RESOURCE REDEPLOYMENT IN BUSINESS ECOSYSTEMS

DOUGLAS P. HANNAH
McCombs School of Business
University of Texas
2110 Speedway, Austin, TX, 78712
douglas.hannah@mccombs.utexas.edu

ROBERT P. BREMNER
Department of Management Science and Engineering
Stanford University
473 Via Ortega, Stanford, CA, 94305
rbremner@stanford.edu

KATHLEEN M. EISENHARDT
Department of Management Science and Engineering
Stanford University
473 Via Ortega, Stanford, CA, 94305
kme@stanford.edu

January 23, 2016

Advances in Strategic Management on Corporate Strategy and Resource Redeployment
(Timothy B. Folta, Constance E. Helfat, and Samina Karim, Eds.)

Abstract: This paper addresses resource redeployment in ecosystems. Prior research examines the value of resource redeployment across product markets in multi-business firms. In contrast, resource redeployment across ecosystems is an important corporate strategy employed by both single- and multi-business ecosystem firms that has received little attention. To address this gap, we present a case study of resource redeployment by an entrepreneurial firm in the US residential solar industry. We propose that the value creation mechanisms (i.e., improving capabilities, bottleneck relief) are fundamentally different when resources are redeployed in ecosystems. We identify "consumption-side" interdependence of components and "production-side" resource relatedness as playing critical roles in both types of value creation, and propose conditions under which resource redeployment is most valuable. Overall, we contribute insights into the literatures on resource redeployment and strategy in business ecosystems.

INTRODUCTION

While it has long been recognized that firms create value through the deployment of resources, scholars have only recently explored the *redeployment* of resources. Redeployment is the partial or complete withdrawal of resources from one business followed by the reallocation, rather than divestment, of those resources into another business (Helfat and Eisenhardt, 2004). Redeployment allows firms to create value by allocating resources to their most productive applications (Galunic and Eisenhardt,1996; 2001). A key driver of value creation via redeployment is inter-temporal economies of scope – i.e, cost savings associated with reassigning existing resources to new uses, rather than obtaining entirely new resources (Helfat and Eisenhardt, 2004). Building on this concept, research recently unpacks the mechanisms by which resource redeployment create value and the conditions under which resource redeployment is most valuable (Sakhartov and Folta, 2014; 2015). This work confirms that resource redeployment allows firms to maximize returns by entering and exiting markets such that they capture the relative returns advantages of one market over another. Overall, redeployment is an important source of value creation over time in multi-business firms, particularly when product-markets are uncertain and their resources are related (Helfat and Eisenhardt, 2004).

But resource redeployment may also be an important strategy in ecosystem firms. Ecosystems are networks of firms that offer discrete products or services that collectively form a valuable solution (Jacobides et al, 2006; Adner, 2012). The smart phone ecosystem, for example, includes operating systems, handset manufacturers, network carriers, and applications developers – each of which provides a key component of the smartphone. Central to ecosystems is what we term "consumption-side" interdependence[i]. By consumption-side interdependence, we mean that the value of one firm's product depends on the availability and performance of complementary products or services that collectively comprise a valuable solution. If a single component falters, then the other components suffer because there is no longer an adequate complete solution. As a result, the performance of firms in one component depends on to the performance of firms in other components (Adner, 2012; Ozcan and Eisenhardt, 2009; Adner and Kapoor, 2010).

The extant literature examines redeployment in multi-business firms where product markets are largely independent, their returns may be negatively correlated, and their resources are often related (Galunic and Eisenhardt, 1996; Anand and Singh, 1997; Sakhartov and Folta, 2014). A next step is to explore redeployment in a novel and contrasting context: ecosystem firms where components have “consumption-side” interdependence, their returns are often positively correlated, and their resources likely have varied relatedness. Ecosystems present distinctive strategic challenges because successful strategy requires envisioning the entire ecosystem (Ozcan and Eisenhardt, 2009), or what Adner (2012) terms the “wide lens” rather than simply a single business. With this in mind, we ask: *How and when does resource redeployment influence firm value in ecosystems?*

We examine our question using an in-depth, inductive case study of an entrepreneurial firm in the US residential solar industry. Inductive case methods are particularly appropriate when theory and evidence are limited, and the research addresses a process question (Eisenhardt and Graebner, 2007). The US residential solar industry is a prototypical ecosystem composed of multiple distinct components. Combining fieldwork and archival data, we track our focal firm from its founding in 2007 through 2014, a period of extreme industry uncertainty. Since our focal firm engaged in multiple redeployments with varying success, we can likely isolate value creation mechanisms underlying resource redeployment in ecosystems.

We contribute to the literatures on resource redeployment and ecosystems. First, we identify the unique inducements for resource redeployment within ecosystems. Prior research on the inducements focuses on comparing market returns in multi-business firms: current returns, volatility of returns, and negatively correlated returns (Helfat and Eisenhardt, 2004; Sakhartov and Folta, 2015). In contrast, inducements in ecosystems turn on how redeployment improves returns in the focal component by: improving the capabilities of lagging components and relieving bottlenecks. Second, we clarify the conditions under which resource redeployment is likely to be of greatest value such as evolving markets, and when it is likely to be most effective. Third, we introduce a key concept, "consumption-side" interdependence, and distinguish it from "returns" interdependence and "production-side" resource relatedness. We add the insight that resource-constrained firms are particularly likely to engage in redeployment. Overall, we contribute to theory on both resource redeployment and strategy in business ecosystems. Despite conditions like varied resource relatedness and correlated market returns that should diminish redeployment, we outline how redeployment is an effective corporate strategy in ecosystem firms.

THEORETICAL BACKGROUND

Resource redeployment is the partial or complete withdrawal of resources from one business followed by the reallocation of those resources into another business (Helfat and Eisenhardt, 2004). Redeployment allows firms to capture "inter-temporal economies of scope" – i.e., the cost savings that result from sharing resources over time by exiting one business and entering a more attractive one, rather than developing entirely new resources. Since it allows firms to apply resources in their most productive product-market uses over time, redeployment is an important corporate strategy when firms operate in uncertain industries – i.e., where product markets are frequently emerging, growing, splitting and declining (Galunic and Eisenhardt (1996; 2001). Redeployment contrasts with synergy, a standard approach to corporate value creation (Helfat and Eisenhardt, 2004; Sakaharov and Folta, 2014; Martin and Eisenhardt, 2010). Synergy relies on the well-known concept of "intra-temporal economies of scope" – i.e., the cost savings associated with sharing resources *simultaneously* across businesses. In contrast, redeployment relies on sharing resources *over time* by exiting and entering businesses.

The literature offers several empirical examples of resource redeployment. This work typically conceptualizes redeployment as a strategy by which firms can maximize performance by continually realigning their business unit portfolios with the most attractive product-market opportunities, and simultaneously reallocating resources among the business units to fit this alignment (Eisenhardt and Brown, 1999). For example, Karim and Mitchell (2004) find that Johnson & Johnson purposefully reconfigured its existing business units in order to search for new business opportunities. Similarly, Karim (2006) studies 250 medical industry firms, and finds that medical industry firms engage in substantial reconfiguration in order to reallocate internal resources while Kaul (2013) observes the same in a sample of about 5000 US manufacturing firms. A key insight is that modular organization through a multiple business M-form makes redeployment easier as firms can more readily exit one business and enter another (Helfat and Eisenhardt, 2004).

Redeployment is particularly relevant in *uncertain markets* where product-market opportunities frequently emerge, change, combine, split, and disappear (Galunic and Eisenhardt, 1996; Karim, 2009; Karim and Kaul, 2014). For example, Galunic and Eisenhardt (2001) examine the "charter change" process by which executives frequently realigned business-units and their resources to address rapidly changing product-market opportunities. In this extraordinarily successful Fortune 100 technology firm, executives reassigned resources to address new business opportunities, realigned their match of business-unit resources with product markets, and moved resources from declining businesses. These redeployments enabled the firm to match its resources with superior product-market opportunities even as those opportunities changed. Similarly, Karim, Carroll, and Long (2015) track 46 medical device firms, and find that executives engaged in redeployment when industry uncertainty was high in order to improve fit with the environment.

Redeployment is also particularly relevant for specific types of *resources.* When resources have greater "production-side" relatedness across product markets, they are likely to be highly useful across applications, and so relevant to redeployment (Sakhartov and Folta, 2014). This relatedness ensure low readjustment costs of resources between product markets, and so makes redeployment advantageous over other approaches to obtaining resources such as acquisition or building from scratch (Helfat and Eisenhardt, 2004). Relatedness also enables reversibility by which firms can move resources back and forth among uses. Such reversibility is helpful when temporary redeployments are germane (Sakhartov and Folta, 2014). Finally, resource redeployment is relevant for "non-scale-free" resources (i.e., cannot be deployed simultaneously across uses because of limited capacity or scalability) (Bryce and Winter, 2009; Levinthal and Wu, 2010), Examples include employees, location-specific assets, and equipment. In contrast, "scale-free" resources such as brands and intellectual property can be simultaneously shared across multiple uses (Panzar and Willig, 1981), and so are relevant to corporate value creation via synergy.

Redeployment creates value when *strong inducements* exist – i.e., settings where the relative performance advantages between markets are high (Penrose, 1959; Anand, 2004; Silverman, 1999). Helfat and Eisenhardt (2004) highlight current-returns differences between two markets as a strong inducement. Sakhartov and Folta (2015) analyze data from the US medical device industry and develop a simulation model to unpack further when strong inducements exist. They find that a greater expected returns disparity exists between two markets (i.e., strong inducement) when the new market has: higher current returns (as anticipated by prior research), higher volatility, and higher negatively-correlated returns. Interestingly, these three conditions characterize the canonical case of redeployment (Helfat and Eisenhardt, 2004) – i.e., related diversified firm in which resources are redeployed as product markets evolve from mature markets to new ones: ones with higher current returns, more volatile returns than mature markets, and negatively correlated returns with mature markets.

Overall, resource redeployment is an important corporate strategy that creates value for firms by allowing them to allocate their resources to their most attractive use over time (Galunic and Eisenhardt, 2001; Helfat and Eisenhardt, 2014; Sakhartov and Folta, 2014). Redeployment is particularly valuable in settings with: (1) high uncertainty such that product-markets are fluid and evolving, (2) non-scale free resources with high "production-side" relatedness (low readjustment costs and high reversibility), (3) modular business-unit (M-form) organization, and (4) strong inducements (i.e., high disparity in expected market returns) to enter new markets. To date, redeployment research has focused on multi-business firms in evolving product markets. A next step is to explore redeployment in a contrasting context: ecosystem firms.

Competing in Ecosystem Industries

Ecosystems are networks of firms producing distinct products or services that together comprise a valuable solution (Jacobides et al., 2006; Adner, 2012). Examples include personal computers (hardware, software, and peripherals), smartphones (carriers, handset makers, operating systems, and applications developers), and 3D printing (scanners, materials, modeling software and printers). Ecosystems are characterized by high consumption-side interdependence. That is, the value of any individual component depends on the performance, availability, and interface with the other components of the ecosystem (Moore, 1993; Adner, 2012).

Ecosystems are shaped by an *industry architecture* that defines the roles and relationships among firms (Jacobides et al, 2006). This architecture is, in effect, the "blueprint" for interactions among component firms (Ozcan and Eisenhardt, 2009). Firms in different components often come from diverse industries, and as such may rely on resources that exhibit little “production-side” resource relatedness (Bremner, Eisenhardt, and Hannah, 2016). For example, the resources of carriers, handset makers, and game developers are largely unrelated in the smartphone ecosystem.

Ecosystems are characterized by both cooperation *and* competition. Since ecosystem firms are highly interdependent, they must work together to create value. As a result, there may be substantial co-specialization and alignment among firms (Bremner et al, 2016). For example, Ozcan and Eisenhardt (2009) describe how a game publisher, carrier, and software platform provider engaged in substantial co-specialization and alignment. This self-named “unholy trinity” ultimately came to dominate the nascent mobile gaming ecosystem. Interdependence also drives the emergence of bottleneck components that can impede the performance of the entire ecosystem (Adner, 2012). For example, Adner and Kapoor (2010) find that technological bottlenecks in complementary components blocked innovation across the photolithography ecosystem. These bottlenecks allowed the rivals of leading innovators to catch up before the leaders could exploit the advantages of their innovations. In contrast to waiting, firms may also mobilize their resources to address bottlenecks in complementary components. For example, Hannah and Eisenhardt (2015) find that high-performing firms in the nascent residential solar industry ecosystem devoted substantial effort to reducing the innovation challenges faced by their partners or to enter bottlenecks themselves. Similarly, Ethiraj (2007) finds that firms in the PC ecosystem allocate R&D resources (measured by patents) to mitigate bottlenecks in complementary components. A key insight is that, within ecosystems (unlike independent product markets), the ability of a firm to succeed in one component depends on both the success in their own component *and* the success of their partners.

Third, while ecosystem partners cooperate to create value, they also compete to capture value (Hannah and Eisenhardt, 2016). For example, they may jockey to become the “kingpin” firm that dominates the ecosystem (Jacobides and Tae, 2015). This simultaneous collaboration and competition among partners, as well as the importance of complementarity and co-specialization, complicate strategy within ecosystems. Yet despite the likelihood of positively correlated financial returns and weak resource relatedness that should diminish redeployment in ecosystems (Sakhartov and Folta, 2015), the shifting attractiveness of ecosystem components, emergence of bottlenecks, and opportunities for co-innovation across components all suggest that resource redeployment may play a valuable role in ecosystems. A next step is to examine *how* and *when* (if at all) resource redeployment creates corporate value in ecosystem firms. Below, we take this step via a detailed case study of an entrepreneurial firm that competes in the US residential solar ecosystem.

METHODS

Given the limited theory and evidence regarding resource redeployment within ecosystems, we conduct a detailed case study of a single firm (Consumer Solar) competing in the US residential solar industry from 2007 to 2014. We combine both theory-building and theory-elaboration. Case studies are appropriate for under-theorized settings as well as for process research questions such as ours (Langley, 1999; Eisenhardt, 1989). Although single cases sacrifice some generalizability, they also enable rich exploration of a specific setting (Yin, 1994).

We study the US residential solar industry for several reasons. First, this industry is a prototypical ecosystem composed of multiple, distinct components. Specifically, the ecosystem consists of several components which together comprise the overall consumer solar product (i.e., grid-connected solar PV system): (1) solar photovoltaic panels, (2) racking, which is the hardware on which the panels are mounted, (3) sales, including system design, (4) installation, including permitting and supply logistics, and (5) consumer finance (see Figure 1). As in all ecosystems, these components have high "consumption-side" interdependence such that they depend on one another to create a valuable solution. Second, we chose the residential solar industry because of substantial media coverage due to public interest in climate change and well-publicized events (e.g. Solyndra failure). This coverage enabled us to develop a rich history of the industry, from its re-emergence in 2007 through 2014. Third, the residential solar industry is highly uncertain and evolving during our study, making redeployment likely to be an attractive strategy (Helfat and Eisenhardt, 2004; Sakhartov and Folta, 2014). Bottlenecks, for example, shifted. In 2007, finance was the bottleneck with, as an illustration, one analyst calling the lack of consumer financing *"the biggest barrier to adoption."* By 2010, the bottleneck was the sales component, and then installation in 2013. PV panels dramatically dropped in price, and technical innovations in sales and installation occurred. States enacted (and sometimes withdrew) various incentive programs and utility connection policies (e.g., net metering). The industry grew by over 1,500% during our study. But while the industry grew consistently at the national level, the growth of individual state markets was highly uncertain. Overall, the industry was characterized by a highly uncertain evolutionary path.

We study a single entrepreneurial firm, Consumer Solar (pseudonym). We chose this firm for several reasons. First, the firm engaged in several instances of resource redeployment across components and geographies, making it useful for illuminating resource redeployment within ecosystems. Second, it is an entrepreneurial firm which allows us to track redeployment since birth, and thus avoid left-censoring. Finally, Consumer Solar was a key player in the resurgent US residential solar industry, and so received unusually rich media coverage that we could use to complement our fieldwork. Several founders were particularly active in engaging with the media.

Data Sources

We rely on several data sources, including (1) semi-structured interviews with firm executives, (2) interviews with industry experts, journalists, and competitors, (3) informal follow-up interviews with key respondents, and (4) archival materials, including press releases, recorded interviews, books, analyst reports, and internet resources. These data allowed triangulation among multiple sources, which strengthened data accuracy and inference quality. A particularly valuable source was archival interviews performed by journalists with firm executives from 2007 through 2012. These and other archival sources provided real-time data, relatively free of retrospective bias.

Semi-structured interviews were also a major data source. During 2013 and 2014, we conducted eight in-depth interviews (in waves) with Consumer Solar executives about their company's history, strategy, and key strategic actions. These informants included Consumer Solar's founders and other key executives such as the finance director and a vice-president. We also gathered data from external informants, including both individuals in the industry (e.g., investors and rivals' executives) as well as those with more general industry expertise (e.g., analysts and technology journalists). These external informants provided a highly informed outsider perspective on Consumer Solar, its competitors and the industry that gave us a richer and more complete picture of events.

The interviews had three sections. The first covered informants' background, work history, and role or familiarity with the company. The second section consisted of a detailed narrative of Consumer Solar's history from founding (or last interview) to the time of the interview. This section focused on specific actions, motivations, and implications vis a vis the ecosystem. The goal was to understand how and why Consumer Solar addressed each component over time. The third section explored specific issues that arose during the interview or in archival research, and the informant's performance assessment of Consumer Solar and its competitors. Each interview lasted one to two hours, and were recorded and transcribed within a day. Follow-up interviews and emails were also used to examine explore particular events more fully.

We took multiple steps to ensure the validity of our data and to minimize informant bias. Interviews were structured to gather specific information and were conducted using techniques such as event tracking and non-directive questioning, which yield more accurate information (Huber, 1985; Huber and Power, 1985). For event tracking, informants walked through the history of the firm to produce a detailed chronology of events (Eisenhardt, 1989). For non-directive questioning, informants were asked to focus on specific facts and events, rather than speculation. We avoided leading questions (e.g., "was the market attractive?"). Furthermore, as described above, we interviewed a wide range of internal and external informants. This diversity of viewpoints provides a more complete and accurate perspective than single informants (Kumar, Stern, and Anderson, 1993). Moreover, all informants were ensured anonymity, which allowed them to speak candidly about the firm's motivations and failures.

Finally, we triangulated between interview and archival data, enabling a rich combination of real-time and retrospective information. The residential solar industry received extensive press coverage throughout the study period. In total, we collected 302 articles (788 pages) and 32 press releases on Consumer Solar, from sources such as the New York Times, Green Tech Media, and Businessweek. These archival data confirmed the interview-based histories, and also generated new insights. In combination, our data sources yield a comprehensive and accurate history of Consumer Solar and the US residential solar industry from 2007 to 2014.

Consumer Solar, Inc.

Consumer Solar was founded in 2007 by environmental activists and an investment banker who were motivated to launch a residential solar company to address climate change. In particular, the founders believed that improving the quality and cost of the sales and design component was critical for industry growth. At the time, the sales component was performed by *"mom and pop"* home contractors. As one Consumer Solar executive described, *"There was just* *nothing simple about it if you were a customer. It was confusing. It was very do-it-yourselfy."*

Another executive concurred,

> *"It's a bunch of men who love their machinery and think that the solar industry is all about the hardware on the roof, whereas it's all about the customer and the service they get. That's the original and blinding insight."*

Consumer Solar's vision was to specialize in the sales and design component, which the founders believed would be the most critical component of the ecosystem over the long term. The founders also believed that focus on a single component (i.e., component strategy) would pay-off. As one stated, *"Installers love to install, sales people love to sell, differentiate, division of labor, do what you're good at."* Thus, their strategy was to rely on partners to provide the remaining hardware, finance, and installation ecosystem components while Consumer Solar was *"using the Internet to change the way solar is sold."* They did the latter by developing an extremely novel, web-enabled sales and design technology that used satellite imagery from Google Earth to create and price solar system designs for homeowners. This greatly streamlined the sales process. Other firms relied on a sales and design process that was largely manual and involved home visits: driving to a prospective customer's house, taking measurements, designing a proposed system, and returning to the "kitchen table" to sell the project. By contrast, Consumer Solar's use of the Internet and satellite imagery enabled the firm to design the system and provide a sales quote in a few hours with no home visit. This drastically cut the cost of sales and design, and the number of necessary sales staff. It freed up the company's limited resources for redeployment to other components.

Consumer Solar maintained this same strategic focus on the sales and design component throughout our study. At the same time, they also engaged in several resource redeployments driven by changes in the residential solar industry. Some addressed emergent bottlenecks in the ecosystem while others addressed the changing geographic attractiveness of various states.

Despite these redeployments, Consumer Solar remained committed its sales component strategy. As one executive described:

> *"[We have] been remarkably true to the original vision. We've had a crew when we need a crew even though we knew we didn't want crews. We've built funds when we needed funds because no one will give us tax equity without our own financial operation. We've gone from that to back to our original vision… We changed and morphed as required."*

By the end of the study, Consumer Solar had emerged as a successful firm in the residential solar industry, ranking among the top ten in the US for cumulative sales. In 2014, the company had deployed 20,000 installations, operated in 10 states with approximately 300 employees, and was consistently ranked by experts as being a major player in the industry.

Resource Redeployment at Consumer Solar

Table 1 lists Consumer Solar's redeployment initiatives along with details regarding the resources and ecosystem components involved, rationale for redeployment, and performance. We describe these initiatives in depth below, first focusing on redeployments across ecosystem components over time and then the company's geographic redeployments.

[Insert Table 1 about here]

Consumer Solar's 2007 entry and 2009 exit from installation

Although founded to address an innovation opportunity in sales and design, Consumer Solar quickly entered the installation component as well as sales when the company launched in 2007. The founders believed that the installation and sales components were tightly linked such that the payoff from co-innovating across these two components was likely to be high (Hannah and Eisenhardt, 2016). In other words, performing installations in-house would be essential to improve Consumer Solar's web-based satellite imagery technology for sales and design, and realize its full value. As one executive stated, *"We had to ground proof and test out the remote solar design to make sure it would work. We started with this lab and ran crews for about a year, which allowed us to hone the tool and make sure that the installation systems were feeding back into the design process."*

By 2009, Consumer Solar had succeeded in refining its sales and design product (with help from its own installation experience) such that it was superior to that of rivals. As one executive described, *"it (Consumer Solar's sales & design product) is better than if you send the guy on the roof. It's the rules-based software. We've gone through tons of thousands of iterations."* This co-innovation success allowed Consumer Solar to exit the installation component in 2009, and return to its original vision of partnering for the installation component.

This installation exit also freed resources that were previously used for installation for redeployment into sales. Senior managers, on-the-roof installers, and permitting specialists as well as supply chain infrastructure (e.g., procurement and hardware distribution) were redeployed from installation to sales, rather than divested. For example, staff that had previously performed installations was integrated into the sales teams, where they coordinated with their installation partners and ensured a high quality customer experience. As one executive described, *"we spoke to every single customer on the phone about how their installer experience was. We also inspected every single install."* Other redeployed staff improved operational efficiency in sales. For example, these staff "pre-wrapped" customers for their installation partners, which allowed these installers to concentrate on the "on-the-roof" activities. Ultimately, the redeployment of installation resources to sales allowed Consumer Solar to improve the quality and capacity of its sales and design business.

How did the redeployment of installation resources into sales improve the sales component and create value? First, once the sales and design component was refined, dedicating resources to installation was not as value-creating for sales as it had been. The product was unique and superior to that of rival firms, and additional installation experience was not providing new insights into further improvements. Second, the redeployed staff was able to exploit their acquired knowledge from installation to improve the overall sales experience. This enhanced the Consumer Solar brand through improved quality control, facilitating additional sales growth through referrals. As one executive described, *"It swung around from our core competency being providing a fast quote to providing an all- around good experience, then leveraging our software platform to encourage people to refer their friends."* Third, the redeployed staff also used their knowledge acquired from installation to improve the interface of installation with sales by orchestrating high value-creating partnerships with the installers. Simply put, the redeployed staff's extensive knowledge of installation enabled the company to select better installation partners and work more effectively with them, thus improving the sales component, its returns, and the overall strength of the ecosystem. Moreover, a key point is that this staff is likely mis-priced in the market – i.e. these individuals are particularly valuable to Consumer Solar because of their knowledge of the two components and the company itself, and yet Consumer Solar does not have to pay for this additional value[ii]. This adds to the attractiveness of redeployment.

Consumer Solar's 2010 entry and 2014 exit from finance

Similar to Consumer Solar's entry into the installation component, the company's 2010 entry into the finance component was motivated by the aim of competing effectively at the sales component and ecosystem-levels. However, whereas the entry into installation was driven by an opportunities to co-innovate across the sales and installation components and the redeployment back to sales further improved the sales component with valuable installation knowledge, its entry into finance was driven by finance's role as the key bottleneck to industry growth.

The US residential solar industry experienced a stunning resurgence with the passage of the federal Energy Policy Act of 2005, which allowed firms to claim a 30% tax credit on the installation of residential solar systems. At this time, residential solar systems cost upwards of

$20,000, and homeowners paid up front or arranged their own financing. As one industry executive said, "*not being able to pay as you go was the number one most important buying obstacle for customers"*. Another claimed, lack of consumer finance was "*the biggest barrier to adoption"*. Enabled by this tax law change, many firms like Consumer Solar entered the industry. But only a few firms mastered the new ecosystem component, finance. The finance product involved providing solar equipment leases to homeowners, and bundling those leases for investors. This financing eliminated the upfront costs of "going solar" and sparked an industry resurgence that attracted entrepreneurial firms like Consumer Solar.

As early as 2007, Consumer Solar's executives realized that the lack of consumer finance was a bottleneck. However, they chose to focus on the sales and design component because they thought finance would quickly commoditize. As one executive stated, *"This is a new asset class and it's bumpy right now, but over time it's going to be just like anything else… How are you going to differentiate? Dollars are fungible."* Moreover, Consumer Solar's executives believed that the finance and sales businesses were too disparate to manage together. As another executive stated, *"We knew right upfront we weren't a financial operation. Not withstanding [founder]'s acumen, which is great - he is a banker from hell - we didn't want to be a mini-bank."* Thus, although Consumer Solar had a founder with finance expertise, they chose to wait for partners to develop the finance component.

By 2010, it was clear that finance was not commoditizing as Consumer Solar's executives expected. In fact, it turned out that the finance component was *"phenomenally complex"* – or as another executive described, *"totally mind-numbingly complicated."* Only two firms had succeeded in developing a consumer finance product that took advantage of the 2005 tax law change. These successful finance entrants developed complex instruments that enabled homeowners to lease their solar equipment while investors purchased securitized bundles of these leases. As a result, these firms became sought after partners by firms like Consumer Solar because they provided a zero-cost path for homeowners to buy a solar system. Moreover, this near-monopoly in the bottleneck component allowed the two finance participants to place exorbitant demands on their ecosystem partners like Consumer Solar and capture disproportionate value within the ecosystem.

Wishing to escape the onerous terms of its finance partners, Consumer Solar entered the finance component in 2010. They did so by hiring a CFO who had experience in consumer finance. Apart from this senior hire, however, the finance team was assembled by redeploying Consumer Solar employees. Specifically, the Consumer Solar's investment banker-founder was shifted from being CEO to overseeing the development of the finance component, and some sales staff was redeployed into finance. While redeployment was effective from installation to sales, it was not for sales to finance. Although there was high consumption interdependence (i.e., consumers highly valued finance and sales together) within the residential solar ecosystem, the finance component was highly technical, and drew on capabilities and resources (e.g., investment fund management, tax law) that were mostly unrelated to sales. Sales and finance had low resource relatedness. As one executive conceded, *"We didn't invest in building a world class tax equity team because we didn't believe that was where the long term value was."* As a result, Consumer Solar developed an inferior finance component that did not competitively address the finance bottleneck.

More importantly, since finance and sales were interdependent as ecosystem components, offering a non-competitive finance product limited Consumer Solar's success despite its excellent sales and design component. Thus, this redeployment failure in finance ended up limiting the growth of the sales and design component, not just finance. This highlights a distinctive feature of ecosystem strategy: performance depends on assembling a complete ecosystem of valuable components, not just producing a superior single component. As one executive lamented, *"Because of difficulties on the project finance side, it certainly stopped us while we got our tax equity sorted out."* Similarly, a media outlet reported, *"a very significant number of solar systems are installed on customer rooftops but are not yet energized because Consumer Solar does not have the funding."*[iii] Looking back, Consumer Solar executives described their failure to build a more competent finance team as their *"biggest fundamental error"* and the mistake that *"almost killed us."*

Why did the resource redeployment from sales to finance fail to create value? First, Consumer Solar's finance product was late. Since Consumer Solar executives expected finance to be a *"temporary arbitrage,"* they initially assumed that the finance component would be unimportant, and that they would be able to choose from many potential finance partners in a commoditized component. While this eventually happened, the timing was several years later than Consumer Solar expected. This limited Consumer Solar's growth in its sales business because the firm lacked a competitive finance product for its potential customers for several years as the ecosystem took off. When Consumer Solar partnered with the few viable finance firms, their extractive terms limited value capture by Consumer Solar in its sales business.

Second, Consumer Solar introduced a weak finance product. Executives assumed that redeploying existing sales resources (rather than investing in new finance resources) would be sufficient. But consumer finance was more difficult than they expected, and its resource requirements were quite different from sales, a point which they ironically understood but ignored. As one executive observed, *"We've never believed you build a brand and a customer relation business that is also fundamentally a financial operation. Those two things are different."* So while redeployment allowed Consumer Solar to avoid many costs associated with developing finance resources, it also led to a weak finance component - one that had delays in raising investment funds, a high cost of capital due to skepticism in the financial community, and problems in managing its securitized leases and funds. These problems put Consumer Solar well-behind its rivals in the sales component. By the time, Consumer Solar developed a competitive finance product, the finance component no longer had attractive returns because it had commoditized (as Consumer Solar predicted) and the bottleneck had shifted from finance.

In 2014, Consumer Solar exited the finance component. As one executive stated, *"As soon as we could, we started to diversify away from running our own tax equity fund."* There were now many companies in the finance component which enabled Consumer Solar to pick among many potential partners and gain attractive terms. Moreover, unlike Consumer Solar, these partners had heavily invested in the finance, accounting, and legal resources necessary to operate effectively in the finance component. Consumer Solar's finance resources, including the staff associated with its tax equity fund management, were redeployed back into the company into various roles, and the company exited the finance component in 2014.

Consumer Solar's participation in the installation and finance components provides an intriguing comparison. Resource redeployment created value for Consumer Solar and the focal solar component in the former, but not the latter, for several reasons. First, although the installation component was not attractive in and of itself, it offered strong inducements that are unique and relevant in ecosystems – i.e., the opportunity to co-innovate and acquire knowledge that could improve the capabilities of the focal sales component. The firm gained hands-on installation knowledge that proved essential to improving the quality of the sales and design product. When installation resources redeployed back to sales, the firm benefitted from employees' acquired knowledge about installation that further improved the sales component (creating component-level value) and the interface between the two components, (creating value at the ecosystem-level). In contrast, while there was also high consumption interdependence between finance and sales (i.e., customers wanted viable finance, sales and installation components), there were no clear opportunities to co-innovate with finance or to acquire knowledge from finance to benefit the sales component and vice versa. Overall, resource relatedness was much higher between sales and installation than between sales and finance. This created readjustment costs in finance that were overwhelming and precluded the effective use of redeployment.

Second, Consumer Solar's executives initially entered installation with better resources, including external resources, than they did for finance. For example, one executive described two early installation hires as, *"the experts, if experts even existed."* Part of the rationale for investing in additional high-quality resources was that they correctly understood that resources developed to compete in installation could be effectively redeployed into sales. In contrast, since Consumer Solar's executives under-valued finance and miscalculated its difficulty, they acquired few external resources. Instead, they relied mostly on redeployed sales resources that were not up to the task. So while the finance component itself was highly attractive (i.e., highest returns, strategic bottleneck), opportunities for co-innovation and knowledge acquisition that would improve component capabilities were too limited for resource redeployment to succeed.

Consumer Solar's 2014 re-entry into installation

From 2009 to 2014, Consumer Solar worked with installation partners to put the systems that it designed and sold on rooftops. This allowed Consumer Solar to focus on sales. However, as the industry evolved with dramatically declining PV panel prices and sales costs, installation became the bottleneck in 2014. Consumer Solar's integrated rivals who competed in installation were quick to innovate and drive down their installation costs. In contrast, Consumer Solar's fragmented and small, local installer partners lacked the resources to do the same. As one Consumer Solar executive lamented, *"We're getting beaten on install efficiency."* Because of its own ongoing resource constraints, however, Consumer Solar could not abandon its installation partners and perform its own installation, particularly since it now operated at a national scale. As one executive stated, *"You don't get to millions of units owning your own trucks and ladders."*

To address the installation bottleneck, Consumer Solar embarked on an "improving strategy" (Hannah and Eisenhardt, 2016) to upgrade the capabilities of its installation partners. Specifically, it redeployed some existing sales and design resources (e.g., operations and supply chain managers, procurement facilities) into the installation component. The firm used these resources to create two installation *"learning centers"* where it experimented to develop new equipment and novel installation processes, which it made available to its installation partners. These installation experiments allowed Consumer Solar to upgrade its installation partners' capabilities. An unexpected benefit was co-innovation: Consumer Solar improved its solar system designs to have better installation efficiency. As one executive described the interdependence, *"Can we trim 1 or 2% off that really complicated array, or just not put the extra array on the north side of the roof? These are things we've got to think through (in our design process)."*

How did the redeployment of sales resources into installation improve the solar component and create value? As in all ecosystems, lack of performance in a complementary component limits performance in the focal component. By redeploying resource *back* into installation, Consumer Solar created value by 1) improving the capabilities of its installer partners and 2) unexpectedly co-innovating to improve its own design product vis a vis greater installation efficiency of its solar system designs. Moreover, this successful redeployment was enabled by the high "production-side" resource relatedness that lowered readjustment costs. Both sales and installation require extensive knowledge of the underlying solar technology and systems design which create high production-side resource relatedness such that people, intellectual property and other resources were easily redeployable across these components.

Consumer Solar's entry and exit into state markets

During our study, the attractiveness of the US residential solar industry varied widely by state. For example, in 2007 California accounted for nearly 70% of new residential installations, but fell to 30% by 2010 as other states adopted incentives to promote solar system usage. By 2010, New Jersey, New York, Pennsylvania, and Massachusetts ranked among the top states. But while the industry grew rapidly at a national level (e.g., 76% in 2011, 60% in 2013), the state markets varied widely. For example, New Jersey implemented a renewable energy credit trading program in which subsidies fluctuated. High subsidies attracted entrants, but then prices crashed such that many entrants failed. In other states, uncertainty was driven by lack of clarity regarding what the incentive policies would actually be. For example, an anticipated incentive program in Texas prompted several solar firms to invest heavily in installation resources (i.e., crews and distribution infrastructure) in the state, only to divest these resources when the state legislature did not approve the program.

Consumer Solar entered and exited these state markets according to their varying attractiveness. The company initially operated in three Western states that offered plentiful sunshine and favourable policy incentives (i.e., California, Colorado, and Arizona). In 2011, the company then entered five Northeastern states when new incentive programs made these states attractive. Consumer Solar did so by redeploying sales staff from a California call center (non-scale-free resource)and sharing sales software with each state (scale-free resource). This redeployment and related use of synergy allowed Consumer Solar to scale rapidly while minimizing its investment in state-specific resources such as permitting expertise, installation crews, and supply chain infrastructure whose deployment would be difficult to reverse. Rather, it obtained these less reversible resources from its installation partners.

Consumer Solar also exited state markets and redeployed their resources rapidly when they became unfavourable. For example, when the incentive program in Colorado ended in 2011 due to lobbying by the state's largest utility, Xcel Energy, Consumer Solar redeployed its Colorado resources to more attractive states. The company laid off one employee, whose job had been to oversee the company's ten installation partners in Colorado. The remainder of the Colorado resources —sales, business development, and marketing teams—were not state-specific, and thus redeployed to other states at very little cost.[iv] As one executive described,

> *"You know, when Colorado's subsidy runs out, we just shifted our marketing dollars to Southern California and that's the end of that. But if you buy distribution centers and trucks and 40 W-2 employees, it gets to be a much more complicated world to live in."*

In contrast, its rivals who also competed in the installation component (with its more irreversible resources) were more damaged by Colorado's decline. An executive at one such rival lamented, *"This (competing in Colorado) is an existential struggle."* A Consumer Solar executive explained, their rivals who also competed in installation had *"bought and hired hundreds of people, and were now facing closure, layoffs, and all that and the black eye, lost morale and discontinuity."*

How did the redeployment of resources across state markets create corporate value? Much like value creation in multi-business firms, Consumer Solar created value by continually redeploying its resources into the most attractive state markets over time – markets that lacked high consumption-side interdependence. Further, Consumer Solar's redeployment was effective because its resources such as sales and marketing staff were largely redeployable across states at low cost – e.g., production-side resource relatedness existed. At the same time, it relied on installation partners – often local home improvement contractors – to provide the state-specific (and thus less reversible) resources. This ensured that Consumer Solar's own resources could be readily redeployed, a feature that is particularly useful when uncertainty is high (Sakhartov and Folta, 2014). In other words, the company benefited from lower adjustment costs driven by resource relatedness (Helfat and Eisenhardt, 2004). An executive confirmed this insight: *"We felt that our business model was more appropriate for the lumpy, on again, off again, nature of the market as it grew."*

DISCUSSION

This paper contributes to the resource redeployment and ecosystems literatures. Prior research examines *resource redeployment* in multi-business firms (e.g. Chandler, 1963; Galunic and Eisenhardt, 2001; Helfat and Eisenhardt, 2004; Karim, 2006), but has yet to explore redeployment in ecosystem firms. Similarly, prior research on *ecosystems* addresses how firms collaborate and compete in ecosystems, settings characterized by consumption-side interdependence among multiple components (e.g., Ozcan and Eisenhardt, 2009; Adner, 2012; Kapoor and Furr, 2014; Hannah and Eisenhardt, 2015), but has yet to clarify how resource redeployment plays a strategic role in such settings.

To address these gaps, we conducted an in-depth case study of Consumer Solar, a firm in the US residential solar ecosystem. We make several contributions. First, we add insights into the strategic differences that motivate redeployment (i.e., inducements) in multi-business v. ecosystem firms. Second, we introduce the concept of "*consumption-side*" interdependence that drives these differences across settings, and distinguish it from "returns" interdependence and "production-side" resource relatedness. Third, we sharpen the conditions under which resource redeployment is likely and effective: market evolution and uncertainty, firm constraints, and resource relatedness (Table 2).

[Insert Table 2 about here]

Value creation through resource redeployment

Resource redeployment is undertaken to increase returns in uncertain and evolving markets. In these situations, redeployment attempts to allocate resources to their "most attractive use" (Sakhartov and Folta, 2014: 1793). In *multi-business firms*, redeploying resources is motivated by comparison of the current and future returns of distinct markets. The canonical situation is redeploying resources by exiting maturing businesses and entering new ones: ones where current returns are higher, future returns are more volatile, and returns are negatively correlated (Sarkhatov and Folta, 2015). The key point is that the inducement to redeploy resources rests on maximizing returns by *comparing returns across markets* (Helfat and Eisenhardt, 2004; Karim, 2006).

Consumer Solar's redeployment between geographic markets reflects this multi-business logic. For example, when the Colorado tax incentives expired, returns were projected to wane. This prompted Consumer Solar to exit and redeploy its Colorado resources to more attractive states. Redeployment was facilitated by Consumer Solar's management such that its "portfolio" of states could be readily re-arranged and its resources re-deployed to match evolving markets and changing returns. The states possessed "production-side" related resources that were easily redeployed, but had little (if any) consumption-side interdependence. Indeed, this Consumer Solar's portfolio of geographic businesses resembled the business portfolio of Omni, a key exemplar in the original statement of inter-temporal economies of scope in multi-business firms (Helfat and Eisenhardt, 2004).

In contrast, since ecosystem components have high consumption-side interdependence, returns in a given component depend on capabilities in that component *and* in the other ecosystem components. Failure in one component affects all components. Thus, in *ecosystem firms*, effective redeployment considers both the focal component and the entire ecosystem (Ozcan and

Eisenhardt, 2009) or as Adner (2012) terms the "wide lens". Redeployment attractiveness rests *on improving the capabilities in the focal component* (either directly or through effects on complementary components) to improve returns, not just on comparison of returns in the focal v. new market. This introduces two additional mechanisms that provide strong inducements for redeployment in ecosystems: capability improvement and bottleneck relief.

Capability improvement: Since consumers use a solution that combines ecosystem components*, capability improvement* in components can increase value creation in the ecosystem and enhance the performance of the focal component. It can, for example, be beneficial for a firm to redeploy resources into complementary components in order to improve them – i.e.., to learn about both the capabilities in that component and how that component interacts with the component of the focal firm. Successful product design and execution in one component is enhanced by capabilities knowledge acquired about other components (Hannah and Eisenhardt, 2015; Adner and Kapoor, 2010). Moreover, the human capital associated with these improved capabilities is likely to be under-priced in the market (relative to the value the focal firm receives).

For example, Consumer Solar's capabilities to produce products in sales and design depended on its understanding of other components such as underlying panel and racking technologies as well as installation. The firm improved its novel sales and design technology by temporarily participating in the installation component in 2007-2008. When Consumer Solar then redeployed installation resources back to sales in 2009, it again improved its sales and design capabilities via knowledge acquired about how to choose better installers and to integrate the two components better to achieve higher quality and superior customer experience. So although installation was itself a fragmented and low-margin business, participation in installation and redeployment of installation resources into sales improved Consumer Solar's capabilities and ultimately performance in its focal sales and design business.

Bottleneck relief: Given the interdependence of ecosystems, bottlenecks often emerge due to poor quality, lagging innovation, and insufficient capacity (Jacobides, Knudsen, and Augier 2006; Jacobides and Tae, 2015). Bottlenecks limit the performance of both the entire ecosystem and individual components (Hannah and Eisenhardt, 2015). Therefore, it can be advantageous to *relieve bottlenecks*, even if participation in the bottleneck component is not attractive in the long run. For example, Consumer Solar redeployed resources to mitigate bottlenecks twice: first by entering finance in 2010, and again when it re-entered installation in 2014. In both cases, the underlying logic was to enter the bottleneck in order to mitigate them and increase the returns to the sales and design component. Both moves were effective from a value creation perspective although the former failed due to low resource relatedness between finance and sales. Finally, given that firms in bottleneck components can become "kingpins" in the ecosystem and capture disproportionate value (Jacobides and Tae, 2015; Hannah and Eisenhardt, 2015), redeployment into bottlenecks can lead to superior performance if the firm can become a "kingpin". In these situations, the comparative returns logic of multi-business firms holds – i.e., the bottleneck component per se is more attractive (higher returns) than the current market.

In summary, redeployment can create value in ecosystem firms in three ways: (1) achieve superior returns through entry into a more attractive component (i.e., traditional multi-business logic, (2) improve capabilities in complementary or focal components to increase the returns of the focal component (ecosystems logic), and (3) relieve bottlenecks to increase the returns of the focal component (ecosystems logic).

Key conditions: Uncertain and evolving markets, related resources and resource constraints

We also contribute insights into the conditions that favour redeployment in ecosystems. We consider the nature of the market, relevance of firm-level resource constraints, and relatedness of resources across markets. First, in both multi-business and ecosystem firms, redeployment is likely to occur when markets are evolving and uncertainty is high. However, these market conditions play out differently in the two settings. In the case of multi-business firms, redeployment is particularly likely in multi-business firms when they participate in markets at varying stages of maturity. This creates greater disparity in the returns across markets, motivating redeployment. The canonical case of the related diversifier is an exemplar of such firms (Helfat and Eisenhardt, 2004).

In contrast, *evolution and uncertainty* across ecosystem components is often driven by differential rates of technological and regulatory change. These changes create disparities in the capabilities across components or to the emergence of bottlenecks, leading to greater use of resource redeployment to ensure that the focal component and its partners are successfully offering viable components that comprise the complete ecosystem. For example, Consumer Solar faced regulatory change with the 2005 tax law enactment that created the opportunity to relieve the consumer finance bottleneck via resource redeployment. Later, technological improvements that dramatically lowered costs in sales and PV panels created the opportunity to redeploy resources to the lagging installation component to improve the capabilities of its installer-partners, creating greater value for Consumer Solar.

Second, firms with *resource constraints* are more likely to engage in resource redeployment because they are less able to acquire or build resources from scratch. For example, like many entrepreneurial firms, Consumer Solar was resource constrained throughout our study. Entrepreneurial firms generally operate under substantial resource constraints (Chatterji, 2009; Katila, Rosenberger, and Eisenhardt, 2008) and their performance often significantly depends on effectively using their limited resources. This makes redeployment particularly salient for them and for resource-constrained firms more broadly. Moreover, archival sources indicate that Consumer Solar deliberately chose to be resource-constrained. Executives implemented a *"capital* *light business model"*, and raised only $2.5M in venture capital during their first two years, compared to the $10M raised by their closest competitor. Thus, constrained resources made resource redeployment a critical part of the Consumer Solar strategy.

Finally, ecosystem firms with *related resources* vis a vis other components are more likely to use redeployment and to be effective in doing so. Here, the readjustment costs of re-purposing resources from one use to another are germane (Helfat and Eisenhardt, 2004). These costs typically turn on the underlying production-side relatedness of the resources (Sakhartov and Folta, 2014). Specifically, when resources are related across uses, they have lower readjustment costs and greater reversibility between uses. The importance of resource relatedness for creating value through redeployment holds true for both multi-business and ecosystem firms (although ecosystems may have varied relatedness since component firms are often from diverse industries). That is, resource-relatedness influences the value creation of redeployment and thus returns in both ecosystem and non-ecosystem settings by reducing adjustment costs and the related specificity of required investments (Sakhartov and Folta, 2014). So even when there is a strong inducement to redeploy resources to improve returns, high readjustment costs can preclude redeployment and instead favor another alternative for obtaining resources such as acquisition or building from scratch.

For example, Consumer Solar's resource redeployment into the finance component primarily failed because of high readjustment costs driven by the unrelated resources needs in finance v. sales. So while there was substantial inducement to relieve the bottleneck in finance, unrelated resources made readjustment costs too high. In contrast, resource relatedness between the installation and sales components facilitated successful redeployment across these two components in support of the performance in focal sales and design business.

CONCLUSION

Resource redeployment is a key corporate strategy for creating value by continually reallocating resources to their most productive uses (Helfat and Eisenhardt, 2004; Sakhartov and Folta, 2014). Prior work examines redeployment in the context of multi-business firms. We contribute by identifying how ecosystem firms can also corporate create value through redeployment. Through our study of Consumer Solar and the US residential ecosystem, we argue that the inducements that underlie resource redeployment across ecosystem components differ from those of multi-business firms. Comparison of returns across markets drives redeployment in multi-business firms. In contrast, both comparison of returns and increases in returns to the focal market from redeployment to and from complementary markets can drive redeployment. Furthermore, the likelihood of resource redeployment depends on market evolution and uncertainty as well as firm-levelresource constraints. Its effectiveness depends on related resources. Overall, despite sometimes weak resource relatedness and positively correlated returns, ecosystems are a key setting for resource redeployment as an effective corporate strategy.

REFERENCES

Adner, R. (2012). The Wide Lens: A New Strategy for Innovation. Portfolio/Penguin, New York.

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

Anand, J. (2004). Redeployment of corporate resources: a study of acquisition strategies in the US defense industries, 1978–1996. *Managerial and Decision Economics*, *25*(6-7), 383-400.

Anand, J., & Singh, H. (1997). Asset redeployment, acquisitions and corporate strategy in declining industries. *Strategic Management Journal*, *18*(S1), 99-118.

Baldwin, C. Y. (2010). When open architecture beats closed: The entrepreneurial use of architectural knowledge. Harvard Business School Finance Working Paper, (10-063).

Bremner, R. P., Eisenhardt, K.M. & Hannah, D.P. (2016, forthcoming). Business ecosystems. In Collaborative Strategy: A Guide to Strategic Alliances (L. Mesauita, J. J. Reuer, and R. Ragozzino, Eds.), Edward Elgar Publishing.

Bryce, D. J., & Winter, S. G. (2009). A general interindustry relatedness index. *Management Science*, *55*(9), 1570-1585.

Chandler, A. D. (1962). Strategy and structure: Chapters in the history of the American enterprise. Massachusetts Institute of Technology Press, Cambridge, MA.

Chatterji, A. K. (2009). Spawned with a silver spoon? Entrepreneurial performance and innovation in the medical device industry. *Strategic Management Journal*, *30*(2), 185-206.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of management review*, *14*(4), 532-550.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. *Academy of management journal,* 50(1), 25-32.

Eisenhardt, K. M., & Brown, S. L. (1999). Patching. Restitching business portfolios in dynamic markets. *Harvard business review*, *77*(3), 72-82.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic management journal*, *21*(1), 1105-1121.

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

Hannah, D.P. and Eisenhardt, K.M. (2015). Origins and outcomes of firm strategy in nascent ecosystems. *Working paper.*

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

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

Galunic, D. C., & Eisenhardt, K. M. (1996). The evolution of intracorporate domains: Divisional charter losses in high-technology multidivisional corporations. *Organization Science,* 7(3), 255-282.

Galunic, D. C., & Eisenhardt, K. M. (2001). Architectural innovation and modular corporate forms. *Academy of Management Journal*, *44*(6), 1229-1249.

Helfat, C. E., & Eisenhardt, K. M. (2004). Inter-temporal economies of scope, organizational modularity, and the dynamics of diversification. *Strategic Management Journal*, *25*(13), 1217-1232.

Helfat, C. E., & Peteraf, M. A. (2003). The dynamic resource-based view: Capability lifecycles. *Strategic management journal*, *24*(10), 997-1010.

Huber, G. P. (1985). Temporal stability and response-order biases in participant descriptions of organizational decisions. *Academy of Management Journal*, *28*(4), 943-950.

Huber, G. P., & Power, D. J. (1985). Retrospective reports of strategic-level managers: Guidelines for increasing their accuracy. *Strategic Management Journal*, *6*(2), 171-180.

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

Jacobides, M. G. (2008). How capability differences, transaction costs, and learning curves interact to shape vertical scope. *Organization Science*, *19*(2), 306-326.

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

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

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

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

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

Karim, S. (2006). Modularity in organizational structure: the reconfiguration of internally developed and acquired business units. *Strategic Management Journal*, *27*(9), 799-823.

Karim, S. (2009). Business unit reorganization and innovation in new product markets. *Management Science*, *55*(7), 1237-1254.

Karim, S., Carroll, T., Long, C., (2015). Delays on the road to prosperity: How firms realign through structural recombination when faced with turbulence. *Academy of Management Journal* (forthcoming).

Karim, S., & Kaul, A. (2014). Structural recombination and innovation: unlocking intraorganizational knowledge synergy through structural change. *Organization Science*.

Katila, R., Rosenberger, J. D., & Eisenhardt, K. M. (2008). Swimming with sharks: Technology ventures, defense mechanisms and corporate relationships. *Administrative Science Quarterly*, *53*(2), 295-332.

Kaul, A. (2012). Technology and corporate scope: Firm and rival innovation as antecedents of corporate transactions. *Strategic Management Journal*, *33*(4), 347-367.

Kogut, B., & Kulatilaka, N. (1994). Operating flexibility, global manufacturing, and the option value of a multinational network. Management science, 40(1), 123-139.

Kumar, N., Stern, L. W., & Anderson, J. C. (1993). Conducting interorganizational research using key informants. *Academy of management journal*, *36*(6), 1633-1651.

Levinthal, D. A., & Wu, B. (2010). Opportunity costs and non-scale free capabilities: profit maximization, corporate scope, and profit margins. *Strategic Management Journal*, *31*(7), 780-801.

Martin, J.A., & Eisenhardt, K.M. (2010). Rewiring: Cross-business-unit collaborations in multibusiness organizations. *Academy of Management Journal,* 53(2), 265-301.

Moore, J. F. (1993). Predators and prey: a new ecology of competition. *Harvard business review*, *71*(3), 75-83.

Panzar, J. C., & Willig, R. D. (1981). Economies of scope. *The American Economic Review*, 268-272.

Penrose, E. T. (1959). *The Theory of the Growth of the Firm*. Wiley.

Rumelt, R. P. (1974). *Strategy, structure, and economic performance*. Harvard University Press.

Sakhartov, A. V., & Folta, T. B. (2014). Resource relatedness, redeployability, and firm value. Strategic management journal, 35(12), 1781-1797.

Sakhartov, A. V., & Folta, T. B. (2015). Getting beyond relatedness as a driver of corporate value. *Strategic Management Journal,* 36, 1939-1959.

Silverman, B. S. (1999). Technological resources and the direction of corporate diversification: Toward an integration of the resource-based view and transaction cost economics. *Management Science*, 45(8), 1109-1124.

Smith, K., W. Ferrier, and H. Ndofor (2001). Competitive dynamics research: Critique and future directions. Handbook of Strategic Management: 315-361.

Vidal, E., & Mitchell, W. (2015). Adding by Subtracting: The Relationship between Performance Feedback and Resource Reconfiguration through Divestitures. *Organization Science*.

Wu, B. (2013). Opportunity costs, industry dynamics, and corporate diversification: Evidence from the cardiovascular medical device industry, 1976–2004. *Strategic Management Journal*, *34*(11), 1265-1287.

Figure 1. Residential Solar Photovoltaic (PV) Ecosystem

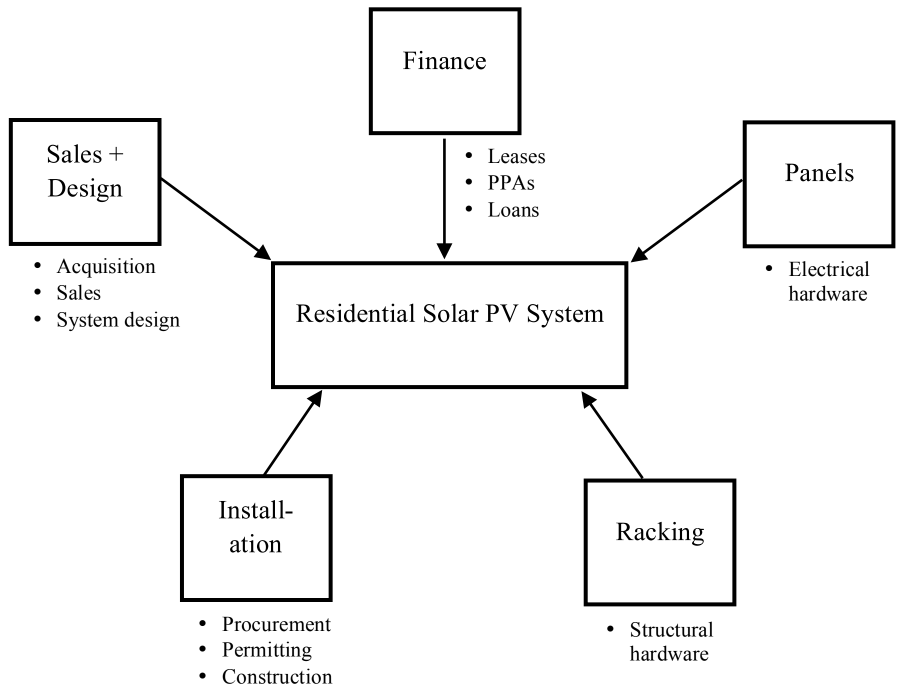

Table 1. Consumer Solar resource redeployment initiatives

Table 1. Consumer Solar Resource Redeployment Initiatives

Redeployment Initiative	Logic Type	Resources	From / To	Rationale	Outcome	Representative Quotes
2009 Installation exit	Ecosystem	Installation crew managers	Installation / Sales and Design	Improve component	Success	*"You don't get to millions of units of household installation owning your own trucks and ladders"*
2010 Finance entry	Ecosystem	Founding partner, finance and sales associates	Sales and Design / Finance	Bottleneck relief	Failure	*"We've built funds when we needed funds because no one would give us tax equity without our own financial operation." "We've never believed you build a brand and a customer relation business that is also fundamentally a financial operation. Those two things are different."*
2014 Installation re-entry	Ecosystem	Supply chain facilities and personnel, operations managers	Sales / Installation	Bottleneck relief	Success	*"We drifted too far from the execution, so we now have our own installers, one on each coast that are basically learning labs."*
2011 entry into various state markets, 2011 Colorado exit	Multi-business	Sales, marketing and design teams	Multiple states / Multiple states	Maximize returns	Success	*"When Colorado's subsidy runs out, we just shift our marketing resources to Southern California and that's the end of that. If you then buy distribution centers and trucks and 40 W-2 employees, it gets a much more complicated world to live in."*

Table 2. How and when resource redeployment creates value

Table 2. How and When Resource Redeployment Creates Value		
	Ecosystem Firms	**Multi-business Firms** (product or geographic markets)
Mechanisms *(How is value created?)*	*Capability improvement* - Firms allocate resources to improve weak capabilities in focal or complementary components, thereby increase focal component returns *Bottleneck relief* - Firms allocate resources to relieve bottlenecks, thereby increase focal component returns	*Maximize returns* - Firms allocate resources from lower return markets to higher return markets
Conditions *(When is redeployment most likely?)*	*High disparity in component capabilities in evolving and uncertain markets drives redeployment* *High rate of technological or regulatory change* - Increases frequency w/which component quality is out of synch, lowering focal component returns - Increases frequency w/which bottleneck components emerge, lowering focal component returns *High resource constraints*	*High disparity in market returns across evolving and uncertain markets drives redeployment* *High current return advantage* - Increases marginal return gained by redeployment into new market *High return volatility* - Increases likelihood of better returns in new market *Low return correlation* - Increases likelihood of divergent returns between markets (return advantage in new market) *High resource constraints*
Conditions *(When is redeployment most effective?)*	*High resource relatedness* - Reduces readjustment cost of redeployment because of high resource similarity - Due to diverse industries, resource relatedness is often varied across ecosystem components *High interdependence* - Amplifies the positive effects of capability improvement and bottleneck relief on focal component returns	*High resource relatedness* - Reduces readjustment cost of redeployment because of high resource similarity - Due to similar industries (related diversifiers), resource relatedness is often high across businesses

[i] We appreciate Gautam Ahuja's insightful suggestions for sharpening this concept.
[ii] We appreciate Harbir Singh's helpful insight on the market failure associated with mis-priced human capital.
[iii] Delays in part occurred because the financial institutions that purchased the funds typically issued one tranche per time period, so that a customer might have to wait for their installed system to be operational. Having multiple open tax equity funds minimized this issue.

[iv] This experience repeated in other states as well. When Arizona incentives were similarly removed, one executive remarked, *"Arizona incentives went away, and we basically do nothing there. If we had lots of employees, it would have been very painful."*