

Personal Statement

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How can large technology-based firms with significant resources stay innovative? This is the question that drives my research at the intersection of the fields of technology, innovation, and strategy. To answer the question, I focus on strategies that enable organizations to continue to discover, develop and commercialize technologies. Overall, my concern is with high-impact problems in innovation and technology strategy that technology-based firms face. My approach is to combine theory with longitudinal large-sample data, background fieldwork, and state-of-the-art quantitative methods. The ultimate objective is to understand what makes technology-based firms successful.

Because of my engineering background, I bring a distinctive understanding of technology to address these organizational issues. The School of Engineering and the Department of Management Science & Engineering are an ideal setting for this research. I have ready access to information about emerging technologies such as robotics and medical devices, as well as to students and faculty who are interested in similar topics. My expertise in large-scale quantitative analysis also complements the MS&E's existing research strengths of qualitative methodologies and modeling. As an engineer, I can also influence strategy research by approaching the study of technology-based firms in unique ways that strategy scholars traditionally cannot (e.g., by introducing more precise measures of technology).

Research Overview

My work focuses on established (large, resource-rich) firms, which often innovate too little and too late, despite substantial investments in R&D. The goal is to understand *how established technology-based firms can become successful at innovation*. To answer this question, I conduct two interrelated streams of research. I study (1) strategies that help firms leverage their existing resources (*leverage stream*), and (2) strategies through which firms can acquire new resources (*acquisition stream*) to create innovation. My contributions, discussed in detail below, redefine the role of existing resources and show their value for innovation, especially in the context of competition. They also identify how the success of resource acquisition depends on other firms, such as acquisition targets and alliance partners.

Research Stream 1: Leveraging Existing Resources

An intriguing paradox of innovation is that *established firms often own the technical resources necessary for innovation but do not fully use them*. My work uses evolutionary theory to explore how firms can leverage their existing resources better; it thus contradicts the long-held belief that innovation depends solely on new resources. In particular, I focus on three issues: innovation strategies that combine new and existing resources (Katila and Ahuja, 2002; Ahuja and Katila, 2004), the unexpected potential of existing resources relative to new ones (Katila, 2002; Katila and Shane, 2005; Katila and Chen, 2008), and industry environments in which it is most advantageous to use existing resources as a source of innovation (Chen, Katila et al., 2010; Katila et al., 2012; Li et al., 2013).

Resource combinations

- “Something Old, Something New” (*Academy of Management Journal*, 2002) changed thinking about the role of existing resources in the innovation process. In particular, the study showed that firms that introduce the most new products do so by leveraging *a combination of existing and new technology resources*, not by relying solely on new resources. This finding was influential because research had focused on the dysfunctions (such as inertia), but not the benefits, of existing resources.

The study employed 12 years of longitudinal data on 124 robotics firms in U.S., Europe and Japan. The method was novel: I combined measures of technological resources (patents) with success-based measures of commercialization (products), thus tracking an innovation from its invention to its introduction in the market. Longitudinal studies usually focus on one or the other, but do not link the two. This study has significantly influenced subsequent work and is highly cited.

Other scholars (e.g., He and Wong, 2004; Laursen and Salter, 2006; Wu and Shanley, 2009; Schilling and Green, 2011; Lee and Huang, 2012) have adopted and extended my patent-based measures of search depth (to measure existing resources) and search scope (to measure new resources). I first developed these methods in my doctoral dissertation and made them available as a software package on my website. My dissertation from which this paper draws, won *two Best Dissertation Awards*, one from INFORMS and the other from the Technology and Innovation Division of the Academy.

- “Where Do Resources Come From?” (*Strategic Management Journal*, 2004) further examined how firms uncover new resources to combine with the existing ones. This study discovered that new types of product users, especially in new national markets, and their unique needs and constraints help firms develop new technology. One of the key implications of these results is to locate *research laboratories close to users* (especially in international markets) in order to learn from them.

The analysis employed a sample of chemicals firms over the period of 1979-1992. This paper appeared in the *Strategic Management Journal's* special issue on the “Global Acquisition, Leverage and Protection of Technological Competences,” for which ten papers were selected from 119 submissions.

Unexpected potential of existing resources

- “Past Ideas in Their Prime” (*Academy of Management Journal*, 2002) and “Lack of Resources” (*Academy of Management Journal*, 2005) demonstrated that the *role of a firm's internal resources was richer than previously thought*. By comparing technology from different sources, I showed that firms often failed to grasp the value of technologies developed within their own ranks. Whereas ideas of rivals depreciated quickly (1-2 years), and ideas from outside the firm's industry gained value slowly (10-12 years), a firm's existing resources could be redeployed in a short time for a variety of uses. Concrete examples include knowledge sharing across departments, licensing, and maintaining shelved technologies while rewarding reactivation.

As in “Something Old,” “Past Ideas” made use of combined longitudinal data on robotics firms. “Lack of Resources,” in turn, tracked commercialization in 340 firms that selected technologically comparable inventions from the same pool (1,397 MIT inventions). Thus, these firms shared technology, but had different industry environments, existing resources, and success. A combination of several industries (medical, communications, chemicals, electronics, and machinery) and several time periods (1980-1996) made the findings particularly generalizable. To initiate a community of researchers studying similar issues, I organized a symposium on Innovation Search at the Academy of Management Meetings. This symposium won the OMT Division's *Best Symposium Award*.

- “The Value of Not Being in Sync” (*Administrative Science Quarterly*, 2008) was based on a simple yet powerful insight: Established firms do not innovate in isolation but in a dynamic interaction with their competitors. In particular, the main finding was that innovators of blockbuster products timed *resource leverage so that they were out of sync* (rather than in lock step) *with their competitors*. The insight was that it is not always necessary to push the technology frontier, as prior work often implicitly assumes, but rather that it can pay to use existing resources to differentiate from rivals.

The research sample of 124 robotics firms extended my original dataset to a longer time period (15-years of longitudinal data) and new variables (such as novel measures of blockbuster products using design characteristics of products). This paper appeared as a *lead article* in the *Administrative Science Quarterly*. It also received Academy's *Entrepreneurship IDEA Award* in 2009 given to 3 top papers published in any organizations area journal in a year. Together, these studies contributed to my receiving the *Emerging Scholar Award* for outstanding research and scholarship from the Strategic Management Society. This international award recognizes a Top Strategy Scholar under 40.

Environment as a boundary condition

- “Life in the Fast Lane” (*Strategic Management Journal*, 2010) examined an overlooked but important *boundary condition on resource leverage*, i.e., environments. This study had an impact because it showed that the motivation to leverage resources depends on the type of industry environment, not just whether performance is high or low, as prior work had assumed. While my previous studies

showed how existing resources can make established firms successful innovators, this study started to decipher the conditions that initiate such successful resource leverage.

The research design was an experiential simulation with 480 participants (spanning years 1999 to 2006) combined with in-depth fieldwork. A comparison of several types of firms (new vs established) and environments (stable vs dynamic) made the results particularly robust. The study appeared in the competitive *Strategic Management Journal's* special issue on “The Age of Temporary Advantage.” The study has become cited by both strategy textbooks and scholarly articles in a short period of time.

- “All the Right Moves” (*Strategic Entrepreneurship Journal*, 2012) continued the research stream on boundary conditions for resource leverage. The study provides one of the few empirical demonstrations of how established firms can be attacked by entrepreneurs’ careful positioning of technology towards price-sensitive customer groups. Research insight was that high-performing strategies are different in different markets and under different competitive conditions.
As in “Life in the Fast Lane”, the sample was 480 simulation participants and their decisions. Similar to experiments, the participants were randomly assigned to executive teams. Random assignment is significant because it alleviates selection bias that influenced inferences about high-performing strategies in the past. It thus makes the study potentially influential for future work.
- “Top Management Attention to Innovation” (*Academy of Management Journal*, 2013) and “Complex Search Process” (*Research Policy*, 2013) took an in-depth look at how, and from what sources, individuals assemble technology resources. This more fine-grained analysis was important because it enabled analysis of *individuals’ ability (and biases) to focus attention on new vs existing resources*. The research sample in in these studies was top executives in 61 publicly traded technology firms, and first-person accounts of 10 inventors, respectively.
- Supported by the *National Science Foundation*, several studies are in progress to extend this stream. “Institutional Logics of Investors” (*Administrative Science Quarterly, R&R*) looks at investments in technology firms and effects on innovation using difference-in-differences analysis. In a second paper (in progress), I examine systematically how environmental complexity and velocity affect resource leverage using a combination of simulation and industry data. Because I am using the power of quantitative analysis and a combination of methodologies (i.e., applying engineering techniques to strategy research), the studies are also methodologically distinctive and, thus, potentially influential.

In sum, the results of the first stream of research challenge the common idea that new resources are the primary, if not the only, source of innovation. The key implication for engineers and executives in technology-based companies is to differentiate not only by exploring the new (i.e., finding the next new technology), but also by mastering the old.

Research Stream 2: Acquiring New Resources

This research stream focuses on how firms acquire technological resources for innovation. The central challenge facing scholars of innovation is to understand why efforts to acquire new technologies often fail; for example, *why more than half of all acquisitions and alliances are ineffective*. Prior research explained failure by studying the characteristics of the acquiring firm (e.g., firm’s experience). My contribution is to use resource dependence and evolutionary theory to show that success also depends on *anticipating other firms’ perspectives*. Thus, I focus on understanding parties that co-create the resources with established firms, such as acquisition targets (Ahuja and Katila, 2001), alliance partners (Katila and Mang, 2003; Katila, Rosenberger, and Eisenhardt, 2008), co-investors (Hallen, Katila, Rosenberger, 2014) and users (Katila et al., 2014).

Acquisition targets

- “Technological Acquisitions and Innovation” (*Strategic Management Journal*, 2001) is a highly cited study of resource acquisition through technology acquisitions. It was the first paper to show that *acquiring small firms with a technology moderately related to the acquirer’s technology is generally*

an effective strategy. Such acquisitions made the buyer more innovative because they were easier for the buyer to integrate while also creating innovation value.

The study tracked the performance of 1,287 acquisitions in the worldwide chemicals industry. The measures of technology that I developed to quantify the resource positions of both sellers and the buyers were an important contribution. The paper was a lead article in the *Strategic Management Journal* and was voted one of the top five papers in the Strategic Management Society's Best Paper Competition (the top 5 were selected from over 700 submissions).

Alliance partners

- "Timing of Collaborations" (*Research Policy*, 2003) examined another source for new resources: R&D collaboration with new firms. These relationships are challenging. Although established firms prefer to collaborate quickly to develop the best technology (and to participate in critical, early decisions about it), new firms with the most promising technologies are usually able to delay, and choose their partners. The main finding of the study was that new firms delay collaboration when they do not know their partner well. This suggests that established firms should *develop social, not only transactional, relationships with young firms* so that they can establish fruitful collaborations. The paper employed data from a longitudinal study of 86 product-development projects in the biotechnology industry. It received the *Best Paper Award* from the Technology and Innovation Management Division of the Academy of Management.
- "Swimming with Sharks" (*Administrative Science Quarterly*, 2008) focused on making investments in young firms as a way to acquire resources. Because cultivating social relationships with particular partners is not always an option (e.g., it may be too slow or unpredictable), many established firms make minority investments in young firms to acquire resources. Challenging the common assumption that such investments are akin to financial transactions, I discovered that success depended on understanding the partner's perspective (i.e., what the young firm was hoping to gain from the investment), and anticipating the defense mechanisms the young firms might use to avoid control (timing, trade secrets, multiple partners). The main finding was that *unique and reciprocal resource exchange* rather than one-sided investment was necessary to woo young firms with the best technology.

The study makes use of data on corporate investments in 701 new firms in five high-technology industries (medical, biotechnology, communications, electronics, and software) over a 25-year period. This multi-industry sample was combined with extensive fieldwork to create a comprehensive dataset. The paper started a new stream of studies on "swimming with sharks," and was invited to be reprinted in the *International Library of Entrepreneurship* (2010). It was also named as one of the most rapidly cited papers in the *ASQ's Editor's Choice Collection*.

- "We've Got Rhythm" (*Academy of Management Best Paper Proceedings*, 2012) brought a completely new unit of analysis to the study of resource acquisition: the rhythm of innovation. The key finding was that firms that could not keep a rhythm or those that mimicked the rhythm of rivals performed poorly. My use of sequence analysis to decipher time-paced rhythms of innovation in large-scale data was also a novel contribution to the field. The paper was selected as one of the best papers delivered in the Business and Policy & Strategy Division of the Academy of Management at the Academy's 2012 meeting. It is being revised for the *Strategic Management Journal*.

Co-investors and users

- "Unpacking Social Defenses" (*Academy of Management Journal*, 2014) examined the role that co-investors have in facilitating resource acquisitions by established firms. I found that resource exchange can be facilitated by *third-party chaperones* (such as central VCs) who may mitigate the loss of power often experienced by young firms that are investment targets. The network resources (ties to co-investors) of established firms thus enable acquisition of new resources.

As in "Swimming with Sharks," the research was based on longitudinal data from five industries over 25 years. I extended the original dataset to include granular measures of inventions and the

investment network. To initiate a community of researchers studying similar issues, I initiated a multi-year workshop on Entrepreneurial Investments at the Academy of Management Meetings.

- In current work, supported by the *Alfred P. Sloan Industry Studies Fellowship*, I am extending my work on resource acquisition into the medical device sector. Supported by this fellowship, my students and I are writing a paper “Doctor in the House” (2014) on how medical device firms can tap the expertise of executives and inventors to innovate better. The research sample is 268 surgical instrument firms over a 31-year period.

In sum, my second stream of research has significantly advanced understanding of how established firms can acquire resources. Key results emphasize the need for acquirers to take into account the perspective of other firms (targets, alliance partners, users) if they are to acquire resources effectively.

Summary of Contributions

Theoretically, my research contributes to a developing evolutionary perspective on how established technology firms can innovate more consistently and effectively. More specifically, I am recognized for extending the theory in two new directions. The first has been to uncover the potential of *existing resources* for innovation. The second has been the insight that successful resource acquisition requires understanding and anticipating the *perspective of other firms* - an insight that integrates two previously separate perspectives: resource dependence and evolutionary theory.

Methodologically, I have introduced several *new measures* that make studying complex innovation tractable. Other researchers have actively adopted my patent-based measures of “search depth,” “search scope” and technology relatedness. I have also introduced ways of using design characteristics to measure product innovativeness. Because I was trained as an engineer, I am able to employ a *unique combination of methods* (e.g., statistical large-sample data analysis, background fieldwork, and simulation) to conduct in-depth analyses of innovation. Finally, I have conducted research in *multiple high-technology industries*, including single-industry studies in industrial robotics, chemicals and biopharmaceuticals, and multi-industry studies in electronics, computer, telecommunications, and software. This combination of research settings enhances the generalizability of my results, and makes it possible to identify technology-specific patterns that would not be observable in a single setting.

Teaching Overview

Two objectives have guided my teaching: (1) to weave my current research into course design by bringing research results on innovation into the classroom, and (2) to design courses that include hands-on learning experiences, such as simulation, in-class exercises, and field projects, which help students apply research into the complexities of innovation in practice. I have applied these principles to teaching at the undergraduate, masters, and Ph.D. levels, including undergraduate courses on Innovation, Creativity, and Change (MS&E 175) and Senior Projects (MS&E 108), a masters-level core course in Strategy in Technology-Based Companies (MS&E 270), and a Ph.D. course in Innovation and Strategic Change (MS&E 371). Two of these courses, MS&E 175 and MS&E 371 had not been previously taught at Stanford. I received the *Eugene Grant Teaching Award* for undergraduate teaching in 2012. I have also served as a faculty director in executive education programs.

In addition to classroom, I believe strongly in involving students in research to expose them to the scientific process. Through the Summer Research College program and through independent studies, I have worked one-on-one with undergraduate students who are interested in conducting research on technology and strategy. I have also co-authored work with several Ph.D. students and have served as a mentor at various doctoral consortia sponsored by the Academy of Management. I served as the Chair (de facto chief executive officer) of the Academy’s Technology and Innovation Management Division in 2013-2014. I have found being involved in projects that foster and support the development of future

scholars of innovation and the strategy community to be rewarding, and I look forward to having similar opportunities in the future.