Received: 3 November 2015 | Revised: 2 August 2017 | Accepted: 22 August 2017

DOI: 10.1002/smj.2750

WILEY STRATEGIC MANAGEMENT JOURNAL

SPECIAL ISSUE ARTICLE

How firms navigate cooperation and competition in nascent ecosystems

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***Research Summary*:** Despite a wealth of research on competitive and cooperative strategy, gaps remain with respect to how firms successfully navigate cooperation and competition over time. This is especially true in ecosystems, in which firms depend on one another to collectively provide components and create value for consumers. Through an in-depth multiple case study of five firms in the U.S. residential solar industry from 2007 to 2014, we induct a theoretical framework that explains how firms navigate nascent ecosystems over time. We identify three strategies, each with a distinct balance of cooperation and competition, as well as unique advantages, disadvantages, and required capabilities. Overall, we contribute to research on ecosystem strategy, crystallize the pivotal role of bottlenecks, and shed light on the dynamic interplay of cooperation and competition.

***Managerial Summary*:** Competition and cooperation are fundamental to strategy, and often closely intertwined. But how firms navigate and balance cooperation and competition over time, especially in ecosystems where firms depend on one another to deliver value to consumers, is unclear. In this article, we conduct an in-depth multiple-case study of five firms in the U.S. residential solar industry to examine how firms can successfully navigate nascent ecosystems over time. We identify three distinct strategies, each with a distinct balance of cooperation and competition, and examine the unique advantages, disadvantages, and required capabilities of each. In doing so, we also contribute novel insights into the evolution of ecosystems and bottlenecks.

KEYWORDS

competition, cooperation, ecosystems, strategy, solar

1 | INTRODUCTION

In 1996, Apple was sinking fast. As its executives scrambled for a lifeline, they made a pivotal choice and bet the firm on a novel ecosystem—a group of firms collectively providing components such as an MP3 player, flash memory, digital music rights, and the iTunes store—that together created a seamless music experience that delighted customers and saved Apple (Yoffie & Rossano, 2012). This ecosystem enabled Apple to *cooperatively* create value with complementors like Universal Music, while also allowing Apple to *competitively* capture a share of that value. This ecosystem kept Apple afloat in the crucial years before the iPhone.

As the Apple story suggests, ecosystems can be critical for defining products and shaping firm success. Consistent with prior work (Adner, 2012, 2017), we define ecosystems as groups of firms that produce products or services that together comprise a coherent solution. Examples include 3D printing (i.e., printers, scanners, feedstock, software) and smartphones (i.e., handsets, apps, operating systems, networks). Successful ecosystems require firms to balance competition and cooperation. On the one hand, if firms cooperate too much, they may not capture enough value to survive. On the other hand, if firms compete too much, the ecosystem may fail to form (Ozcan & Santos, 2015). Consistent with Das and Teng (2000), we define cooperation as firms jointly pursuing mutual interests and common benefits, and competition as firms pursuing their own interests at the expense of others.

Ecosystems have unique features. First, ecosystems are organized around a final product such that their components are *complementary.* A firm cannot create value unless all components are present. Moreover, the interdependence among components can be complex (Adner, 2017; Jacobides, Cennamo, & Gawer, 2017). Further, components often draw on different capabilities, have distinct economics, and exhibit varying innovation rates (Casadesus-Masanell & Yoffie, 2007).

Second, ecosystems have *bottlenecks.* Bottlenecks are components that constrain the overall growth or performance of the ecosystem due to poor quality, weak performance, or scarcity (Adner, 2012; Baldwin, 2015).[1] For example, the iTunes music store resolved the bottleneck of paying for digital music, triggering the massive growth of the iPod ecosystem (Yoffie & Rossano, 2012). A bottleneck prevents other components and the entire system from operating at their potential (Adner & Kapoor, 2016). Firms that occupy bottlenecks (i.e., produce the bottleneck component) thus have the chance to reduce the constraint on ecosystem growth, and bottlenecks may contain none, one, or even many firms. Overall, ecosystems are thus a specific economic setting with particular strategic implications, such as bottlenecks.

Third, firms in ecosystems balance *cooperation* to create value and *competition* to capture value. For example, while Universal Music and Apple cooperated to increase revenue, they competed to split that revenue and related profits. Cooperation and competition can also unfold simultaneously and differently at multiple ecosystem levels: within components; across firms in a focal ecosystem; and among rival ecosystems. These characteristics increase the complexity of balancing cooperation and competition by firms within ecosystems.

[1]Although sometimes confused, ecosystems and bottlenecks are conceptually distinct from networks and structural holes. Networks are composed of the ties among a set of firms (e.g., an industry) that shape resource and information flows. By occupying a structural hole, an actor can broker between others who are disconnected in the network. But, networks also abstract away the technical interdependence that is central to ecosystems. In contrast, ecosystems are organized around an output, and so reflect technical interdependence, rather than the structure of ties per se. Firms that occupy bottlenecks (i.e., produce the bottleneck component) have the opportunity to reduce a constraint on ecosystem growth. For example, scarcity of the flash memory *component* created a bottleneck in the iPod ecosystem. While a key flash memory *producer* formed a tie with Apple to supply this bottleneck component, this producer did not occupy a structural hole in the network of ties among iPod complementors. Thus, while a firm has a unique network position (such as occupying a structural hole) that is defined in relation to the entire tie network, a bottleneck component is defined instead by technical performance.

Several research streams explore how firms balance cooperation and competition in ecosystems. One describes strategies that firms use to navigate ecosystems (Arora & Bokhari, 2007; Farrell, Monroe, & Saloner, 1998), such as the *system strategy* (enter multiple components, minimize cooperation) and the *component strategy* (enter a single component, cooperate for the rest). Yet, while this research offers a useful typology of strategies, it has a static perspective on *how* firms balance cooperation and competition over time.

A related stream is the strategy research on ecosystems (Adner & Kapoor, 2010; Ansari et al., 2016; Hannah, 2017; Ozcan & Eisenhardt, 2009). Some studies examine cooperative actions that firms use to create value, such as joint R&D to resolve bottlenecks (Ethiraj, 2007). Other work explores competitive actions that firms take to capture value, such as playing partners off of one another (Jacobides, MacDuffie, & Tae, 2016). Yet it is unclear how firms successfully *balance* these competitive and cooperative behaviors, especially over time and at different levels, such as component and ecosystem (Ozcan & Santos, 2015).

A third stream is the alliance literature. Although ecosystems are not networks, both share a similar tension between competition and cooperation (Bremner et al., 2017). Here, research offers contrasting views. One line of (largely theoretical) work argues that alliances succeed when participants balance the dialectic tension between cooperation and competition in their relationship (Das & Teng, 2000; Lado, Boyd, & Hanlon, 1997). In contrast, empirical work says that alliances "tip" toward competition or cooperation (Doz, 1996; Sytch & Tatarynowicz, 2014). Thus, firms are likely to succeed by creating *portfolios* of both cooperative and competitive ties (Uzzi, 1997), or by separating cooperative and competitive behaviors over time (Navis & Glynn, 2010). Yet, it is unclear which of these views is valid.

Taken together, these research streams confirm that cooperation and competition are central to ecosystems, and provide insights into the strategies by which firms either cooperate or compete. But they leave open how firms balance cooperation and competition over time, whether they are separate vs. in dialectic tension, and their implications for performance. Thus, we ask: *How do firms successfully balance competition and cooperation over time in ecosystems?*

Given this limited theoretical understanding, we conduct a multiple case theory-building study (Eisenhardt & Graebner, 2007). Our setting is the nascent U.S. residential solar industry. Using rich field and archival data, we follow how five closely-matched ventures balanced (or failed to balance) cooperation and competition from their founding in 2007 through 2014. These ventures start in the same industry and at the same time, and so create a revealing comparison of strategies for cooperation and competition within ecosystems over time, and their performance impacts.

Our study contributes at the intersection of strategy, ecosystems, and the interplay of competition and cooperation. Our primary contribution is to clarify three ecosystem strategies by which firms successfully balance competition and cooperation over time. One, the *bottleneck strategy,* is new to the literature, and produces a *complex* mix of competition and cooperation. In contrast, the other two, *component* and *system* strategies*,* produce *simple* patterns that intensify over time. Overall, we refine the concept of ecosystem strategy, introduce the novel bottleneck strategy, and add a more complete and dynamic lens to the component and system strategies. We also contribute insights into the strategic implications of bottlenecks. Broadly, we observe that, while the component and systems strategies tip toward either cooperation or competition, the bottleneck strategy maintains a dialectic tension at the "edge of chaos" between the two.

2 | BACKGROUND

Several research streams relate to how firms within ecosystems successfully balance cooperation and competition over time. One examines strategies in ecosystems. Here, the central questions are which

and how many components to enter (Arora & Bokhari, 2007; Farrell et al., 1998). This work argues that firms adopt either a *system strategy* (i.e., enter multiple components and minimize cooperation) or a *component strategy* (i.e., enter one or a few components and cooperate for the rest). The core tradeoff is the cost to develop multiple components vs. the benefit of capturing multiple profit margins. Related work explores when firms adopt these strategies. For example, Farrell et al. (1998) argue that firms are likely to adopt a system strategy when they possess broad capabilities relevant to many components. Kapoor (2013) finds that firms are likely to adopt a system strategy in mature ecosystems where the principal problem is opportunism, rather than innovation. Yet, this stream provides only a static "snapshot" of trade-offs that leaves unclear: (a) whether this is the complete range of ecosystem strategies, (b) how these strategies evolve (see Kapoor, 2013 for an exception), and (c) which are high performing.

A second stream is the strategy research on *ecosystems.* Here, one strand focuses on *cooperation* and *value creation.* Since cooperation is critical to ensure the availability of components, one or several firms often orchestrate this cooperation to facilitate ecosystem emergence. For example, Ozcan and Eisenhardt (2009) study six game publishers in the nascent wireless gaming industry. They find that the successful publishers led the emergence of the industry by promoting a vision of the ecosystem and proactively organizing firms like carriers and handset makers to provide their respective components. Adner (2012) similarly attributes the success of the Kindle ecosystem to Amazon's recruitment of major publishers to provide complementary e-books. Other work examines how bottlenecks affect innovation and firms' ability to jointly create value (Adner & Kapoor, 2010; Hannah, 2017; Hannah, Bremner, & Eisenhardt, 2016). For example, Gawer and Henderson (2007) find that Intel dedicated resources to improving its complementors in bottleneck components of the PC ecosystem. Similarly, Ethiraj (2007) finds that firms may increase their R&D to improve bottleneck components.

Another stream focuses on *competition* and *value capture.* While competition occurs across ecosystems and within components, this research centers on competition between firms providing complementary components. It shows that firms capture the most value for themselves by restricting competition in their own component while fostering competition in complementary components. A key construct is market power (Santos & Eisenhardt, 2009), which firms can achieve by entering components early on and then preventing further entry (Jacobides, Knudsen, & Augier, 2006). For example, Gawer and Cusumano (2002) note how Intel and Microsoft entered the microprocessor and operating system components of the PC ecosystem then limited others' entry by establishing standards and exploiting scale economies. Firms can also gain market power by limiting dependence on complementors. For example, Jacobides et al. (2016) find that automakers captured an outsized share of value in the U.S. automotive ecosystem by requiring suppliers to circulate component specifications, thus making each individual partner redundant. Similarly, Ferraro and Gurses (2009) find that MCA captured disproportionate value in the talent industry by encouraging "ferocious competition" among its complementors.

Overall, research in this stream unpacks relevant cooperative and competitive actions within ecosystems. But its disparate strands lack insight into (a) how firms successfully balance cooperation and competition to achieve value creation *and* value capture, especially over time, and (b) how these actions broadly relate to successful ecosystem strategies and high performance.

A third stream is research on *alliances.* Although ecosystems and networks are not the same, both share a tension between cooperation vs. competition. Much empirical work indicates that alliances "tip" toward cooperation or competition. For example, de Rond and Bouchikhi (2004) study an alliance between a pharmaceutical giant and a biotech venture, and find that the relationship oscillates between cooperation and competition, but finally spirals into competition. Sytch and Tatarynowicz (2014) also study biotech–pharma alliances, finding that simultaneously competing and cooperating is unstable. Thus, alliances tend to evolve toward one or the other.

Other work offers insights into *which* process (cooperation or competition) will dominate. Khanna, Gulati, and Nohria (1998) argue relative scope (i.e., ratio of common to private benefits) shapes whether alliances remain cooperative or become competitive. In a study of six alliances, Doz (1996) finds that initial conditions like task clarity shape the emergence of cooperation vs. competition. Moreover, active learning over time by both parties can trigger a positive spiral of deepening trust and cooperation, while early failures create a negative spiral leading into competition. Other work indicates that separating cooperation and competition over time can be effective. For example, Navis and Glynn (2010) show that while XM and Sirius first cooperated to jointly establish the legitimacy of satellite radio, they later competed for customers and partners after the category had been established. Similarly, Davis and Eisenhardt (2011) study R&D alliances. They find that rotating leadership allows each partner to competitively pursue its self-interest for a limited time, leading to superior innovation.

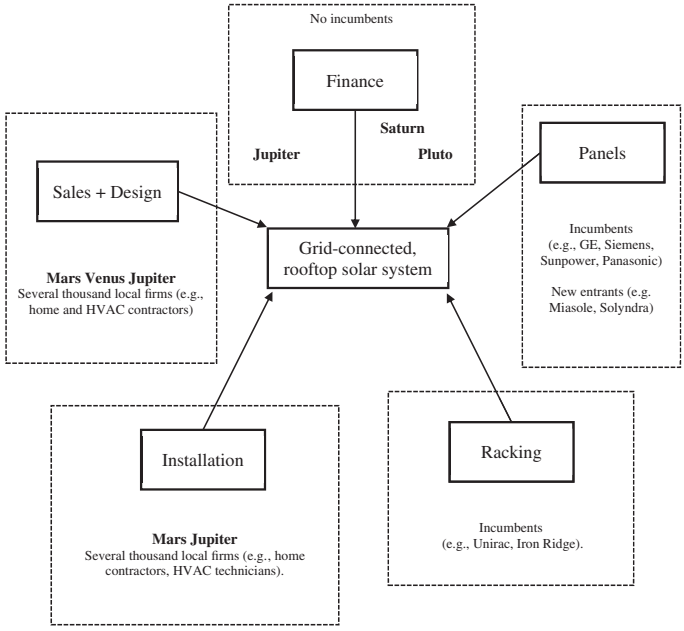
Related work on *alliance portfolios* offers further insights. Building on the alliance literature, this work suggests that firms effectively balance cooperation and competition by maintaining a mix of cooperative and competitive relationships (Uzzi, 1997). For example, Hoffmann (2007) studies two Siemens businesses, and finds that these executives used a repertoire of portfolio strategies (e.g., adapting, stabilizing, shaping) corresponding to differing degrees of uncertainty. The result was that their portfolios contained different numbers of alliances and distinct mixes of strong (cooperative) and weak (competitive) ties. Thus, although each tie was either competitive or cooperative, the firm achieved a balance of the two at the portfolio level.

In contrast to the empirical literature above, a theoretical *alliance* literature proposes the effectiveness of a dialectic tension between competition and cooperation within a single relationship. For example, Lado et al. (1997) argue that competition and cooperation are distinct, but intertwined dimensions—and partners that simultaneously engage in both are likely to outperform partners that emphasize one or the other. Das and Teng (2000) similarly advocate a dialectical view that embraces the unity of opposites. They advocate balancing the inevitable tension between cooperation and competition within relationships such that neither dominates, and predict that this balancing will produce more stable and successful relationships. Related work on complexity theory (Davis, 2016; Davis, Eisenhardt, & Bingham, 2009) suggests that this balancing occurs at an "edge of chaos" that leads to more complex, adaptive, and unpredictable behaviors. But, while intriguing, it is unclear how and when firms actually achieve a dialectic tension, especially given the conflicting empirical evidence above.

Together, these research streams confirm the tension between competition and cooperation. They indicate static strategies for navigating this tension within ecosystems (Farrell et al., 1998), identify specific cooperative and competitive behaviors leading to value creation and value capture (Adner & Kapoor, 2010; Jacobides et al., 2006), and contrastingly advocate separating cooperation and competition (Navis & Glynn, 2010; Uzzi, 1997) vs. maintaining a dialectic tension between the two (Das & Teng, 2000). Yet, prior research leaves open: (a) whether system and component comprise the full range of ecosystem strategies, (b) how firms successfully intertwine competition and cooperation over time, and (c) whether firms separate the two or maintain a dialectic tension between them. Thus, we ask: *How do firms successfully balance competition and cooperation over time in ecosystems?*

3 | METHODS

Given the limited theory and evidence, we conduct a theory-building, multiple-case study (Eisenhardt & Graebner, 2007). This method is also particularly relevant for process questions such



Panels: Electrical hardware including solar photovoltaic panels and inverters. A commodity with steeply declining prices throughout the course of the study.

Racking: Mechanical hardware on which panels are mounted plus other hardware known as "balance of the system" A commodity until an unexpected innovation during our study.

Finance: Leases and power purchase agreements (i.e., "third party ownership business models"). Prior to 2007, this component did not exist as homeowners paid cash or obtained loans. A 2005 tax law triggered finance innovation that introduced third party ownership business models and re-launched the industry.

Installation: Hardware procurement, permitting, and construction of solar system. Prior to 2007, this component was often combined with Sales and Design by local home improvement contractors.

Sales and Design: Sales plus electrical and architectural design of the solar system. Prior to 2007, this component was often performed by local home improvement contractors and required an on-site visit to assess the building site, rooftop, and shade.

FIGURE 1 Residential solar ecosystem components in 2007

as ours (Eisenhardt, Graebner, & Sonenshein, 2016). Our setting is the U.S. residential solar industry from 2007 to 2014. This is an appropriate setting for several reasons. First, it is an ecosystem industry with five distinct components: (a) solar photovoltaic (PV) panels, (b) racking (a structural component for mounting panels), (c) sales and design, which we refer to as sales, (d) installation, and (e) finance. Each component draws on distinct capabilities and has little value in isolation (Figure 1). In 2007, panels and racking were commodity products manufactured by large incumbents like GE and Siemens and by ventures like Solyndra. Sales and installation were provided by several thousand local contractors, who often sold solar as one of many services. At the start of the study, no firms provided finance. Instead, homeowners paid cash (often up to $40,000) or took out loans. Second, the industry is nascent, which allows us to observe firms when their strategic flexibility is likely high. Prior to 2007, U.S. residential solar was a fragmented, small, and stagnant industry (See online Appendix for an industry history). The Energy Policy Act of 2005, which created a 30% tax credit for residential solar systems, returned the industry to a nascent state. It disrupted the ecosystem, altered the competitive dynamics, and prompted massive growth (over 2,000% cumulative growth in installations during our study). Along with steeply falling panel prices and growing awareness of climate change, this policy shock effectively relaunched the industry. Third, the industry is well-documented by the media.

Our sample is five ventures (i.e., young, privately owned, professionally funded firms) founded in the U.S. residential solar industry in 2007 (Table 1). We chose ventures for several reasons. First, given their small size, ventures are relatively transparent and thus more easily studied than large firms. Second, their evolution can be tracked from birth, avoiding left-censoring. Third, and as is often true in nascent industries, ventures are the key actors during our study. We identified the focal ventures by combing archival publications from 2006 to 2008 to determine the ventures (other than panel makers) founded at this time. We then interviewed industry experts to identify any other relevant ventures. These informants confirmed our sample as the full population of "first frontier"

TABLE 1 Sample firms

			Founders						Data	
Firm	**Founding**	**Initial funding**	**Number founders**	**Avg. age**	**Startup exp.**	**Highest degree**	**Prior firm function**	**Prior industry**	**Interview[a]**	**Archival[b]**
Jupiter	2007, West Coast	$10 M VC, Self	2	31	Yes	BS	General Management, Engineering	Software	19 internal 15 external	560 articles 47 press releases 1552 pages
Saturn	2007, West Coast	$12 M VC, Angels	3	29	No	MBA	Finance, Intelligence	Finance, Military	10 internal 26 external	447 articles 30 press releases 1,750 pages
Venus	2007, West Coast	$2.5 M VC, Angels	3	37	Yes	MBA, MS	General Management, Finance	Nonprofit, Energy	16 internal 28 external	520 articles 32 press releases 1315 pages
Mars	2007, West Coast	$7.4 M Angels, Self	2	37	No	MBA, JD	General Management Finance, Legal	Software, Consumer goods	9 internal 19 external	247 articles 38 press releases 893 pages
Pluto	2007, West Coast	$10 M CVC, VC	2	35	Yes	MBA, MS	General Management, Finance	Energy, Consulting	8 internal 15 external	38 articles 5 press releases 117 pages

[a] Internal informants include founders, CEOs, VPs, and board members. External informants include executives at utility partners, VC (venture capital) firms, and rival installers. These counts exclude twenty additional industry expert interviews, including analysts, regulators, journalists, and academics.

[b] Sample sources include newspapers (e.g., *Wall Street Journal, New York Times*), technology blogs (e.g., Techcrunch, Greentechmedia), magazines (e.g., *Businessweek*), and industry analyst reports (e.g., Solar Energy Industry Association).

ventures founded in 2007. We tracked these firms from 2007 to 2014, when outcomes were clear, and when, as an analyst declared, *"the winners have emerged."* Fortuitously, the founding teams are similar in age, size, and education. Moreover, no firm initially had a superior reputation, network, or funding. While this similarity does not rule out other explanations, it allows us to focus on the variation of interest while controlling for less central factors like initial conditions (Le Mens, Hannan, & Pólos, 2011).

3.1 | Data sources

We used several data sources: (a) semistructured interviews with focal firm executives, (b) interviews with industry experts and participants such as regulators and complementors, (c) informal follow-up interviews, and (d) archival material (Table 1). A particularly valuable source is 95 interviews conducted by journalists and analysts with executives from 2007 to 2014.

We conducted three waves of interviews with firm executives and complementors about the focal firm's history, strategy, and key strategic actions. We relied on internal and external informants. Internal informants are individuals within the focal firms such as founders, CEOs, and functional managers. External informants include individuals connected to specific firms (e.g., investors, complementors), as well as outsiders like utility executives and regulators.

The focal-firm interview had three sections. The first covered the informant's background and role. The second was a detailed narrative of the firm's history from founding (or last interview) to the present. The focus was on specific actions of firm executives with respect to the ecosystem as well as their implications and motivations. Our goal was to understand major decisions (e.g., entry into a component) as well as alternatives considered but not taken (e.g., decline of a partnership). The third section explored topics that arose in the interview or in the archival data. We obtained the informant's assessment of firm performance and that of rivals. The interviews lasted between 45 minutes and 2 hours and were recorded. Where necessary to fill in gaps, we used follow-up interviews and emails.

We also interviewed nonfocal firm participants, such as regulators, and executives at utilities and complementors. These interviews were adjusted to fit the informant, and allowed us to triangulate insights of focal-firm informants and improve our understanding of the industry.

We took several steps to ensure data validity. First, we used interviewing techniques such as nondirective questioning, which are likely to yield accurate information. Second, we used event-tracking, in which informants walk through a step-by-step chronology of events (Eisenhardt, 1989). Third, we interviewed multiple informants inside and outside each firm, and from varied functional areas and hierarchical levels. This creates a more accurate understanding than single informants can provide. Fourth, anonymity encouraged informants to speak with candor.

We collected in-depth archival data including press articles, company press releases, technology blogs, books, conference presentations, and analyst reports. We began with Factiva and LexisNexis to gather all press coverage for each firm from founding through 2014. This yielded over 1,000 unique articles. We then manually gathered an additional 922 articles from major blogs such as GreenTech Media. We also collected all press releases and blog posts released by the firms, using archived versions of their websites from archive.org. Finally, we collected press related to firm executives as well as publicly available interviews with them.

3.2 | Data analysis and theory building

We began our analysis by synthesizing the data into a comprehensive case history for each firm. Each case tracks the firm's major activities over time. We focused on information that could be

corroborated from multiple data sources and was emphasized by informants. When details were missing, we obtained added archival information or conducted follow-up emails or phone calls. One author wrote drafts of the initial cases while a second reviewed the data to form an independent view. When conflicts arose, we revisited our data to resolve them. We then identified emergent patterns by analyzing each case through the lens of our research question.

After completing within-case analysis, we conducted a cross-case analysis using replication logic in which emergent patterns are confirmed across cases (Eisenhardt & Graebner, 2007). Using tables and charts, we listed tentative theoretical constructs such as market power and co-opetition, and compared them across the cases. We then cycled between emergent theory and data to clarify constructs, develop measures, adjust abstraction, and strengthen the underlying logical arguments that connected constructs. As our theoretical insights became more refined, we referred to prior literature to compare with existing research, before turning back to the data. In this way, we followed an iterative process of refining insights, building underlying logical arguments, and relating them to existing theory (Eisenhardt, 1989).

Given our research question, we assess firm performance during our study, at its 2014 conclusion, and poststudy in 2015 (Table 2). Our focal performance variable is growth. We focus on growth for several reasons. First, growth is a performance variable that is relevant across industries, and is often an antecedent to other performance measures such as profitability. Second, growth is particularly relevant as it is the primary metric by which analysts, investors, and executives gauged performance in our study. Third, growth is particularly germane to ventures because it captures whether the venture is gaining traction with customers, and for that reason is often used to assess venture performance. In contrast, survival is a coarse measure that does not distinguish successful firms vs. the "living dead." Finally, and as typical of ventures, growth measures are available while other measures like profit are not until very late (if at all).

We measure performance using quantitative measures from firm and public sources: (a) *cumulative installations* compiled from press releases and verified in state-level databases,

TABLE 2 Post-study firm performance

Firm	Industry ranking[a]	Cumulative installations[b]	Est. 2015 revenue	Tot. project financing[c]	Number of employees	Number of states	Qualitative assessment (representative quotes)
Jupiter	Top three IPO	100,000	$350 million	$3 billion	10,000	20	*The* de facto *heavyweight (analyst)* *The clear number one (competitor)*
Saturn	Top three IPO	65,000	$300 million	$2 billion	2,000	12	*Among the best (competitor)* *Easily next best after Jupiter (analyst)*
Venus	Top five acquired	25,000	$150 million	$200 million	400	12	*They're very good at customer acquisition. The best, really (competitor)* *A smaller potato relative to its larger and buzzier counterparts (industry press)*
Mars	Fading	15,000	$30 million	$0	1,000	4	*The weakest of the major players, and this [2014] is likely the last time we'll see them among the top (competitor)*
Pluto	Failed	<1,000	$0	$20 million	0	5	*We'll be the first of the initial wave that will be forgotten (founder)*

[a] Includes incumbent firms and diversifying entrants.

[b] Approximate counts as of Q4 2014. Total share of the U.S. residential solar market for the five firms was approximately 40% in 2014 and increasing.

[c] Reflects only project financing (e.g., tax equity) raised to support project installations. Jupiter, Saturn, & Venus reached profitability.

(b) *number of states* in which each firm operates, (c) *number of employees*, and (d) *total project financing* raised. We also use qualitative measures: (e) *qualitative assessment* using typical quotes from the media and informants, and (f) *industry ranking* from analysts. We include (g) *estimated 2015 revenue*, as well as information on failures, IPOs, and profitability, as available. Overall, there was a high convergence across these performance measures for each firm.

Performance diverged dramatically among the firms. Jupiter and Saturn were the highest performing. Each performed or financed over 60,000 installations, had several hundred million dollars in annual revenue, some profitability, and successful IPOs. As one analyst stated, Jupiter is "*the clear number one*," and another declared, Saturn is "*easily the next best.*" Venus also performed well, but had fewer installations. By 2015, it was profitable, growing rapidly, and had been acquired. In contrast, Mars struggled with declining revenues that dropped by almost 70% in 2015. They sought to be acquired, but as one informant stated, "*they're not getting any takers because there is nothing special about them.*" Finally, the lowest performer, Pluto, failed.

4 | EMERGENT THEORETICAL FRAMEWORK

Our emergent framework identifies three viable ecosystem strategies by which firms successfully balance cooperation and competition (Table 3). Two build on prior work: the *system strategy*, in which firms enter most or all components at founding; and the *component strategy* in which firms enter a single or subset of components and obtain the remaining components from others. Our framework adds a dynamic process understanding of *how* these strategies unfold, and identifies the *simple* patterns of competition and cooperation that emerge. The third is a novel strategy that emerged from our data that we term the *bottleneck strategy*. Following this strategy, firms enter the bottleneck component at founding, and then enter successive bottlenecks as they emerge. This strategy yields a *complex* pattern of cooperation and competition as firms renegotiate their roles and relationships over time. The high-performing firms (Jupiter, Saturn, Venus) followed one of these strategies while the less successful firms (Mars, Pluto) did not.

4.1 | 2007–2009: Organizing the ecosystem and competing in the finance bottleneck

The five ventures began in 2007. Some entered ecosystem components that fit their capabilities or had weak competition. But the high-performing firms entered components based on their long-term strategy, with the most successful entering the bottleneck component. We define a *bottleneck* as the component that most constrains the growth or performance of the ecosystem due to poor quality, poor performance, or short supply (Adner, 2012; Ethiraj, 2007). The high-performing firms also gained access to the remaining ecosystem components.

We determined the bottleneck component from our interview data, and corroborated it with archival data. In 2007, there was a widely shared consensus that the bottleneck was *finance*. Prior to 2007, residential solar systems cost up to $40,000, and homeowners paid these costs upfront. These costs were commonly viewed as the primary constraint on industry growth, and thus finance was the bottleneck. Yet, *although executives at all five firms identified finance as the bottleneck*, they entered different components and adopted different ecosystem strategies.

Saturn illustrates (Table 4). Saturn was founded by three recent MBAs who saw an opportunity in the 2005 Energy Policy Act. This law enabled commercial entities to gain tax savings from investment in solar systems, but did not extend these savings to residential owners of solar equipment. The founders believed that they could revolutionize the traditional solar business model by

TABLE 3 Viable ecosystem strategies

Ecosystem strategy	Cooperation-competition	Key moves	Advantages	Disadvantages
Bottleneck	Competition and cooperation	Enter bottlenecks as they emerge Cooperate and compete with complementors Adjust cooperation-competition balance with bottleneck crowdedness	Always in the high growth component which increases value creation Resource investment spread over multiple entries Scales quickly initially	Requires foresight and transition skill when bottlenecks shift Operationally complex Over time, may resemble system strategy and so require some component exits
Component	Cooperation	Enter a component, innovate, and orchestrate complementors Adjust innovation focus to fit shifting bottlenecks Differentiate from within-component rivals	Likely to develop a superior component which increases value creation and may increase value capture Can adjust ecosystem with changing complementor quality which increases value creation Least resource intensive	Growth may be constrained when not in bottleneck component Less ability to integrate components to improve system performance
System	Competition	Enter multiple components simultaneously Maintain moderate innovation Integrate components to achieve synergies	Eliminates need to track bottlenecks Enables integration of components which increases value creation Limits dependence on partners which increases value capture	Costly and time-consuming to develop multiple components Requires aggressive growth and sensitive to demand drops Slow to scale initially

owning the installed solar systems, selling the power produced to homeowners, and passing the tax credits to investors. For homeowners, this would reduce the cost of the system, and ease the hassle of finding financing and maintaining panels. For investors, this would create an attractive securitized investment vehicle. Thus, Saturn's entry into finance addressed the bottleneck that was constraining industry growth.

In addition to entering the finance bottleneck, Saturn also secured access to the remaining ecosystem components. They did so by cooperating with complementors to sell and build the systems, which allowed Saturn to focus on creating the finance 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."* The finance component required complex financial engineering to obtain capital, securitize bundles of solar leases, and organize the tax benefits, but it also provided unique value to complementors. Moreover, by relying on complementors for the sales and installation components, Saturn was able to scale more quickly than if its executives had taken the time to develop or acquire these components internally.

For its sales and installation components, Saturn selected larger firms. As one executive stated, *"We didn't want to work with every mom and pop."* Larger firms had two advantages. First, they enabled Saturn to operate with fewer partners, which simplified operations. Second, these firms were typically high quality, with robust track records. High-quality partners attracted tax equity investors, who as the systems' end-owners had a strong interest in their quality. This buy-in allowed Saturn to secure an uninterrupted flow of tax equity finance, despite there being few interested banks early on and Saturn not having Wall Street connections. Moreover, by securing these relationships, Saturn also blocked the ability of rivals to do the same.

TABLE 4 Organizing the ecosystem and competing in the bottleneck (finance)

Firm and strategy	Period perf.[a]	Initial ecosystem strategy	Representative quotes	Competition vs. cooperation	Representative quotes	Result
Jupiter *System*	++++++ *3,000 systems*	Enter installation, sales, and finance Source from numerous hardware providers	*The only way to get to scale is if you control and maintain your destiny. (CEO)*	*Competition in all components* Do not provide finance component to sales rivals Source from many panel makers to reduce dependence Acquire small rivals	*Because we can do all the pieces there is no reason for us to give anybody else that business (Manager)*	Rapid growth as finance bottleneck addressed by Jupiter, but not most rivals
Saturn *Bottleneck*	++++++++ *4,000 systems*	Enter finance Partner with large and successful sales complementors Rely on complementors to source hardware and installation	*There were other companies who could do the sales and do the builds well. For us, it made more sense to focus on getting the financing and be able to provide financing to the industry. (VP)*	*Cooperate with quality complementors but compete with extractive terms* Provide finance to quality complementors in sales and installation Exert control over complementors by branding, high fees, and exclusivity Limit finance rivals by requiring exclusivity from sales partners	*Saturn took the approach to partner with top installation companies…we didn't want to work with every mom and pop. (VP)* *Saturn imposed harsh terms – we wouldn't agree. (VP Venus)*	Rapid growth as finance bottleneck addressed by Saturn for complementors; finance rivals deprived of complementors by exclusive ties
Venus *Component*	+ *500 systems*	Enter sales Partner with numerous firms in installation Initially ignore finance then enter late Source from numerous hardware providers	*Installers love to install, sales people love to sell. Differentiate, division of labor, do what you're good at. (Chair)* *Owning the customer is where value will be (President)*	*Cooperate with complementors* Develop novel sales technology and partner with sales & installation complementors to sell at low cost Source from many panel makers to improve product diversity	*The whole point of Venus is to facilitate the scaling of solar by making it easier…for installers and other contractors to get into the game. (President)*	Growth initially low b/c no finance component, late entry into finance difficult b/c investors locked up by Saturn and Jupiter
Mars *Straddle Component and System*	+ *500 systems*	Enter sales and installation Initially forgo finance, later partner with Saturn, then others Source from one hardware provider, later several	*Sales was something we thought we could participate in (CEO)* *The competition looked easy in sales while finance is hard. (VP)*	*Cooperate with specific finance and hardware firms, compete with rivals* Initially exclusive tie with panel maker; later diversify Initially exclusive tie with Saturn for finance component Develop efficient tele-sales and installation operation	*Our core DNA has been focused on lead generation, sales execution, and operational efficiency. (President)*	Growth initially low b/c no finance component; later exclusive reliance on Saturn allows Saturn to impose extractive terms

TABLE 4 (Continued)

Firm and strategy	Period perf.[a]	Initial ecosystem strategy	Representative quotes	Competition vs. cooperation	Representative quotes	Result
Pluto *Component*	– *100 systems*	Enter finance Partner with many "mom and pop" firms in sales and installation Rely on complementors to source hardware	*We wanted just to be a financial services company. (VP)* *In 25 years, we will still be an energy finance company. (CEO)*	*Weakly cooperate with low quality complementors, ignore finance rivals* Form non-exclusive relationships with numerous "mom and pop" sales & installation complementors Focus on developing finance component and remain "hands off" complementors	*Our entire appeal was our ability to provide a lease. Beyond that, there was really no sense for an installer to work with [us]. (VP)*	Very low growth as Pluto is unable to attract investors due to low quality sales & installation complementors

[a] *Installation data triangulated from Solar Energy Industries Association data and internal firm reports.*

Yet cooperating with large firms also posed challenges. As one executive noted, *"The bigger somebody is the more they would have to modify their own business process to sell our product."* Some firms also contested Saturn for control of the relationship. As one sales partner quipped, *"Who is trying to commoditize who?"* Nonetheless, Saturn's finance solution unlocked a large customer segment, which allowed it to provide value to and have leverage over its sales and installation complementors. Saturn also imposed strict requirements, such as exclusivity, high fees, and co-branding. This allowed it to capture value relative to its complementors, and also impaired the entry of later rivals into the finance component by locking up access to some of the best installers and sales firms. Thus, by focusing on the bottleneck component and partnering for other ecosystem components, Saturn achieved early industry-leading growth.

As the industry evolved, Saturn executives continued to track the migration of industry bottlenecks with its *bottleneck strategy.* As we describe later, they entered the sales, installation, and finally the racking components as the bottleneck shifted. From the start, the strategy was to move to bottlenecks as they arose, rather than stay focused on finance. As one executive stated, *"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."*

The other high-performing firm, Jupiter, also entered the finance bottleneck. Jupiter was founded by two software entrepreneurs who were attracted to the solar industry by what they perceived to be weak competition. As one incredulously asked, "*Is this really the competition?"* Unlike Saturn's executives, Jupiter's executives adopted a *system strategy*, in which they initially entered multiple components: finance, sales, and installation (and later panels and racking). The founders emphasized control and wanted to minimize dependence on partners, thinking that this strategy would enable Jupiter to out-compete rival ecosystems by ultimately having the lowest costs and the most seamless customer experience. As one described,

> *We took the path… 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.*

Consistent with its system strategy, Jupiter entered the finance component. Since the founders lacked finance capability, they hired experts to develop the finance component. Yet the firm was also simultaneously building and acquiring the sales and installation components (rather than partnering as Saturn did), and so its entry into finance was slowed by several months. Consistent with its system strategy, Jupiter emphasized competition at the ecosystem level, and neither cooperated with other firms nor made its finance component available to them. As one executive noted, "*Because we can do all the pieces there is no reason for us to give anybody else that business."* Although slightly behind Saturn, Jupiter still grew rapidly.

In contrast, Venus and Mars (middle performers at this time) did not initially enter the finance bottleneck. Venus illustrates. Venus was founded by two environmental activists and an investment banker, who, like the others, recognized finance as the bottleneck. As one executive confirmed, "*Not being able to pay as you go was the number one most important buying obstacle for customers.*" Yet, unlike Saturn, they believed that the barriers to entering the finance component were low, that creating a finance product would be easy, and that finance would eventually commoditize. One founder explained, "*How are you going to differentiate? Dollars are fungible.*" Instead, Venus executives believed that sales would be the essential component over the long run. So, they entered sales with a *component strategy* and partnered with installers. 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.*

Although they knew finance was the bottleneck, they refused to accept Saturn's extractive terms to provide finance. Instead, they relied on inferior options (e.g., homeowner self-finance and city loan programs) and waited for finance commoditize; yet, since this took 3 years, Venus suffered. As one executive said, *"The delay almost killed us."*

Likewise, Mars did not enter the finance component. Mars was founded by two friends with backgrounds in finance and law. Although one founder had finance experience, the friends saw the finance component as too difficult to master. Thus, they chose to enter the sales and installation components (as described later, they straddled component and system strategies), which they saw as having weak competition. As one founder 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."* Instead, Mars partnered with Saturn for finance. Although this partnership gave Mars a complete ecosystem, its dependence on Saturn allowed the latter to extract disproportionate value. Mars grew, but was forced by Saturn to agree to exclusivity and large fees. One VP lamented, "*With an exclusive relationship, your whole business is almost built to work with one partner.*"

The lowest performer, Pluto, was founded by two finance executives from the energy sector. They adopted a finance *component strategy.* Like the entrepreneurs at high-performing Saturn, they saw an opportunity to create an innovative finance solution. But unlike Saturn, Pluto did not assemble a complete ecosystem. Their major mistake was working with many small complementors in the sales and installation components. As one VP described, 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, but often low-quality and time-consuming to manage. Further, when Pluto reached out to the financial community to find tax equity investors (i.e., banks to buy Pluto's lease bundles), they found little interest in investing in an ecosystem with so many poor complementors. As a Pluto executive described,

> *We ran into this challenge - we had a number of these smaller installers and collectively they could add up to originate $50–$100 million of deals, but the tax investors at the time were feeling like they needed a stronger underlying credit quality. The question the banks asked was "What happens if these guys go away? Can we trust these smaller dealers?"*

Thus, despite being *"one of the first firms to doc up a finance product"* and having founders with finance expertise, Pluto fell behind. They failed to assemble high-quality complementors (unlike Saturn and Venus), and neglected to capture value from them (unlike Saturn). Overall, Pluto neither cooperated (to create value) nor competed (to capture value) effectively. As one executive said, *"We spent a long time spinning our wheels."*

4.1.1 | Summary

Why were Jupiter and Saturn high-performing at this time? First, both firms addressed the finance bottleneck, and so unblocked industry growth. Second, they assembled the remaining ecosystem components, albeit in different ways. With its bottleneck strategy, Saturn relied on high-quality

complementors that attracted tax equity investors. With its system strategy, Jupiter minimized dependence on complementors, and entered the sales, installation, and finance components itself. Thus, both firms created value. Third, both Jupiter and Saturn exploited their market power to capture value. Saturn did so by imposing fees and exclusivity requirements on its complementors. Jupiter did so by not providing finance to rivals to impede their growth.

A key theoretical insight is that firms are successful when they simultaneously *create value* (address the bottleneck and cooperate to assemble the entire ecosystem) and *capture value* (compete via market power). So, while prior research focuses on cooperation and value creation (Adner & Kapoor, 2010) *or* competition and value capture (Jacobides et al., 2016), we bring the two processes together. We also observe that there are multiple successful strategies. One of these, the *bottleneck strategy,* is new to the literature. Bottleneck strategists like Saturn combine cooperation and competition (i.e., jointly pursue mutual interests while extracting value). In contrast, the *system strategy* emphasizes competition (i.e., actively pursue individual benefit at the expense of other firms). Finally, the *component strategy* emphasizes cooperation.

A related insight is that firms that neglect both cooperation (e.g., "hands off" interactions with weak complementors) *and* competition (e.g., failing to exploit market power) are unlikely to succeed, even if they address the bottleneck, as Pluto illustrates. Thus, while there are multiple approaches to combining competition and cooperation, addressing neither is ineffective.

Finally, we observe that ecosystem strategies exhibit *distinct dynamics as ecosystems begin.* While prior research emphasizes a static tradeoff between the costs of developing capabilities vs. the benefits of capturing multiple profit margins (Arora & Bokhari, 2007; Farrell et al., 1998), we note the distinct temporal implications of each ecosystem strategy. Bottleneck strategists like Saturn are initially advantaged: they can scale rapidly since they occupy the bottleneck and require relatively few resources to complete their ecosystem. In contrast, system strategists like Jupiter are slower to scale since they require more resources and time to develop broad component capabilities. Finally, component strategists like Venus may have difficulty completing their ecosystems, especially when they occupy a nonbottleneck component. They may seek cooperation, but will suffer if complementors impose extractive terms or simply refuse to cooperate as Saturn and Jupiter, respectively, did.

These insights are reflected in firm performance during this period (Table 5). Saturn completed about 4,000 installations from launch to 2009 and Jupiter completed 3,000, while Venus and Mars grew more slowly with only 500 each. Pluto lagged even farther behind.

4.2 | 2010–2012: Emphasizing innovation and cooperation in a crowded bottleneck

Bottlenecks shape ecosystems by defining opportunities for value creation and industry growth. But, they can also move. Our informants (and archival sources) agreed that a bottleneck shift occurred in 2010: from finance to *sales.* One factor was falling panel costs. While these costs had been dropping over time, in 2009 they fell precipitously to from $4/watt to less than $2/watt. This made purchasing a solar system without finance possible for the first time for many homeowners. Another factor was the increasing commoditization of finance. As one analyst stated, "*finance is becoming the norm in the industry.*" Finally, sales costs remained high, making sales the bottleneck to homeowners' purchase of solar systems and thus also to industry growth. For example, one executive estimated that her firm spent $2000 to acquire a customer. Overall, an analyst described sales as "*the hot space for residential solar,*" while an executive stated, "*we see originations [sales] as the belle of the ball right now.*"

A key difference between the new sales bottleneck and the prior finance bottleneck is that the sales bottleneck was *crowded*: several thousand firms provided sales. As a result, simply occupying

TABLE 5 Emphasizing innovation and cooperation in a crowded bottleneck (sales)

Firm and strategy	Period perf.[a]	Consequence of Bottleneck shift to sales component	Actions taken to respond to sales Bottleneck	Competition vs. cooperation	Representative quotes	Result
Jupiter *System*	++++ *20,000 systems*	Little effect; own sales component already well developed	Innovate in sales through community sales programs and home improvement lefts Interrelate sales and installation components to lower total costs	No change; compete vs. rival ecosystems	*Super low cost of acquisition (sales) drives our model. That's why we've been successful in taking market share from our competitors. (CMO)*	Rapid growth due to ecosystem-level improvements
Saturn *Bottleneck*	++++ *20,000 systems*	Mixed effect; less market power vs. complementors as finance becomes commodity Creates need to enter sales bottleneck and new opportunity	Gradually enter sales component w/ innovative consumer brand and advertising, and slowly add pilot internal sales team Co-innovate with partners with sales and design tools as well as training programs	More cooperative; enter sales but also cooperate closely with sales and installation complementors, co-innovate	*We see originations [sales] as sort of the belle of the ball right now. (Manager)* *If we can create these tools for our partners and make them more efficient, that will drive their costs down (VP)* *Being part of the Saturn program has provided the support I need. (Complementor)*	Moderate growth, lower market power due to loss of finance bottleneck offset by improved cooperation with complementors and entry into sales
Venus *Component*	++++ *5,000 systems*	Positive effect, own sales component already well developed	Innovate in sales component by developing novel Internet sales and design technology Co-innovate with installation complementors to develop project management tools and processes	More cooperative; Compete with sales rivals and cooperate and improve installation complementors	*It's this classic mistake… where they fixate on the upstream, forgetting the customer…We just thought we'd get ahead of that curve. (President)* *What we're looking for is a very deep relationship with high quality partners. (VP)*	Very rapid growth; well-developed sales component, internal innovation, and ecosystem-level innovations with installation complementors
Mars *Straddle Component and System*	++++ *5,000 systems*	Positive effect, own sales component already well developed	Innovate in sales component by adding novel channels such as canvassing and referrals Introduce numerous efficiency improvements in sales through HR and process innovation	No change; Compete with sales and installation rivals	*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)* *We went from being a one cylinder engine…to being a seven or eight cylinder one. (VP)*	Very rapid growth; well-developed sales component and internal innovation
Pluto *Component*	– *<1,000 systems*	Negative effect, less market power vs. complementors as finance becomes commodity	Do not enter sales component to avoid channel conflict with complementors Ask complementors to use off-the-shelf management tools	No change; ignore finance rivals and stay "hands off" sales and installation complementors	*Neither Pluto nor our partners were really figuring out how to actually sell to the consumer. (VP)*	Low growth due to loss of finance bottleneck, weak installation and sales and partners

[a] Installation data triangulated from Solar Energy Industries Association data and internal firm reports.

the bottleneck and assembling a complete ecosystem were no longer sufficient. Thus, high-performing firms also: (a) *competed* through innovation in the sales bottleneck and (b) *cooperated* by helping complementors in nonbottleneck components to improve (Table 5).

Venus illustrates. Venus was pursuing a component strategy focused on sales (prior section). As one executive stated, "*Installers love to install, sales people love to sell. Differentiate, division of labor, do what you're good at.*" As part of this strategy, Venus created a novel online sales and design technology that fit the founders' vision to *"use the Internet to change the way solar is sold."* Using satellite imagery like Google Earth, Venus could design a system and produce a quote within 24 hours, which saved the time and cost of actually visiting the home. Thus, while many rivals were still having "*kitchen table"* discussions, Venus was revolutionizing sales. Its approach simplified the process for homeowners (cost and design were a click away) and eliminated the highest sales expense (i.e., the initial home visit), resulting in costs 20% below the industry average. A press headline at the time ran, "*Dell of solar [i.e., Venus] seeks to make it cheap and user-friendly to get rooftop PV.*"

At the same time, Venus explicitly devoted resources to cooperating with its installation complementors by helping them "*professionalize.*" An executive noted, "*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.*" To aid installers, Venus launched a "contractor platform" with advanced project tools. Venus also inspected the workmanship of its partners and used this information to allocate future jobs. Describing Venus's relationship with its complementors, an executive described, "*What we're looking for is a very deep relationship with ambitious, high-quality partners."*

By competing successfully through innovation in the sales bottleneck and cooperating intensely with installer partners, Venus grew rapidly. In 2011, it expanded into five new states in 3 months, and became the fastest growing solar company in California (the largest marketin the U.S.).

The shifting bottleneck also benefitted Mars, which was already in the sales component and was thus well-positioned to take off as well. 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.*

Like Venus, Mars competed via innovating in sales, for example, by investing heavily in call centers and customer segmentation. Mars's sales more than doubled each year. In 2011, the firm became the largest installer in California. As one founder exclaimed, "*Everything was lining up for us… All of a sudden, we had a business that was in that perfect spot for that perfect wave.*"

With its system strategy, Jupiter was also already in the sales bottleneck. As before, it continued to emphasize competition by improving its sales component and innovating to better integrate its components. For example, Jupiter created a novel program in which communities received discount pricing for purchasing systems in bulk. This lowered sales costs (by generating referrals) and installation costs (by clustering work sites). As one executive explained, "*If you go to one house and you install one system… 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.*" In this way, Jupiter expanded into six new states and grew by 85% in 2011 alone.

While Jupiter, Venus, and Mars were well-positioned with respect to the new bottleneck, Saturn was not. Yet consistent with its bottleneck strategy, Saturn entered sales as it emerged as the

bottleneck. An executive described: "*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."* At the same time, Saturn's entry into the sales component was challenging. First, it had to develop sales capabilities that rivals had been honing for years. Second, its entry into the sales component meant that it was now competing directly with its own sales complementors. Saturn addressed both challenges by gradually transitioning into sales. It began by building its consumer brand via billboard and radio advertising, which were industry firsts. As one rival noted, *"Saturn forever said, '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."* Saturn also built a sales team gradually. As one executive said, *"We started small with a group to pilot sales…We did some things wrong and some things right and learned…So we understood it, so we could grow over time."*

Saturn's gradual transition allowed its sales complementors to adjust to Saturn's new role as both competitor and collaborator. Yet, Saturn's entry into sales did cause consternation. As one sales complementor stated, "*You want to originate in our territory? We're just going to give our business to [your finance competitor]."* However, many of Saturn's partners, even the most reluctant, continued to work with them, and did so on Saturn's terms because Saturn still offered an excellent finance solution and was now a much more cooperative complementor. Moreover, having many potential partners eased the transition. As one executive noted,

> *You certainly wouldn't want to take a large partner who is doing 20% of your volume and really piss them off. But the fact is in another year or two it's probably not going to be that same partner doing that 20% of your volume.*

Coupled with its *competitive* entry into sales, Saturn also began *cooperating* with its complementors in sales and installation. It created extensive project and solar design tools that its complementors could use from the initial sales lead through system design to project completion (similar to Venus). A complementor described, "*Being part of the Saturn Program has provided the support I need for my teams to be successful. The dedicated support staff has always been there for me."* A Saturn executive agreed, *"If we can create these tools for installing partners and make them more efficient, then that will drive their costs down. It will make them more effective."* Thus, Saturn improved both its own *and* complementors' ability to compete against rivals like Jupiter and Venus.

Overall, Saturn engaged in a complex interplay of cooperation and competition within its ecosystem during this period. It cooperated with its sales and installation complementors by helping them to improve their capabilities, even as it (a) competed by capturing value from their finance relationships, and (b) competed directly against them in sales. As one executive explained,

> *If our partners 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.*

Finally, the lowest performer, Pluto, stayed with its component strategy. Its executives recognized emergence of the sales bottleneck, but remained true to their vision of being a finance company. An executive said, "*In 25, 30 years we'll be in the business of supporting renewable energy technology finance.*" Unlike Saturn, they also avoided competing with their complementors. As one executive noted, "*The first time [our partners] see us as a threat to their customer, they think 'we'll just build this ourselves.' Really the only pitch to the installers was we don't have any motivation to*

go around you." But as competition in sales increased, Pluto's sales complementors were too weak to challenge Mars, Venus, and Jupiter. Unlike Venus, Pluto's executives had not figured out effective cooperation. As one described,

> *Neither Pluto nor our strategic partners were really figuring out how to actually sell to the consumer. By the time we did get to market we realized we just didn't have that capability. The companies that we were partnering with didn't really have it either.*

4.2.1 | Summary

How did the firms (except Pluto) become high performing during this period? For one, they *competed* by innovating in the sales bottleneck. For example, Venus developed a revolutionary web-based sales technology, and Saturn pioneered branding. Second, they actively *cooperated* with their complementors. For example, both Venus and Saturn invested in tools to improve their complementors' capabilities (Jupiter increased integration among its components). In contrast, Pluto did neither.

A key theoretical insight is that when successfully implemented, the three ecosystem strategies exhibit *distinct patterns of cooperation and competition.* System strategists emphasize competition: their goal is to create value by integrating components, and to capture value by minimizing dependence on partners and undercutting rival ecosystems. Component strategists emphasize cooperation: their goal is to create value through mutual specialization, and to capture value by innovating and outshining within-component rivals. Thus, both system and component strategies exhibit *simple* patterns of competition and cooperation, respectively. Conversely, bottleneck strategists simultaneously compete and cooperate, for example, by improving complementors capabilities even as they impose extractive terms. Thus, this strategy exhibits a *complex* pattern of cooperation and competition that requires adroit management to maintain and balance.

A final theoretical insight is that ecosystem strategies have *distinctive dynamics as bottlenecks shift.* While Adner and Kapoor (2010) explore the implication of bottleneck location for innovation by component strategists, we add insight into how shifting bottlenecks affect all three strategies. For system strategists like Jupiter, shifts in the location of the bottleneck have little impact, as the firm is already in the new bottleneck. In contrast, for bottleneck strategists like Saturn, a shift has profound implications, as they must to develop new capabilities and realign complementors' roles and relationships in order to enter the bottleneck. As a result, they face increased operational complexity. Further, bottleneck strategists also risk "missing" the shift in bottleneck. Thus, bottleneck shifts emerge as a challenging time for bottleneck strategists that demands foresight and dynamic capabilities to avoid being left behind. Finally, component strategists like Venus prosper as the bottleneck moves to their home court. However, as we observe in the next section, they face challenges when the bottleneck moves elsewhere.

These insights are reflected in the performance of this period (Table 6). Mars and Venus installed 5,000 systems from 2010 to 2012—a compound annual growth rate over 100% (over twice that of the industry). Saturn and Jupiter also exceeded industry growth, installing about 20,000 systems each and retaining the lead. In contrast, Pluto struggled to break 1,000, and failed in 2013.

4.3 | 2013–2014: Intensifying competition and cooperation in uncrowded bottlenecks

While occupying a crowded bottleneck (like sales) favors cooperation, occupying an uncrowded bottleneck (like finance) favors competition. Saturn and Jupiter illustrated this insight during the finance bottleneck, when Saturn forced complementors into deals in which it captured disproportionate

TABLE 6 Intensifying competition in uncrowded bottlenecks (installation and racking)

Firm and strategy	Period perf.[a]	Consequence of bottleneck shift to Installation	Actions taken to respond to installation and racking bottlenecks	Competition vs. cooperation	Representative quotes	Result
Jupiter *System*	++++++ *75,000 systems*	Little effect; own installation component already well developed	Acquire innovative racking firm to (1) create new bottleneck in racking, (2) address installation bottleneck with improved racking technology Cut off access to racking component to undermine rivals Attack Mars	Increasingly competitive	*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)*	High growth as both bottlenecks are addressed
Saturn *Bottleneck*	++++ *35,000 systems*	Mixed effect; less market power vs. complementors Creates need to enter installation and new opportunity	Acquire installation firm to jumpstart entry into installation bottleneck Acquire innovative racking producer to (1) exacerbate bottleneck in racking, (2) address installation bottleneck with improved racking technology Use scale and access to racking to impose strict terms on complementors	Increasingly competitive	*We have real buying power, we can try to push down – that sounds aggressive – but we can try to encourage them to reduce their costs so that we can together get more volume." (VP)*	High growth as both bottlenecks are addressed
Venus *Component*	+++ *20,000 systems*	Negative effect; no internal installation capability and less market power vs. installation complementors	Add more high quality installation complementors to address bottleneck together Experiment with new installation techniques and share with complementors Continue to innovate in sales component and with complementors to compete on customized customer service and climate change activism	Increasingly cooperative	*The industry has always been weirdly competitive. I think we would we cooperating much more if we were mature. (President)* *There are so many roofs for solar and so why compete? (Chair)* *High quality, ambitious partners, and we give them the tools to grow (VP)*	Moderate growth b/c cooperation with quality complementors, co-innovation & differentiation somewhat offset rivals' moves

TABLE 6 (Continued)

Firm and strategy	Period perf.[a]	Consequence of bottleneck shift to Installation	Actions taken to respond to installation and racking bottlenecks	Competition vs. cooperation	Representative quotes	Result
Mars *Straddle Component and System*	+ *8,000 systems, then decline*	Little effect; own installation component already well developed	Maintain focus on sales operation Do not interrelate installation with racking or system design	No change; compete with rival installers	*This is fundamentally a consumer marketing and sales business, so it's all about cost effective lead generation and sales execution. (President)*	Low growth due to bottlenecks and Jupiter's attack
Pluto *Component*	– *<1,000 systems, then fail*	Negative effect; even less market power vs. complementors as finance becomes less relevant	Maintain finance focus Struggle to find competitive sales and installation complementors Experiment with new solar finance products Fail in late 2013	No change; compete with finance rivals	*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.' (VP)*	Low growth due to bottlenecks and weak complementors Fail 2013

[a] Installation data triangulated from Solar Energy Industries Association data and internal firm reports.

value, and Jupiter refused to provide any finance to others. These two firms again favored competition as two new uncrowded bottlenecks emerged: installation and racking.

In 2013, all informants agreed (and archival data corroborated) that the bottleneck had shifted again, this time from sales to *installation.* Several factors drove this shift. First, residential solar had become widespread, so customers needed less education regarding its value. Second, many of the sales innovations pioneered by Jupiter, Saturn, and Venus were now commonplace. Against this backdrop, installation costs remained high, sometimes over 50% of total cost. Even panel manufacturers recognized this shift: an executive at one noted, *"the real issue is the soft cost of installations."* Thus, installation emerged as the new bottleneck constraining industry growth (Table 6).

The highest-performing firms, Saturn and Jupiter, participated in the new installation bottleneck. As before, Jupiter's system strategy meant that it was already in the installation component when the bottleneck emerged. As early as 2007, for example, an executive had stated, "*Our vision is to reduce the cost of solar. The way to do this is to become more efficient at installing solar.*" Since Jupiter had also innovated over time to become more efficient, for instance, by pioneering novel approaches to routing its installation crews, its installation costs were well below the industry average. So, while many small firms participated in the installation component, Jupiter effectively occupied an uncrowded bottleneck.

In addition to occupying the bottleneck, Jupiter also increased its competitive intensity. For example, Jupiter attacked Mars on its home territory with an aggressive, price-cutting expansion that Mars could not match. As a Jupiter executive said, *"How do I make sure that I am taking out my competition? We're constantly looking at market share reports, seeing who's climbing up and we're putting strategies in place for them."* Other executives agreed. One noted, "*Quite frankly, if we can cripple our competitors, we'll do it in a heartbeat. We're very ruthless.*"

Consistent with its system strategy, Jupiter also took the additional step of acquiring the manufacturer of an innovative racking product. Until then, racking had been a low-technology commodity component. This acquired firm, however, had unexpectedly introduced technology that dramatically reduced the onsite time (and thus the labor costs) of installation. By acquiring this innovative technology, Jupiter further lowered its costs in the installation bottleneck.

More importantly, Jupiter used this acquisition to create a second bottleneck, *racking*, by blocking rivals' access to the racking innovation. In addition to being the largest racking firm (with a 30% market share), the acquired firm's patented technology cut labor costs by 25% and was described by analysts as *"the dominant state of the art racking system."* Moreover, since racking is often tightly integrated with the installation process, restricting access was particularly disruptive. As a Venus complementor told us, *"Installers have a very hard time changing a racking product."* Similarly, executives at Jupiter's largest rival stated that their ability to meet demand was severely affected such that they would *"only be able to offer our systems at higher costs or after delays."* By depriving rivals of access to superior racking technology, Jupiter limited rivals' ability to reduce costs and serve customers, thus creating a new bottleneck component. As a Jupiter executive explained,

> *We had selected [acquisition target] 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.*

The other high performer, Saturn, continued with its bottleneck strategy by entering the installation component as it became the bottleneck. Saturn also continued its complex interplay of

competition and cooperation by cooperating with its installation complementors even as it began to compete against them. One action was to follow Jupiter and acquire a second leading racking firm. According to Saturn executives, they pursued this acquisition for two reasons. One was to ensure their own and their complementors' access to racking. The other was to exacerbate the new racking bottleneck for rivals. Thus, like Jupiter, Saturn improved its own installation efficiency and that of its complementors, while preventing rivals from doing the same.

With its component strategy, Venus remained focused on the sales component. They also remained committed to intensely cooperating with complementors. As one executive stated,

> *You morph and mix…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.*

Yet while firmly ensconced in the sales component, Venus' executives also recognized the emergence of the installation bottleneck and took several actions. One was to consolidate its existing relationships and form new relationships with high-quality regional installers. As one executive explained, "*We work with local craftsmen, regional companies who are high quality, ambitious partners, and we give them the tools to grow.*" Another action was to set up labs and experiment with new installation technologies to share with their complementors. Overall, Venus doubled down on cooperation and nurturing its ecosystem. A founder noted, *"We're all on the same team."* At the same time, the firm also began differentiating its superior sales process and ecosystem vis-à-vis rivals by emphasizing customized service and climate change activism.

Finally, Mars faded. It straddled component and system strategies without committing to either. Unlike Venus (component), it was not innovative and lacked best of breed complementors like high-quality installers. Unlike Jupiter (system), it lacked a full suite of components to integrate. A rival remarked, *"They weren't able to innovate. Now they're just a mom and pop."*

4.3.1 | Summary

How did Jupiter and Saturn become the highest performers? First, they effectively addressed the installation bottleneck that blocked industry growth. Second, both firms emphasized competition by erecting barriers to entry, creating and exacerbating the bottleneck, and exploiting their market power. In contrast, Venus and Mars had to defend against these competitive actions (Pluto had failed). Mars in particular was deeply damaged by Jupiter's attack, as well as by its own strategic straddling and poor innovation. Venus also fell behind, but performed better because it had an effective component strategy (i.e., innovation, differentiation, and active cooperation), as well as a broad view of the industry and ecosystem.

A key theoretical insight is that *bottleneck crowdedness* affects how firms balance cooperation and competition. With many firms in the bottleneck (i.e., when it is crowded), it can be difficult to stand out. So, innovation becomes critical to help firms differentiate and attract high-quality complementors. Cooperation also becomes critical, since crowded bottlenecks mean that non-bottleneck firms have many potential partners and occupying the bottleneck offers less market power than when it is uncrowded. Thus, firms have to offer more to complementors. In contrast, in uncrowded bottlenecks, successful strategists like Jupiter and Saturn succeed by exploiting their market power, amplifying their competitiveness against component rivals, and reinforcing barriers to entry. So, while emphasizing cooperation and innovation leads to success in crowded bottlenecks, the balance shifts to competition in uncrowded ones.

A related theoretical insight is that ecosystem strategies exhibit *distinct dynamics as ecosystems mature.* Prior work suggests that over time firms tend to adopt the system strategy, as opportunism becomes more germane than innovation (Adner & Kapoor, 2010; Kapoor, 2013). We observe that, in fact, successful system strategists may begin as system strategists. Over time, they may develop capabilities to better integrate their components and thus become more entrenched in the system strategy. Similarly, successful bottleneck strategists may become like system strategists as they add components. Or, they may not: poststudy, Saturn's executives were considering exiting prior bottleneck components that had become low margin—actions consistent with a bottleneck, not system, strategy. Finally, successful component strategists need not become system strategists either, but may rather survive and thrive by becoming increasingly cooperative with their complementors, and more innovative and differentiated from their rivals.

These insights are reflected in period performance (Table 6). As our study ended, Mars's installations dropped, and fell steeply again by 75% in 2015. In contrast, Jupiter was now among the largest U.S. solar firms, extending its system strategy to manufacturing PV panels, and had a successful IPO (with profitable quarters). Saturn, too, was among the largest, was profitable, and went public soon after our study ended. Although smaller, Venus was also successful—it grew 100% in the final year of our study and was successfully acquired. As the CEO of a major utility said, "*The residential solar market* was *anyone's game. Today, the top tier is established."*

5 | DISCUSSION

Our key insight is that firms successfully balance cooperation and competition by following one of three ecosystem strategies. Prior research conceptualizes ecosystem strategies (component vs. system) as static (Arora & Bokhari, 2007; Farrell et al., 1998), and typically focuses on cooperation and value creation (Adner & Kapoor, 2010; Ozcan & Eisenhardt, 2009) *or* competition and value capture (Jacobides et al., 2016). We contribute an emergent theoretical framework that combines ecosystem strategies with cooperation and competition. In so doing, we refine the concept of ecosystem strategy, introduce a third ecosystem strategy—the *bottleneck strategy*, and add a more complete, dynamic lens to the system and component strategies. Broadly, we observe that, while the component and systems strategies "tip" toward cooperation and competition, respectively, the bottleneck strategy maintains a dialectic tension between the two. We also contribute novel insights into the strategic implications of bottlenecks, especially in dynamic settings and over time.

5.1 | Ecosystem strategies: Bottleneck, component, and system

A core contribution is an emergent theoretical framework that identifies three viable strategies for balancing cooperation and competition in ecosystems. Extending Adner (2017), we define *ecosystem strategy* as the firm's choice of (a) how many and which components to enter, (b) with which complementors to align, and (c) how to balance cooperation and competition. This framework consists of three viable ecosystem strategies: *bottleneck*, *component*, and *system.* It contrasts with traditional conceptions of business strategy that emphasize competition, but neglect cooperation. It also contrasts with extant ecosystem research, which separates cooperation and value creation (Adner & Kapoor, 2010; Ozcan & Eisenhardt, 2009) from competition and value capture (Jacobides et al., 2016), by considering both together.

Our framework makes several contributions. First, we contribute a "new to the literature" strategy, which we term the *bottleneck strategy.* In this strategy, firms (a) enter bottleneck components

as they emerge, (b) innovate within them, and (c) orchestrate complementors for the remaining components. A salient feature is an *emergent and complex* interplay between cooperation and competition. A key contingency is *bottleneck crowdedness.* When the bottleneck is uncrowded, bottleneck strategists emphasize competition by exercising market power, as Saturn did in the finance and racking bottlenecks. In contrast, when the bottleneck is crowded, bottleneck strategists emphasize innovation and cooperation, as Saturn did in the sales bottleneck. Overall, this strategy highlights agility and a complex repertoire of moves.

Second, we contribute a more complete and dynamic view of the *component strategy* to strategy research. In a component strategy, firms (a) enter a single or few components, and (b) rely on complementors for the rest. A salient feature is a *simple* interplay between cooperation and competition, with an emphasis on cooperation. Prior research suggests that in selecting a component strategy, executives weigh the costs of producing many components vs. the benefits of multiple profit margins (Arora & Bokhari, 2007). In contrast, we observe that executives adopt the component strategy and choose their component based on perceptions of rivalry, competencies, and long-term component value. We also observe that component strategists are especially vulnerable early on when they do not yet have a complete ecosystem of complementors. More broadly, since the risk of the component strategy is not having access to components, the strategy puts a premium on collaborative capability (Rothaermel & Deeds, 2006). Over time, component strategists succeed by innovating in their own components and bottlenecks, differentiating from rivals, and building a community of high-quality partners.[2]

Third, we contribute to strategy research by developing a more complete and dynamic understanding of the *system strategy*, in which firms compete in most or all components. A salient feature is a *simple* interplay between cooperation and competition, with an emphasis on competition. While system strategists may be motivated by multiple profit margins (Arora & Bokhari, 2007), we observe that they are also motivated by control. System strategists are particularly vulnerable early on, as it takes time to build components and achieve the integration across them that is at the heart of advantage in this strategy. As a result, the system strategy is expensive. Later, occupying multiple components creates capacity risk —that is,it requires smooth, growing demand flow. Overall, the system strategy is most effective when integrative synergies among components are high and pace of innovation is manageable, as was the case here.

Finally, less successful firms fail to conceptualize the ecosystem broadly, and are likely to enter components based on their capabilities (Pluto) or perception of weak competition (Mars) rather than a viable ecosystem strategy. These firms may adopt a viable strategy, but then execute poorly (e.g., Pluto), or they may straddle viable strategies and so implement neither well (e.g., Mars). Overall, we observe that unsuccessful firms cooperate less intensely (e.g., fail co-innovate with partners) and compete less intensely (e.g., fail to exploit their market power) than more successful firms. Simply, they are myopic and laissez faire.

In summary, we contribute an emergent theoretical framework of three viable ecosystem strategies (Figure 2). Prior research conceptualizes ecosystem strategies (component vs. system) as static (Arora & Bokhari, 2007; Farrell et al., 1998), and focuses on cooperation and value creation (Adner & Kapoor, 2010; Ozcan & Eisenhardt, 2009) or competition and value capture (Jacobides et al., 2006, 2016). We contribute by bringing these research streams together—that is, blending cooperation and competition with research on ecosystem strategies. In so doing, we add (a) a more

[2]This is consistent with Ozcan and Eisenhardt (2009), who attribute the success of component strategists in the wireless gaming industry to their ability to recruit and manage partners. Although not observed in our study, component strategists also succeed when they can erect entry barriers and limit crowdedness, as Microsoft and Intel did with scale economies in the PC ecosystem.

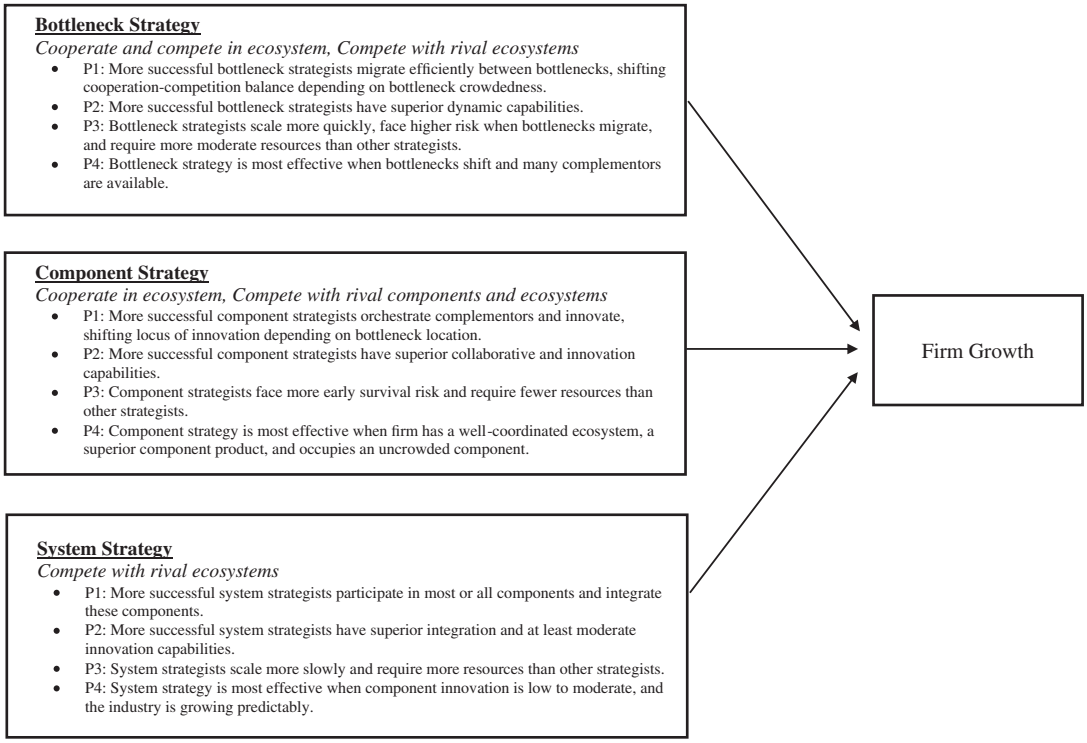


FIGURE 2 Viable ecosystem strategies

complete set of viable ecosystem strategies, (b) depth on the behaviors and capabilities in each, and (c) insights into the temporal dynamics of these strategies.

5.2 | Ecosystems: Properties and strategic implications of bottlenecks

A second contribution is to deepen our understanding of ecosystems by elaborating the bottleneck concept. First, we note several core properties. Bottlenecks are relatively easy to identify, but hard to predict. As we saw, industry observers can often readily spot a bottleneck in the moment. The challenge comes in predicting when a bottleneck will arrive, and how long it will stay. For example, the sales bottleneck was predictable from factors like falling panel prices. Even so, the timing of its arrival and resolution was uncertain. At other times, a bottleneck may be truly unpredictable, as with the unexpected racking innovation that turned a commodity component into a bottleneck. Bottlenecks may also emerge for different reasons. For example, bottlenecks may be triggered by exogenous changes, as when the Energy Policy Act of 2005 offered a way to resolve the finance bottleneck. Or, they may arise endogenously from strategic moves, such as Jupiter's acquisition creating a racking bottleneck.

Second, bottlenecks have strategic implications within ecosystems. Prior work by Adner and Kapoor (2016) and Ethiraj (2007) highlights one such implication: bottleneck location affects where innovation should be focused. Innovating upstream from a bottleneck, for example, is likely immaterial for overall performance (Adner & Kapoor, 2010, 2016). We contribute added strategic implications. One is the relevance of distinguishing between occupying a bottleneck vs. bottleneck crowdedness. *Occupying a bottleneck* offers the opportunity to resolve the bottleneck, create value, and grow. So, it is strategically advantageous to position here when growth is important. In contrast, *bottleneck crowdedness* affects the ability of firms to gain market power and capture value. From

the focal firm perspective, occupying an uncrowded bottleneck is ideal: by exploiting an uncrowded component firms can create value and ride a growth wave while simultaneously capturing value and creating profits. A second strategic implication is that bottleneck shifts destabilize ecosystems. They can reshuffle relationships and roles, and thereby create *opportunities for advantage.* Jupiter and Saturn, for example, strung together a series of these advantages over the course of the study.

Overall, a *winning ecosystem strategy* depends on: effectively implementing a viable strategy, the number and crowdedness of bottlenecks, and the strategies of rival firms. Thus, the bottleneck, system, and component strategists can all be successful—as they were in our study. That said, their relative ranking in the residential solar industry might have unfolded differently if, for example, bottlenecks like sales had been defensible over the long term for component strategists like Venus, or if firms like Jupiter had been less ruthlessly competitive.

Finally, *initial capabilities* (unlike bottlenecks) had surprisingly little influence despite their relevance in prior work (Klepper & Simons, 2000; Moeen & Agarwal, 2017; Qian et al., 2012). Firms' initial entry decisions did not always follow founder capabilities, for example, nonfinance founders entered finance (Jupiter) and finance founders started in sales (Venus, Mars). Instead, founders' long-term vision of the industry seems to have played a greater role (e.g., Hannah & Caldwell, 2017). Similarly, a match between capabilities and component was unrelated to success. For example, finance founders failed in finance (Pluto) while software founders (Jupiter) succeeded. Thus, while capabilities did influence success (e.g., Venus's collaborative skills, Jupiter's integrative skills), they seemed to have been learned via experience. Overall, perhaps in complex strategic settings like ecosystems, strategy is more consequential than initial capabilities.

5.3 | Balancing cooperation and competition: Tipping dynamics v. dialectic tension

A final contribution is to shed light on how firms balance cooperation and competition. Prior work offers contrasting views. One line of (largely theoretical) work argues for balancing a dialectic tension between cooperation and competition (Das & Teng, 2000; Lado et al., 1997). A second line of (empirical) work finds that relationships "tip" to one or the other (Doz, 1996; Sytch & Tatarynowicz, 2014). Our study contributes by reconciling how *both* are accurate.

On the one hand, the *component* and *system strategies* exhibit *tipping dynamics*—becoming more cooperative (component) or more competitive (system) over time. In particular, these strategies favor a type of behavior, and these repeated behaviors become reinforcing. For example, successful system strategists become larger and able to compete across components, and successful component strategists become more cooperative as they build communities.

On the other hand, the *bottleneck strategy* exhibits the *dialectic tension* suggested by theoretical work (Das & Teng, 2000). Consistent with complexity theory (Davis et al., 2009), the bottleneck strategy itself is simple, but its pattern of cooperation and competition is *emergent* and behaviorally *complex.* It requires managing an "edge of chaos" between cooperation and competition, which, as we observed at Saturn, requires substantial operational attention—more so than component and system strategies with their simple and predictable approach to this balance. Overall, the interplay of competition and cooperation within the bottleneck strategy is a dialectic tension—both adaptive and emergent, while requiring adroit management.

ACKNOWLEDGEMENTS

We would like to thank Ron Adner, Michael Jacobides, Dev Jennings, Rahul Kapoor, Rory McDonald, Mahka Moeen, Henning Piezunka, Ryan Raffaelli, and Mary Tripsas, as well as seminar

participants at the University of Maryland, the University of Oregon, the University of Texas, USC, IESE, Wharton, UNC, Northwestern, Boston College, and attendees at the Sumantra Ghoshal Conference, Academy of Management, BYU-Utah Winter Strategy Conference, Strategic Management Society, and West Coast Research Symposium for their helpful comments. We are especially grateful to Werner Hoffmann, the editors of this special issue, and two anonymous reviewers for their guidance and feedback. Financial support was provided by Stanford Technology Ventures Program.

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SUPPORTING INFORMATION

Additional Supporting Information may be found online in the supporting information tab for this article.

How to cite this article: Hannah DP, Eisenhardt KM. How firms navigate cooperation and competition in nascent ecosystems. *Strat Mgmt J*. 2018;1–30. https://doi.org/10.1002/smj.2750