



THREE ESSAYS ON PRODUCT FORM CHOICE

by

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## ABSTRACT

Innovators and high-technology entrepreneurs have three principal options for transforming their innovations into viable business models and deriving value from their innovations. They may: market intellectual know-how (via licensing and/or proof-of-concept), market intermediate products (i.e., sell components/sub-systems), or market end-products (i.e., sell complete systems/solutions). In this dissertation, I aim to contribute to the organizational design and marketing strategy literature with three separate essays that study these fundamental strategy alternatives, which are called “product form strategy”. In the first essay, I explore product form strategies in the context of early-stage and established firms engaged in new product development projects, and generate a theoretical framework that shows (a) how technology, market, and enterprise-resource related factors systematically impact this choice, and (b) how the enterprise coordinates with other actors in its “ecosystem” to design, produce, and market effective products/solutions based on the core innovation. The other two essays use two different methodologies and contexts to systematically test some key refutable predictions from the framework developed in Essay 1. In particular, in the second essay, I use simulated experimental scenarios and ordered-choice models to investigate product form strategy in the context of early-stage ventures seeking angel investor funding to examine the effect of technology, marketing, and firm-level factors on product form decisions. In the third essay, I use primary survey data obtained from executives from firms selling industrial equipment in four industry sectors to study how coordination and safeguarding motives, in conjunction with a firm’s unique set of product development resources impact their product form decision.

Technological advances in a wide variety of business-to-business product and service markets not only originate and get developed in established industrial firms but also in high-technology start-up ventures and university-based research laboratories. One of the most critical strategic marketing decisions faced by these firms (ventures) is: *Where should we participate in the value chain?* Said otherwise, the key decision firms must make is the commercialized form in which these innovations should be offered in the marketplace (to derive the value/revenues from it)? The three principal “pure-play” options that firms usually have to transform their innovations into viable business models are: market *intellectual know-how* (via licensing and/or proof-of-concept), market *intermediate products* (sell components/sub-systems), or market *end-products* (sell complete systems/solutions). We call these alternatives as **product-form choice** and this decision as **product-form strategy**.

Consider two examples that illustrate these “product-form” decisions:

- Bio-medical and nano-engineering based biotechnology firms are developing techniques that improve the prospect of micro-dosing and direct drug delivery to specific organs. Firms in this line of business have three options for deriving commercial value from their techniques. They may license the technology to established pharmaceutical companies, which then need to develop the micro-dosing platforms on their own. Alternatively, the bio-tech firm may develop a broad drug delivery component-platform (for different drugs addressing different ailments) that embodies the technology and sell this platform to various drug manufacturers on a non-exclusive basis. The drug manufacturers then need to configure this platform into their final drug. Finally, the bio-tech firm may customize the delivery mechanism to an organ/ailment and co-develop the delivery system with the specific drug– in effect offering a complete “drug and delivery” solution.
- In the high-technology sector, Oracle (a prominent supplier of business software) acquired hardware manufacturer SUN Microsystems with the objective of integrating SUN’s hardware with their own software to effectively compete against full systems/solutions providers like IBM. With this acquisition, Oracle has clearly signaled its intent on increasingly competing as a “one-stop system/solution” provider rather than primarily being a business-software (component) vendor.

The examples above clearly suggest broad-ranging strategic implications of product form strategy. For instance, this decision on where to participate in the value chain to best commercialize an innovation fundamentally impacts who belongs to the set of direct customers and competitors and

what key value-chain activities need to be undertaken. Yet, despite its strategic value and impact on subsequent marketing strategy decisions, scant attention has been paid to developing an understanding of this strategy. For instance, typical marketing journals and textbooks on new product marketing strategies typically focus around *segmentation, targeting and positioning* (STP) decisions as key to NPD success. These crucial STP decisions however assume that the firm/venture has already made a decision on the product-form they should market.

The central aim of the dissertation is to gain an understanding of how decision makers conceptualize this product-form choice problem and to generate a testable framework that implicates certain factors and their impact on product-form strategy. To accomplish this, I use a multi-method approach to study this choice in two contexts: (a) Early-stage product development projects undertaken by start-up enterprises in high-technology sectors that are supported by venture capital/angel investors (VC/AI) and (b) Established firms marketing their innovative products in the industrial sector.

To address this “What should we sell?” question, I start with the organizational design theories and the safeguarding versus adaptation dynamics inherent in transaction cost economics (Williamson 1985) to integrate a variety of streams of research, including the scope of the firm (Teece 1982), vertical positioning (John et al 1999), governance value analysis (Ghosh and John 1999), vertical architecture (Jacobides and Billinger 2006) and adjustment costs (Novak and Wernerfelt 2008) to develop an overarching theoretical framework that would show how specific technology, market, and enterprise resource factors systematically impact a firm’s/venture’s product-form decision. The research shows how the logic underlying the theory of the firm can be extended beyond the economizing rationale (the archetypical example being the classic make versus buy supply-chain decision) to a strategizing rationale of what customer-side market should we participate

in (which precedes the make versus buy decision) and its implications for the management and commercialization of innovations.

This is accomplished in my dissertation through three studies that use multiple methods (qualitative and quantitative) to represent the perspectives of executives, investors, and entrepreneurs. Commercializing innovation in high-technology sectors is a highly complex process that requires inputs from executives across functional units as well as an understanding of how the core innovation fits with other technologies in the market-place. These decisions are relatively extended in duration as well as resource intensive. Hence, I use a multi-method approach that includes qualitative interviews for grounded theory building (Eisenhardt 1989), a simulated (experimental) protocol analysis using VCs/AIs as my subjects, and a primary survey of established firms in 4 industrial sectors to gain a broad understanding of the phenomenon of interest and its implications. Below, I describe each of the three essays in brief.

Essay 1 uses a grounded theory approach to develop a conceptual framework for understanding how firms/ventures in high-technology sectors choose among these strategic alternatives. Depth interviews with key decision makers and participant observation techniques—over a two-year period—were used for both early-stage and established firms. Grounded theory provided the best approach for understanding this topic because early-stage technology projects are often a tightly guarded secret by both early-stage ventures and established firms. The framework generated from these interviews provides two fundamental insights. First, three key mechanisms seem to be the primary drivers of this product-form decision – the *ability to coordinate* (work with other actors in the eco-system), the *ability to safeguard* (secure the proceeds from their innovation), and the *ability to garner internal resources* (human-capital, technical, and marketing/channels). Second, a multiplicity of environmental (e.g., ability to enforce IP), technology (e.g., mix-and-match and complexity), venture-level (e.g., internal product development resources), and customer-level

(e.g., end-customer expertise) factors influence the firm's ability to coordinate, safeguard, and generate internal resources. Crucially, these rationales are consistent with those espoused in organization design theories such as transaction cost economics (TCE) and the resource-based view (RBV) of the firm; in that light, these product-form decisions can be considered as strategic product-level governance decision.

Essay 2 uses a simulated experimental protocol and actual venture capitalists and angel investors as subjects to test the key hypotheses that emerge from Essay 1. This method was purposefully chosen to test the theoretical mechanism using real decision makers while simultaneously avoiding the extraneous effects that could confound the analysis. An orthogonal design was used to generate 8 fictitious venture proposals (similar to the ones these VC/AI receive from innovators/entrepreneurs) and subjects were asked to choose the product form alternative they believed would generate the most value. Informants considered early-stage ventures with variable levels of mix-and-match technologies, intellectual property strength, and product development resources. Consistent with Essay 1, we found the role of ability to coordinate, ability to safeguard, and ability to garner resources as significant drivers of their product-form decisions in these experiments, providing robust evidence of the framework. Specifically, when technologies were easier to mix-and-match investors chose to sell less integrative products (e.g. components) as compared to more integrative products. Furthermore, I found that investors were more likely to choose to sell more integrative products when the venture had greater product development resources. However, findings reveal directional support for the interaction between modularity and resources which suggests that even when early-stage ventures are faced with technological factors likely to induce the sale of less integrative products, firms will move toward selling more integrative products as a result of higher levels of new product development resources. The interaction between enforceability and resources is also directionally consistent but non-significant.

Even within a particular legal environment (say the US), there are large variations in the enforceability of intellectual property (IP) rights. For instance, IP protection is generally weak in the software sector but strong in the pharmaceutical sector. The emergent framework from Essay 1 suggests the role of appropriability/safeguarding hazard as one of the key drivers of product-form choice. In Essay 3, I use primary survey data obtained from industrial firms in 4 different industry sectors to systematically examine the impact of enforceability of IP on product-form strategy. The key argument is that environments with weak IP enforceability create appropriation hazards (because the innovators cannot claim their fair share of the value derived from the innovation); firms will hence choose a product-form that minimize such appropriation risks for their innovation. Furthermore, I investigate how the firm's own resource set enables it to choose a product form that minimizes the appropriation risks arising out of weak IP enforcement. Findings reveal a fascinating interplay between the firms' need to protect its innovation and its ability to generate a product-form that protects the innovation. Specifically, when IP enforceability is low, firms generally seek to sell more integrative products (systems); however, only firms that possess high levels of integrative resources are capable of successfully marketing such systems. These findings are consistent with the framework generated in Essay 1.

Product-form strategy provides the starting point of a roadmap on how to take technological innovations to market and hence poses a series of valuable questions to innovation managers. First, key SWOT analysis questions like "Who are my customers?" and "Who are my direct competitors?" depend crucially on the chosen product-form and depending on who the customer is (e.g., the systems manufacturer or the end-user) the firm will have to design its channel strategy. Second, if enforceability issues restrict the value firms could claim from their innovations, firms might want to offer (and actually do so) different product forms in different international markets with differing norms and standards for IP enforceability. Third, how does the product-form strategy interplay with



the sourcing strategies that firms use for upstream sourcing/downstream supply arrangements? This will be crucial for new product success. Fourth, what is the role of unique firm resources (product-development versus branding/marketing) on the ability of the firm to effectively develop a profitable product-form? These and other related questions are critical for the success of an innovation. I intend to address some of these questions in a programmatic fashion in future research.

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