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RECONFIGURATION STRATEGIES, ENTREPRENEURIAL ENTRY AND INCUBATION OF NASCENT INDUSTRIES: THREE ESSAYS

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University of Maryland, 2013

This dissertation examines firms' entrepreneurial investments in anticipation of entry into a nascent industry. In the first essay, I study the intertwined processes of firm-level economic value capture and industry-level ecosystem formation that underpin incubation of nascent industries. The second essay focuses on the capability antecedents of a firm entry into a nascent industry and makes a distinction between a firm's pre-entry and pre-investment capabilities. In the third essay, I discuss the nature of the capability reconfiguration efforts that are undertaken by firms in anticipation of entry into nascent industries and their differential nature given firms' historical antecedents.

Category: Strategy, Entrepreneurship, Industry Evolution

Keywords: Entrepreneurial Entry, Nascent Industries, Capability Reconfiguration

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EXECUTIVE SUMMARY

Overview

The main focus of my dissertation is to study firms' entrepreneurial entry to nascent industries. The existing literature has typically considered a firm's product commercialization as the focal point of a firm's entry into a nascent industry, and has largely abstracted away from analysis of the firm-level technological investments undertaken by firms prior to product commercialization. The three essays of my dissertation seek to fill this research gap and address the following questions when taking into account firms' technological investments prior to product commercialization in a nascent industry: What capabilities enable entrepreneurial foray of firms to nascent industries? What are the breadth and depth of reconfiguration strategies that are undertaken in anticipation of creation of a nascent industry and a firm's subsequent entry to that industry? What are the firm-level and industry-level consequences of firms' investments in a nascent industry?

In addressing these questions, I draw on the empirical context of the agricultural biotechnology industry. Agricultural biotechnology is the use of modern biotechnology techniques to improve or modify plants with a particular focus on enhancing agricultural traits such as herbicide tolerance, pest resistance, and resistance to environmental stresses. Regulatory requirements in this industry require that firms seek permits from the USDA to conduct experiments with their transgenic crops outside the conditions of the laboratory. A firm's application for these permits indicates that it has devoted resources to conduct technological experiments related to the agricultural biotechnology

industry. This unique characteristic enables a systematic analysis of firms' activities prior to product commercialization, and thus makes this industry an ideal context to study firm's efforts prior to product commercialization. Below, I elaborate on each of the essays.

Essay 1 --- Modes of Value Capture in Ecosystems of Nascent Industries: Evidence from Agricultural Biotechnology

The first essay of my dissertation focuses on the *incubation* stage of an industry, defined as the period between introduction of a technological change and its first commercialization. The objective of this essay is to document firms' investment patterns in a nascent industry and study the intertwined processes of firm-level economic value capture and industry-level ecosystem formation that underpin incubation of nascent industries.

While the classic industry evolution literature has provided important insights about evolution of industries, a primary assumption in these models is that firm entry into an industry is analogous to its first instance of product commercialization. Accordingly, inception of a nascent industry is conceptualized based on the first instance of product commercialization at the industry level. This conceptualization of inception of nascent industries abstracts away from considering the fact that technologies often undergo an incubation period. For example, the first transgenic seed was commercialized in 1995 and this year marks the inception of the agricultural biotechnology industry. However, the technological breakthrough that formed the basis of this industry preceded the instance of product commercialization by 18 years. Further empirical evidence is consistent with this observation. Agarwal and Bayus (2002)[1] have documented the average duration of the incubation period across 30 new industries as 28 years. In addition, Golder, Shacham and Mitra (2009)[2] have

[1] Agarwal, R., & Bayus, B. 2002. The market evolution and sales takeoff of product innovations. *Management Science*, 48(8): 1024-1041.

[2] Golder, P. N., Shacham, R., & Mitra, D. 2009. Innovations' origins: When, by whom, and how are radical innovations developed? *Marketing Science*, 28(1): 166-179.

documented the average duration of the incubation period across 29 radical innovations as 26 years. These examples underscore the importance of analysis of the incubation period.

The detailed analysis of incubation of agricultural biotechnology leads to identification of three important patterns that I discuss below. First, I show the investment life cycle for the agricultural biotechnology industry indicating that when firms' investments in a technology is considered, the magnitude of investment life cycle is much larger than what is typically observed in the classic industry evolution life cycle based on product commercialization patterns. In particular, 85.5 percent of firms that were involved in technological investments did not commercialize any product in the nascent industry. Not only are there many more investing firms relative to commercializing firms, but also heterogeneity in the type of investing firms increases. While the population of investing firms in the agricultural biotechnology comprised of startup firms, agriculture incumbents, and diversifying entrant from chemical industry, product commercialization was disproportionately pursued by diversifying entrants. These important patterns highlight the contrasting inferences that may be made about evolution of industries based on technological investment patterns during incubation stage as opposed to commercialization patterns.

The second key finding of this essay relates to the alternative modes of economic value capture within nascent industries. The substantial decline in the number and heterogeneity of commercializing firms relative to investing firms motivates a critical understudied aspect of incubation stage regarding the role and fate of the firms that do not engage in product commercialization. Do they represent failures? Or, do these firms capture value in modes other than commercialization? At the firm level of analysis, I show that firms may capture economic value from their investments as they license their technologies to third parties or as they get acquired. For example, while there were not too many startup companies with a commercialized product in the agricultural biotechnology industry, startup companies were present at equal numbers as other types

of firms during incubation stage. More importantly, these startups were able to capture economic value by licensing critical pieces of technology to other companies or by selling their companies. Indeed, the acquisition deal value exceeded that of all rounds of venture capital investment in the startup companies in multiple cases, which indicates that these acquisitions could be categorized as instances of a successful mode of economic value capture.

The third finding relates to how firms that did not engage in product commercialization helped define subsequent industry evolution and formation of ecosystems. At the industry level, I show that as firms captured economic value through modes other than commercialization, their capabilities were used and retained in the industry innovation ecosystem. Accounts of nascent industries and technologies underscore the need for firms to embed themselves within an innovation ecosystem. For example, product commercialization within the context of agricultural biotechnology required gaining access to critical sources of technical capabilities and complementary assets that reside in the innovation ecosystem. Although diversifying firms are considered the focal entrant to the agricultural biotechnology industry, startups and conventional agriculture firms also contributed critical resources and capabilities to the emerging industry. In so doing, they contributed to the process of industry emergence via participation as support firms in the industry ecosystem. Product commercialization by diversifying firms occurs as a result of firms' internal capability development as well as integration of resources provided by these support firms in the ecosystem.

Overall, this essay underscores the importance of studying firm's investments in a nascent industry prior to product commercialization. Analyses of firm's technological investments enabled us to provide evidence of heterogeneity in firm types and modes of value capture during the incubation stage of industry life cycle. The implications of these findings might have been very different if the sole focus of analysis had been on firms' product commercialization.

Essay 2 --- Pre-entry or Pre-Investment Capabilities? The Role of Capability Reconfigurations for Market Entry into Nascent Industries

The second essay focuses on the capability antecedents of a firm's entry into a nascent industry. In particular, it examines the pre-investment capabilities that impact the likelihood of a firm's market entry into a nascent industry. The existing literature suggests that a firm's endowment of technical capabilities and complementary assets are critical factors determining a firm's market entry into a nascent industry; however, these capability endowments are measured as the stock of a firm's capabilities prior to its first product commercialization. An understudied question is how a firm's capability portfolio at the time of the initial technological investment in a nascent industry is related to its likelihood of entry. In order to address this question, I make a distinction between a firm's *pre-investment* and *pre-entry* capabilities – i.e., a firm's capability portfolio prior to its initial technological investment in the nascent industry and prior to its market entry, respectively.

I will elaborate with an example. One of the early entrants to the agricultural biotechnology industry was DeKalb Genetics. When DeKalb Genetics commercialized its first transgenic seed in 1997, it was considered a highly capable firm both in terms of technical capabilities and complementary assets required for operations in the agricultural biotechnology industry. This is consistent with the predictions of the existing literature that firms with better technical capabilities and complementary assets are more likely to enter an industry. However, DeKalb's investments in the agricultural biotechnology industry may be traced back to 1982 when it formed a joint venture with Pfizer. In 1982, DeKalb did not possess the technical capabilities and complementary assets for operations in the industry. In fact, given that the agricultural biotechnology was itself in its incubation stage, it was not even clear what the nature of required technical capabilities and complementary assets would be. Therefore, while possession of technical capabilities and complementary assets in 1997 may explain the likelihood of DeKalb's entry into the agricultural

biotechnology industry, some other characteristics of DeKalb in 1982 need to be examined to explain its entry into this nascent industry. The focal research question of the second essay of my dissertation is to examine the type of capabilities that firms similar to DeKalb possess when they initiate their technological investment toward a nascent industry.

Using the empirical context of agricultural biotechnology, the findings of this essay corroborate the well-established relationship that a firm's pre-entry stock of technical capabilities and complementary assets is related to the likelihood of entry into a nascent industry. However, it extends the existing literature by providing evidence that a firm's reconfiguration experiences prior to initial technological investment are the key pre-investment factors that are related to the likelihood of entry into a nascent industry. Prior reconfiguration experiences are defined as a firm's experiences in modifying its capability portfolio prior to its investment in the focal industry. In the case of DeKalb Genetics, for instance, prior reconfiguration experiences refer to the extent to which DeKalb has accumulated related experiences in change before its investment in the agricultural biotechnology in 1982. I suggest that these experiences enable a firm's efforts in gaining access to the technical capabilities and complementary assets that have been suggested as crucial pre-entry capabilities. Therefore, pre-investment reconfiguration experiences affect the likelihood of entry via their influence on pre-entry technical capabilities and complementary assets. In other words, it is not that DeKalb's experiences in reconfiguration per se influence its likelihood of entry into the agricultural biotechnology industry. Rather, these experiences enable DeKalb's efforts in gaining access to the technical capabilities and complementary assets that it does not posses at the time of initial investment and need to possess by the time of product commercialization.

In this essay, I draw attention to the endogenous sources of heterogeneity in pre-entry capabilities across firms. My hypotheses build on the literature regarding the role of a firm's pre-entry capabilities and extend it by accounting for the capability reconfiguration efforts that are

undertaken by firms in anticipation of entry into a nascent industry. Rather than presuming firm's pre-entry capabilities as exogenous factors that are leveraged to the new industry context, I emphasize that pre-entry capabilities are indeed developed during incubation period.

Essay 3 --- Filling Heterogeneous Capability Gaps: Reconfiguration Strategies in Anticipation of Entry into Nascent Industries

In the third essay, I elaborate on the reconfiguration strategies that firms undertake in anticipation of their entrepreneurial entry into nascent industries. In particular, I focus on the extent to which startup companies, incumbents of the obsolescing industry, and diversifying firms differ in terms of the content, sequence and sources of capability reconfiguration strategies. In addition, I use three firm case histories from the agricultural biotechnology industry to discuss the implications of my propositions.

Prior to their entry into a nascent industry, firms tend to reconfigure their capability portfolio according to the requirements of the nascent industry. As discussed in the second essay, the likelihood of a firm's entry into a nascent industry may be explained by the extent to which a firm has access to technical capabilities and complementary assets by the time of its entry. Accordingly, the objective of a firm's capability reconfiguration strategies is typically to narrow the capability gap that exists between its initial capabilities and the required portfolio of technical capabilities and specialized complementary assets in a nascent industry. These reconfiguration efforts often entail a firm's efforts in internal capability development and external capability sourcing through alliances and acquisitions.

I suggest that capability reconfiguration efforts of firms take the two forms of capability extension and capability deepening. Due to the differential historical antecedents, incumbents of the obsolescing industry, de novo startups and diversifying firms differ in whether they pursue capability extension or capability deepening. Specifically, incumbents are more likely to engage in capability

extension for achieving the required portfolio of technical capabilities, while startups and diversifying firms are more likely to engage in capability deepening for achieving the required portfolio of technical capabilities. For obtaining specialized complementary assets, incumbents are more likely to engage in capability deepening, while startups and diversifying firms are more likely to engage in capability extension.

In terms of the sequence of capability reconfiguration strategies, incumbents are likely to pursue extension of technical capabilities prior to deepening of complementary assets. Diversifying entrants are likely to pursue deepening of technical capabilities concurrent with extension of specialized complementary assets. De novo entrants are likely to pursue deepening of technical capabilities prior to extension of specialized complementary assets. Similarly, these three types of firms differ in the extent to which they draw on internal versus external sources of capabilities.

This essay contributes to the strategic management literature by suggesting that although firms may be similar in their focus on achieving a similar configuration of capabilities, they are likely to pursue divergent processes in terms of the sequence of reconfiguration efforts and sources of capabilities. Specifically, while firms undertake different sequence of activities or draw on different sources of capabilities, they were all focused on attaining a similar configuration of technical capabilities and specialized complementary assets.

Contributions to the Entrepreneurship Research

My dissertation provides several important contributions as well as future research opportunities within the field of entrepreneurship. First, my dissertation underscore the importance of alternative modes of value capture in a nascent industry. Firms that are involved in technological investments within a nascent industry may capture economic value through licensing their technologies or selling their companies. Both licensing and acquisition represent critical strategic

levers for entrepreneurial startups. Managers contemplating a technological investment in a nascent industry may consider for these modes of value capture as viable exit plans.

Second, I discuss the importance of ecosystem development for incubation of nascent industries. Although firms with a commercialized product are typically considered to be core firms in an industry, my dissertation highlights the critical role of support firms in an industry's innovation ecosystem. Managers contemplating entry into nascent technological field may rely on the available resources in their ecosystem as opposed to internal development of all required capabilities.

Third, the essays emphasize the role of reconfiguration efforts of a firm for entry into nascent industries. While it is important for a firm to possess technical capabilities and complementary asset for entry into a nascent industry, it is not necessary to possess them right at the time of initial investment. Rather, it is important to accumulate these capabilities during incubation stage and in anticipation of entry into an industry.

Together, the three essays shed light on an understudied phenomenon –incubation of a nascent industry, with a focus on heterogeneity among firms, and their strategic reconfiguration efforts. Contrary to prior literature that has focused on stocks of endowments, my dissertation shows that firms actively engage in entrepreneurial reconfiguration of capabilities, and in doing so, impact the incubation and evolution of a nascent industry.