14 When Do User Innovators Start Firms? A Theory of User Entrepreneurship

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14.1 Introduction

The importance of user innovation as a source of novel technologies and products has been well documented in the innovation literature (von Hippel 1976, von Hippel 1977, Finkelstein and von Hippel 1979, von Hippel 1986, von Hippel 1987, von Hippel 1988). Users innovate frequently and create economically significant innovations. Research in this tradition has posited that although users innovate, they do not generally attempt to commercialize their innovations (von Hippel 1988). The established wisdom is that users frequently contribute their innovations to manufacturers for commercialization, capturing limited economic benefit beyond their own use.

Recent studies, however, point to many cases where users found firms to capture economic value from their innovations. Entrepreneurial users have commercialized their own innovations in industries ranging from medical devices to sporting equipment, ice harvesting to juvenile products, and stereo components to new media (Langlois and Robinson 1992, Utterback 1994, Shah 2005, Shah and Tripsas 2007, Haefliger et al. 2010, Winston Smith and Shah 2011). This

phenomenon has been labeled *user entrepreneurship* (Shah and Tripsas 2007). The process by which user innovators become entrepreneurs differs from the typical entrepreneurial journey. Users tend to experience a need in their own lives, develop an innovation to address their need, and sometimes even openly share their solution with others *before* commercializing a product. Many users are "accidental entrepreneurs" in that starting a for-profit company was not the initial motivation for their innovation, but rather the outcome of a journey inspired by their own needs (Shah and Tripsas 2007). Surprisingly, user entrepreneurship occurs frequently and across many industries: 46.6% of innovative startups founded in the United States in 2004 that survive to age five are founded by users (Shah et al. 2011).

We make sense of these varied empirical findings by developing a theory of user entrepreneurship that explains when users are likely to commercialize their innovations as opposed to simply benefitting from their use. More specifically, we articulate the conditions under which users, manufacturers, neither, or both are likely to enter the product market. Our model hinges upon the interplay of two factors experienced by both users and manufacturers: their estimates of the financial returns to entering the product market and their profit thresholds. User's and other manufacturers' estimates are likely to differ due to access to complementary assets, information asymmetries, and distinct interpretations of available information. Our model suggests that users are most

likely to commercialize their innovations when they have access to complementary assets such as distribution channels (e.g., Teece 1986), when they possess informational advantages enabling them to uniquely identify opportunities that established firms would underestimate, and when the rents from entrepreneurial activity exceed the opportunity costs of their time. These factors help explain why user entrepreneurs are likely to spawn the creation of altogether new product markets and even industries. We illustrate the model with examples from the field of consumer sporting goods.

14.2 The User Innovation Phenomenon

A rich and distinguished body of research from a variety of disciplines has documented the importance of user innovations (e.g., von Hippel 1988, Oudshoorn and Pinch 2003). Anecdotal examples of user innovation have been described in the literature for decades, but von Hippel produced the first systematic documentation and theoretical development of the concept in a series of articles leading to the publication of *The Sources of Innovation* in 1988. This detailed and thorough body of work has shown us that users are an important and frequent source of innovation and innovate across a wide variety of product domains and user innovations may be qualitatively different than those of manufacturers. This research also held that users rarely, if ever, commercialize their own innovations, however this assumption has been challenged and

corrected by empirical evidence that has emerged over the past ten years. We review each of these contributions below.

Numerous studies conducted during the last 30 years have documented the importance and magnitude of user innovation in a wide range of industries, offering the following key insights. (1) *Many important innovations are developed by users.* Users are responsible for creating a large fraction creating a large fraction—and sometimes even the majority—of key innovations in a wide variety of product domains, including medical devices, scientific instruments, semiconductors, software, and sports equipment (for a review of this literature, see von Hippel 2005). For example, 76% of the key innovations in the field of scientific instruments (von Hippel 1976), 67% of the key innovations in semiconductor and electronics subassembly manufacturing equipment (von Hippel 1977), and 60% of the innovations in consumer sporting equipment (Shah 2005) were developed by users. (2) *A large fraction of users innovate.* Many individuals innovate to solve their own unique needs, resulting in a large number of innovations (Morrison et al. 2000, Franke and Shah 2003, Franke and von Hippel 2003, Lüthje et al. 2005). For example, 26% of the users of library information systems (Morrison et al. 2000), 19% of the users of Apache security software (Franke and von Hippel 2003), and up to 38% of consumer sports enthusiasts (Franke and Shah 2003, Lüthje et al. 2005) report innovating for their own use. Even in the general population, user innovation is common: In a recent

survey of 2,019 consumers in the United Kingdom, 6.2% of respondents reported engaging in user innovation (von Hippel et al. 2010). (3) *Users innovate over a wide variety of product domains*. Users have created radical and incremental innovations across a range of product classes, industries, and scientific disciplines (Nuvolari 2004, Shah 2005, von Hippel 2005). In additions to the fields mentioned above, these include industries as diverse as automobiles, astronomy equipment (i.e., telescopes), medical devices, and designs for blast furnaces (Allen 1983, Kline and Pinch 1996, Franz 1999, Ferris 2002, Chatterji and Fabrizio 2011).

Existing work also suggests that the *content* of user innovations is distinct from manufacturer innovations: In a study of scientific equipment innovations, user innovations tended to embody more novel functionality—that is, they tended to do altogether new things—whereas manufacturer innovations tended to address needs that are more widely recognized (Riggs and von Hippel 1994). Lead user theory takes this observation a step further and suggests that *some* user innovations will presage the creation of new market niches. Lead users (1) experience needs months or years before the bulk of the marketplace encounters them, and (2) are positioned to benefit significantly by obtaining a solution to those needs (von Hippel 1986). Product concepts developed by lead users are often rated more highly—and are often more profitable for manufacturers—than

those developed by the manufacturers alone (von Hippel 1986, Urban and von Hippel 1988, von Hippel et al. 1999).

Finally, early research proposed that innovative users would *not* engage in economic or commercial activity. Instead, manufacturers of existing or related equipment would find out about user innovations, refine them, and introduce them to the market if they had commercial value (von Hippel 1988). In fact, the early literature goes so far as to assume that user innovators will neither assume the role of manufacturer nor license their innovation to others.[1]

Early empirical studies seemed to support this view. For example, in the field of scientific instruments, user innovations include the electron microscope, well-regulated high voltage power supplies, and the high temperature specimen stage. Innovating users—often academic scientists or technicians—communicated their ideas to others via publication, symposia, and visits with other users (von Hippel 1988). In the case of innovations to the semiconductor and printed circuit board assembly processes, von Hippel (1988) notes that details of the transfer process between users and manufacturers were not well documented, but it appears that innovating users (most often employees of user firms) shared their information freely with the staff of other user and manufacturer firms. By and large, existing firms were the ones that commercialized user innovations, although in a few cases users became equipment producers (von Hippel 1988, 24).

These studies appear to support the assumption that users innovate but do not engage in commercialization activity, however, we believe these early results may have been driven by the choice of setting. Many of the studies conducted in the first 25 years of this literature focused on innovations made by employees of firms or users who were academic scientists. These users faced significant opportunity costs to starting a firm, and therefore relayed their ideas to manufacturers for integration into future products. Noncompetition agreements may have restricted some innovative users from engaging in entrepreneurial opportunities in fields similar to their employers. In addition, many academic scientists *want* to be scientists (see, for example, Stern 2004) or may have felt inhibited from starting a venture due to cultural norms within their professional societies, decreasing the appeal of an entrepreneurial venture. As a result, it appeared that user activities were largely confined to innovation.

Despite these early assumptions, recent theoretical and empirical work indicate that users do much more than "just" innovate (Franke and Shah 2003, Shah 2005, Baldwin et al. 2006, Mody 2006, Shah and Tripsas 2007, Shah and Mody 2011). Next, we briefly present data on the prevalence and significance of user entrepreneurship. Then, we present a model that predicts when users will become entrepreneurs. Applying the parameters of this model will help us reconcile why early studies of user innovation found little evidence of user entrepreneurship, despite its pervasiveness as a phenomenon.

14.3 The Prevalence and Significance of User Entrepreneurship

Data from several recent studies paint a striking picture of the phenomenon of user entrepreneurship. These studies illustrate both the prevalence of user entrepreneurship and the importance of user entrepreneurship as a mechanism for introducing innovations into industrial systems.

14.3.1 Prevalence

A recent study finds that 10.7% of all startups and 46.6% of innovative startups founded in the United States in 2004 that survive to age five are founded by users (Shah et al. 2011). User entrepreneurship occurs in vastly different industries. Physicians frequently innovate and commercialize novel devices to treat their patients: 29% of U.S.-based medical device startups were founded by physicians (Chatterji 2009). In the juvenile products industry (firms producing products for infants and toddlers, such as strollers, car seats, diaper bags, etc.), 84% of the firms founded between 1980 and 2007 were founded by users, i.e., parents, grandparents, and babysitters.

14.3.2 Technological Significance

Entrepreneurship by users introduces technological change into the industrial system. At a high level, innovative startups founded by users are more likely to possess patents—indicators of the technological knowledge possessed by the

venture—than other startups (Shah et al. 2011). While some user entrepreneurs commercialize incremental product improvements, others introduce groundbreaking new products that spark the creation of new industries as diverse as extreme sports (Shah 2005) and atomic force microscopy (Mody 2006). In extreme sports, 43% of all key innovations were first commercialized by the users who developed them (Shah 2005). In the atomic force microscopy industry, all (three) early firms were founded by users (Mody 2006). In the typesetter industry, two out of three major technological revolutions were ignited by products developed and introduced into the marketplace by user entrepreneurs (Tripsas 2008). User entrepreneurs were among the first to commercially produce *Machinima*, a new film genre characterized by shooting film in video games (Haefliger et al. 2010). In a similar vein, Winston Smith and Shah (2011) argued and found evidence supporting the notion that user entrepreneurs introduce *highly novel* insights into the industrial system. These studies highlight the innovative contributions of these firms to society and the commercial marketplace.

14.3.3 Economic Significance

Firms founded by user entrepreneurs differ in meaningful ways from both the average startup and even from other innovative firms (Shah et al. 2011).[2] Firms founded by *professional user entrepreneurs*—users whose innovations were meant for use in a previous job or business—are less likely to be founded at

home, less reliant on self-financing, more likely to have revenues, and generate higher revenues than both comparison groups (Shah et al. 2011). The data suggest that professional user entrepreneurs may be particularly highly skilled and may also reap significant pecuniary benefits through entrepreneurship.

In contrast, firms founded by *end-user entrepreneurs*—users whose innovations were meant for personal use—may possess fewer resources and come from less privileged populations. Firms founded by end-users employ fewer workers, have lower revenues, are more likely to be founded at home and operate from home five years after founding, are more heavily self-financed five years after founding, and are less likely to receive bank financing. End-user entrepreneurs are more likely to be female and members of minority groups (Shah et al. 2011). Specifically, they are more likely to be an American Indian, Alaskan Native, or Black, and less likely to be Asian (Shah et al. 2011). End user entrepreneurship may be one of the few entrepreneurial paths followed by members of these groups—and hence worth investigating further as a path towards meaningful career options and economic self-sufficiency.

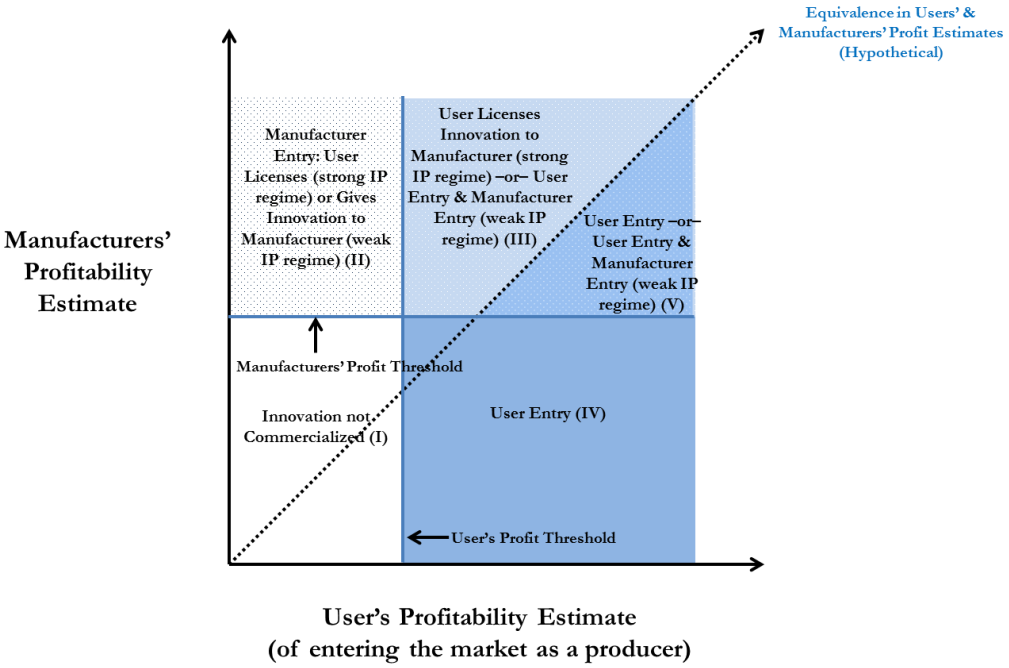
Despite these differences, firms whose founders are professional user entrepreneurs or end-user entrepreneurs each introduce novel or customized products into the marketplace and are more likely than other firms to receive venture capital financing and obtain patents than firms in either comparison groups (Shah et al. 2011). Specifically, 5.8% of firms founded by professional

user entrepreneurs and 4.0% of firms founded by end user entrepreneurs receive venture capital financing in their first five years of operation, versus 1.1% of all startups and 3.7% of other innovative firms (Shah et al. 2011). This is a striking finding: The venture capital interest in these firms suggests that user entrepreneurs commercialize innovations with high market potential more frequently than other entrepreneurs.

14.4 A Theory of User Entrepreneurship

We next develop a model that predicts when a user will attempt to appropriate financial benefit from his or her innovation by commercializing it—through patent licensing, patent assignment, or by entering the product market—as opposed to simply benefiting through use and letting manufacturers exploit any potential commercial value. Our conceptualization of manufacturers is a broad one: It includes any manufacturer, typically firms that operate in the same or a related industry or that possess relevant complementary assets.[3] At the core of our model is the notion that users and manufacturers differ along two critical dimensions: their estimates of the financial returns to entering the product market and their profit thresholds. Depending upon the magnitude of these differences, we propose alternative commercialization outcomes.

Figure 1: Who Will Commercialize a User Innovation?



Note: This illustration sets the user's profit threshold at a lower level the manufacturer's profit threshold.

14.4.1 Sources of Divergence in User and Manufacturer Estimates of Financial Returns

When deciding whether to commercialize an innovation, potential entrants estimate financial returns based on a number of factors, including projected market size and growth, customer needs, competitive conditions, and the firm's unique ability to add value. Users and manufacturers are likely to have different estimates of the profit potential from commercializing the same innovation for many reasons, including complementary assets, information asymmetries, and differing interpretations of available information.

The commercialization of any technology in the product market requires complementary assets such as access to distribution, brand recognition, or manufacturing capability (Teece 1986). In situations where necessary complementary assets are controlled by established manufacturers and potential new entrants cannot contract for those assets, successful new entry is difficult, even if new entrants possess superior technical solutions (Tripsas 1997, Gans and Stern 2003). Under these conditions user innovators would be at a disadvantage, and manufacturers' estimated profits would exceed those of users. Manufacturers will also have a higher profit estimate if they can achieve a superior cost position by leveraging existing capital-intensive manufacturing facilities or taking advantage of economies of scope in other activities such as distribution (Teece 1986, Baldwin et al. 2006).

Information asymmetries are another source of the disparity between users' and manufacturers' expected profits. Informational advantages have long been recognized as a source of entrepreneurial opportunity (Shane and Venkataraman 2000). Schumpeter (1934) argued that the constant state of disequilibrium in which economies operate, and the resulting unequal distribution of information, enables actors with informational advantages to earn entrepreneurial profits. Similarly, unequal distribution of knowledge creates asymmetries in beliefs about the potential profits associated with entrepreneurial activity, resulting in new entry by parties who have 'discovered' an opportunity first (Hayek 1945).

Users are often better positioned than manufacturers to both recognize and commercialize an innovation given their unique, private knowledge of the market. In particular, users have significant informational advantages in emerging markets where the knowledge is rapidly evolving, sticky, and difficult to verify. When a market is new, needs are uncertain and continuously evolving (Clark 1985). Potential consumers—the likely subjects of firm-sponsored market research—have not used the product and therefore have difficulty articulating their preferences, making it difficult for manufacturers to gauge market potential (von Hippel 1986, Nonaka and Takeuchi 1995). Use, however, enables learning about the product's reliability, its durability, what features are valuable, and how the product works in combination with other products. Experienced users are best

positioned to create and understand needs for these novel products. In addition, users have an advantage since knowledge of needs might be 'sticky', i.e., costly to access, transfer, and use in a new location, even when both the sender and receiver are committed to its transfer (Polanyi 1958, von Hippel 1994, Szulanski 1996, Tyre and von Hippel 1997).

Users may also be well positioned to create, refine, diffuse, and value an innovation through participation in innovation communities (Franke and Shah 2003, Shah 2005). Community members are likely to provide assistance with improving and refining the innovation, thereby improving the design and functionality of the product. If the innovation is adopted by many community participants, the user innovator can observe its value and begin to assess others' willingness to pay. In fact, some user entrepreneurs did not think to produce their innovation for sale to others until after receiving multiple requests to purchase a copy of the innovation (Shah 2005).

In addition to having preferential access to information, user innovators may also interpret the information related to an innovation through a different lens from manufacturers. Individuals with different backgrounds have been found to perceive different sources of value in the exact same technology, highlighting the importance of prior experience in the conception of opportunity (Shane 2000) and the framing of a new product category (Benner and Tripsas 2012). Since users are

not embedded in the existing industry belief systems of manufacturers, their interpretation of the potential value of an innovation will likely differ.

14.4.2 Sources of Divergence in User and Manufacturer Profit Thresholds

We propose that, on average, users will require a lower profit threshold than manufacturers to justify entering the product market. Lower profit thresholds can result from a user's lower opportunity costs or from non-economic factors (e.g., personal preference, legal barriers).

Opportunity costs—what the user would forego to start a firm—will vary by profession. The innovative bicycling enthusiast who is also an orthopedic surgeon will likely require higher financial returns to start a bicycle firm than the innovative bicycling enthusiast who is a 'sports fanatic'—taking odd jobs in order to support a sports-centric lifestyle. Amit et al. (1995) provide large-sample empirical support for this phenomenon. A user innovator may also choose to start a firm in her spare time. Such a decision generally decreases the profit threshold required of the business as returns are viewed as additional—rather than primary—sources of income.

Considerable research indicates that many entrepreneurs are motivated, at least in part, by non-economic goals, including the satisfaction derived from self-employment or from engaging in work that they enjoy (Smith and John 1983, Lafuente and Salas 1989, Gimeno et al. 1997, Scott-Morton and Podolny 2002).

Starting a business may be the user innovator's vehicle for fulfilling these goals. The utility generated from self-employment or working in an area that she is passionate about may lead the user innovator to substitute 'love' for 'money' (Douglas and Shepherd 1999).

In general, one would expect manufacturers to have higher profit thresholds than individual users since non-monetary personal benefits are not included as part of the upside when evaluating the venture. Instead, investments are viewed relative to a set of possible projects competing for resources. Many firms even have a 'hurdle rate' that new projects must exceed in order to receive funding (Bower 1970, Brealey and Myers 1984).

14.5 Commercialization Outcomes

In this section we describe commercialization outcomes for the user innovation using examples from the sporting goods industry.[4] The general context of sports equipment is appropriate for two reasons. First, new sports emerge relatively frequently. It is therefore possible to study the economic and social history of new sports via primary data collection methods, including discussions with early innovators and other actors. Second, the fields are relatively free of government regulation compared to some other industries (e.g., pharmaceuticals), a factor that could shift activity towards firms and institutions able to bear legal and financial risk.

14.5.1 Region I: Innovation Not Commercialized

In Region I of Figure 14.1, we predict that a user innovation will not be commercialized; its projected returns fall below the profit threshold of both users and manufacturers. This situation would prevail when an innovation meets idiosyncratic user needs such that neither the user nor the manufacturer would expect high levels of demand (Franke and von Hippel 2003). Similarly, commercializing incremental user innovations that add only a small amount of value relative to the overall value of the product would not likely appeal to either users or manufacturers. Such innovations may still diffuse from user to user, even though they are not commercialized. That said, if the innovation becomes popular enough, manufacturers might incorporate it into their product designs at a later point.

14.5.2 Region II: Manufacturer Entry: User Licenses (Strong IP Regime) or Gives Innovation to Manufacturer (Weak IP Regime)

In Region II of Figure 14.1, the user's estimated profit from entry falls below his or her threshold level, but the manufacturer's estimated profit exceeds its threshold. Many of the innovations studied in the first two decades of the user innovation literature fall into this category, e.g., we see this pattern in the field of scientific instruments, where scientists face high opportunity costs to starting a

business, so manufacturers commercialize user innovations (von Hippel 1976). Such conditions might also exist when established firms control essential complementary assets, thereby leading the user to either give the innovation to a manufacturer for commercialization or license it if the intellectual property regime[5] is strong. Since the manufacturer's estimated profit from product market entry exceeds its threshold, the manufacturer should be a willing licensee.

Sherman Poppen is an example of a user innovator in Region II. The 'formal' history of the snowboard began with Poppen's *Snurfer* (short for *snow surfer*) (Stevens 1998). Poppen was a full-time chemical gases engineer in Muskegon, Michigan, with several industrial gas patents to his name. His opportunity costs for starting a business were most likely high and his professional training likely made him familiar with the patent and licensing process. Poppen licensed his patented *Snurfer* design to an existing manufacturer of children's toys. The *Snurfer* became commercially quite successful. In fact many subsequent snowboarding innovators first experienced the thrill of the sport as children riding on Poppen's *Snurfers*.

Sherman Poppen's background and actions suggest a potential area for future research: Are user innovators with prior knowledge of the intellectual property system more likely to protect and then license their innovations out than are other user innovators? Are such user innovators equally or less likely to share

their innovations with others and hence less likely to benefit from community involvement?

14.5.3 Region III: User Licenses Innovation to Manufacturer (Strong IP Regime) or User and Manufacturer Both Enter Product Market (Weak IP Regime)

In Region III, both the user's and the manufacturer's profit estimates are above their profit thresholds, however the manufacturer expects to achieve a higher financial return than the user does. These conditions provide the user an opportunity to either enter the product market or attempt to license the innovation to a manufacturer.

Whether the user enters the product market or licenses in this situation will depend upon three factors: the intellectual property regime for the innovation, the newness of the market, and the licensing fees the user is able to extract given the difference in the user's and manufacturer's expected profits. We discuss each factor below.

If the intellectual property regime in the product area surrounding the innovation is strong—for instance, when patents are effective—then there is a market for ideas (Gans and Stern 2003) and the user can attempt to license. If the intellectual property regime is weak, the user's only commercialization alternative is to enter the product market. It is also possible that the costs of patenting and/or

enforcing a patent are high enough that licensing is no longer viable, leaving product market entry as the preferred alternative.

When a market is relatively new, the costs of contracting are likely to be high due to the time and effort required to explain the technology and/or describe the market, and take into account contingencies arising from the high uncertainty. If the cost of contracting is high, the user is more likely to start a firm than attempt licensing.

Finally, if licensing seems feasible (because the intellectual property regime is strong and the cost of contracting is low), a negotiation between the manufacturer and user will determine whether the user enters the product market or licenses. Because the manufacturer's estimate of the profitability of the market is *higher* than the user's in Region III, there is a good chance that a licensing agreement that appeals to the user can be negotiated. We believe that licensing will be a common outcome in this region. However, in some cases, manufacturers will not be interested in licensing the innovation and users seeking to financially benefit from their innovation will need to enter the market as entrepreneurs. Manufacturers may choose to enter the market as well, particularly in industries characterized by weak intellectual property regimes.

In the field of windsurfing, a user innovator was granted a patent on *camber inducers* in the 1980s —a product used to hold the leading edge of the sail stable and hence generate greater stability and power. At this point windsurfing

was a young but established market, manufacturers acknowledged the value of the innovation, and those manufacturers expected to profit by commercializing the innovation and selling it as a component of a full windsurfer. As a result, it is likely that the manufacturers might have expected to profit more highly from commercializing the innovation than its inventor might have profited by selling the innovation on its own. So he chose to license the patent to a large firm. Initially, he consulted for the firm and received royalty payments. Unfortunately, the royalty payments stopped when the manufacturer's management changed and the consulting relationship ended. The case was brought to court and decided in the innovator's favor, however the innovator never received the full royalty payment. This example illustrates the difficulty faced by user innovators when licensing to large, established firms with financial and legal resources. This user may well have been better off entering the product market himself.

14.5.4 Region IV: User Entrepreneur Enters the Product Market

In Region IV of Figure 14.1, we predict that the user innovator would choose to enter the product market. Since the expected profit exceeds his or her profit threshold, but not the manufacturer's, this is the only commercialization option available to the user.

A description of innovation activities among 'the Hawaiians' conveys the flavor of innovation, fun, and competition that can result in product market entry.

The Hawaiians were a group of 4-7 people in their early 20s who lived together in a house in Kailua, Hawaii, in the 1970 through the early 1980s. They windsurfed daily off a beach near their house. As they experienced the very high wind and wave conditions common to the area and experimented with various new windsurfing techniques and tricks, new needs emerged—needs that the existing equipment could not fulfill. They innovated in order to tailor the equipment to the conditions they were experiencing and the techniques they were developing. As people who saw or heard about their advanced sailing techniques and equipment asked to purchase the equipment, the Hawaiians made and sold handmade copies of the products from their house (for the first 3 or 4 years) and then from a small storefront. Eventually, their brand became one of the most popular in the windsurfing industry.

Why did the Hawaiians—and not a manufacturer—commercialize their innovations? The Hawaiians valued the commercial potential of the innovations more highly than manufacturers and possessed a lower profit threshold. In fact, we know that the Hawaiians presented their early innovations to an existing manufacturer and asked the manufacturer to consider producing the innovations (they did not request financial remuneration). The manufacturer declined. The Hawaiians then shared their prototypical designs with friends and visitors to the island of Hawaii who witnessed the fun they derived from the sport, and contributed articles describing how to make and use the innovations to early

enthusiast newsletters. Eventually, they received requests from enthusiasts interested in buying the innovation; these requests signaled the potential profitability of the innovation in the then-emerging commercial marketplace. In addition, the Hawaiians possessed a low profit threshold as their opportunity costs for starting a business were low: Most of them worked in the tourism and construction industries in order to live a sports-centered lifestyle in Hawaii.

14.5.5 Region V: User Entrepreneur Enters the Product Market - and so do Manufacturers When the IP Regime is Weak

In Region V, the value of commercializing the innovation exceeds both the user's and the manufacturer's profitability thresholds, with the user's estimate being higher. The manufacturer's willingness to pay for a license will be based on a lower estimate of the potential opportunity, and therefore, it is unlikely the user would be able to negotiate a licensing deal that is more attractive than product market entry regardless of the strength of the intellectual property regime. However, in this Region, manufacturers will also find product market entry attractive and may choose to enter in weak intellectual property regimes where they can either invent around or even copy the innovation freely.

14.5.6 Extensions

The model we present here is a simple and stylized one, however it can be used to explain changes in commercialization outcomes over time and commercialization outcomes in different intellectual property regimes. Over time, users and manufacturers might adjust their profitability estimates, leading them to enter or exit the product space. In particular, many users who create a new market may exit if the market does not grow, whereas many manufacturers may observe a small market grow and subsequently enter. This issue is more pronounced in the early stages of industry formation where commercial activity may be sparked by users in Regions I and IV. As the industry matures, manufacturers will enter the product market, initiating activity in Regions III and V. As existing firms begin to dominate an industry, subsequent user innovations may be commercialized in Region II. Recent work in the sports equipment and film industries provide preliminary support for these predictions (Shah 2005, Haefliger et al. 2010).

14.6 Discussion and Conclusions

The importance, frequency, and pervasiveness of the phenomenon of user entrepreneurship suggests that it is a vital component of the innovation ecosystem worthy of further study, further theoretical and conceptual development, and integration into existing theories of innovation and economic change. In this paper we developed a theory of user entrepreneurship and articulated the conditions under which user innovators are likely to commercialize their innovations as

opposed to simply using them. We examined differences between users and manufacturers along two dimensions, while also taking into account the strength of the appropriability regime: their assessment of the innovation's profit potential, and their required profit threshold. The model allows us to explain when users will share innovations freely with manufacturers, license innovations to manufacturers, or attempt to commercialize their innovations independently. By parsing out the underlying drivers of commercialization decisions, the model reconciles the existing literature on user innovation, which documents user innovations being commercialized by existing manufacturers, with the phenomenon of user entrepreneurship.

The model also allows us to identify the factors that make a product context particularly *favorable* for user entrepreneurship. These conditions include open product design, modular product architecture, early stages of the industry life cycle, and government regulation that small, early-stage ventures can comprehend and afford to comply with. By making it easier for users to experiment with a product, open product design and modular product architecture enable user innovation and thus user entrepreneurship. In addition, modular product architectures have standardized, documented interfaces among components, thereby allowing innovation by more actors and entry by more firms (Langlois and Robinson 1992, Baldwin and Clark 2000). The stage of the industry life cycle can also make it more or less difficult for users to start firms; in general,

user entrepreneurs will have an advantage over established firms during the early, fluid phase of industry development, although conditions may favor their emergence throughout the industry life cycle (e.g., as parts or components suppliers in modular product domains). Finally, significant government regulation may also lead to low levels of user innovation and user entrepreneurship, *if* such regulation significantly increases barriers to entry by new firms. To this end, some government agencies lower the financial costs of regulatory approval for startup firms in order to increase competition, while providing consumer safeguards.

Theoretical Contributions

The model has implications for theories of innovation, entrepreneurship, and industry evolution. Innovations—and their diffusion—are critical to economic progress (Solow 1957). Understanding the ways in which user innovations are commercialized brings us a step closer to understanding how to support the commercial diffusion of innovative ideas. To date, only two studies have documented content differences between knowledge generated by users and other sources (Riggs and von Hippel 1994, Winston Smith and Shah 2011). Our model also suggests—albeit indirectly—that user knowledge contains more novel content than knowledge from other sources.

Entrepreneurship scholars have focused much attention on spin-outs from incumbent firms (also referred to as *employee entrepreneurship*) (Klepper and

Sleeper 2005, Franco et al. 2009). A robust line of research examines how these startups differ from their parents. It is likely that a high fraction of employee-founded firms are also user-founded firms, allowing employees to benefit from their knowledge of a particular industry without competing with their parent firm; they may even become a supplier to their parent firm (data in Shah et al. 2011 provide support for this idea). Finally, analyzing the behaviors of user entrepreneurs enriches our theoretical understanding of the sources of entrepreneurial ideas and drivers of new firm formation. In particular, the user entrepreneurship phenomenon highlights the importance of social interactions and prior experience in identifying and framing opportunities (Shah 2005, Shah and Tripsas 2007, Shah and Mody 2011). Whereas past work has emphasized the importance of beliefs that originate from prior industry experience (e.g., Shane 2000, Benner and Tripsas 2012), user entrepreneurship research emphasizes the importance of beliefs that originate from interactions associated with use.

Many firms enter and exit during the early or 'fluid' phase of industry development, however existing research tells us little about where these firms come from (Tushman and Anderson 1986, Utterback and Suarez 1993, Fligstein 2001, McKendrick and Carroll 2001, Agarwal and Gort 2002). This paper suggests that at least some of these firms are founded by user innovators, and that user entrepreneurs have informational advantages over other entrepreneurs due to rapidly developing and evolving user preferences, participation in innovation

communities, and knowledge from experimentation and use. User innovators and user entrepreneurs may also play a role in creating technological discontinuities or subsequent eras of ferment. These areas are ripe for elaboration.

Policy Implications

Much government policy, firm strategy, and academic research has been guided by the assumption that profit-driven firms, supported by regimes with strong intellectual property rights, drive product innovation and commercialization (Schumpeter 1934, Demsetz 1967, Dosi 1988).[6] As we have seen, user entrepreneurs also engage in innovation and commercialization activity; however, many user entrepreneurs are guided by different motives. As a result, the impact of these policies on user innovators and user entrepreneurs needs to be carefully examined. First, while intellectual property protection methods should ideally protect the rights of users as well as manufacturers who innovate, a better understanding of whether or not the system upholds the rights of user innovators in practice is needed and system-wide safeguards or additional policies might need to be put into place to prevent inequity. Second, user innovators may be less likely to patent innovations immediately, instead choosing first to share the innovation with others. Some user innovators purposely release their work into the public sphere in order to benefit from incremental improvements on the innovation by other users. As a result, they may be prevented by law from

patenting if they do not file for patent protection within the first year after disclosing details of the innovation. While such sharing is discouraged by the existing system, it is these very behaviors that help generate interest in the product and give rise to new product markets. Policy makers wishing to spur economic growth by crafting programs and policies that encourage and support startup activity should consider the prevalence, technological importance, and distinctive behaviors of user entrepreneurs.

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Figure 14.1: Who Will Commercialize a User Innovation?

Note: This illustration sets the user’s profit threshold at a lower level the manufacturer’s profit threshold.

[1] The situation is similar in the history and sociology of technology literature: although users might relay product preferences to designers or perhaps even innovate for themselves, it was largely assumed that users do *not* engage in economic or commercial activity. There are several reasons for this. The "social construction of technology" (SCOT) approach initially endowed *technologies* with "interpretive flexibility" such that consumers had the ability to interpret and use technologies in new ways but did not have the ability to alter those technologies (i.e., innovate). It was only after Mackay and Gillespie (1992) criticized the SCOT approach for not thoroughly exploring the range of activities that users might engage in and for not showing how users could actively *modify* stable technologies, that Kline and Pinch (1996) conducted a study of the Model T showing how users can act as "agents of technological change" - that is, as innovators. However, it was largely new kit makers and existing automobile manufacturers who commercialized these innovations. A separate study of automobile innovations during the same time period (early 1900s) finds that "[t]he rewards of tinkering lay not in economic success within the auto accessories market, but in the cultural space of leisure where amateurs produced their own narratives of ingenuity and claimed knowledge of the new machine." (Franz 1999, 149). Two subsequent studies - Lindsey (1997) on the TRS-80 personal computer and Muñiz Jr. et al (2005) on the Apple Newton PDA -

showed that users might adopt multiple identities or roles with respect to a particular technology *when faced with no other choice.* Both studies find evidence that users and user communities engage in the service, sale, and resale of beloved products that are no longer supported by commercial manufacturers. Additional roles for users are less well-understood in this literature. Rosen (1993) and the studies in Oudshoorn and Pinch (2003) argue for expanding and further studying the role of users, particularly how the activities of one set of users influences other sets and how user activities influence industrial production models.

[2] Conduct of R&D in the first year of operations is the proxy used to identify

[3] The conceptual model can also be used to consider when non-user-founded start-ups might commercialize a user innovation. Such firms would likely fall somewhere between users and manufacturers in terms of the information they possess and their assessments of the innovation's profit potential.

[4] Examples of sporting equipment innovations and their commercial histories are based on descriptions and analyses found in Franke and Shah (2003) and Shah (2005).

[5] By intellectual property regime, we are primarily referring to the effectiveness of formal IP mechanisms such as patents or copyright, in the industry context in which the user is engaged. See, for instance, Cohen, Nelson & Walsh (2000) for a discussion of how the strength of the IP regime varies by industry.

[6] A number of scholars, policy-makers, and practioners have questioned the validity of this assumption, although this assumption is often used to guide policy and practice. Readers interested in learning more about whether or not patents spur innovation might start with a recent report by the National Academies (2003), as well as a recent paper by Tomlinson and Torrance (2009) titled "Patents and the Regress of the Useful Arts."