kraemer, and Lindon, 2010), it has neglected to explore the influence of shifts in their locations over time. Similarly, prior work on capabilities has emphasized that the development of capabilities is path dependent and driven by initial entry decisions (Helfat and Lieberman, 2002; Mayer, Somaya, and Williamson, 2013). As a result, firms that enter components consistent with their preexisting capabilities are likely to continue developing these capabilities over time and thus dominating their particular component. In settings where the location of bottlenecks and the required capabilities are relatively static – that is, in established ecosystems – these prescriptions are likely to allow firms to succeed.

In contrast, within nascent ecosystems, the location of bottleneck components and the relative importance of capabilities are likely to change over time. Our framework indicates that the strategies of successful firms explicitly address this dynamism, with firms entering and exiting components in tune with the changing location of bottlenecks and the fluid relationships between components. A surprising insight however is that entering bottlenecks well before they emerge is not necessarily a path to higher performance. In particular, those firms that sought to

"get ahead of the curve" and position themselves "*to catch that perfect wave"* by addressing bottlenecks they believed would emerge in the future in fact exhibited far lower performance than those firms that addressed the bottlenecks present in the industry at the time. The underlying insight is that within nascent ecosystems it may be impossible to accurately predict the rate at which the components and their relationships will evolve (Hannah and Eisenhardt, 2014; Ferraro and Gurses, 2009). By foregoing current bottlenecks in order to preemptively address bottlenecks that may arise in the future, firms thus run the risk of incorrectly predicting the future structure of the industry, or at least the timing of its development.

Overall, a key insight is that executives at successful firms demonstrate a rich cognitive understanding of the ecosystem and of the interdependence between components. They are more likely to conceptualize strategy within the context of the ecosystem, and to ensure their ability to create and capture value over time by assembling and improving their own and their partners' capabilities across multiple components. In contrast, executives at weaker firms are more likely to conceptualize strategy within the context of individual components. While doing so may allow them to succeed within a particular component, their ability to create and capture value is likely to be constrained by either unavailable components or bottlenecks elsewhere in the ecosystem. In other words, strategy in nascent ecosystems is fundamentally different from strategy in contexts where the interdependence between components is less salient – and executives at successful firms enact their strategy accordingly.

Equifinality in the Navigation of Nascent Ecosystems

A second contribution is the discovery that there are multiple, distinct strategies for successfully navigating nascent ecosystems. Prior literature has examined two strategies: the system strategy and the component strategy (Farrell, Monroe, and Saloner, 1998; Hannah and

Eisenhardt, 2014), and has sought to identify the conditions under which each is optimal.

We extend this work by identifying and explicating a third strategy, which we term the *bottleneck* strategy. This strategy is driven by a strategic logic of value creation. In following a bottleneck strategy, firms enter bottlenecks sequentially as they emerge over time. In doing so, they remove constraints on their ability to jointly create value with their partners while also ensuring their bargaining power relative to those partners. Unlike the system and component strategies, the bottleneck strategy is fundamentally dynamic. Its advantage is that it allows firms to create and capture value in an evolving ecosystem without requiring them to develop capacity in multiple components simultaneously. The primary disadvantage of this strategy is that it requires significant strategic foresight, and that firms run the risk of failing to recognize the shifting location of the bottleneck component (See Table 7).

A related contribution is to shine additional light on the dynamics of the *system* and *component strategies* within nascent ecosystems. Prior research that analyzes these strategies has done so within the stable context of established ecosystems (e.g., Farrell, Monroe, and Saloner, 1998; Kapoor, 2013). This research has typically characterized the tradeoff between the two strategies in terms of the cost to develop a broader array of capabilities vs. the benefit of capturing multiple profit margins (Arora and Bokhari, 2007). While illuminating, prior research thus leaves open the question of how each strategy performs within more dynamic contexts.

We address this gap by examining the relative advantages and disadvantages of each strategy within the dynamic context of a nascent ecosystem. In following a *system strategy*, firms simultaneously enter multiple components. This strategy is driven by a strategic logic of control. The system strategy addresses two primary issues posed by nascent ecosystems. First, system strategists ensure the availability of the components required to create value by producing all

components internally and minimizing dependence on partners. This simultaneously mitigates the risk that the components required to create value may not be available, while also ensuring the firms' own ability to capture value. Second, over time, the system strategy frees firms from constraints that may arise as the bottleneck shifts. At the cost of being more expensive to implement, it thus requires less foresight and is more likely to allow the firm to succeed.

In contrast, in following a *component strategy*, firms enter an individual component. The component strategy is driven by a strategic logic of focus. Entering a single component requires firms to develop fewer capabilities, and may thus be less resource intensive (Arora and Bokhari, 2007). Within the dynamic context of nascent ecosystems, however, the component strategy has the disadvantage that the firm may be constrained by bottlenecks elsewhere in the ecosystem, and thus unable to create or capture value, especially as these bottlenecks shift over time.

A critical insight is that although the bottleneck strategy would be indistinguishable from either the system strategy or the component strategy in a static analysis, it is distinct in terms of both the firm's position in the ecosystem over time (dynamic vs. static) as well as the underlying strategic logic (value creation vs. focus or control). In this study, both the bottleneck strategy and the system strategy proved successful, as the firms that adopted each entered the bottleneck components, assembled the remaining non bottleneck components, and created new bottlenecks for rivals. Each strategy carries its own unique set of advantages and disadvantages, however, and identifying the conditions under which strategy is likely to be successful is thus a promising opportunity for further research.

Boundary Conditions

The boundary conditions of our study warrant discussion. We study the strategy of entrepreneurial firms in a dynamic and rapidly evolving ecosystem. A question is thus whether

our framework generalizes to two related cases: (1) established firms in nascent or evolving ecosystems, and (2) entrepreneurial firms in more stable settings. In the first case, established firms are likely to face a similar set of challenges related to the shifting bottleneck components and the lack of clarity around technologies and partner capabilities. Moreover, while established firms are more likely to have well-defined capabilities, which may limit their perceived strategic flexibility, they also superior resources, which may increase it (Bayus and Agarwal, 2007). Thus, we expect the framework apply.

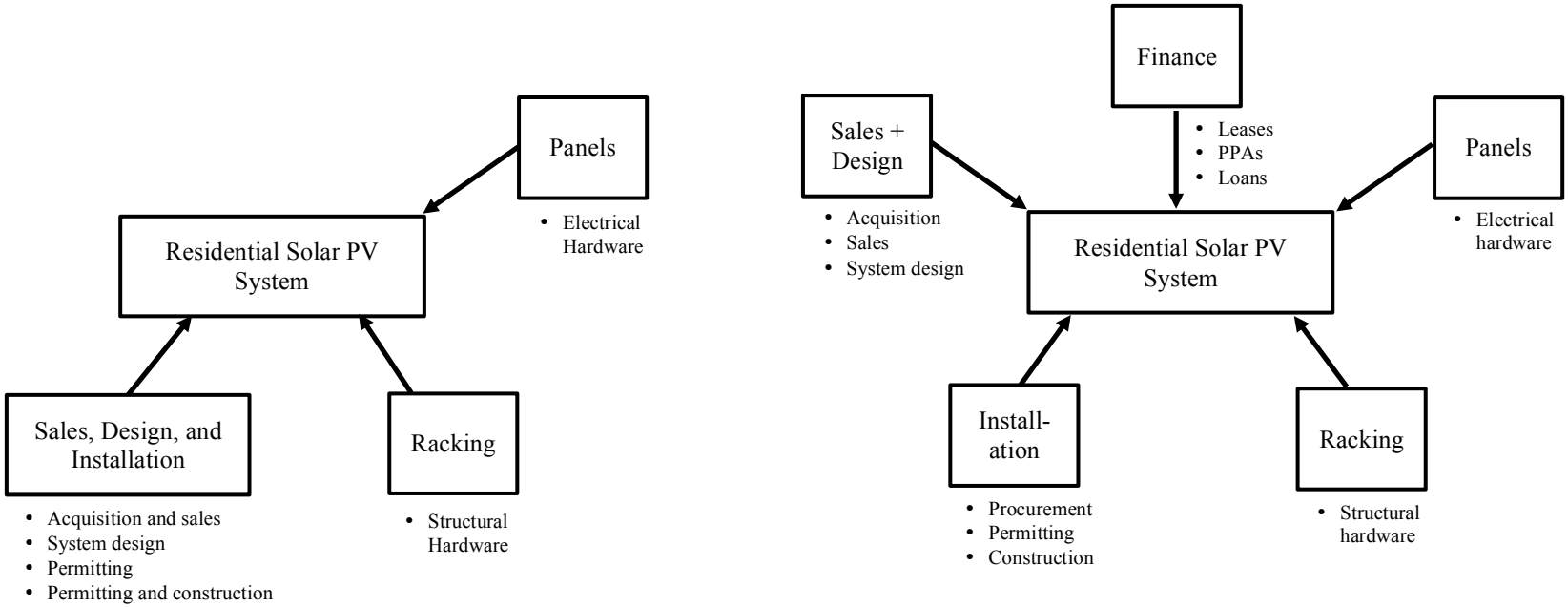
In the second case of entrepreneurial firms in more stable ecosystems, our framework may be less applicable. Adjusting position within components to account for shifting bottlenecks is relevant only in so far as those bottlenecks are changing or can be changed. In static settings, or in cases where the relationship between components plays less of a central role, existing prescriptions based on the capabilities and industry structure perspectives may apply.

A second question is whether this framework applies in settings where there is a greater potential for first mover advantage than existed in the components of the residential solar industry. With substantial first mover advantage, firms may be able to monopolize individual components and thus create fixed bottlenecks. For example, in the PC industry, enormous fixed costs and minimal variable costs in operating system software allowed Microsoft to gain massive scale economies and high switching costs, and so raised entry barriers and gave the firm a long-term competitive advantage. Nonetheless, even if some components exhibit first mover advantage, others may not, and the framework may thus apply to the remainder of the ecosystem. Moreover, since nascent ecosystems are likely to exhibit substantial uncertainty (Santos and Eisenhardt, 2009; Rindova and Fombrun, 2001), firms may have limited ability to identify the components that are critical to the overall ecosystem – and thus worth defending.

CONCLUSION

Firms within ecosystems face a critical strategic choice in terms of which components to enter and which to leave for partners. Prior research emphasizes a view of firm strategy within these settings that prioritizes the ability of individual firms to create value in particular components and foster competition among others to capture it. In contrast, we suggest that within the context of nascent ecosystems, successful firms are those that both capture value by occupying shifting bottlenecks and create value by jointly working with partners in other components. We present a theoretical framework that describes how firm strategy unfolds in nascent ecosystems over time, and offer contributions to research on strategy, entrepreneurship, and organization theory.

Figure 1: The Residential Solar Photovoltaic (PV) Ecosystem



Panels: This component consists of the electrical hardware (panels and inverters).

Racking: This component consists of the hardware with which panels are mounted on a roof, as well as minor associated hardware known as the "balance of system". It was considered to be a commodity until an unexpected innovation in 2010 introduced a substantially superior product.

Finance: This component consists of leases and power purchase agreements (collectively known as "third party ownership models") as well as consumer loans through which the up-front cost of the systems were met. Prior to 2007 this component did not exist, as most sales were done with cash purchases.

Installation: This component consists of hardware procurement, permitting, and construction activities associated with installing the panels on a homeowner's roof. Prior to 2007, this component was typically bundled with sales and provided by local installers.

Sales + Design: This component consists of lead generation, sales, and the custom design of a system for a customer, including the electrical and architectural design. Prior to 2007, this was typically performed by local installers.

Table 1: Sample Firms at Founding

					Founders					
Firm	**Year Founded**	**Initial Market**	**Funding**	**Amount Raised**	**Number Founders**	**Avg. Age**	**Startup Exp.**	**Highest Degree**	**Prior Firm Function**	**Prior Industry**
Jupiter	2007	West Coast	VC, Self	$10 million	2	31	Yes	BS	General Management, Engineering	Software
Saturn	2007	West Coast	VC, Angels	$12 million	3	29	No	MBA	Finance, Intelligence	Military, Finance
Venus	2007	West Coast	VC, Angels	$2.5 million	3	37	Yes	MBA, MS	General Management, Finance	Energy, Nonprofit
Mars	2007	West Coast	Angels, Self	$7.4 million	2	37	No	MBA, JD	General Management Finance, Legal	Software, Consumer goods
Pluto	2007	West Coast	VC, CVC	$10 million	2	35	Yes	MBA, MS	General Management, Finance	Energy, Consulting

Table 2: Overview of Interviews and Archival Methods

Firm	Number of Interviews	Title of Focal Informants	Number of Articles / Pages	Sample Sources	Press Releases
Jupiter	10	CEO/Founder COO/Founder VP of Product	316 articles 750 pages	Wall Street Journal New York Times Techcrunch Venturebeat	47
Saturn	9	CEO/Founder VP of Product Senior Finance Director	520 articles 1,359 pages	New York Times Green Tech Media Bloomberg Forbes	30
Venus	8	President/Founder Board Chair/Founder VP of Business Development Senior Finance Director	302 articles 788 pages	New York Times Green Tech Media San Francisco Chronicle Businessweek	32
Mars	11	CEO/Founder President/Founder VP of Operations	116 articles 526 pages	New York Times Los Angeles Times MarketWatch Investor's Daily	38
Pluto	9	VP/Founder VP of Business Development VP of Operations Marketing Director	21 articles 74 pages	Businessweek Green Tech Media Renewable Energy World Bloomberg	5

Table 3: Firm Post-Study Performance

Firm	Industry Ranking	Number of Installations	Cumulative Project Financing	Number of Employees	Number of States	Qualitative Assessment (Typical Quotes)
Jupiter	Top Three	80,000	$4 billion	5,000	14	The de facto heavyweight (analyst) The clear number one (competitor)
Saturn	Top Three	60,000	$2 billion	1,000	11	Among the best (competitor) Easily next best after Jupiter (analyst)
Venus	Top Ten	20,000	$200 million	250	8	A smaller potato relative to its larger and buzzier counterparts (industry press) We've got the best platform, but we need to figure out how to leverage it (manager)
Mars	Top Ten	13,000	0	1,000	5	They've been trying to sell themselves for a while. They're not getting any takers and the reason is there's nothing about them that's special (competitor)
Pluto	Failed	2,000	$20 million	0	5	We'll be the first of the initial wave that will be forgotten (founder)

Table 4: Rise of an Ecosystem (2007 – 2010)

Firm	Strategy	Initial Components	Representative Quotes	Approach to Finance	Consequences	Representative Quotes
Jupiter	System	Sales Installation Finance	The only way to get to scale is if you control and maintain your destiny. (CEO)	Develop a finance product to sell through internal sales team; do not make the finance available to rival solar firms	Rapid growth as finance bottleneck addressed for Jupiter, but not rivals	If we can alleviate the barriers adoption which is primarily the up front cost, there's a big market. (VP)
Saturn	Bottleneck	Finance	There were other companies who could do the sales and do the builds well. For us, it made more sense to try to focus on getting the financing and be able to provide financing to the industry. (VP)	Provide finance to high-quality partners in the sales and installation components; require those partners to be exclusive	Rapid growth as finance bottleneck is addressed for Saturn's partners; potential finance rivals are deprived of partners	We were really deliberate about what parts of the [ecosystem] we entered. The goal was to do things that are hard to do but scale really well and are high value (Manager)
Venus	Component	Sales	Installers love to install, sales people love to sell. Differentiate, division of labor, do what you're good at. (Chair)	Initially forego finance to focus on sales; later enter finance in order to address bottleneck; finally partner with Saturn and others	Constrained growth due to missing finance component, late entry into finance is difficult due to partners being locked up by Saturn and Jupiter	Even if we were right about project finance being commoditizable and not defensible over time, it was a big deal for a minute there and it almost killed us. (Chair)
Mars	Component	Sales & Installation	[Sales] was completely fragmented at the time. People were still figuring out how this market was going to work (CEO) Sales was something we thought we could participate in (CEO)	Initially forego finance bottleneck to focus on sales; later partner with Saturn to address bottleneck	Constrained growth due to missing finance component; later exclusive reliance on Saturn allows Saturn to impose extractive terms	Financing is a completely different business and not at all related to our core competencies. (President)
Pluto	Component	Finance	We're going to become a consumer finance company that originates and prices and quotes [systems] for various customers. (VP)	Provide finance to any and all firms in the sales and installation components; do not require those partners to be exclusive	Constrained growth as Pluto is unable to attract investors due to low partner quality in sales and installation	The question [from banks] was what happens if these guys go away, can we really trust these smaller dealers? (VP)

Table 5: A Shifting Bottleneck (2010 – 2013)

Firm	Strategy	Approach to Sales	Consequences of the Bottleneck Shifting to the Sales Component	Actions to Address the Emerging Sales Component Bottleneck	Representative Quotes
Jupiter	System	Internal	Rapid growth; own sales component already well developed as sales becomes the bottleneck	Elaborated and expanded sales component through community sales programs and call centers	Super low cost of acquisition drives our model. That's why we've been very successful in taking market share from our competitors. (CMO)
Saturn	Bottleneck	High quality partners; also follows bottleneck and enters sales itself	Moderate growth; dependent on partners for sales component as it becomes the bottleneck	Gradually entered sales component by building a consumer brand and piloting an internal sales team. Invested in partners by providing a suite of sales and design tools	Now that [sales] is half to two thirds of the total cost, attention shifts to doing sales in a really efficient way, in a way that wasn't as important for us three or four years ago (VP) If we can create these tools for our partners and make them more efficient, that will drive their costs down (VP)
Venus	Component	Internal	Very rapid growth; own sales component already well developed as sales becomes the bottleneck	Elaborated and expanded sales component by developing an entirely online sales and design technology Invested in partners by providing a suite of project management tools	It's this classic mistake of industry development that people made in personal computing and other sectors as well where they fixate on the upstream, forgetting the customer…We just thought we'd get ahead of that curve. (President)
Mars	Component	Internal	Very rapid growth; own sales component already well developed as sales becomes the bottleneck	Elaborated and expanded sales component by diversifying channels and improving operational efficiency	Everything was lining up for us… all of a sudden we had a business that was in that perfect spot for that perfect wave. (President)
Pluto	Component	Any willing partners	Constrained growth; dependent on largely incapable partners for sales component.	Did not enter sales component to avoid channel conflict with partners Provided minimal sales training to partners in order to maintain focus	Neither Pluto nor our partners were really figuring out how to actually sell to the consumer. (VP)

Table 6: The Winners Emerge (2013 – 2014)

Firm	Strategy	Approach to Installation	Consequences of the Bottleneck Shifting to Installation	Actions to Address the Emerging Installation Bottleneck	Representative Quotes
Jupiter	System	Internal	Rapid growth; own installation component already well developed as installation becomes the bottleneck	Acquire a racking producer in order to (1) create a new bottleneck in racking component (2) address installation bottleneck by interrelating installation and racking components	Our vision is to reduce the cost of solar. The way to do this is to become more efficient at installing solar. (CEO) We're looking for ways we can continue our market dominance and quite frankly, if we can cripple our competitors, we'll do it in a heartbeat. (CMO)
Saturn	Bottleneck	High quality partners; also follows bottleneck and enters installation itself	Moderate growth; dependent on partners for installation component as it becomes the bottleneck	Acquire an existing installation partner in order to develop own in-house installation component Acquire a racking producer in order to (1) create a new bottleneck in racking component (2) address installation bottleneck by interrelating installation and racking components	The next biggest cost reduction in the industry comes from soft costs, not from hardware. Meaning the time it takes to install a system. (Manager)
Venus	Component	Low quality partners at first; later switches to high quality partners	Moderate growth; dependent on partners for installation component as it becomes the bottleneck	Shifted to higher quality installation partners to improve quality and reduce oversight costs Experimented with new installation methods to address installation bottleneck by (1) training partners, and (2) interrelating sales and installation components	We think Jupiter is beating us on install efficiency. Maybe it's because we drifted too far from the execution. (Chair)
Mars	Component	Internal	Moderate growth; own installation component already well developed as installation becomes the bottleneck, but maintains sales focus	Expanded installation component. Did not consider interrelations with racking or system design. Growth is constrained by the new racking bottleneck	This is fundamentally a consumer marketing and sales business, so it's all about cost effective lead generation and sales execution. (President)
Pluto	Component	Low quality partners	Constrained growth; dependent on largely incapable partners for installation component	Unable to find competitive installation partners, Pluto pivoted to offer finance through panel manufacturers' captive installers; moderate growth until those manufacturers exit the market	One of our follies was 'let's not do anything to compete with our installer partners,' when in fact what we should have been doing was 'let's try to do the highest value activity that we can do.' (VP)

Table 7: Strategies for Navigating Emerging Ecosystems

Strategy	Logic	Tactics	Advantages Within Nascent Ecosystems	Disadvantages Within Nascent Ecosystems
System	Control	Enter multiple components simultaneously	Eliminates need to track bottlenecks Limits dependence on partners Allows interrelation of components	Costly Slow to scale
Bottleneck	Value	Enter multiple bottleneck components sequentially	Always in the high margin component Allows interrelation of components in which the firm is participating	Requires foresight
Component	Focus	Enter individual components, often based on capability or perception of rivalry	Allows focus Least resource intensive	Growth likely constrained by unaddressed bottlenecks Limited opportunity to interrelate components to improve system performance

REFERENCES

Adner, R.
2006 "Match your innovation strategy to your innovation ecosystem." Harvard Business Review 84: 98–109.

Adner, R., and R. Kapoor
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.

Afuah, A.
2000 "How much do your co-opetitors' capabilities matter in the face of technological change?" Strategic Management Journal, 21: 387–404.

Argyres, N.
1996 "Evidence on the role of firm capabilities in vertical integration decisions." Strategic Management Journal, 17: 129–150.

Arora, A., and F. Bokhari
2007 "Open vs. closed firms and the dynamics of industry evolution." The Journal of Industrial Economics, 55: 499–527.

Bayus, B., and R. Agarwal
2007 "The Role of Pre-Entry Experience, Entry Timing, and Product Technology Strategies in Explaining Firm Survival." Management Science, 53: 1887–1902.

Casadesus-Masanell, R., and D. Yoffie
2007 "Wintel: Cooperation and conflict." Management Science, 53: 584–598.

Chatain, O., and P. Zemsky
2011 "Value creation and value capture with frictions." Strategic Management Journal, 32: 1206–1231.

Chatterji, A. K.
2009 "Spawned with a silver spoon? Entrepreneurial performance and innovation in the medical device industry." Strategic Management Journal, 30: 185–206.

Chen, P., C. Williams, and R. Agarwal
2012 "Growing pains: The effect of pre-entry experience on impediments to growth." Strategic Management Journal. 33: 252–276.

Collis, D.
1992 "Birds Eye and the U.K. frozen food industry." Harvard Business School Case 792-074.

Dedrick, J., K. L. Kraemer, and G. Linden
2010 "Who profits from innovation in global value chains? A study of the iPod and notebook PCs." Industrial and Corporate Change, 19: 81–116.

Eisenhardt, K. M.
1989 "Building theories from case study research." The Academy of Management Review, 14: 532–550.

Eisenhardt, K. M., and M. E. Graebner
2007 "Theory building from cases: Opportunities and challenges." Academy of Management Journal, 50: 25–32.

Eisenhardt, K. M., and J. Martin
2000 "Dynamic capabilities: What are they?" Strategic Management Journal, 21: 1105–1121.

Farrell, J., H. K. Monroe, and G. Saloner
1998 "The vertical organization of industry: Systems competition versus component competition." Journal of Economics & Management Strategy, 7: 143–182.

Ferraro, F., and K. Gurses
2009 "Building architectural advantage in the US motion picture industry: Lew Wasserman and the Music Corporation of America." European Management Review, 6: 233–249.

Fixson, S. K., and J.-K. Park
2008 "The power of integrality: Linkages between product architecture, innovation, and industry structure." Research Policy, 37: 1296–1316.

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

Hannah, D., and K. M. Eisenhardt
2014 Puzzles or pieces? Competition in nascent system industries. Working Paper. September 8, 2014.

Hargadon, A. B., and Y. Douglas
2001 "When innovations meet institutions: Edison and the design of the electric light." Administrative Science Quarterly, 46: 476–501.

Helfat, C., and M. Lieberman
2002 "The birth of capabilities: Market entry and importance of pre-history." Industrial and Corporate Change, 11: 725–760.

Huber, G.
1985 "Temporal stability and response-order bias in participant descriptions of organizational decisions." Academy of Management Journal, 28: 943–950

Huber, G., and D. Power
1985 "Retrospective reports of strategic-level managers: Guidelines for increasing their accuracy." Strategic Management Journal, 6: 171–180

Hughes, T. P.
1983 "Networks of power: electrification in Western society, 1880-1930." Baltimore: Johns Hopkins University Press.

Jacobides, M. G.
2005 "Industry change through vertical disintegration: How and why markets emerged in mortgage banking." Academy of Management Journal, 48: 465–498.

Jacobides, M. G.
2008 "How capability differences, transaction costs, and learning curves interact to shape vertical scope." Organization Science, 19: 306–326.

Jacobides, M. G., and L. M. Hitt
2005 "Losing sight of the forest for the trees? Productive capabilities and gains from trade as drivers of vertical scope." Strategic Management Journal, 26: 1209–1227.

Jacobides, M. G., J. P. MacDuffie and C. J. Tae
2014 "Agency, structure, and incumbents' dominance: Change and stability in the automotive sector." Working Paper, November 2, 2014.

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

Jacobides, M. G., and C. J. Tae
2014 "Kingpins, Bottlenecks, and Value Dynamics within a Sector." Organization Science, Forthcoming.

Jick, T. D.
1979 "Mixing qualitative and quantitative methods: Triangulation in action." Administrative

Science Quarterly, 24: 602–611.

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: 1195–1213.

Kapoor, R., and R. Adner
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: 1227–1248.

Kapoor, R., and N. Furr
2014 "Complementarities and competition: Unpacking the drivers of entrants' technology choices in the solar photovoltaic industry." Strategic Management Journal, Articles in advance.

Kapoor, R., and J. M. Lee
2013 "Coordinating and competing in ecosystems: How organizational forms shape new technology investments." Strategic Management Journal, 34: 274–296.

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

Katila, R., J. D. Rosenberger, and K. M. Eisenhardt
2008 "Swimming with sharks: Technology ventures, defense mechanisms and corporate relationships." Administrative Science Quarterly, 53: 295–332.

Klepper, S., and K. Simons
2000 "Dominance by birthright: Entry of prior radio producers and competitive ramifications in the U.S. television receiver industry." Strategic Management Journal, 21: 997–1016.

Kumar, N., L. W. Stern, and J. C. Anderson
1993 "Conducting interorganizational research using key informants." Academy of Management Journal, 36: 1633–1651.

Langley, A.
1999 "Strategies for theorizing from process data." Academy of Management Review, 24: 691-710.

Langlois, R. N., and P. L. Robertson

1992 “Networks and innovation in a modular system: Lessons from the microcomputer and stereo component industries.” Research Policy, 21: 297–313.

Mayer, K., D. Somaya, and I. O. Williamson.
2013 “Firm-specific, industry-specific, and occupational human capital and the sourcing of knowledge work.” Organization Science, 23: 1311–1329.

Michael, S.
2000 “Investments to create bargaining power: The case of franchising.” Strategic Management Journal, 22: 497–514.

Navis, C., and M. A. Glynn
2010 “How new market categories emerge: Temporal dynamics of legitimacy, identity, and entrepreneurship in satellite radio, 1990–2005.” Administrative Science Quarterly, 55: 439–471.

Ozcan, P., and K. M. Eisenhardt
2009 “Origin of alliance portfolios: Entrepreneurs, network strategies, and firm performance.” Academy of Management Journal, 52: 246–279.

Ozcan, P., and F. M. Santos
2014 “The market that never was: Turf wars and failed alliances in mobile payments.” Strategic Management Journal, Articles in Advance.

Pfeffer, J., and G. Salancik
1978 “The external control of organizations: A resource dependency perspective.” New York: Harper & Row.

Porter, M. E.
1980 “Competitive strategy: Techniques for analyzing industries and competitors.” New York: Free Press.

Qian, L., R. Agarwal, and G. Hoetker
2012 “Configuration of value chain activities: The effect of pre-entry capabilities, transaction hazards, and industry evolution on decisions to internalize.” Organization Science, 23: 1330–1349.

Rindova, V., W. J. Ferrier, and R. Wiltbank
2010 “Value from gestalt: How sequences of competitive actions create advantage for firms in nascent markets.” Strategic Management Journal, 31: 1474–1497.

Rindova, V. P., C. J. Fombrun
2001 “Entrepreneurial action in the creation of the specialty coffee niche.” The

Entrepreneurship Dynamic. Stanford: Stanford University Press.

Santos, F., and K. M. Eisenhardt
2009 "Constructing markets and shaping boundaries: Entrepreneurial power in nascent fields." Academy of Management Journal, 52: 643–671.

Shervani, T., F. Frazier, and G. Challagalla
2007 "The moderating influence of firm market power on the transaction cost economics model: An empirical test in a forward channel integration context." Strategic Management Journal, 28: 635–652.

Staudenmayer, N., M. Tripsas, and C. L. Tucci
2005 "Interfirm modularity and its implications for product development." Journal of Product Innovation Management, 22: 303–321.

Teece, D. J.
1996 "Firm organization, industrial structure, and technological innovation." Journal of Economic Behavior & Organization, 31: 193–224.

Yin, R. K.
1994 "Case study research: design and methods." London: Sage.