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INFORMATION EXPOSURE, OPPORTUNITY EVALUATION, AND ENTREPRENEURIAL ACTION: AN INVESTIGATION OF AN ONLINE USER COMMUNITY

ERKKO AUTIO
Imperial College Business School

LINUS DAHLANDER
ESMT European School of Management and Technology

LARS FREDERIKSEN
Aarhus University

We study how an individual's exposure to external information regulates the evaluation of entrepreneurial opportunities and entrepreneurial action. Combining data from interviews, a survey, and a comprehensive web log of an online user community spanning eight years, we find that technical information shaped opportunity evaluation and that social information about user needs drove individuals to entrepreneurial action. Our empirical findings suggest that reducing demand uncertainty is a central factor regulating entrepreneurial action, an insight that received theories of entrepreneurial action have so far overlooked.

Opportunity discovery and entrepreneurial action are at the heart of modern theories of entrepreneurship (Kirzner, 1973, 1997; McMullen & Shepherd, 2006; Shane, 2001; Shane & Venkataraman, 2000). The recognition of third-person entrepreneurial opportunities—that is, the conjecture that an opportunity exists for the willing and able to sell products and services at a price greater than the cost of their production—is a necessary but not sufficient prerequisite for entrepreneurial action (Grégoire, Shepherd, & Schurer Lambert, 2010; Shane & Venkataraman, 2000).[1] Because entrepreneurship is purposive and consequential social action (Granovetter, 1985), an individual also needs to form a belief that the opportunity offers a feasible and desirable course of action for him- or herself, as otherwise the individual would not act. To advance the empirical understanding of entrepreneurial action, we therefore study how individuals recognize and evaluate third-person opportunities for entrepreneurial action and what factors influence the conjecture that the recognized opportunities represent feasible and desirable courses of action (Shepherd, McMullen, & Jennings, 2007).

Although opportunity recognition and evaluation are key prerequisites of entrepreneurial action, there is surprisingly little empirical research on how individuals recognize and evaluate third-per-

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[1] We use the term "opportunity discovery" to refer to instantaneous reduction in radical uncertainty (Kirzner, 1997). "Opportunity recognition" refers to an individual's awareness of third-person opportunities for entrepreneurial action. "Opportunity evaluation" refers to his/her action of evaluating whether third-person opportunities represent feasible and desirable first-person opportunities for entrepreneurial action. We operationalize opportunity evaluation as business planning and entrepreneurial action as specific venture organizing and operating activities (also see Methods).

son opportunities, and when opportunity evaluation is likely to lead to entrepreneurial action (Haynie, Shepherd, & McMullen, 2009). The arguably dominant influence on research on entrepreneurial opportunity *discovery*—the "Austrian" tradition—has treated it as a virtually instantaneous event that is almost automatically followed by opportunity pursuit (Kirzner, 1997). In this tradition, emphasis is attached to factors regulating opportunity discovery, while the processes regulating opportunity evaluation and entrepreneurial action are given less attention (Shane, 2000; Shane & Venkataraman, 2000).

In an important complement to the opportunity discovery tradition, McMullen and Shepherd (2006) argued that central to entrepreneurship is not whether objective and observable opportunities exist independently of individuals, but rather, whether individuals *perceive* opportunities and *act* upon them. Their action approach portrays individuals as reacting to external stimuli and forming third- and first-person opportunity beliefs as a result. Third-person opportunity recognition is a necessary precondition for opportunity evaluation, and if the evaluation results in a first-person opportunity belief, the entrepreneurial action of selling products and services may be triggered. The process of opportunity evaluation is portrayed as an intensive cognitive process, during which information describing a person's external environment guides and updates his/her emergent cognitive representations (Shepherd et al., 2007). However, because it is difficult to obtain unbiased observations of individuals in prefounding situations (Shane & Khurana, 2003), little research exists on where external information stimuli come from, how individuals evaluate them, and under which conditions a sufficient reduction in response uncertainty is achieved to trigger entrepreneurial action (Grégoire et al., 2010). The few empirical studies building upon McMullen and Shepherd's (2006) action theory of entrepreneurship employ experimental designs to examine how individuals judge opportunity scenarios (Fitzsimmons & Douglas, 2011; Grégoire et al., 2010; Haynie et al., 2009). While illuminating the cognitive processes of opportunity evaluation, such experimental designs tell little about where stimuli arise from in practice and which conditions facilitate the conversion of these into first-person opportunity beliefs and entrepreneurial action.

In this article, we address this gap by exploring how an individual's exposure to external information regulates the recognition and evaluation of third-person opportunities, on the one hand, and subsequent entrepreneurial action, on the other. Specifically, we explore how the production and distribution of information regarding "means" and "ends" in social systems regulates these processes. We suggest that in contexts characterized by frequent technological advances, potential entrepreneurs are usefully thought of as embedded in not one, but two, interconnected information domains: one associated with technological advances (i.e., "means"), and another associated with user needs (i.e., "ends"). The two domains exercise different influences on opportunity evaluation and entrepreneurial action. Specifically, we propose that technological information regulates third-person opportunity recognition and opportunity evaluation by individuals. We further posit that exposure to information about user needs drives entrepreneurial action, both in its own right and (especially) when combined with information about technological solutions.

We test our theoretical model using data from an online user community. Online user communities are internet-based platforms for communication and exchange among users interested in a given product or technology (Baldwin & von Hippel, 2011; Jeppesen & Frederiksen, 2006). They are typically not confined to the boundaries of any given organization. Joining such communities is usually easy, and there is usually little screening of community members beyond self-selection based on thematic interest (Dahlander & O'Mahony, 2011; Lee & Cole, 2003). In online user communities, users of different products and services share and debate experiences, news, and ideas regarding product and service features, uses, and improvements (von Krogh & von Hippel, 2006). Such communities facilitate collective experimentation and exploration around a given set of technologies and thus provide an ideal platform for the study of the effect of technological and user information on opportunity recognition and entrepreneurial action (Haefliger, Jaeger, & von Krogh, 2010; Lakhani & von Hippel, 2003). We study the Propellerhead online community, which has stimulated extensive user innovation and entrepreneurship in software for music production, processing, and editing (Jeppesen & Frederiksen, 2006).

Our study offers four distinctive contributions. First, we provide a rare examination of the facilitators of opportunity evaluation and entrepreneurial action by individuals in prefounding situations, thereby contributing to the action theory of entrepreneurship. Second, and specifically, we advance understanding of how the production and distribution of different kinds of information in social systems facilitates individuals' opportunity evaluation and entrepreneurial action. Third, our work contributes to the emerging research stream on user entrepreneurship (Shah & Tripsas, 2007) by moving beyond descriptive and conceptual studies toward theory testing. Finally, while earlier work shows that user communities are important platforms for innovation and experimentation (Dahlander & Frederiksen, 2012), we demonstrate how these communities can also provide a fertile ground for entrepreneurial action.

In addition to providing empirically grounded insight into the origins and operation of stimuli for opportunity evaluation and entrepreneurial action, our model also has broader implications for management scholars. Entrepreneurial action is not confined to new and small firms alone. For established firms to recognize and act upon diversification opportunities, they need to match the discovery of technological opportunities with the identification and evaluation of unrealized user needs (Alderson, 1965). Although the need to reduce both supply and demand uncertainty is commonly accepted by management scholars, it has not been widely tested empirically. Our model should therefore have implications in contexts other than new ventures—for example, corporate venturing.

THIRD-PERSON OPPORTUNITY RECOGNITION AND EVALUATION AND FIRST-PERSON OPPORTUNITY BELIEFS

Entrepreneurship is purposive social action that requires foresight, effort, and resources. Entrepreneurial initiatives therefore reflect an individual's conjecture that a first-person opportunity exists and is attractive—that is, if realized, the opportunity promises returns greater than the cost of its pursuit (Eckhardt & Ciuchta, 2008). To explicate how such conjectures are formed, McMullen and Shepherd (2006) drew on the psychology and philosophy of action to build an action theory of entrepreneurship. Central to their conceptualization were the notions of judgment, response uncertainty, and doubt. Following Hebert and Link (1988) and Casson (1982: 22), they defined an entrepreneur as someone who specializes in making judgmental decisions about the coordination of scarce resources. Such decisions are made in response to external stimuli. Whether or not an individual interprets an external stimulus as signaling a feasible and desirable course of entrepreneurial action will depend on judgments formed during opportunity evaluation. Because of the uncertainty characteristic of future-oriented endeavors, entrepreneurial judgments are accompanied by doubt, which tends to block or delay action (Lipshitz & Strauss, 1997) by giving rise to hesitancy, indecision, and procrastination (McMullen & Shepherd, 2006).

Given that uncertainty inhibits entrepreneurial action, it is important to consider how potential entrepreneurs evaluate third-person opportunities and overcome uncertainty. McMullen and Shepherd (2006) posited that the opportunity recognition process consists of "attention" and "evaluation" stages. In the attention stage, individuals observe third-person opportunities by virtue of having been sensitized to a given set of problems (e.g., dissatisfaction with existing digital tuning algorithms, in our empirical context) and exposed to information describing potential solutions. Once an individual recognizes a third-person opportunity, a first-person evaluation ensues, during which the individual identifies a defined course of action (i.e., the launch of an entrepreneurial venture to exploit the opportunity) and determines whether the identified course of action is feasible and desirable. If the evaluation suggests a strong enough composite of feasibility and desirability, action to create value by selling products and services will be triggered.

This schematic illustration of the attention and evaluation stages is silent about how the evaluation is actually performed and what triggers entrepreneurial action. In a follow-on work, Shepherd et al. (2007) elaborated on this aspect and presented a model of the formation of opportunity beliefs by individuals. They drew on coherence theory (e.g., Rensink, 2002) to build a process model that portrayed opportunity belief formation as either a cognitive bottom-up process driven by an individual's formation of gestalt-like mental representations of his/her environment or a top-down process driven by the individual's preconceived knowledge and motivation structures, which are updated against information describing the environment. This suggests that the formation of first-person opportunity beliefs is a cognitively intense process characterized by interaction between an individual's knowledge and motivation, and external information.

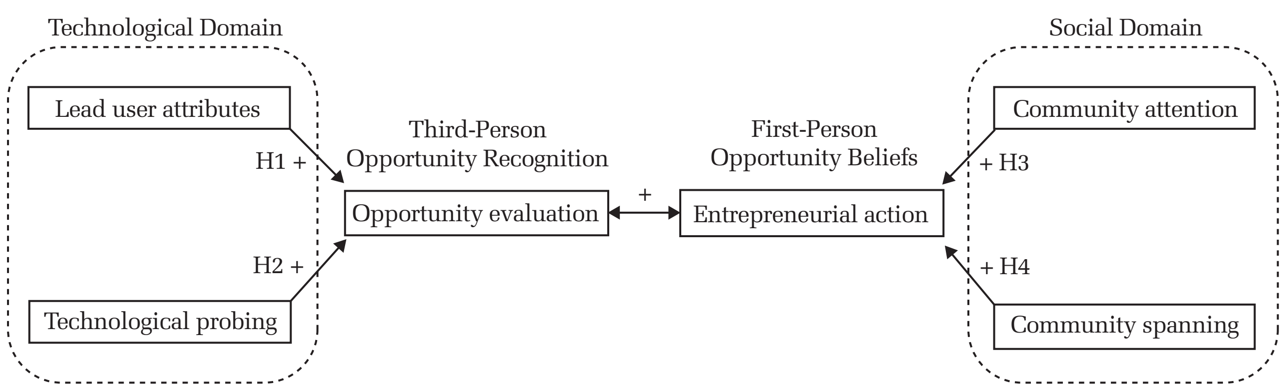
The centrality of external information as an initiator and regulator of opportunity beliefs raises the question of whether and how information exposure influences the process. Because of its narrow focus on entrepreneurs' cognitive processes, the action theory of entrepreneurship does not provide detailed elaboration of this aspect, beyond general references to external stimuli and individuals' exposure to information flows. We think this question merits attention, since individuals can only recognize and react to stimuli that they are exposed to, and they can only combine their knowledge and motivation with environmental information that they are able to access. It is therefore important to consider how the exposure to different kinds of information influences opportunity evaluation and entrepreneurial action by individuals.

The effect of information on opportunity discovery is extensively discussed in research that draws on Austrian economics (Eckhardt & Shane, 2003; Kirzner, 1997; Shane & Venkataraman, 2000). In the Austrian portrayal, the distribution of information in social systems regulates opportunity discovery. Individuals partly access, partly create this information through their interactions with others, as they mutually learn about one another's plans, preferences, and intentions (Kirzner, 1997). Thus, rather than regulating action, information regarding opportunities is produced through speculative actions by market participants. Because of the way information is partly embedded in social systems, partly produced through mutual interaction, it is not fully knowable to any single individual ex ante, but rather, only gradually revealed through interactions with others (Hayek, 1945). New opportunities are discovered through uncovering new means-ends relationships that, if fruitfully combined with an individual's idiosyncratic skills, experience, and resources, trigger entrepreneurial action (Eckhardt & Shane, 2003; Shane, 2000).

The opportunity discovery perspective suggests two important insights into how an individual's exposure to external information influences opportunity recognition and evaluation and subsequently drives entrepreneurial action. First, given the way information relevant for the formation of opportunity beliefs is embedded in social structure, an individual's position within a social structure should matter for first-person opportunity beliefs and entrepreneurial action. Second, the prevalent notion of opportunities taking the form of new means-ends relationships implies that to embark on entrepreneurial action, the individual needs to be exposed to information of at least two kinds—information on both means and needs. Information relevant to each may reside in different parts of the social structure, and the individual's position may therefore matter differently for exposure to the two different kinds of information.

In what follows, we build a model that explicates how an individual's exposure to information regarding means and ends regulates the recognition and evaluation of third-person entrepreneurial opportunities and entrepreneurial action, respectively. Figure 1 presents our model, which distinguishes between exposure to information residing in the technological domain and that in the social domain. We submit (following McMullen and Shepherd [2006]) that an individual's exposure to technological advances will enhance the recogni-

FIGURE 1
Conceptual Model



[a] We expect a positive correlation between opportunity evaluation and entrepreneurial action, as illustrated with the positive sign. However, in the article we do not theorize about this relationship. Our estimations are able to empirically deal with this correlation.

tion of third-person opportunities and trigger opportunity evaluation activities. We also suggest that for the individual to decide that opportunities represent feasible and desirable first-person opportunities, information on user needs is necessary. However, we are not suggesting that entrepreneurial action should *always* be preceded by an empirically observable evaluation phase. As Shepherd et al. (2007) noted, individuals, especially when in the "top-down" mode of opportunity belief formation (a mode driven by established knowledge structures rather than emergent cognitive representations of environment, as is the "bottom-up" mode), can form first-person opportunity beliefs quite rapidly, even instantaneously.

HYPOTHESES

Exposure to the Technological Domain and Third-Person Opportunity Recognition

Opportunities evolving in the technology domain represent observable third-person opportunities for individuals. Technological progress consists of the creation of physical and knowledge-based artifacts that can be harnessed to serve instrumental purposes (Niiniluoto, 1993). Because technological advances exploit organized knowledge concerning physical reality, technological information tends to be more structured than information concerning user tastes and preferences (Clark, 1985; Wade, 1996). It is organized around technological trajectories (Dosi, 1982), punctuated by technological guideposts (Sahal, 1985), and constrained by dominant designs (Abernathy & Utterback, 1978; Anderson & Tushman, 1990). These characteristics make technological progress more predictable than social progress, enabling individuals to predict, recognize, and contemplate third-person opportunities created by technological advances.

Although technological progress is largely predictable, not all individuals are equally positioned to access and evaluate information concerning technological advances. Two factors are particularly salient in this regard. First, individuals' experience-induced awareness of technological bottlenecks, along with their experience searching for solutions, sensitizes them to information stimuli that signal third-person opportunities. These qualities resonate closely with the notion of *lead users* (Morrison, Roberts, & Midgley, 2004; von Hippel, 1988). Second, *technological probing* enables individuals to participate in, and sometimes lead, the articulation and creation of new technological advances in a community (Morrison, Roberts, & von Hippel, 2000). In the following section, we elaborate how these characteristics facilitate an individual's recognition and evaluation of third-person opportunities created by technological advances.

Lead User Attributes and Third-Person Opportunity Recognition

Lead users are individuals whose goal fulfillment is hampered by technological performance bottlenecks and who therefore expect significant benefits from technological advances in a given solution domain (von Hippel, 1988). Since lead users' ability to meet desired ends is constrained by the technological state of the art in this domain, they are more likely than ordinary users to search for potential solutions and be cognizant about and monitoring relevant technological advances. This scanning activity makes lead users better aware than ordinary users of emerging technological trends and associated third-person opportunities. Lead users should therefore be more likely than ordinary users to engage in evaluation of third-person opportunities for entrepreneurial action.

Sometimes lead users experience technological constraints so acutely that they start developing technological solutions by themselves (Morrison et al., 2000). A literature has documented a multitude of examples of lead users who have developed product modifications, add-ons, and completely new products in a wide range of industries (Franke & Shah, 2003; von Hippel, 1988). To develop new technological solutions, lead users occasionally interact with others who are likely to possess the kind of state-of-the-art knowledge required to develop solutions. This activity should further enhance lead users' recognition of third-person opportunities, as well as the likelihood that they engage in opportunity evaluation.

Although lead users experience bottlenecks and performance constraints more clearly than ordinary users, their estimations regarding the potential economic value of technological solutions remain subjective and may lack external validation. While lead users may be sensitized to technological trends, they may lack access to endorsement and information from other users. However, the assessment of the economic potential associated with third-person opportunities opened by technology trends requires access to information regarding other users' needs (Companys & McMullen, 2007; Shane, 2000). Therefore, although early discovery of third-person opportunities is likely to prompt speculation whether user-developed solutions might be useful to other users (Jeppesen & Laursen, 2009), solution discovery alone may not be sufficient to trigger entrepreneurial action:

Hypothesis 1. Individuals with a high degree of lead user attributes are more likely to engage in opportunity evaluation.

Technological Probing and Third-Person Opportunity Recognition and Evaluation

Communication among users in online communities is organized around discussion "threads": users open new discussion threads to signal and frame a new issue, problem, call for advice, or area of exploration. We characterize this activity as technological probing. We propose that technological probing provides informational advantages that facilitate the recognition of technological opportunities, prompting evaluation of these. This is because technological probing makes users better aware of technological trends and developments, and it also helps advance desired developments within a user community.

Individuals active in technological probing can enjoy early access to information about emerging technological developments in online user communities. By opening new discussions, technological probers can receive early feedback about the viability of technological developments of interest for them. This information advantage enhances their ability to recognize which developments are technically possible and which developments a user community supports. However, because technological probing explores emergent technological paths rather than unrealized user needs, it does not necessarily yield information advantages regarding user needs. Absent information about the potential economic value of alternative technological development paths, the enhanced recognition of third-person opportunities in the technological domain should encourage opportunity evaluation but not necessarily entrepreneurial action.

Technological probing not only increases users' awareness of technological opportunities, but also may enhance the viability of the technological developments probed. By highlighting given technological issues and solutions, technological probers draw the attention of their user community to these, helping prompt technological development activity around the issues probed. This way, technological probers may act as opinion leaders who help steer the allocation of technological effort in the community toward given technological issues and solutions (see also Myers & Robertson, 1972). Although the opinion leadership effect is, in most cases, an unintended consequence of technological probing activity, the agenda-setting effect of such probing should nevertheless facilitate the emergence of technological solutions that are of interest for the technological probers. The emergence of such solutions should trigger opportunity evaluation. Summarizing, we predict:

Hypothesis 2. Individuals engaged in a high degree of technological probing are more likely to engage in opportunity evaluation.

Exposure to the Social Domain and Entrepreneurial Action

We argued that exposure to technological information imbues individuals with domain insight and stimulates opportunity evaluation. However, in the absence of strong preconceived knowledge and motivation, third-person opportunities alone do not necessarily prompt the conjecture that the opportunities observed represent actionable first-person opportunities for an individual. If response uncertainty prevails, the individual is likely to hesitate and forego or postpone action (McMullen & Shepherd, 2006). We propose that the individual's exposure to information regarding user needs reduces response uncertainty and lowers his/her threshold for entrepreneurial action.

Our model contains two factors in the social domain that affect individual propensity for entrepreneurial action. First, we expect that *community attention* received an individual receives from other users facilitates insights regarding unrealized user needs. Second, we expect that *community spanning* enables the individual to draw on analogous examples in related domains to validate tentative conjectures regarding user needs, and thus, judge the potential economic value of new developments.

Community Attention and First-Person Entrepreneurial Action

In the context of entrepreneurial action, an important aspect of response uncertainty concerns the scale of market demand for new products and services. We define market uncertainty as the sum of demand uncertainty, product uncertainty, and supplier uncertainty. Demand uncertainty concerns underlying market demand (i.e., Is there a need for a solution like this?). Product uncertainty concerns the attractiveness of a given solution relative to other solutions (i.e., Would other users choose this particular solution?). Supplier uncertainty involves the legitimacy of an individual as the supplier of the solution (i.e., Would other users buy this solution from me?). Community attention should lower all three aspects of market uncertainty. Attention signals that the individual's actions resonate with others in his/her user community and provides proof of widely experienced needs and emotional commitment to the eventual outcome, increasing individual's confidence that others will commit to a particular solution (Franke, Schreier, & Kaiser, 2010).

The magnitude of consumer response is a well-established metric of market demand in the marketing literature (Rein, Kottler, & Stoller, 1987). For example, consumer goods companies routinely use the speed and magnitude of returned coupons as a reliable metric of consumer demand (Berry & Linoff, 1999). As users share experiences, propose and select solutions, and exchange ideas regarding a given product in user communities, their responses reveal what they care about (Whittaker, Terveen, Hill, & Cherny, 1998). Therefore, responses to online postings provide an important source of information on user needs. The higher the number of responses received, the greater the reduction in demand uncertainty should be.

Individuals who engage in a conversation regarding new technological developments by responding to postings are more likely to develop a feeling of psychological ownership toward any solution developed as the outcome of the conversation (Franke et al., 2010). This form of consumer empowerment can be a potent tool for increasing users' emotional attachment to a given product (Fuchs, Prandelli, & Schreier, 2010). Franke et al. (2010) demonstrated that proposing solutions to a problem shared in a user community increased respondents' emotional commitment to the eventual solution and their willingness to pay—a dynamic referred to as the "I designed it myself" effect (Norton, 2009). Attention from other users is therefore a promising sign of other users' likely commitment to any new developments resulting from a conversation, thereby reducing market uncertainty. In addition, a high level of community attention has been shown to enhance the ability of an individual to solicit positive emotional responses from other users, thereby increasing confidence that other users will react positively to his/her offerings (Kurzman et al., 2007).

To summarize, a high level of community attention to a focal individual's expressed technological interests informs the individual that a widespread need exists for the solution or issue under discussion; signals that other users will likely experience psychological ownership of the resulting solution; and suggests that the community is likely to accept a solution supplied by that individual. All this lowers market uncertainty and therefore, the threshold for entrepreneurial action:

Hypothesis 3. Individuals who receive a high degree of community attention are more likely to engage in entrepreneurial action.

Community Spanning and Entrepreneurial Action

We propose that community spanning, defined as participation in several communities, helps reduce market uncertainty and thus lower the threshold for entrepreneurial action. First, community spanners gain informational advantages from participation in several communities (Tushman & Scanlan, 1981; Vaghely & Julien, 2010). Second, community spanning enables individuals to draw on parallels and analogies when judging the economic viability of technological options and anticipating demand patterns (Gaglio & Katz, 2001; Lee, Goodwin, Fildes, Nikolopoulos, & Lawrence, 2007). Third, individuals exposed to diverse "thought worlds" are able to frame problems differently (Dougherty, 1992), which helps reduce perception of market uncertainty in any given community.

Community spanners have the potential to observe related, yet different, social dynamics. Exposure to different communities enables individuals to more accurately recognize incipient and potentially influential social trends and foresee their likely outcomes (Vaghely & Julien, 2010). Community spanning also allows individuals to learn and reuse different practices, tricks, and references from different communities, strengthening the focal individuals' belief in the first-person viability of third-person opportunities.

Community spanning enables individuals to draw on analogies when evaluating opportunities.

Analogous reasoning provides a useful device for predicting future developments in uncertain situations (Gaglio & Katz, 2001), because it provides a source of surrogate experience that enables the individuals to more accurately estimate the outcomes of socially complex developments (Autio, George, & Alexy, 2011). Demand patterns often unfold in similar ways in related communities: the usefulness of drawing on observed demand patterns in related contexts is well established in the area of demand forecasting (Lee et al., 2007). The ability to draw on analogous examples from other communities therefore lowers demand uncertainty for a focal individual.

Finally, community spanning exposes individuals to different thought worlds and ways of framing problems (Dougherty, 1992). An important aspect of third-person opportunities concerns the assessment of alternative approaches to opportunity pursuit. By virtue of their ability to better reframe the problem to which a given technological development is applied, community spanners are able to circumvent seemingly difficult obstacles, thereby sidestepping aspects of demand uncertainty. When demand uncertainty is lowered, entrepreneurial action is more likely to follow:

Hypothesis 4. Individuals who engage in a high degree of community spanning are more likely to engage in entrepreneurial action.

We hypothesized that exposure to a technological domain enhances the likelihood of opportunity evaluation, while exposure to a social domain enhances the likelihood of entrepreneurial action. However, we are not formally hypothesizing a mediating relationship here, as we recognize that the formation of first-person opportunity beliefs can sometimes be virtually instantaneous (Shepherd et al., 2007). Our approach is also consistent with that of Haynie et al. (2009), who argued that since opportunity evaluation gives rise to future-oriented cognitive representations of what would happen, were the individual to pursue an opportunity, opportunity evaluation is likely to proceed and be separate from a decision to exploit. Thus, we recognize that individuals can exhibit four combinations of opportunity evaluation and entrepreneurial action: (1) no evaluation of third-person opportunities and no entrepreneurial action; (2) evaluation of third-person opportunities without action (i.e., "unrealized opportunities"); (3) entrepreneurial action with virtually instantaneous evaluation (i.e., "opportunistic action"); and (4) evaluation combined with action (i.e., "premeditated action"). Figure 2 illustrates these combinations.

METHODS

Research Setting

To test our theoretical model, we use unique data from a public, unrestricted online user community, hosted by the Swedish music software firm Propellerhead, that focuses on digital music production and editing software. This company has hosted a website since 2001 to allow users to communicate with one another, solve problems, and tinker with its digital music production and editing platform. Members of the community create, produce, process, and record music with Propellerhead's software and develop related complements. Over the years, the community has spawned more than a 100 product modifications and customized applications that either added features and functionalities to the software platform or provided connectivity to other software products in useful and value-adding ways. Because of this, the Propellerhead community has become an important forum for the discovery and pursuit of entrepreneurial opportunities and seen more than 30 new ventures created by community members.

Because the community has active contributing members from more than 35 countries, and because the online user community provides the main plat-

FIGURE 2
Opportunity Evaluation and Entrepreneurial Action

		Entrepreneurial Action: No	Entrepreneurial Action: Yes
Opportunity Evaluation	No		Opportunistic action
	Yes	Unrealized opportunities	Premeditated action

form for interaction between these individuals, the vast majority of all interactions between community members have taken place online, where they have been recorded and made available for post hoc analysis. This setting therefore provides a unique opportunity to track how an individual's experience and position within a community influence third-person opportunity recognition and evaluation and entrepreneurial action.

Data

We adopted a multimethod strategy and "triangulated" data by using different data sources (Jick, 1979; Miles & Huberman, 1994). A multimethod inductive-deductive approach permitted us to better validate constructs and to choose an appropriate theoretical lens for the study (Edmondson & McManus, 2007). Our data came from (1) interviews, (2) a survey, and (3) a web log (message archive) of all interactions in the Propellerhead user community (henceforth, "the community"), thus helping us avoid common method bias (Doty & Glick, 1998). We used web log data and content coding to track users' information exposure prior to the distribution of the survey, which collected data on opportunity evaluation and entrepreneurial action. We matched survey data with web log data using a unique identifier for each respondent.

Interviews. We conducted 42 interviews with 19 individuals in the community and Propellerhead employees before the end of 2011. The interviews provided contextual grounding for our theory development and supported the empirical validity of our theory and constructs. We sought to understand how the community worked in terms of communication between users, problem-solving processes, and the ideation, creation, and dissemination of new products and solutions within the community.

To obtain insight into the history and evolution of the Propellerhead community, we conducted interviews with the CEO of Propellerhead as well as with its product developers and the moderator of the online user community. We interviewed individuals within the user community, oversampling individuals who had started entrepreneurial firms on the basis of their experiences in the community but also including individuals who had not pursued entrepreneurial opportunities.[2] We conducted interviews face-to-face and by telephone and also corresponded by e-mail. We recorded and transcribed each interview and, in most cases, took notes during and after interviews. We used the interviews to guide our questionnaire design and quantitative data collection. In parallel with analyzing our quantitative data, we conducted additional interviews and built interpretations from the qualitative data. When building our interpretations, we iterated back and forth between data, relevant literature, and embryonic theory (Dougherty, 2002). To provide contextual grounding for our interpretations and theory and to illustrate the possible direction of underlying causal mechanisms (Kim & Miner, 2007), our Results section introduces a few qualitative findings after we present the quantitative analysis.

Survey. We collected data on entrepreneurial activities among community members with an online survey administered at the community's website. The questionnaire was open for replies for one month and attracted answers from 280 of 966 users who logged in during this period. Only users who logged in to the community pages were presented with the option to participate in the survey. After a review, we dropped five responses because of missing information on the dependent variables, leaving us with a survey sample of 275 valid answers and a 28.5 percent response rate. The survey employed previously validated multi-item scales to measure our theoretical constructs. Following Podsakoff, MacKenzie, Jeong-Yeon, and Podsakoff (2003) we protected anonymity, counterbalanced question order, and used several scale anchors and scale formats. We pretested the survey with a small number of individuals in the community before distributing it.

Our checks for response bias (Armstrong & Overton, 1977) revealed that individuals who responded to the survey were slightly more active than the general population in the community. As explained later in the Analysis section and the Appendix, we controlled for self-selection bias by computing the inverse Mill's ratio, using information about nonrespondents from the web log data.

Web log of interactions. To complement the survey data, we obtained data from the community's message archives (web log) of all interactions in the community from its 2002 inception to May 2008. All communications within the online community are recorded in online archives and provide a valuable, unbiased source of behavioral data on intracommunity interactions. We gathered complete in-

[2] We also conducted interviews with people in the community who cannot be labeled as lead users.

formation from all participants, including the sender of each posting, timing, subject, message content, whether the posting was a first thread in a new conversation, and who the recipient was. The web log contained all 151,092 messages posted in the community by a total of 8,640 individuals. This unique data set enabled us to monitor an individual's engagement and role in the user community rather than rely solely on self-reported data. We used a unique identifier to link the web log data with the survey data.

We also used the web log to code the content of messages (Weber, 1990) to verify the quality, usefulness, and degree of technical specification of questions and answers provided by users. Coding allowed us to control for any effects these aspects exacted on users' opportunity evaluation and entrepreneurial action.

Measures

Dependent variables. Using data from the survey instrument, we developed two dependent variables that reflect third-person opportunity recognition and evaluation and first-person entrepreneurial action, respectively. Because entrepreneurial action requires time and effort, it is typically preceded by premeditation and planning (Bird, 1988). As our proxy for third-person opportunity recognition and evaluation, we used a set of questions designed to determine whether an individual had undertaken tangible action to evaluate opportunities, drawing on their activities and experience in the Propellerhead community. We chose a proxy that covers both opportunity recognition and evaluation because opportunity recognition is difficult to observe directly. Observing evaluation was appropriate, because evaluation must necessarily be accompanied by recognition of the stimulus that is being evaluated. Although not all stimuli are subjected to evaluation, we chose to capture tangible evaluation activities because these signal meaningful intent (see McMullen & Shepherd, 2006: 148–149). Our operationalization of opportunity evaluation is consistent with the theory of the psychology of action, which distinguishes between "motivational" and "volitional" phases of the opportunity awareness and evaluation continuum and positions planning activities in a volitional preactivity phase (Gollwitzer, 1996: 289).

Opportunity evaluation was coded as a dummy ("yes" = 1) if (1) a respondent stated that he/she had "made written plans to start a business" or "looked for resources to start a new business (e.g., funding, business partners, business premises, etc.)" and (2) stated that "my community experience was of importance" in that action.[3] These items were adopted from the Panel Study of Entrepreneurial Development (PSED), which is widely used in the entrepreneurship research community (Reynolds, 2007). When recognizing a potential opportunity for entrepreneurship, individuals often undertake precursory activities—planning activities intended to determine the feasibility and desirability of the new venture without representing a definite commitment to the venture (Carter, Gartner, & Reynolds, 1996; see also Gollwitzer, 1990). Our operationalization is close to the one used by Delmar and Shane (2003); Shane and Delmar (2004), and Dimov (2010), who also used a PSED-based measure of business planning as a proxy for opportunity evaluation. Although business planning represents a volitional planning activity (Gollwitzer, 1996), it does not automatically lead to entrepreneurial action: indeed, the PSED shows that nearly two-thirds of nascent entrepreneurs never actually start a new business (Reynolds, 2007).

We measure entrepreneurial action by capturing definite venture organizing activities (e.g., Delmar & Shane, 2003). We captured entrepreneurial action with a dummy variable that was assigned the value 1 if an individual reported that he or she had "sent invoices for products or services offered by your company," "done the paperwork and officially registered the company," or "sold products and services through my company" and that "my community experience was of importance" in these actions.[4] The statements focusing on sales and value creation capture a tangible validation that an opportunity actually exists to sell products and services (Eckhardt & Shane, 2003).

[3] To ensure that the survey respondents' activities surrounding opportunity evaluation and entrepreneurial action were directly linked to their community participation, we included an additional scale in our questions probing the extent to which community experience was important ("not important," "of little importance," "somewhat important," or "very important") relative to the question at hand.

[4] For validation purposes, we also constructed an alternative objective measure of entrepreneurial action using data on start-ups in the community. We were able to assess this for all cases except a handful, and in those cases in which we had data, this measure was perfectly aligned with our self-reported measure.

Independent variables. We based our scale of *lead user attributes* on the work of Morrison et al. (2004). Because we perceived a few methodological issues with their scale, we extended it to eight items in the online survey to create a more comprehensive measure.[5] We used a Likert scale ranging from 1 ("strongly disagree") to 5 ("strongly agree"). The internal reliability of this scale was good (α = .75). The lead user attribute scale was formed as the arithmetic mean of the different items.

Opening new online discussion threads can be a powerful means to shape the agenda of a user community. We therefore measured an individual's *technological probing* activity in the community by the total number of new threads started by the individual divided by the overall activity (total number of postings) of the individual. Similarly, we measured the *community attention* received by the individual by using the average number of responses received for each online posting of the individual.

Finally, we argued spanning multiple communities provides informational advantages that lower perceived response uncertainty for entrepreneurial action. To measure *community spanning*, we used a two-stage question in the online survey. We asked, "Have you actively participated in other online communities NOT hosted by Propellerhead during the last three years?" For those individuals that ticked "yes," a follow-up question queried about the names of other online communities. We used Google and other search engines to identify and code all communities mentioned. The content coding of these communities was carried out by two of the authors independently and cross-checked afterward. We reasoned that participation in multiple online communities that were technologically related to the focal community, as opposed to online community engagement in general, would provide more pertinent information advantages. We therefore only included those communities that, similarly to Propellerhead, dealt with (1) software products for music production, recoding, and processes, or (2) addressed music editing for creating sound tracks, music, or (3) hosted communities for inspiration and downloading new samples, or (4) hosted communities for downloading and engaging with software products not directly connected to music production but that supported, for example, software programming or sound track production. We excluded general social networks such as Facebook and Yahoo user groups.

Control variables. Longer tenure in the community would allow individuals more time to recognize opportunities and, presumably, give them more experience in sourcing information from it. We used the web log data to control for *community tenure*, measured as the number of years since an individual's first posting in the community.

To isolate the community attention effect, we needed to rule out the effect of sheer number of postings in the community. The nature of a given individual's contributions varied considerably. Some postings were more sophisticated, asking, for example, about suggested solutions for difficult technical problems. Others were thank you or idle chatter messages. To isolate relevant postings, we measured the *number of questions* using content coding. Only postings requesting information and helping to solve technical problems were counted as relevant. We also controlled for the *number of answers* by only counting when an individual provided an answer to another individual's question. Before initiating this content coding, we read over 5,000 postings, which we divided into distinct categories. We developed a coding scheme with four different categories of postings: (1) "question," (2) "answer/response," (3) "comment," and (4) "other." We developed the coding scheme by actively debating alternative categorizations. Two coders then each coded the messages independently. When evaluating the coders after the first 200 posts, we had an agreement of 86 percent and a Cohen's kappa of .83. We also discussed the sources of disagreements and how they could be overcome. Once we had ensured this initial reliability among the two coders, we distributed samples of 2,700 posts to each coder to make sure we had some overlap (2,700 $\times$ 2 = 5,400). To ensure high intercoder reliability, we had an overlap of posts that we evaluated throughout the process. These checks were similar to the first test of inter-

[5] We used the following items: "I find out about new products and solutions earlier than others in the community"; "I would benefit by early adoption and use of new products"; "I have tested prototype versions of new products"; "I use Propellerhead's products more regularly than other software related products"; "I have made suggestions for how to improve Propellerhead's products"; "I often identify important ideas or trends related to Propellerhead's community before other members in the community"; "I am interested in doing prototype evaluation on products before public release"; and "I would be willing to spend plenty of time to get access to novel information before others."

coder reliability, suggesting that the coders' ratings were consistent over time. A kappa of .83 is considered to show good intercoder reliability (Cohen, 1960), especially for a nonestablished coding scheme. The coders were good in separating questions from answers or responses. Indeed, for these two categories, the two coders had an agreement of 94 percent.

An individual's belief in his or her ability to succeed in specific situations (Bandura, 1977) could affect both dependent variables. Inspired by the PSED II (Reynolds & Curtin, 2009), we separated items that measured an individual's belief that he or she has the skills, abilities, experience, and contacts to start a business. A factor analysis found that the items loaded on two factors. One we labeled as "skills," and the other we labeled as "resource mobilization." The first factor captures individuals' belief they have sufficient skills to become entrepreneurs. We used items from the Global Entrepreneurship Monitor survey to form a scale of *skills self-efficacy* (α = .85): "I am confident I would succeed if I started my own firm" and "I have the skills and capabilities required to succeed as an entrepreneur" (1 = "strongly disagree," 5 = "strongly agree"). The second type of self-efficacy captured individuals' belief in their access to resources, which has been shown to affect propensity for entrepreneurial action. We again used items from the Global Entrepreneurship Monitor survey to form our *resource mobilization self-efficacy* scale (α = .91): "I have the right contact network to start a new firm," "It would be easy for me to gather the resources necessary to get the new firm going (e.g. funding, employees, etc.)," "I have the right business contacts to make a new firm possible." Since prior research has demonstrated an effect of age on entrepreneurial action (Evans & Leighton, 1989), we created three dummies to control for *age*: under 30 years, between 30 and 40 years, and above 40 years.

An individual's level of education can shape opportunity evaluation and entrepreneurial action. Hence, we controlled for *university degree* by coding a dummy 1 for a bachelor's degree or higher level of education.[6]

The survey respondents were slightly more active in the online community than the nonrespondents in our survey, suggesting a degree of respondent self-selection. Restricting the analysis to respondents could potentially bias the results by ignoring factors that encouraged individuals to self-select into the sample. To alleviate this problem, we first estimated the inverse Mill's ratio as a selection parameter using the full data set and then included this measure for individuals who responded to the survey (Heckman, 1979). To calculate the selection parameter, we used available information about the nonrespondents, namely, the number of answers and questions and their tenure in the community. We then controlled for self-selection bias by inserting the inverse Mill's ratio as a control variable in regressions predicting user entrepreneurship (see the Appendix for details).

Estimation Strategy

As expected, the two dependent variables were correlated, as Figure 3 illustrates. Entrepreneurial action was more likely among individuals who engaged in opportunity evaluation. But, as noted above, we did not treat opportunity evaluation as a necessary condition for entrepreneurial action, which would have required the use of a selection model approach.[7] Because our theoretical model did not imply that the two forms of information exposure operate in a mediation relationship, we

[6] We excluded gender as a control in our analysis as only 1.44 percent of community members were female.

[7] A traditional Heckman approach would ignore the fact that some individuals undertake entrepreneurial action without opportunity evaluation. In this view, entrepreneurial action would always be preceded by opportunity evaluation.

FIGURE 3
Actual Distribution of the Relation between Opportunity Evaluation and Entrepreneurial Action

		Entrepreneurial Action		
		No	Yes	
Opportunity Evaluation	No	224	13	*237*
	Yes	18	20	*38*
		242	*33*	*275*

employed an analytical approach to consider these choices jointly.

To accommodate for the different pathways, we used a bivariate probit model to estimate opportunity evaluation and entrepreneurial action as a pair of seemingly unrelated regressions. Such a model allows for two binary dependent variables that vary jointly. For example, it has been used to study make-or-buy decisions, in which two choices are considered simultaneously (see, e.g., Oxley & Sampson, 2004). This specification allows for estimating the coefficients while adjusting for correlations between the error terms for opportunity evaluation and entrepreneurial action. This technique allowed us to control for unobservable factors that affect both dependent variables. The estimates are more efficient because they account for correlation between the two equations (Greene, 1997). Indeed, we expected opportunity evaluation and entrepreneurial action to be correlated, and we found evidence that the bivariate probit regression fitted the data better than two separate probit equations.

RESULTS

The descriptive statistics used for the statistical analysis are presented in Table 1. Our respondents were clustered in 31 countries, each representing a different set of institutional conditions for entrepreneurial action. Hence, there was a possibility that our explanatory variables would predict the dependent variables differentially across countries, causing nonnormality in the distribution of random errors and raising the prospect of type I errors. We therefore employed the Huber-White sandwich estimate of variance to obtain robust variance estimates and adjust for within-cluster correlation.

Table 2 presents the results from bivariate probit regressions predicting opportunity evaluation and entrepreneurial action jointly. The ancillary parameter rho (ρ), which captures the correlation of the residuals from the two models, is significant, suggesting that the two equations were related and that a bivariate probit strategy was suitable for the data, rather than two separate probits (model 1: $\rho = .77$, Wald $\chi^2 = 93.3$, $p < .01$; model 2: $\rho = .79$, Wald $\chi^2 = 88.1$, $p < .01$). The results are presented in two columns, one for the analysis of opportunity evaluation and one for the analysis of entrepreneurial action. Model 1, the baseline, includes the controls only, and model 2 includes the independent variables.

The first two hypotheses test the determinants of opportunity evaluation, which are shown in the left column of model 2 in Table 2. Consistently with Hypothesis 1, we observe that lead user attributes had a positive and significant effect on opportunity evaluation ($p < .01$). Lead users have deep knowledge of product functionalities and features and also perceive themselves to be ahead of market trends. They therefore thought themselves able to clearly see the value-creating potential obtained by addressing various technical opportunities. The connection between an individual's lead user attributes and opportunity evaluation was also spelled out in our interviews.

In support of Hypothesis 2, we observe a positive relationship between technological probing activities and opportunity evaluation ($p < .05$). Some users, by virtue of discovering new problems and related solutions and communicating these within the community, are in a position to steer collective learning through aspirational search (Smith & Cao, 2007). The resulting influence on the collective mind-set helped create momentum for these users' discoveries. One interviewee commented on how technological probing can enhance opportunity recognition:

> Some sort of competition on setting agendas does take place in the community. What type of technological development is cool, etc. Sometimes unconscious but slowly proliferating into a creation of a potential commercial opportunity.

Tests of Hypotheses 3 and 4 are displayed in the right column of model 2. Hypothesis 3 proposes that community attention has a positive association with entrepreneurial action. This hypothesis is supported ($p < .01$). Our interviewees explained that users attract attention from their peers in the community by coming up with novel and innovative ideas and engaging in technical problem solving. Individuals who achieved these activities obtained the social validation signals required to embark on entrepreneurial action:

> I always felt that if I have this status [in the community] people will allow me to set up my business. . . . They love someone who shows entrepreneurial spirit. So, when I initially set up my company I wrote something on the community board and a lot of people wished me luck and started listening to my music and using my products. So, it helped.

We also find support for Hypothesis 4, which states that community spanning should be posi-

TABLE 1
Descriptive Statistics[a]

Variable	Mean	s.d.	Minimum	Maximum	1	2	2	3	4	5	7	8	9	10	11	12	13	14
1. Opportunity evaluation	0.13	0.34	0	1														
2. Entrepreneurial action	0.12	0.32	0	1	.49													
3. Lead user attributes	3.41	0.76	1.38	5	.22	.13												
4. Technological probing	0.15	0.22	0	1	.1	.11	−.03											
5. Community attention	4.23	4.74	0	46.5	.07	.2	.22	.13										
6. Community spanning	2.3	2.17	0	10	.09	.22	.24	.04	.31									
7. Tenure in community	1.55	1.84	0	5	−.01	.06	.19	−.21	.22	.15								
8. 1 + number of coded answers[b]	0.26	0.61	0	3.29	.02	.16	.11	−.08	.24	.17	.35							
9. Self-efficacy: Skills	3.88	1.05	1	5	.21	.08	.22	.04	.00	−.01	.04	−.06						
10. Self-efficacy: Resource mobilization	3.01	1.24	1	5	.27	.18	.22	.04	.02	.08	−.01	−.06	.61					
11. University degree	0.62	0.49	0	1	.04	.00	−.08	.06	−.02	.02	−.09	.00	−.01	.04				
12. Product experience	4.26	0.85	2	5	.04	.11	.31	.05	.19	.22	.2	−.04	.08	.09	.01			
13. Age: Under 30 years	0.38	0.49	0	1	.00	−.03	.08	−.04	−.07	−.08	−.06	−.05	−.06	−.17	−.25	−.07		
14. Age: 30–40 years	0.44	0.5	0	1	.06	.06	.04	.09	.03	.07	.08	.05	.14	.19	.19	.1	−.69	
15. Age: Above 40 years	0.18	0.38	0	1	−.07	−.05	−.13	−.06	.06	.01	−.02	.00	−.11	−.04	.09	−.04	−.36	−.41

[a] n = 275.
[b] Logarithm.

TABLE 2
Bivariate Probit Regressions Predicting Opportunity Evaluation and Entrepreneurial Action[a]

Variables	Model 1		Model 2	
	Opportunity Evaluation	Entrepreneurial Action	Opportunity Evaluation	Entrepreneurial Action
Control				
1 + number of answers to questions[b]	0.18†	0.48**	0.11	0.34*
	(0.10)	(0.13)	(0.14)	(0.14)
Self-efficacy: Skills	0.11	−0.13	0.05	−0.12
	(0.08)	(0.11)	(0.07)	(0.14)
Self-efficacy: Resource mobilization	0.37**	0.37**	0.35**	0.34**
	(0.06)	(0.09)	(0.07)	(0.08)
University degree	0.16	−0.04	0.22	−0.05
	(0.16)	(0.28)	(0.22)	(0.33)
Product experience	0.05	0.29*	−0.15	0.15
	(0.14)	(0.14)	(0.14)	(0.14)
Age: 30–40 years	−0.18	−0.06	−0.13	−0.12
	(0.20)	(0.31)	(0.20)	(0.30)
Age: Above 40 years	−0.52**	−0.28†	−0.49†	−0.36†
	(0.19)	(0.17)	(0.28)	(0.19)
Inverse Mill's ratio	0.11	0.08	0.16	−0.15
	(0.36)	(0.32)	(0.45)	(0.34)
Independent				
H1: Lead user attributes			0.50**	0.06
			(0.08)	(0.05)
H2: Technological probing			0.51*	0.61
			(0.25)	(0.38)
H3: Community attention			0.01	0.03**
			(0.03)	(0.01)
H4: Community spanning			0.04	0.11**
			(0.03)	(0.02)
Constant	−3.09**	−3.26**	−4.04**	−3.03*
	(0.79)	(1.26)	(0.93)	(1.28)
Log pseudo-likelihood		−164		−154
df		16		24
n		275		275

[a] Unstandardized coefficients are shown, with Huber-White robust standard errors clustered by nation in parentheses.
[b] Logarithm.
† $p < .10$
* $p < .05$
** $p < .01$
Two-tailed tests.

tively associated with entrepreneurial action ($p < .01$). In an interview, one user said:

> Being active in other related communities on software or music production is useful also for my entrepreneurial activities. You can check out if your idea has interest beyond the users in the Propellerhead community, you may pick up an idea for how to improve or develop new products or features for your software, music or your business in general.

Overall, the statistical analysis provided support for our conceptual model. Lead user attributes and technological probing facilitate opportunity evaluation, and community attention and community spanning affect entrepreneurial action. These findings suggest that exposure to technological domain information drives third-person opportunity recognition, while exposure to a social domain confers informational advantages and reduces perceived demand uncertainty, thereby lowering the threshold for entrepreneurial action.

An additional advantage of our empirical strategy is that it allows us to develop marginal effects of the likelihood of an individual locating in any of the four cells presented in Figure 2. The ancillary parameter rho shows that the two outcome variables are correlated, which is accounted for in our

TABLE 3
Marginal Effects for Cell Membership Based on Regressions[a]

Variables	No Entrepreneur	Unrealized Opportunities	Opportunistic Action	Planned Behavior
H1: Lead user attributes	−0.06**	0.05**	−0.02*	0.03**
H2: Technological probing	−0.12*	0.03	0.04	0.05*
H3: Community attention	0.00	0.00	0.003*	0.00
H4: Community spanning	−0.02**	0.00	0.01**	0.01**

[a] $n = 275$. The marginal effects of the independent variables with all other variables held at their means are shown. For instance, the column for planned behavior is Pr(*opportunity evaluation* = 1, *entrepreneurial action* = 1). These values are based on the results from model 2 in Table 2.

* $p < .05$

** $p < .01$

Two-tailed tests.

estimation strategy. Table 3 presents the marginal effects of locating in any of the four cells in Figure 2 based on the results from model 2 in Table 2, holding all other variables at their means. The marginal effects extend our insights about why different users end up in different cells. Users that evaluate third-person opportunities but do not engage in entrepreneurial action are often lead users, but none of the other marginal effects are significant (see Table 3). One lead user explained how he evaluated opportunities but decided not to start a business:

> I have a lot of entrepreneurial ideas and actually engaged in real activities to see if something could be done about them. I evaluated the options to achieve financial return from doing something like selling this product. But I found it wasn't worth it; it was just too time consuming.

In contrast, as shown in Table 3, lead user attributes had a negative effect on opportunistic action (i.e., entrepreneurial action without exhibiting observable evaluation activities). This is consistent with our reasoning. Further, Table 3 shows that community attention and community spanning both exhibited a positive marginal effect on opportunistic action. A quote from a user who explained how he became an entrepreneur illustrates the mechanism for this path: "The only planning activity was that I wanted to get out and network. The rest of it fell into place and through some flexibility I was able to make the most of some opportunities that came up."

We also found that lead user attributes, technological probing, and community spanning all had a positive marginal effect on planned behavior (i.e., entrepreneurial action associated with opportunity evaluation). For community spanning, this path reflects our reasoning that users exposed to multiple thought worlds are able to draw on analogous experiences to both evaluate opportunities and act upon them.

Robustness Checks

We conducted several robustness checks. First, we reestimated the regressions using two separate probit regressions, confirming that a bivariate probit specification is a better fit with our data. Second, we tried an alternative measure of community attention, the Bonacich centrality measure, which captures whether a given individual is connected to other central individuals. We were able to test this measure because we had a full matrix of all interactions between all members in the community. Third, we checked whether including the inverse Mills ratio affected our results. None of these modifications altered our results.

DISCUSSION

The past decade has witnessed a significant amount of research and theorizing on opportunity discovery, evaluation, and pursuit. Much of this research has focused on the sources of opportunities (e.g., Eckhardt & Shane, 2003; Shane, 2000), debated the nature of opportunities (e.g., Alvarez & Barney, 2007; Companys & McMullen, 2007; Shane & Venkataraman, 2000), and studied the drivers of opportunity discovery (e.g., Foss & Foss, 2008). More recently, the pendulum has started to swing away from an interest in opportunities themselves toward the study of conditions that prompt individuals to perceive opportunities, evaluate them, and act upon them (Choi & Shepherd, 2004; Grégoire et al., 2010; Haynie et al., 2009). Yet, few empirical studies examine the drivers of opportunity recognition and entrepreneurial action in prefounding situations. We contribute by building and testing a model of how an individual's exposure to different kinds of information affects opportunity evaluation and entrepreneurial action. Our findings suggest that the individual's exposure to technological information increases the likelihood that he or she will recognize third-person opportunities as manifested in evaluation, whereas exposure to information about user needs exhibits significant influence on first-person opportunity beliefs as manifested in entrepreneurial action. Several important implications emerge from these findings.

Our most important finding is that opportunity evaluation and entrepreneurial action are regulated by different external stimuli. This supports the position that third-person opportunity recognition and entrepreneurial action are distinct processes (Grégoire et al., 2010; Haynie et al., 2009; McMullen & Shepherd, 2006). In received research on opportunity discovery, the two processes have been typically conflated into a single discovery or evaluation event (Kirzner, 1997). On the other hand, the "structuration" and "effectuation" perspectives, while recognizing opportunity evaluation and entrepreneurial action as distinct processes, nevertheless have emphasized their intertwined and iterative character, implying that the two are subject to the same external stimuli (Sarason, Dean, & Dillard, 2006; Sarasvathy, 2001). We find that the two processes are not only distinct, but also, at least partly responsive to different influences.

Our model also supports McMullen and Shepherd (2006), by highlighting that reduction in response uncertainty is central for triggering entrepreneurial action. Mere exposure to third-person opportunities will not stimulate action if response uncertainty prevails. In our model, this reduction in response uncertainty is driven by (1) an individual's exposure to alternative thought worlds (through participation in different online communities) and (2) the attention given to the individual's statements in the focal online community. Both of these are social mechanisms that emphasize the role of information obtained through social interactions with others. Given that social trends tend to be less predictable than technological trends, this role of social mechanisms emphasizes the intersubjective character of response uncertainty reduction, in which beliefs regarding the commercial viability of third-person opportunities emerge through social interactions (Giddens, 1984; Shepherd et al., 2007).

Our model also highlights the importance of exposure to technological development as an important driver of third-person opportunity recognition and evaluation. Although both Austrian and action theories routinely point to technological development as a source of opportunities, few studies have empirically examined how an individual's connectivity with the technological domain facilitates third-person opportunity recognition. We addressed this gap by considering the effect of technological probing and lead user attributes. We found that exposure to technological developments facilitates evaluation actions but does not necessarily support entrepreneurial action directly. This finding suggests that opportunity evaluation is a future-oriented activity that informs but is separate from entrepreneurial action (Haynie et al., 2009). Being at the vanguard of a given technology enables individuals to perceive trends earlier than others and also to evaluate emerging opportunities as they see them. In keeping with the action theory of entrepreneurship, our findings also support the importance of problem sensitization to the recognition of third-person opportunities arising from technological advances.

Although our theoretical model provides a welcome empirical test of the McMullen and Shepherd (2006) model, it also extends their framework in important ways. The focus of their model and its subsequent tests (Grégoire et al., 2010; Haynie et al., 2009) has been predominantly on the motivational, goal-intention-forming stage of the theory of the psychology of action (Gollwitzer, 1996: 289).[8] Our model extends their theory to a volitional planning stage, which nevertheless usually precedes the entrepreneurial action itself. As business planning activity signals awareness of third-person opportunities and a reasonable supposition that these might constitute feasible and desirable first-person opportunities, our empirical test highlights a stage at which opportunity awareness induces volitional evaluation. Although the evaluation activity itself may feed escalation of commitment, our test highlights the importance of demand uncertainty reduc-

[8] We thank Jeffrey McMullen for sharing his insight and for explaining the relationship between his action theory and the theory of the psychology of action.

tion for the transition from volitional evaluation to volitional action. Our model, therefore, helps pinpoint the threshold between evaluation and entrepreneurial action while also highlighting stimuli that facilitate crossing this threshold.

By demonstrating the different effects of external information exposure on opportunity evaluation and entrepreneurial action, respectively, we extend the analysis of opportunity recognition from individual-centric considerations toward the broader social system within which individuals are embedded. Therefore, our study provides a bridge between the action and network perspectives to entrepreneurial opportunity evaluation and entrepreneurial action. Our model is consistent with the structural paradigm of network research, in the sense that an entrepreneur's network is seen as regulating his/her exposure to information regarding opportunities (Aldrich & Kim, 2007; Ma, Huang & Shenkar, 2011; Podolny, 2001). However, whereas the emphasis in the network tradition is on self-reinforcing, power- and resource-based constraints on entrepreneurial action (Hallen, 2008; Zaheer & Soda, 2009), our model highlights informational facilitators of action. In short, whereas received network studies have focused on whether an entrepreneur *can* act, our model highlights conditions under which the entrepreneur *will* act. A combination of power-based and cognitive explanations could provide more nuanced insight into the varied influences of social networks on entrepreneurial action.

We also contribute by moving the conversation about the role of users in innovation (von Hippel, 1988) toward understanding users as entrepreneurs. The internet makes it possible to sustain geographically disparate communities where users create and exchange ideas. Several studies have explored why users are motivated to share ideas with other users (von Krogh & von Hippel, 2003). Although it is frequently assumed that sharing prevents commercialization, sharing may also encourage commercialization by allowing a user community to weigh in on the developments. Users with access to shared ideas can build products and services around identified needs in user communities. We show how interactions in user communities may actually lower the threshold for entrepreneurial action: Individuals who both attract community attention and span multiple external communities will, in effect, reduce their demand uncertainty. Collecting a similar amount and quality of knowledge would presumably be more time consuming and more expensive in an "offline" context. Our study highlights the implications for understanding the social patterns that unfold in online communities and how they provide opportunities for user entrepreneurship.

Thus far, research on user entrepreneurship has focused on describing the phenomenon and exploring sector-level regulators of user entrepreneurship while overlooking individual-level influences (Baldwin, Hienerth, & von Hippel, 2006; Lettl, Hienerth, & Gemuenden, 2008). Our study has addressed this oversight with a large-sample empirical analysis that draws on unique microlevel data describing individuals' communication patterns and networks. We add to research that has demonstrated cross-industry variance in user entrepreneurship (Shah & Tripsas, 2007) by showing that within a given industry, the exposure of individual users to different knowledge domains regulates the propensity of users to move from innovation to entrepreneurship. We also demonstrated that exposure to social information affects entrepreneurial action: While community attention and community spanning regulated entrepreneurial action, they had no significant effect on opportunity recognition.

Von Hippel (1988) highlighted the information advantages that lead users enjoy as a result of their sensitization to technological bottlenecks. Because of their heightened awareness of technological bottlenecks, lead users are better positioned than ordinary users to monitor and even anticipate technological developments. Our study shows that such sensitization can, when combined with community spanning and community attention, also propel entrepreneurial action via reduction in response uncertainty. This is an interesting finding that may offer utility in, for instance, predicting where technology entrepreneurs are more likely to emerge in social networks.

Finally, our findings may have implications for managerial practice. First, our findings highlight the importance of online communities as platforms for technological and economic coordination among geographically dispersed users. Specifically, our findings suggest that some community participants, by virtue of their position relative to the technological and economic domains, may be more likely than others to identify viable technological paths and even embark on entrepreneurial action to exploit these. By monitoring user communities and other similar online communities, therefore, platform owners might gain valuable, perhaps even predictive, insight into where technological innovation is more likely to occur within a community and what forms it might take. Our study has highlighted some structural determinants of such activities, but there might be others that our inquiry has not covered. This appears a promising avenue for further research, one with potentially significant implications for practice. Second, our findings may have implications for corporate venturing. Many established firms seek to encourage intrapreneurial (i.e., corporate entrepreneurial) activity among their employees. Our findings imply that connectivity with social domain and technological domains, perhaps in the form of active participation in boundary-spanning communities of practice, could prove a useful inducement for the development of commercially viable initiatives. Third, our findings on the role of technological probing highlight the potential utility of active community participation not only for gaining information, but also for shaping the directions of collective development efforts. Thus, our study provides support for the effectiveness of active participation in online practitioner communities as both a form of "disembodied experimentation" (Keil, Autio, & George, 2008) and a device with which firms can subtly steer technological complements and externalities.

Limitations and Future Research

Although our conceptual model emphasizes the joint effects of exposure to technological and social information on opportunity evaluation and entrepreneurial action, we have been careful not to imply a mediation effect, in which discernible opportunity evaluation must always precede entrepreneurial action. By so doing we have made an allowance for Austrian or Kirznerian discovery (e.g., Kirzner, 1973, 1997), in which the realization that a third-person opportunity exists is followed almost immediately by opportunity pursuit. Indeed, while our empirical model supports the distinction between opportunity evaluation and entrepreneurial action, a number of our respondents exhibited entrepreneurial action without engaging in evaluation activities—a circumstance we operationalized in Figure 1. This may be a sign of opportunistic behavior, in which individuals react opportunistically to the market needs they detect. However, we cannot exclude the possibility that such individuals may be aware of technological opportunities without undertaking any volitional action to evaluate them, as specified in our operationalization. After all, our empirical context was an online user community, where recognition of technological advances could be taken as given. We expected to find a positive correlation between opportunity evaluation and entrepreneurial action, and our modeling strategy confirmed this expectation.

We tested our hypotheses with a data set of interactions in one online community in the software industry, a decision that could have implications for the generalizability of our results. Central to our argument is the idea that information about user needs reduces demand uncertainty and shapes entrepreneurial action. A scope condition of our theory is that this is more likely to apply when a knowledge frontier is gradually evolving and some individuals are better positioned than others to receive signals about user needs.

We cannot preclude the possibility that individuals who intend to become entrepreneurs behave in a certain way to manipulate their positions in a social structure, creating a problem of reverse causality. Although we cannot fully rule out the alternative causation, we consider this explanation to be unlikely for two reasons. First, community attention reflects actions by others more than those of the focal individual. We measure *others*' responses to an individual's postings, and it is difficult to affect the views of other community members. Second, it is not immediately apparent why entrepreneurial actions would drive individuals to participate in several related user communities. Nevertheless, to elaborate on the chain of events merits further research attention.

Finally, although we controlled for a number of possible alternative explanations and used content analysis to check the face validity of our measures, we have not closely examined the content of the communication among users over time. Future studies could productively incorporate more extensive content analysis into studies of user entrepreneurship from online communities. This could shed light on, for example, how different types of individuals frame their messages, their use of specific words, how these factors are associated with opportunity evaluation and entrepreneurial action, and, in particular, how user entrepreneurs engage in communication in the community to discover opportunities and mobilize resources. Finally, research on user entrepreneurship could be improved by adding dynamics into the various empirical models. For example, by adding aspects of individuals' network positions over time, the general evolution of a community network, and the exact timing of entrepreneurial actions (i.e., the time that a firm was established or first sale was executed), would offer rich insights into how and why user entrepreneurship happens.

Conclusion

Our study breaks new ground for the understanding of entrepreneurship using a large-scale empirical study, in particular, for entrepreneurial action theories and studies of user entrepreneurs. Exposure to technological and social information shapes opportunity evaluation and entrepreneurial action, albeit in different ways. These findings create broad implications for entrepreneurship and management scholars by highlighting the critical importance of reducing demand uncertainty and empirically testing how this occurs through community attention and spanning multiple communities. More people seem to engage in different types of online communities each year. Our study enriches the understanding of how these communities nurture the development of user entrepreneurs by showing that the exchange of and exposure to technological information, although important, is not enough.

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APPENDIX

Because we coded all 5,000 posts in the community before distributing the survey, we could compare respondents and nonrespondents. Respondents were more likely to answer questions and less likely to pose questions in the Propellerhead community. Individuals who posed questions were likely to respond to the survey, but this variable was not correlated with opportunity evaluation and entrepreneurial action. We thus used the number of questions posed as an exclusion restriction variable. Obviously, for the nonrespondents we had less information than for the respondents, so we used the information available to predict the likelihood of responding to the survey (see, e.g., Bae and Gargiulo [2004] and Polidoro, Ahuja, and Mitchell [2010] for a similar approach). The idea that individuals who pose questions are not associated with the entrepreneurial outcomes was also confirmed in interviews with community members. Table A1 shows the mean numbers of the variables and results of *t*-tests of the differences.

Next we used a probit regression to predict the probability an individual would respond to the survey. Table A2 shows the correlations between the variables. Table A3, which shows the results from the regression, illustrates that the number of questions has a negative effect on the probability of responding to the survey (community newcomers were slightly less likely to

TABLE A1

Comparing Respondents and Nonrespondents[a]

Variable	Respondents	Non-respondents	*t*
1 + number of answers to questions	0.77	0.41	**
1 + number of questions	0.48	0.81	**
Tenure in community	1.62	1.51	

[a] Respondents, $n = 280$; nonrespondents, $n = 686$.
** $p < .01$
Two tailed tests.

TABLE A2

Correlations[a]

Variable	1	2
1. 1 + number of answers to questions		
2. 1 + number of questions	.32	
3. Tenure in community	.22	−.07

[a] $n = 966$.

TABLE A3

Probit Regression Predicting Response to Survey[a]

Variable	Model A
Tenure in community	−.01
	(.02)
1 + number of answers to questions	.44
	(.09)**
1 + number of questions	−.81
	(.10)**
Constant	−.35
	(.07)**
Log-likelihood	−545.49
Selected observations	280

[a] Robust standard errors are in parentheses. $n = 966$.
** $p < .01$

take part in the survey). From this result we developed the inverse Mill's ratio included in Table 3. Including the inverse Mill's ratio in our regressions did not alter the direction of coefficients or the significance of our results.

Erkko Autio (erkko.autio@imperial.ac.uk) is chair of entrepreneurship and technology transfer at Imperial College Business School, London. He is also a visiting professor at Aalto University. His research focuses on comparative entrepreneurship, national systems of entrepreneurship, and international entrepreneurship. He received his Ph.D. from Helsinki University of Technology.

Linus Dahlander (linus.dahlander@esmt.org) is an associate professor at ESMT European School of Management and Technology. He is currently studying how networks unfold when people can choose their collaboration partners and consequences for innovation outcomes. He received a Ph.D. from Chalmers University of Technology and was a postdoctoral fellow at Stanford University.

Lars Frederiksen (l.frederiksen@asb.dk) is professor at the Innovation Management Group, School of Business and Social Sciences, Aarhus University. He received a Ph.D. in business administration from Copenhagen Business School. His current research interests include evolution of knowledge producing communities, entrepreneurship, and user innovation.