Confidential Areas in Innovation Communities: An Agent-Based Model Using Fuzzy Logic and Qualitative Empirical Data

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KEYWORDS

Community-based innovation, Complex systems, Innovation communities, Agent-based modeling, Fuzzy logic, Qualitative empirical research

ABSTRACT

This paper examines the relationship between social and utilitarian incentives in innovation communities. We develop an agent-based model using insights from a qualitative empirical study. This method combination is motivated by shortcomings of empirical research to capture the dynamics and the interactions between social and utilitarian incentives. Thus, we use the synergy between complex systems thinking and its strengths in modeling in combination with qualitative empirical research, which is powerful to recognize phenomena. The problem of incorporating decisions driven by multiple motivations is approached by including fuzzy interfaces in the model. With the method combination of qualitative empirical research, agent-based modeling, and fuzzy logic we can answer questions of social and utilitarian motives and their relation to innovation performance in communities. We find that community members do not only want to innovate but have social motives in addition. Further, some innovation communities have areas which we call confidential areas. These are areas for high performers. In the simulation we find that such confidential areas improve innovation performance. However, this effect depends on the access restriction. The contribution of this paper is twofold. First, it improves the understanding of innovation communities and the incentives for contributing. The extant literature on innovation management profits from a dynamic perspective on community-based innovation. Second, we provide a novel method combination that is useful for capturing complex phenomena from the empirical perspective.

INTRODUCTION

Collective innovation (Allen 1983), for instance in the form of innovation communities, is an example of a real-world phenomenon in the area of management science fitting the criteria of complex systems. Innovation communities consist of interacting individuals without central authority and they have the potential to produce emergent phenomena. The field of management science and innovation management has acknowledged properties of complexity in innovation (Lundvall 1988, Fleming & Sorenson 2001, Bleda & del Río 2013). Conversely, complex systems scholars have approached the topic of innovation with their modeling methods, in particular agent-based modeling (Frenken 2005, Watts & Gilbert 2014).

However, both fields work isolated from each other on the common topic of innovation. This applies in particular for the subtopic of community-based innovation. In this subtopic research from the management perspective has developed a rich understanding (Franke & Shah 2003, West & Lakhani 2008, Dahlander & Frederiksen 2012, Boudreau & Lakhani 2015), but this perspective does not capture the dynamic perspective to a satisfying degree.

We approach this research gap by introducing a research concept that combines qualitative empirical research (Creswell 2013) with agent-based modeling (Gilbert & Troitzsch 2005) and fuzzy logic (Zadeh 1965, Gorrini & Bersini 1994). The concept begins with qualitatively interviewing participants of innovation communities. Qualitative interviews are useful to capture the basic phenomena. They allow to tap knowledge that is not directly observable (Mackey & Gass 2005). The weakness of qualitative empirical research is that individual knowledge barely captures the dynamics of a complex system. Since the individuals are elements of such a system, they are only aware of a limited portion of it. Thus, we combine qualitative empirical research with a simulation method in the second step of the research concept. This adds dynamics and completes the picture of innovation communities. So static and individual aspects are covered by qualitative empirical research and the simulation complements the dynamics.

With this method combination we address the question of how individuals' motivation – utilitarian (i.e., improving and developing own projects) and social (i.e., socializing with others) – influences the performance of innovation communities, contingent to exogenous influences. In the qualitative part

Proceedings 29th European Conference on Modelling and Simulation ©ECMS Valeri M. Mladenov, Petia Georgieva, Grisha Spasov, Galidiya Petrova (Editors)
ISBN: 978-0-9932440-0-1 / ISBN: 978-0-9932440-1-8 (CD)

of our research, we find that some communities provide so-called *confidential areas*. In such areas, some participants of communities can work more focused but exclude others. We model the impact of confidential areas on utilitarian and social motivations and how this relation in turn influences innovation performance of the community. Recurrent fuzzy logic is used in order to model individuals' experiences on the social and utilitarian level, as well as their decision to participate in the confidential area or not.

The contribution of this paper is twofold. First, we add to the literature of innovation communities. We introduce the phenomenon of confidential areas in communities to the current understanding and show that the consideration of social aspects in addition to utilitarian motives changes the innovation performance. Second, we provide an approach for incorporating qualitative empirical data in an agent-based model. This approach can be embedded as one step in an iterative research procedure for theory building involving simulation modeling (Dilaver 2015, Neumann 2015). The approach is not only suitable for research on innovation communities, it is also useful for other complex systems that can be studied from an empirical angle.

The remainder of this paper is structured as follows. Next, the literature on the topic of innovation communities is reviewed. Then, we describe the qualitative study and develop a conceptual model based on the results of the study. An agent-based model based on the conceptual model is developed and results are reported. Finally, we draw a conclusion and develop some ideas for future research.

THEORETICAL BACKGROUND

In this section, we briefly review the most important aspects of the extant literature on innovation communities, in particular participants' motivations for sharing knowledge and contributing. We also outline the basics of fuzzy logic as a non-standard modeling technique.

Innovation, communities, and incentives

Innovation communities are a highly relevant topic in the area of innovation management. They provide a source for several kinds of input for companies and fulfill multiple functions, for instance, they are a source for innovations (Baldwin, Hienerth & von Hippel 2006), development of brands (Füller, Schroll & von Hippel 2013), and as test environment for new products (Matzler, Grabher, Huber & Füller 2013). On several occasions communities even substitute companies completely, for instance in the case of Wikipedia and the Encyclopedia Britannica. Another example with huge economic impact is open source software development (von Hippel & von Krogh 2003, Shah 2006, von Krogh, Haefliger, Spaeth & Wallin 2012).

In general, communities can be assigned with a high potential for innovation. Among the members of communities, knowledge is shared and thus it is possible that cumulative innovation takes place (Franke & Shah 2003, Lakhani & Panetta 2007, Balka, Raasch & Herstatt 2014, Boudreau & Lakhani 2015). Because of the combination of users and specialists, such communities provide the feature to augment knowledge about need and application. Need knowledge is highly valuable to companies because it allows them to address the demand of consumers intermediately (von Hippel 1986, von Hippel 2005).

The phenomenon of knowledge revealing is an aspect of communities that has fascinated scholars in the area management science (Harhoff, Henkel & von Hippel 2003, Henkel 2006, von Krogh et al. 2012, Levine & Prietula 2014). An even more fundamental question is the economic and institutional background for participating, contributing, and cooperating (Zaggl 2014, Williams & Hall 2015). No direct compensation takes place and participation is often voluntarily. Reputation concerns, learning, reciprocity, feedback, and signaling of competence that enhances job prospects are the main motivations for participation (Lakhani & von Hippel 2003, Lakhani & Wolf 2005).

In addition to that, social benefits from communities can also be seen as an incentive for participation in communities. People receive a benefit from the social activity itself. Thus, they join the community and participate for getting into contact with other people.

The literature on innovation communities provides a deep understand of community-based innovation. Parts of that literature have a strong emphasis on theory development (von Hippel & von Krogh 2003, von Krogh et al. 2012). However, the dynamics of communities are barely covered. One reason is probably the difficulty to conduct empirical research. This motivates our design. We develop an agent-based model which allows us to add dynamics to static empirical data. Since motivation plays a major role, we want to research its effect on the performance on the community level. In an exploratory approach, we want to find out what contingency may influence motivation of participants.

Fuzzy logic

When individuals express their beliefs, desires, and intentions, they are often vague and use linguistic categories with blurred edges and gradations of membership. Moreover, complete determined decisions are an over-simplification of real human decision-making. To deal with this and in order to increase the agents' decision quality, the usage of fuzzy logic in agent-based models has been proposed (Cioffi-Revilla 1981). The basic idea of fuzzy logic is to model human-like decision-making mathematically. In contrast to classic boolean logic, fuzzy can describe a certain vagueness in decisions grounded on the linguistic classification of human individuals.

Given a certain universe of interest $\mathcal{X} = \{x\}$, a fuzzy set $L^x \in \mathcal{X}$ is defined by a membership function $\mu_{L^x}(x) : \mathcal{X} \mapsto [0, 1]$ assigns a certain degree of membership to each $x \in \mathcal{X}$ (Zadeh 1965). As an example, the linguistic expression 'cold' could be realized as a fuzzy set L_1^x in the universe of temperature $\mathcal{X}$ by a membership function $\mu_{L_1^x}(x)$ (Fig. 1). Based on these fuzzy sets, operators are defined in order to realize operations like $L_1^x \cap L_2^x$ representing the linguistic expression 'cold and warm'. Fig. 1 illustrates the resulting membership function $\mu_{L_1^x \cap L_2^x}(x) = \mu_{L_1^x}(x) \cdot \mu_{L_2^x}(x)$ realized by multiplication of the respective membership functions.

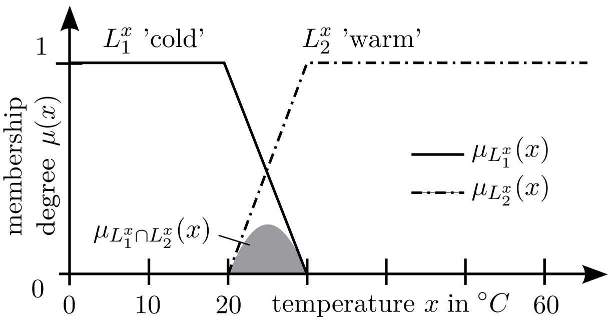

Fig. 1. Partitioning of an universe of interest in fuzzy sets

Recurrent fuzzy systems (Gorrini & Bersini 1994) can be used to model nonlinear dynamic systems

$$\mathbf{x}[k+1] = \mathbf{f}(\mathbf{x}[k], \mathbf{u}[k]), \tag{1}$$

where $\mathbf{x} \in \mathcal{R}^n$ are the state and $\mathbf{u} \in \mathcal{R}^m$ the input variables of the system, through a linguistic rule base

$$\text{If } \mathbf{x}[k] = \mathbf{L_j^x} \text{ and } \mathbf{u}[k] = \mathbf{L_q^u} \text{ then } \mathbf{x}[k+1] = \mathbf{L^x_{w(j,q)}}, \tag{2}$$

where $\mathbf{L_j^x} = \{L_\mathbf{j}^{x_i} | i = 1, ..., n\}$ and $\mathbf{L_q^u} = \{L_\mathbf{j}^{u_p} | p = 1, ..., m\}$ summarize the partitioning $L_\mathbf{j}^{x_i} = \{L_1^{x_1}, L_2^{x_1}, ...\}$ and $L_\mathbf{q}^{u_p} = \{L_1^{u_1}, L_2^{u_1}, ...\}$ in fuzzy sets $L_j^{x_i}$ and $L_q^{u_p}$ for each state and input variable respectively.

Transition adaptive recurrent fuzzy systems (Stahl, Diepold, Pohl, Greitemann, Plehn, Koch & Lohmann 2013, Diepold & Lohmann 2010) are a special class of discrete-time recurrent fuzzy systems where each rule of the rule base is weighted individually during the aggregation process. In this way, a transparent adaptation of the dynamic of the fuzzy system is possible without changing the general system structure.

QUALITATIVE STUDY

The qualitative study allows to capture phenomena in innovation communities and thus it provides an empirical data input for the simulation model. For the purpose of gathering qualitative data, we contacted people active in innovation communities. We identified interview candidates by searching in innovation communities and business networks (linkedin.com, xing.com) and by using personal contacts. The selected four interviewees represent different professions and they were all active in communities reflecting their professional interests. All of these communities were online communities. The community of interviewee B1 did include workshop meetings in addition to online exchange. For an overview of the interviewees, their profession and their community, see Table I.

Interviewee	Profession	Community subject
B1	Media design	3D-printing
B2	Software development	Application-development
B3	Product design	Product design
B4	Civil engineering	Housing automation

TABLE I. INTERVIEWEES AND THEIR COMMUNITIES

The exploratory character of the first part of the method combination suggests semi-structured interviews (Creswell 2013). For that purpose, the rather small sample size is sufficient (Creswell 2013). Accordingly, we developed an interview guideline that assured that the most important questions were posed, but the interviewees still had the chance to come up with unexpected information. The interview guideline covers four major areas each addressing individual or behavioral/dynamical concerns.

- *Community:* general questions about the community, its structure, and collaboration behavior within the community
- *Motivation:* factors influencing social and utilitarian motivation of the participants
- *Innovation behavior:* external influences on the individual innovation behavior
- *Commercialization:* general and individual opportunities for innovation commercialization by others

Interviews were conducted in summer 2014, each interview took about 45 minutes. The interviews were recorded and transcribed. Two researchers independently coded the transcriptions with the software MAXQDA (version 11.0.8) resulting in an inter-coder reliability of $\alpha = .81$ (Krippendorff 2011). We structure the findings according to the four areas of the interview guideline.

Community: In the general discussion on the communities, the interviewees provide insights on the characteristics of the system as whole. The interviews showed that trust and reputation associated with the community played an essential role (B3-20, B3-70)[1]. This is consistent with the discussed literature. Beyond that, we found that some communities explicitly provide confidential areas ("*[...] there are certain areas [in the community], so called confidential areas, in which only particular designers and users can submit threads and also comment.* ." B3-20). We found in addition that members sometimes seek to communicate directly and independently of the one-to-many communication channels (B1-41).

Motivation: Motivations for engaging in a community are diverse, but not surprising against the background of the extant literature. The motive of learning has been mentioned frequently (e.g., "*My motivation with such projects is often to learn something from the technology.*" B2-28). Socializing or similar kinds of direct rewards from participation ("*I simply had fun in a community [...]*" B1-26) as well as satisfying own needs ("*Actually, it all began with that. I do not have an alarm clock which wakes me up, and I wanted to build a light which functions like a wakeup light, but is time controlled and I can nicely set the alarm time.*" B4-10) have been mentioned by the interviewees.

Reputation concerns, awareness, and recognition of the own work are also important motivations (answer on the question of why a particular community has been selected by the interviewee: "*[T]hey have [...] a wide public, attract attention [...].*" B3-18). Also commercial interests are mentioned but not as primary incentive ("*The secondary aspect is of course, surely, that the work is paid.*" B2-18). We found that the community members' expectation for monetary or material

[1]The authors are willing to provide the entire transcriptions. Note that the interviews and the transcripts are in German language.

compensation seems to be rather exceptional (e.g., "*An explicit reward, no [...] it is the implicit reward, simply the satisfaction, [...] because I have learned something.*" B2-38).

Innovation behavior: When it comes to innovation or development and implementation of new ideas, we found that a lack of knowledge is a main driver to seek for collaboration in a community and thus a kind of shared labor system emerges. First, direct collaboration is important to community members. Second, we identify a link between collaboration and (the lack of) knowledge.

As expected, one of the major aspects of the communities is direct collaboration ("*Occasionally, I contribute to projects of others.*" B2-22; "*If I know there is the need for illustration [where I am not very good in], then in most cases I search for an expert and ask if he wants to collaborate with me in that project.*" B3-44; "*I would say that in principle standard task can be solved with the wiki or the forum. When it comes to the implementation of own ideas, you cannot work alone anymore.*" B4-32; "*It is a bit task sharing. Everyone relies on each other.*" B4-26).

The lack of knowledge is an essential driver of collaboration. People sometimes create ideas that exceed their technical skills ("*[...] an example is, I want to build an automated garden watering system, but I have little knowledge of how.*" B1-30; "*[...] things I am simply not capable of.*" B2-50).

Specialization was mentioned often. The interviewees reported about their own specialization ("*I started roughly 17 years ago with software development in general, then being a student and getting a doctoral degree, and now I also work in that area. Half to three quarters of my work time I spend with software development.*" B2-6; "*I did this avocational, I would say rather as a hobby, until I started to become occupied with that topic intensively about 5 years ago. Since then I have learned much and took many courses.*" B3-14) and about the specialization of the other community members ("*And there is one guy he is doing Perl server-sided [...]*" B4-10; "*There are always such hardware developers, they are involved and they are specialized on hardware and to design the boards. And there are others, they say I have nothing to do with hardware, but I can do software.*" B4-10).

Commercialization: The risk of commercialization by other members of the community, when an idea, innovation, or parts of it is disclosed, differs among the kinds or communities. In the area of software development, the community members describe the established legal mechanisms as sufficient ("*[...] you have to, or you should, license it when you put something online. And the intention is known by the license. If I license something under GPL, then I know I don't want that this is integrated somewhere and sold. [...] If I use a BSD license or an Apache license, which says, here it is, do what you want with it; okay, then I reckon of course that a company takes it and does something with it, even only for internal use or that they integrate in a product and sell it.*" B2-66).

However, there is less certainty about how to deal with the risk of commercialization by others in other areas than software development ("*I am not sure. The funny thing is that many companies are involved.*" B4-50). Commercialization in general, seems to be widely accepted ("*In principle, I think [commercialization of user innovations] is not bad.*" B3-72; "*[Commercialization] is great. [...] In the best case when somebody says, hey this is so awesome, I pay you money for that.*" B2-62).

CONCEPTUAL MODEL

From the results of the qualitative interviews we develop a conceptual model. It considers the insights on motivation and the innovation behavior but not the findings on commercialization. We simplify from the latter even though it could provide some interesting extensions for the model. We discuss these possible extensions in the conclusion section.

From the perspective of management science, we seek to address the performance of innovation communities. Thus, innovation performance is defined as the dependent variable in the conceptual model. Performance of the community is a macro-level measure.

We infer from the qualitative study that socialization and the use of the innovation outcome are the main motivations of the individual members. In addition, we found that knowledge in different specializations is a crucial element in innovation communities. We denote to this element as capability. Furthermore, we assume that agents have social skills that affect their socialization activities.

From the topic of communities in general, we conclude that different areas of the communities provide different degrees of confidentiality. This enables participants to exclude members that are undesired in the particular circumstance (e.g., for the particular project or question). We assume that there is an entry threshold and that this is a feature of the community. Thus it is a moderating influence on the relation of the members' behavior and the performance of the community.

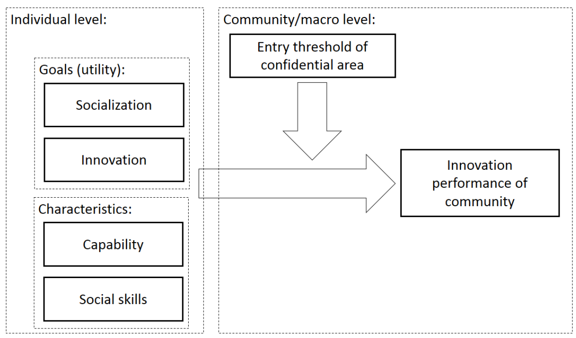

Fig. 2. Conceptual model

AGENT-BASED MODEL

Based on the conceptual model we develop an agent-based model. The model is implemented in NetLogo (version 5.0.5) (Wilensky 1999). In the following, the structure of the model (community and agents), the dynamic processes, the outcome variables, and the experimental design are described.

Community structure

The community structure determines the environment for the agents. Thus, it is an abstraction of the community conditions. We focus on the concept of confidential area and model it as a kind of elite sub-community. The confidential area is an alternative to the public area. The agents can only be active in one of the areas at a given time. In order to enter the confidential area, an agent has to reach a certain level of innovation performance, meaning successful innovations during a given period of time.

Agents

Each member of the community is represented by an agent. Agents have the goals to innovate and to socialize. For both goals the agent uses the community.

Innovation: Agents are assigned to tasks, which represent ideas or innovation projects. Each agent has exactly one task at a given time. Tasks require a certain level of capability $\mathbf{r}$ in five disciplines. Such disciplines can be any kind of specialization (e.g., mechanical construction, software development, controller design). In the same manner agents have capabilities $\mathbf{c}$ in the five disciplines to solve the tasks. We model requirement and capability as vectors:

$$\mathbf{r} = [r_1, r_2, ..., r_5], r_i \in [0, 10] \quad (3)$$

$$\mathbf{c} = [c_1, c_2, ..., c_5], c_i \in [0, 10] \quad (4)$$

For successful innovation (i.e., solving the task) the agent's capability $\mathbf{c}$ must fulfill the requirement of the task $\mathbf{r}$, i.e. $c_i \geq r_i \forall i$.

Agents with insufficient capability can collaborate with other agents. Collaboration means that an agent a temporarily shares his or her capability with a collaboration partner b. Thus, a's capability vector changes to

$$\begin{aligned} \mathbf{c_{a,coll}} = [c_{a,1,coll}, c_{a,2,coll}, ..., c_{a,5,coll}], \\ c_{a,i,coll} = max(c_{a,i}, c_{b,i}), i = \{1, 2, ..., 5\} \end{aligned} \quad (5)$$

for the duration of collaboration.

Specialization: As specialization was often mentioned within the qualitative study, different kinds of agents were implemented. Specialized agent display high expertise values within few areas of the capability vector, whereas unspecialized agents have average expertise values throughout the capability vector. The degree of specialization describes the extent of which an agent is specialized.

Motivation: We inferred from the qualitative study that socialization and innovation are the main motivations of community members. Depending on the experience of socialization and innovation, each agent develops a certain preference for innovation and socialization respectively. Since experiences are not only formed through current events but also include information from the past, two transition adaptive recurrent fuzzy experience systems are constructed for socialization and innovation within each agent.

The updated preference for innovation $p_i[k+1]$ depends on the preference for innovation in the last iteration $p_i[k]$, the current area $a[k]$ (confidential or public area), and the success in innovation $i[k]$ (Fig. 3). The preference on socialization is modeled analogously based on the success in socialization (Fig. 4). For socialization each agent has an individual parameter *social skill*. The success of socialization depends on that variable and the size of the community area in which he or she is currently participating.

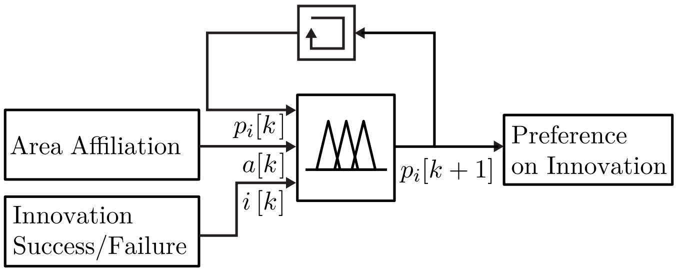

Fig. 3. Fuzzy innovation experience

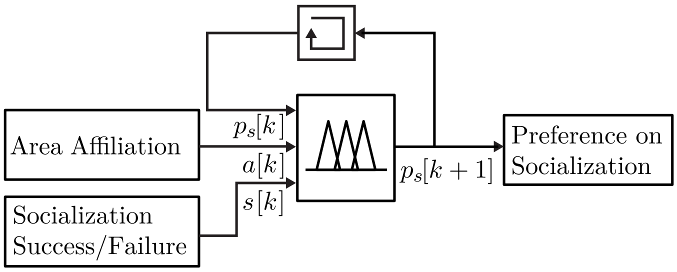

Fig. 4. Fuzzy socialization experience

Selecting community area: Depending on the agent's innovation performance and his or her preference for innovation or socialization, he or she has a propensity to either of the community areas. This propensity is again modeled through a fuzzy system (Fig. 5). Depending on the innovation performance, the agent might not be allowed to enter the confidential area of the community. In this case, the agent remains in the public area irrespectively of his or her preferences.

Model process

The process of the model consists of a predefined number of iterations of the following sequence. First, all agents validate their own capabilities with the required level of capability for their respective task. If all requirements are met, the task is solved (i.e., an innovation occurs). Otherwise, the agents randomly search for another agent within the same community area. This procedure only takes place every 4th iteration because it is assumed that forming collaboration consumes time.

Second, socialization takes place between each agent and the rest of his or her community area. The success or failure depends on the social skill and amount of members within the community area.

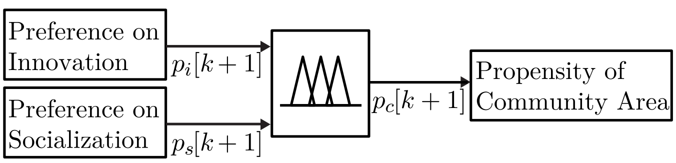

Fig. 5. Prospensity of community area

Finally, agents decide in which area to innovate and socialize based on their propensity of area.

Independent variables and experimental design

We set the *degree of specialization*, the *ratio of specialization*, and *entry threshold* as independent variables. In our model, these contextual characteristics are included as exogenous variables, that is, their values are determined by the experimental design. They vary between but not within simulation runs. The *degree of specialization* determines the distribution of specialists in the community. It varies on a scale between 1 (highly unspecialized community, i.e., capabilities are equally distributed) and 5 (highly specialized community, i.e., capabilities are disparately distributed). The *ratio of specialization* determines the percentage of specialized agents within the community. A *ratio of specialization* = 0 represents the absence of any specialists within the community. The *ratio of specialization* does not depend on the *degree of specialization*. The *entry threshold* of the confidential area represents the minimum requirement on innovation performance for each agent to get access.

We design a simulation experiment (Law 2006) with the following settings: *degree of specialization* = {1, 2, 3, 4, 5}, *ratio of specialization* = {0.0, 0.1, 0.2, 0.3, 0.4, 0.5}, and *entry threshold* for the confidential area = {0.0, 1.5, 3.0, 4.5, 6.0}. Hence, there are 150 different combinations of settings.

The capability vector of each agent is initialized randomly according to the settings of *degree of specialization* and *ratio of specialization*. All agents start within the public area and get a random value for the social skill. The number of agents is set to 100 and does not change in a simulation run. To handle randomness, each setting is repeated 30 times. Each run lasts 500 time steps.

Outcome measures / Dependent variables

To analyze the outcome of the model at the macro level, we consider the innovation performance of the community. This performance measure is calculated as the sum of innovations (solved tasks) made within a community per time unit.

SIMULATION RESULTS

First, we test the effect of the *entry threshold* of the confidential area on innovation performance. Fig. 6 shows the innovation performance relative to a setting of the *entry threshold* of 0. An incline of innovation performance is observed when the *entry threshold* is increased. The maximum innovation performance is at about a setting of 3, then it declines.

The influence of the specialization characteristics of the community members shows a consistent tendency. Fig. 7 shows an increase by specialization degree and specialization ratio.

DISCUSSION AND CONCLUSION

This paper addresses the question on the relationship between individuals' motivation and the performance on the

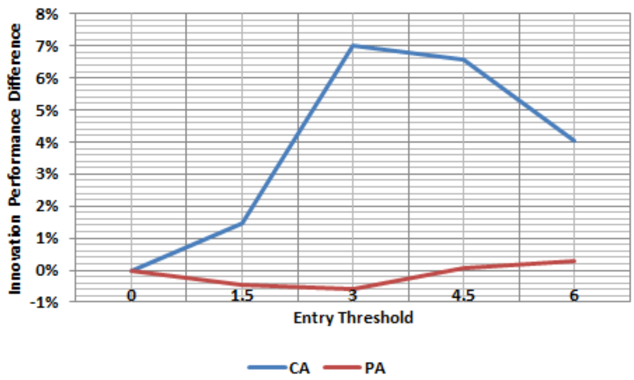

Fig. 6. Influence of *entry threshold* on innovation performance in confidential (CA) and public area (PA)

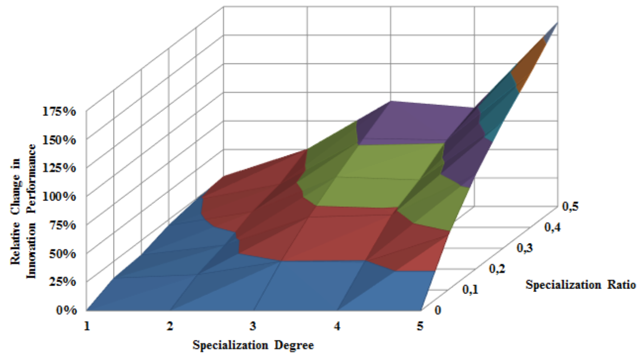

Fig. 7. Influence of specialization (*degree of specialization* and *ratio of specialization*) on innovation performance

macro level of innovation communities. To approach the answer, we developed an agent-based model with fuzzy interfaces and incorporated insights from qualitative empirical research.

In an empirical study we found that confidential areas are a feature of some innovation communities. Furthermore, agents are motivated by socialization in addition to the utility of solving a problem (developing an innovation). With the agent-based model we added dynamics to these insights and fuzzy interfaces allowed us to combine the different motivations in agents' decision making. Specifically, the transition adaptive recurrent fuzzy experience system enabled an individual weighting for each rule of the fuzzy rule base. We measured innovation performance dependent on different thresholds for entry in the confidential area. The result was that restricting access to successful agents increases innovation performance considerably. However, too restricted access reduces innovation performance of the community. Furthermore, the performance of the public area of the community is only slightly reduced when high performing agents are attracted to the confidential area.

This paper provides two contributions. First, it adds to the literature of innovation communities. In particular, the understanding of cumulative innovation and community-based innovation. It extends the understanding by adding the phenomenon of confidential areas. We found that such areas can increase innovation performance. Setting the right entry barriers, however, is essential. Second, we provide a research concept that uses fuzzy interfaces in an agent-based model in combination with data from qualitative interviews. Generally, that approach is suitable for supporting research on complex systems that are empirical accessible. In the area of management, the approach can be applied to other questions on innovation communities or other complex systems, such organizations or business ecosystems. Future research is encouraged for application of the process in these and similar systems and in this way also to improve the approach. We expect future research on innovation communities with approaches and thinking from complex systems. A first step could focus on other observations from the qualitative study of this paper. Commercialization, for example, is an interesting issue influencing the behavior of community members.

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ACKNOWLEDGEMENTS

We thank the German Research Foundation (DFG) for funding this research project, which is part of the Collaborative Research Centre 768 (Sonderforschungsbereich 768) *Managing cycles in innovation processes – Integrated development of product service systems based on technical products.*