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AGENCY PROBLEMS AND GOVERNANCE MECHANISMS IN COLLABORATIVE COMMUNITIES

Vegard Kolbjørnsrud
Assistant Professor
BI Norwegian Business School
vegard.kolbjornsrud@bi.no
Mobile: +47 95170895

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Abstract
Collaborative communities—where participants collaboratively solve problems and integrate their contributions—are increasingly popular organizational forms in a wide variety of domains. As with any cooperative effort communities involve differential interests and information asymmetries, creating potential agency problems. I undertake an exploratory multiple-case study of four communities within the domains of enterprise IT, sustainable products and services, drug discovery, and digital marketing and communication. I find that agency relationships in the collaborative communities are characterized by three distinct multiple agency structures: commons, team production, and brokering. These are governed by four main categories of mechanism: 1) mutual monitoring, enabling self-regulation and peer-based control; 2) membership restrictions, regulating admission to the community; 3) values and rules, guiding member action and collaboration; and 4) property rights and incentives, regulating rights to community resources and distribution of rewards. I also identify contingencies between governance mechanisms and agency problems.

Key words: Agency problems, governance mechanisms, collaborative community

INTRODUCTION

Collaborative communities are increasing in both number and impact across diverse and important fields such as biotechnology, professional services, information and communication technology, financial services, health care, and military operations (Alberts et al., 1999; Applegate, 2006; Benkler, 2002; Maccoby, 2006; Powell et al., 2005). They enable and enhance networking among crowds of autonomous and interdependent participants, entailing membership, commitment to shared purposes, and rules for participation (Heckscher and Adler, 2006; Snow et al., 2011). Such communities—where participants collaboratively solve problems and integrate their contributions—are found to facilitate trust, adaptability, innovation, knowledge creation, opportunity identification and development in business, science, and society (Heckscher and Adler, 2006; Lakhani et al., 2013; Snow et al., 2011). With characteristics such as actor autonomy, self-assignment to tasks, sharing of resources in commons, and peer-based control the new collaborative community designs appear to be governed significantly differently than conventional hierarchical designs (Fjeldstad et al., 2012; Lee and Cole, 2003; O'Mahony, 2007; Ostrom and Hess, 2006; Puranam et al., 2014).

Much of what we know about governance problems and mechanisms in communities are based on studies of Open Source Software (OSS) communities (e.g. de Laat, 2007; O'Mahony and Ferraro, 2007). The OSS literature highlights the governance problems related to commons—the shared resources built, maintained, and used by a community—and the associated challenges in overcoming free-riding issues (Benkler, 2002; Lerner and Tirole, 2002; O'Mahony, 2003). Ostrom (1990: 29) frames the commons problem in agency terms as "how a group of principals who are in an interdependent situation can organize and govern themselves to obtain continuing joint benefits when all face temptations to free-ride, shirk, or otherwise act opportunistically." OSS communities have characteristics that may not necessarily be shared with other forms of collaborative community; specifically, designing and developing a pure information good with a high degree of modularity and open and free access to a common resource (the source code) and the finished product (the software application)(Lerner and Tirole, 2002; Varian, 2000; von Hippel and von

Krogh, 2003). For instance, in the case of physical depletable resources one can expect that the consequences of free-riding to be greater (Ostrom, 1990). We have limited knowledge about whether collaborative communities in other domains face other agency problems; whether building and using other resources, developing and providing other types of products and services, mobilizing different groups of participants, or seeking profits will lead to other governance challenges and mechanisms than what we know from OSS. These gaps are important because collaborative communities in particular, and collaborative forms more generally, are becoming increasingly widespread across a wide array of domains (Adler et al., 2008; Fjeldstad et al., 2012).

In order to address these gaps, I investigate the following research questions: What agency problems are present in collaborative communities beyond the context of OSS? How are governance mechanisms used to mitigate them? I do so by way of a multiple-case study of four communities within the domains of enterprise IT, sustainable products and services, drug discovery, and digital marketing and communication. The cases span diverse contexts, providing rich empirical evidence and a solid basis for exploring the research questions.

The communities I study exhibit three modes of collaboration: collaboration around a commons, team production, and matching of community members in problem solving through brokering. My examination highlights the different agency problems they face and identifies the governance mechanisms that mitigate them: mutual monitoring, membership restrictions, shared purposes and rules, and property rights and incentives. I also identify contingencies for and among the governance mechanisms. First, I find that the extent of mutual monitoring is inversely related to the extent of membership restrictions, as these are alternative modes of quality control. Second, community performance is contingent upon values, rules, incentives, and their enforcement. Any inadequacy in these increases agency problems and the risk of failure. Third, formalization of rules and transparency supported by technical infrastructures allow the communities to grow while maintaining effective governance and avoiding bureaucratization.

My study makes two contributions to the literature on communities and governance of collaborative organizational forms. First, it expands our knowledge of the relationships between collaborative form and governance problems. Second, the study contributes to our understanding of how communities are governed by specifying a taxonomy of governance mechanisms, tracing how the mechanisms are used and combined, and identifying key contingencies for effective governance. I synthesize the theoretical implications of my findings in a set of propositions. I expect my findings to apply to collaborative communities in general, however the applicability beyond the cases studied here will have to be verified by future research.

COLLABORATIVE COMMUNITIES, GOVERNANCE, AND AGENCY PROBLEMS

Collaborative communities experience governance challenges unlike those found in hierarchical organizations and utilize different governance mechanisms. For example, collaboration[1] relationships among community participants differ in nature from conventional hierarchical authority structures and employment relationships, self-organization and peer-review diverge from allocation and evaluation of work by supervisors, and community-managed commons differ from hierarchical allocation of resources (Benkler, 2002; O'Mahony, 2003; Puranam et al., 2014). Governance mechanisms refer to the formal and informal means that organizations deploy to influence organization members and other stakeholders to contribute to organizational goals and purposes and the means by which the goals and purposes are determined (Foss and Klein, 2013; Sitkin et al., 2010). Most of the literature on organizational governance is based on hierarchical schemes (e.g. Jensen and Meckling, 1976; Williamson, 1975), which is of limited relevance to communities. Drawing on a growing body of research on organizational and community governance, and in particular from the literatures on OSS, commons, and trust (e.g. O'Mahony, 2007; Ostrom, 2009; Puranam and Vanneste, 2009) we can identify a number of governance mechanisms.

[1] I follow Wood and Gray's (1991: 146) conceptualization of collaboration: "Collaboration occurs when a group of autonomous stakeholders of a problem domain engage in an interactive process, using shared rules, norms, and structures, to act or decide on issues related to that domain."

In the following review I discuss three of the main categories of community governance mechanisms found in literature: peer-based control (Lee and Cole, 2003), shared rules and norms (Ostrom, 2000), and trust (Adler et al., 2008). Peer-based control mechanisms are a defining characteristic of collaborative community governance, contrary to the well-known authority-based mechanisms of hierarchies (Benkler, 2002; Fjeldstad et al., 2012). Transparent task structure, resource commons, and membership let participants self-assign to tasks, contribute to and find new uses for shared resources, and initiate new collaborative relationships (Puranam et al., 2014). Peer review assure quality by way of peers rather than supervisors (Lee and Cole, 2003; Zuckerman and Merton, 1971). Following from such peer-based mechanisms, peer recognition becomes an important source of reward, motivation, and social status (Lakhani and von Hippel, 2003; Raymond, 1999; Stewart, 2005).

The importance of shared rules and norms is a common theme in the literatures on communities and commons (Benkler, 2002; Heckscher and Adler, 2006; Ostrom, 1990; Ostrom and Hess, 2006). Rules are guides to action (Knight, 1992:67). Rules in terms of protocols for interaction provide actors with the guiding principles to self-organize; effectively identify and mobilize collaborators and resources; collaborately solve problems; share knowledge and ideas; and distribute rewards (Fjeldstad et al., 2012). As in many social and economic systems there is convergence on norms of reciprocity and fairness (Fehr and Gächter, 2000; Ostrom, 2000; Shah, 2006). Norms of reciprocity are for instance formalized in the GPL (GNU General Public License) and similar licensing schemes in OSS (O'Mahony, 2003; Stallman, 1999).

Trust is conducive to collaboration (Dodgson, 1993; Jarvenpaa and Leidner, 1999) and identified as an important governance mechanism in—and a distinguishing mark of—collaborative communities (Adler, 2001; Heckscher and Adler, 2006). It allows for effective knowledge creation and sharing and reduces the need for more intrusive governance mechanisms (Adler et al., 2008; Hsu et al., 2007). Trust in organizations is a multi-dimensional and multi-level construct that is viewed both as a governance mechanism in its own right (Bradach and Eccles, 1989), as a contextual factor

influencing the efficacy of other governance mechanisms and itself being influenced by the use of other governance mechanisms (Hsu et al., 2007; Kramer, 1999). Studies of other organizational forms show that trust and formal governance can have both complementing and substituting effects on each other (Puranam and Vanneste, 2009), but we have limited knowledge of this relationship in collaborative communities.

Agency problems

Agency theory is one of the leading economic theories on governance and offers an explanation for why governance problems arise and how to mitigate them. Any cooperative effort involving two or more actors involves differential interests and information asymmetries, creating the potential for opportunism and agency costs, which influence the relative efficiency of different forms of governance (Jensen and Meckling, 1976: 309). In Jensen and Meckling's (1976) view, agency costs are the sum of the monitoring costs of the principal, the bonding expenditures by the agent, and the residual loss. Agency theory prescribes incentive alignment and monitoring as the main governance mechanisms (Fama, 1980; Fama and Jensen, 1983). In this study, I use the term agency problem as a shorthand for any governance issue arising from differences in interests and information asymmetries among two or more actors—who can act as agents, principals, or both.

I build on the perspective that views community as a third ideal-type governance structure that complements hierarchy and market structures (Adler, 2001; Bradach and Eccles, 1989; Powell, 1990). Hierarchies and markets exhibit agency problems in different ways. The principal-agent logic has been applied extensively to market contracting as a representation of buyer-supplier relationships (Akerlof, 1970; Zsidisin and Ellram, 2003). Markets also perform information aggregation, matching, and price-formation functions (Felin and Zenger, 2011) potentially triggering brokering issues (Marsden, 1982). Agency problems in organizations have been discussed and studied predominantly in the context of hierarchical organizations with agency problems embedded in principal-agent relationships (Eisenhardt, 1989a; Jensen, 1983). The principal-agent structure is one of the defining characteristics of an organizational hierarchy.

Cascading principal-agent relationships define relationships between owners and managers, and managers and subordinates across all organizational levels (Aoki and Jackson, 2008; Child and Rodrigues, 2003). Such a relationship structure and interaction pattern is not an accurate representation of the multi-actor collaborative relationships in collaborative communities (Fjeldstad et al., 2012). Multiple agency perspectives capture more of the complexity and diversity in agency relationships than the simple dyadic principal-agent structure does. Studies of multiple agency—situations with multiple agents, multiple principals, or both (Child and Rodrigues, 2003)—include contexts such as multiple agents cooperating in teams (Alchian and Demsetz, 1972; Holmstrom, 1982); agents monitoring agents in micro-finance (Varian, 1990); multiple principals sharing resources in commons (Ostrom, 1990); managers, underwriters, and venture capitalists in initial public offerings (IPOs) (Arthurs et al., 2008); stock options and the risk taking of outside board directors and CEOs in large firms (Deutsch et al., 2011); multiple venture capitalists in syndicates (Wright and Lockett, 2003); and multiple affiliates and the federation management organization in collaborative federations (Fleisher, 1991).

Attempts have been made to incorporate embeddedness (Lubatkin et al., 2007) and stakeholder (Donaldson and Preston, 1995) issues into a more “social” agency theory by including institutional context factors and relaxing the behavioral assumption of amoral self-interest (Wiseman et al., 2012). Principals and agents have socially derived interests that may or may not converge and do not have to be motivated by individual wealth maximization for agency problems to appear (Jensen, 1994; Wiseman et al., 2012). Managing agency problems may not be sufficient to achieve high performance, but unmitigated agency problems will impair organizational performance and potentially lead to failure. Ostrom's (1990) framing of the commons problem in agency terms shows the relevance of such a view to communities. However, we do not know if the commons problem is critical in all collaborative communities, whether there are other multiple-agency problems present, and the potential implications for the effectiveness of different governance mechanisms and combinations of such problems may entail.

METHODS

I have chosen an exploratory, multiple-case study design (Eisenhardt, 1989b; Glaser and Strauss, 1967; Graebner et al., 2012; Pettigrew, 1987; Yin, 2009). Multiple cases provide a base of varied empirical evidence on which more robust theories can be built and make it easier to determine the appropriate level of construct abstraction and develop more precise definitions (Eisenhardt and Graebner, 2007; Pettigrew and Whipp, 1991). Furthermore, there are recent calls for more comparative research on community organizing (O'Mahony and Lakhani, 2011).

I identified and selected cases according to theoretical sampling principles (Glaser & Strauss, 1967) following a stepwise process: 1) mapping of collaborative communities; 2) definition of case selection criteria; 3) evaluation and shortlisting of prospective cases; and 4) case selection. First, I identified and logged 70 prospective collaborative communities by examining the academic and practitioner literature, searching the Internet, and through personal and professional networks. I deliberately did not sample OSS communities, which represent one of the most common types of collaborative community. These are well-researched and I draw on the extant literature in this study (e.g. Benkler, 2002; O'Mahony and Ferraro, 2007).

I selected cases based on similarity and variation on the following criteria. First, cases had to possess characteristics of collaborative communities as defined above, specifically 1) enabling networking, 2) autonomous and interdependent participants, 3) membership, 4) commitment to shared purposes, and 5) rules for participation (Heckscher and Adler, 2006; Snow et al., 2011). To ensure observability, there had to be significant interaction and exchange in the case communities and participation had to involve more than a small team of members. Second, I sought variation in terms of forms of collaboration to provide rich empirical settings for investigating agency problems and governance mechanisms. Third, variation in terms of geography, business sector, and performance mitigate cultural, industry and field, and success biases, respectively (Baum, 2007). Finally, I selected four cases which are listed in their order of selection in Table 1, which also shows how they vary in key characteristics.

Insert Table 1 about here

The case studies are based on data from interviews, documents, and observations (Yin, 2009). Multiple types of data from different sources inside and outside the community provide rich structural, processual, and contextual insights and increase the robustness of results through triangulation (Jick, 1979; Pettigrew, 1990).

I conducted 75 semi-structured interviews with 83 people. Fifty-six of the interviews were made in person and on site, and all were recorded and transcribed. Six of the OSDD interviews were group interviews, and six people across the OnCorps, LOHAS Asia, and OSDD cases were interviewed multiple times in order to trace development over time. I interviewed a diverse set of people in and around each community in terms of roles, backgrounds, seniority, centrality, competencies, etc., including organizers and external stakeholders, such as investors. Data collected per case and data type are summarized in Table 2.

Insert Table 2 about here

As far as possible, I collected documents on all the cases. Document types include contracts, process descriptions, vision and value statements, financial statements, membership lists, presentations for internal and external audiences, news reports, academic publications, and websites. In the DigiFam case, I had full access to the electronic archives.

During six field research trips over a total of seven weeks, I conducted the majority of interviews in person and in the context where the interviewees work and socialize. Interaction in the online collaboration spaces of the LOHAS Asia and OSDD cases were observed both in real time and retrospectively. In the OSDD case, I conducted eight days of observation, five days in the project director's office and three days during an annual scientific review meeting with 60 participants who participated actively during presentations and discussions. All interview transcripts and key documents were coded and analyzed using NVivo qualitative research and analysis software. I

combined inductive, deductive, and iterative approaches in generating, applying, and developing the coding system. First, I read some of the first interview transcripts and inductively identified categories from the text. Second, I synthesized a number of key constructs from a review of a number of the main theories informing organization design and governance. Third, I entered the identified categories into the software and added and organized categories as I coded the interviews and other materials. The coding system gradually evolved throughout the coding process as I uncovered new patterns. The use of NVivo qualitative data analysis software supported the analysis process in at least two ways. First, it has an indexing and organizing function, which makes it easier to systematically search and analyze large volumes of textual data and avoid the ever-present danger of "death by data asphyxiation" (Pettigrew, 1990). Second, it brings rigor and traceability to sensemaking and theorizing from the case material (Sinkovics and Alfoldi, 2012). I conducted literature studies, data collection, coding, analysis, and theorizing in iterative cycles—the different activities mutually informing each other during the study (Glaser and Strauss, 1967; Van Maanen et al., 2007).

FINDINGS

In this section I present four case narratives, describe and discuss the agency problems and governance mechanisms found within and across cases, and discuss how the findings relate and add to the extant literature. Finally, I identify and discuss contingencies between agency problems and governance mechanisms.

OnCorps

OnCorps is a community of IT executives and practitioners offering peer-based analytics and advisory services on a commercial basis under the motto "peer collaboration to accelerate technology adoption." The community and its business model have evolved in three distinct stages so far, labeled OnCorps 1.0, 2.0, and 3.0 for short. OnCorps (OnCorps 1.0) was founded in the fall of 2009 and by the fall of 2011 it had about 300 members, comprising current and retired CIOs of *Fortune* 500 companies, senior IT and management consultants, and finance executives. During

this first stage, the community facilitated peer-based advisory services, technology brokering, and angel investment opportunities for its elite members. Initially, OnCorps had very strict requirements for admitting new members.

Individual members signed a membership agreement with the community organizers regulating issues such as participation, intellectual property, disclosure policies, commitment to ethics, and incentives. This agreement guided member-to-member collaboration up to a point where separate contracts were written. Organizers were entitled to a commission when members were matched and paid advisory services were provided. When technology partner firms were introduced to potential customer organizations through OnCorps and its members, and the process led to a deal, both the brokering member and OnCorps centrally were entitled to commissions. Furthermore, members with knowledge needs were matched with others in the community who had technology knowledge and execution experience and exchanges of knowledge and money took place.

The majority of members were CIOs or held similar roles, implying that they were involved in traditional employment relationships that constrained the types of knowledge exchange and commercial activities in which they could participate. The CEO and co-founder of the community expressed this as a concern and OnCorps inserted clauses in the membership agreement regulating such issues. The motivation was to protect members, clients, partners, and the community from potentially destructive conflicts of interests. This indicates that potential diverging interests among members and the community did not necessarily originate in self-interest, but also in organizational multi-membership. Member lists were not openly available. According to the CEO, this was done to avoid two issues: spamming of their highly attractive member base and bypassing OnCorps in commercial transactions, indicating a potential agency problem.

The next stage in OnCorps' evolution, OnCorps 2.0, was marked by the capital investment of technology venture capital firm Andreessen Horowitz that OnCorps received in August 2011. Later that fall OnCorps initiated the development of the new "analytic collaboration engine" for "real-

time data science collaborative matching." With the beta launch in late 2012, OnCorps started inviting members to share their IT project and performance data and get real-time, anonymous benchmarking against their peers. At this time they extended membership to IT practitioners on different levels. Expert matching was based on project performance and track record in the system. During the piloting of the new platform in 2012–13, OnCorps discovered a strong interest among members and potential corporate clients in licensing the new real-time analytics platform on a software-as-a-service basis, marking the entry into its 3.0 stage. My analysis focuses on stages 1.0 and 2.0 in OnCorps' development.

During the 1.0 stage, potential agency problems were mainly related to its brokering activities—community members matching technology partners with corporate clients, the community brokering member investments, and matching members to each other for knowledge sharing. There was a concern that members could bypass the community after the initial introduction when deals were made. The most salient governance mechanisms were very strict member-selection practices, clear rules regulating disclosures and commissions to avoid conflicts of interest, and financial incentives. Transitioning to stage 2.0, the intention of building a knowledge commons of member data and maintaining data anonymity became important. Member selection was relaxed as OnCorps wanted to grow a larger and more diverse community of practitioners and could more easily trace performance on the analytic collaboration platform.

LOHAS Asia

LOHAS Asia is a community where firms committed to serving the LOHAS (Lifestyles of Health and Sustainability) consumer segment collaborate to exchange knowledge and develop new business opportunities. Firms can become members of "THE HUB by LOHAS," an online forum for exchange of experience and ideas, free of charge. Member firms have to make "the LOHAS Pledge" when they register on the Hub, committing to LOHAS values and practices such as (§2), "I/We shall apply LOHAS principles of social justice and environmental protection when choosing

our suppliers." Members are required to self-report their compliance to LOHAS principles and practices on an annual basis or membership may be terminated (§4).

The community was founded in early 2009 and by the end of 2013 there were more than 900 Hub member firms, most of which are small. The membership list is available to all members. LOHAS Asia is coordinated by a small team based in Singapore and provides services in four areas on a commercial basis: investment brokering, i.e. matching LOHAS Asia start-ups and investors; market research on the LOHAS segment; education and conferences; and advisory services. A large share of Hub membership is from outside Singapore, and even outside Asia.

LOHAS Asia matches entrepreneurs and start-up firms within the community with funding partners, and claims an equity warrant and small commission if funding deals are made. LOHAS Asia's funding initiative, the Accelerator, is a structured process for matching LOHAS start-ups and investors. The second and third Accelerator rounds during the fall of 2012 and the summer of 2013 resulted in one and two companies, respectively, obtaining funding from investors. LOHAS Asia select and coach companies in a staged process supported by a funding panel, which consists of investors, LOHAS organizers, and experts from large multinationals such as Ogilvy, Google, and Accenture. The process implies financial incentives for most participants: capital to the investing firms, attractive investment opportunities for participating investors, and commission or finder's fee for LOHAS Asia when deals are realized. The diversity of experience represented by the funding panel is both a source of insight and potentially conflicting interests.

There is also an inherent conflict in combining the dual purposes of financial returns and environmental and social sustainability: "In the longer term there is a conflict between doing something sustainable and doing something that is actually going to generate value for shareholders. There is conflict in general in the short term or the longer term." (Advisor on funding panel)

So far LOHAS Asia has mainly focused on matching member firms with investors, so brokering-related agency issues have been prominent. However, the different interests represented on the funding panel also display agency problems in team decision making. These issues have not materialized in actual conflicts but are nevertheless concerns shared by most funding panel members. LOHAS Asia uses a number of governance mechanisms. Clear LOHAS values and rules are embedded in the LOHAS Pledge that prospective members have to make when applying for membership. The purpose of this is to reduce goal incongruence. The introduction to the Pledge states explicitly: "In order to ensure that we are building a community of like-minded companies and to prevent LOHAS-washing, we ask all prospective members of THE HUB by LOHAS to read and sign the Pledge below." The requirement of submitting an "Annual LOHAS Statement" on the Hub portal provides some degree of transparency and enables peer review. LOHAS also provides both monetary and non-monetary benefits to members and investors.

OSDD

Open Source Drug Discovery (OSDD) is a collaborative community established to discover therapeutic drugs for poor patients in the developing world. OSDD leverages the collective capabilities of an open and diverse community of experts and volunteers in drug discovery and development. The community was launched in 2008 and as of November 2013 it consisted of more than 7900 participants from more than 130 countries. It is funded and coordinated by the Indian Council of Scientific and Industrial Research (CSIR), one of the world's largest publicly funded research institutions. The founders selected Tuberculosis (TB) as the first target area. TB claimed about 940,000 lives worldwide in 2012, 270,000 in India alone (WHO, 2013). No new general TB drugs have been launched for 40 years and problems with drug resistance are increasing (Zignol et al., 2012). OSDD is currently extending its efforts to malaria and further extensions into other infectious diseases are intended in the future. The community is based on open participation, open peer review, and open source intellectual property rights (IPR) principles (Sugumaran, 2012).

OSDD mobilizes actors with a diverse set of competencies and capabilities, such as computational and wet lab biology and chemistry, informatics, pharmacology, and clinical medicine. Although all the data are shared online in virtual knowledge commons, a large share of the work is done physically, e.g. in wet labs and screening facilities. OSDD has made significant progress in collecting, systematizing, and analyzing biological data, identifying drug targets, synthesizing and screening chemical compounds. It launched the first clinical trials (Phase 2b clinical trials of the Pa824 molecule) in collaboration with the Global Alliance for TB Drug Development (TB Alliance) in March 2014.

OSDD requires contributors to accept its "terms of use" when they register as users of the SysBorg 2.0 portal, research data repository, and collaboration platform. These terms regulate use, intellectual property rights, user rights, liabilities, and so on. All OSDD members sign up via the SysBorg 2.0 portal, through which they can search for other members, access and comment on their contributions, initiate and participate in discussions, and contact other members directly. In principle, all data, problems, results, and comments are available to all members. OSDD's commons comprise a heterogeneous set of physical and intangible resources: biological and chemical data, chemical compound libraries, biological samples and assays, research protocols and lab notebooks, and ideas and project proposals. The community collectively contributes to, stewards, and uses resource commons that grow and evolve over time.

In summary, multiple large-scale commons constitute a core element of OSDD and the community has to manage commons-based agency problems similar to accounts of OSS communities (Benkler, 2002; O'Mahony, 2003). These include free riding and exploitation of individual contributions, as well as ensuring continued openness and the addition of extensions based on the content of the commons. In addition, OSDD has specific rules for attribution in academic publishing and enables and encourages private patenting under the condition of unrestricted usage rights for the community. The patenting practice represents a novel approach to property rights and attribution in an open source context. The high degree of transparency and extensive use of open peer review

enable quality assurance and reduce information asymmetries. OSDD uses an extensive set of governance mechanisms to mitigate commons-related agency issues: values of openness, meritocracy, and providing affordable healthcare; rules for attribution; transparency and peer review of proposals and contributions; combining individual property rights with open sharing; and monetary and non-monetary incentives.

DigiFam

DigiFam was a community of consultants within digital marketing and communications based in Stockholm, Sweden. It was founded in 2008 by a group of independent consultants who wanted to work together and support clients on their "digital journeys" with larger and more complex transformational projects. The founders emphasized the community as a "family" and members were invited to "family parties" and "family lunches" for professional knowledge sharing and social community building. Members could freely use shared office facilities. DigiFam rapidly attracted members and grew its business. During the first months of operation, the founding team and other early members agreed on a revenue-sharing model outlining how revenues from joint projects should be shared among project participants and DigiFam. The community was legally structured as a limited liability company with 10 shareholders from the outset, of whom most were active community members. The founders believed in distributed ownership among members to increase commitment and sense of community, and after the last "family share issue" in August–September 2011 there were 33 shareholders.

By the end of the first full fiscal year in April 2010 DigiFam was turning a healthy profit. Twenty to 30 people were generating a significant share of their revenues from community projects, and the community was characterized by energy and optimism. The completion of its longest and largest project toward the end of the summer in 2010 coincided with a slump in market demand for its services. The loss of revenue was not compensated with revenues from new projects. Gradually key members and organizers realized that the revenues could not sustain the costs, and from the fall of 2010 onward, conflicts among key organizers and the board began to surface. There was a

change of leadership in the fall of 2011. The new leadership took measures to cut costs and increase revenues, for example, charging members for office rent. The measures taken did not resolve the problems; indeed, by some accounts they may have accelerated the decline by alienating members. DigiFam filed for bankruptcy in May 2012. The community had about 100 members when it defaulted.

DigiFam members did not sign formal membership agreements with the organizing unit when joining the community, but informal terms and conditions were accepted through socialization and embodied in the members' handbook and the revenue-sharing model. DigiFam conducted most of its client business in project teams of consultants. Collaboration was direct and mostly in person. The community's largest project was a digital transformation program for a mid-sized publisher involving 8–10 consultants over a period of 18 months. The project was sold and coordinated by the community CEO and staffed by independent consultants in the community who were contracted for the assignment. This model provided a high degree of freedom to appoint the consultants most fitted to the relevant roles, as DigiFam employed no permanent consultants. A number of the members thought that the distribution of revenues on some of the projects was not fair. Some people contributed less operationally and appropriated more of the financial benefits. Many of the same consultants were given repeated project roles. Some of the interviewees thought this had happened because those consultants were known and liked by the organizers and not necessarily selected because they were best fitted for the job. There was also an occasion where a new community member was brought onto a project and used the role opportunistically to try to be recruited by the client. The other team members considered this unacceptable and her contract was terminated. Due to contracting issues and labor laws, DigiFam had to use community resources to compensate her. Several informants expressed concerns about a "free-riding culture" in the community: "A lot of people joined, but very few contributed anything actively. Everybody wanted a piece of the pie and everybody wanted assignments, but very few contributed with anything more."

The narrative of the DigiFam community exposes team production and brokerage-related agency problems. One can observe two team production issues: 1) some members appeared to appropriate an unfair share of revenues on some projects and 2) one consultant behaved opportunistically at the expense of the project team and the community as a whole. The brokering issues were possibly even more significant. First, the perceived bias in staffing projects repeatedly with the same consultants indicates unfair and non-meritocratic access to opportunities and assignments. Second, the lack of compliance with and enforcement of the revenue-sharing model allowed members to free-ride, benefiting from the ideas and opportunities generated within the community without sharing the financial returns. This made DigiFam financially unsustainable over time. There were some indications that the revenue-sharing model was not adequately calibrated to the business needs, which may have added to the difficulties. The main governance mechanisms in DigiFam were values and incentives. The "family" values contributed to a sense of community, but the inclusiveness also allowed free-riding. The incentive model was essential, but inadequately enforced. The community's social structure was also vital. It was cohesive in the early stages, but became less so with the community's rapid growth and there were few more scalable formal mechanisms in place to compensate for this.

Agency problems and structures

These case narratives reveal patterns of consistency and variation in agency structures and problems across the four communities. I observe three distinct multiple agency structures—commons (Ostrom, 1990), team production (Alchian and Demsetz, 1972), and brokering (Marsden, 1982)—and agency problems associated with them. The three structures are present and important in the four cases collectively, but their presence and relative importance varies significantly per case.

Commons. Commons are present in all four communities; however, their size, complexity, and importance vary significantly across the cases, as do the nature and severity of the associated agency issues. In DigiFam, community commons were mainly the brand and the shared offices, in

LOHAS Asia they were the Hub portal, and in OnCorps 2.0 the member data. Commons or common-pool resources (CPR) are shared resources built, managed, and used by a community and may consist of physical or intangible resources such as knowledge (Ostrom, 1990; Ostrom and Hess, 2006). Access to commons can be libertarian or associational, i.e. public or limited to a group or community (Levine, 2006). Commons-related agency problems are negligible in DigiFam and LOHAS Asia and moderate in OnCorps.

The large-scale commons of heterogeneous resources are essential to OSDD and commons-related agency problems are the most prominent. Such problems include the risk of free-riding, such as plagiarism, private appropriation, and restricting the openness of the commons. These are well-known problems from the literature on OSS communities (e.g. Benkler, 2002; O'Mahony, 2003). OSS communities collaboratively design and develop software, which is a modular, perfect information good (Lerner and Tirole, 2002; Varian, 2000), whereas OSDD's commons comprise heterogeneous problem-state representations and problem-solving resources, such as biological and chemical data and models, biological samples and assays, and chemical compounds. The diversity of OSDD's members' professional background and culture amplifies the complexity of the agency challenges. Scientists are more reserved in sharing their data and findings than students, wet-lab researchers are less used to sharing than computational researchers, and chemists are more secretive than biologists. Initially, experienced scientists were skeptical about joining the community and share their research openly in the commons. A PI comments: "It took me some time to understand that. First of all, I mean, the whole idea that can we do research in an open way? I mean, most scientists could not digest that, because being a scientist, I mean lots of scientists are protective before they open their research. They want to have some kind of safeguard around their research. So that was the apprehension like, what about the IPR issues? Those are still there, I mean, I don't think those are fully addressed."

The open commons are not perceived as a concern among participating students; students were the first member category to join the community en masse through the Connect2Decode (C2D)

annotation exercise. In the four months following December 2009 more than 800 students volunteered to reannotate the Mtb genome. This involved identifying elements in the genome and attaching biological information to them, drawing on the literature and genomic databases. This shared dataset has been used in predictive bioinformatics models and genomic maps to help identify new drug targets and design drugs aimed at them. Even though some express concerns about the risk of plagiarization, there have been no reports of such opportunistic behavior in OSDD during its first five years of existence.

The heterogeneity of resources and participants makes it difficult to design a simple "one-size-fits-all" set of governance mechanisms and practices. While the commons-based agency issues are of concern for community organizers and members in OSDD, so far they have not materialized in serious episodes or conflicts. This is probably attributable to the effectiveness of the community's governance mechanisms. Accounts of OSS communities (Benkler, 2002; O'Mahony, 2003), and collaborative organizational forms (Fjeldstad et al., 2012) more generally, accentuate the criticality of commons in collaborative communities. This is consistent with the OSDD findings, but less so with the other cases.

Team production. Tracing the direct links between contributors, inputs, and outputs can be very difficult, leading to significant team production issues (Hamilton et al., 2003; Holmstrom, 1982). Team production refers to when multiple actors cooperatively produce joint outcomes. It implies that multiple types of resources are used in a production process, that outcomes are not a separable sum of outputs from each resource, and that not all resources belong to one actor (Alchian and Demsetz, 1972: 779). This problem was observed in the DigiFam case in terms of unfair distribution of financial rewards within project teams and an instance of opportunistic behavior by a consultant. Agency issues also arose in the team decision-making process of the LOHAS Asia funding panel: "First of all you have a panel of people making an investment recommendation. The panel and the ultimate sources of funding do not share the same identity. A panel of ten people may say this is the company that we've selected. But I am one of the potential funding sources or

[investor X] is one of the potential funding sources and ultimately we may have a slight, even a slight difference of opinion to the overall consensus" (Investor on funding panel).

Teamwork is essential in OSDD projects as well, and in settings with senior and junior researchers and students there are hazards: "Very strong professionals are coming into this space, but they must come in with a positive attitude not to exploit the young people. See, on this platform you can exploit a lot of young people. [The young people have] their personal aspiration also, professional aspirations. So you have to make sure that you are fair, so you give the right credit to them when the paper is published" (OSDD PI). However, in this case no unmitigated team-related agency problems have been observed so far. Alchian and Demsetz (1972) prescribed hierarchical, centralized monitoring as the solution to the team production problem. This does not capture the logic of community governance, as I will discuss later.

Brokering. Matching actors and resources is important in all four cases and some actors perform roles as intermediaries (Obstfeld, 2005): LOHAS Asia matches member firms with investors through the funding panel; OnCorps 1.0 connects technology partners and clients with the help of community members; DigiFam matched members with other members and clients; and OSDD organizers bring together scientists with complementary ideas, knowledge, and resources. Matching members with complementary interests and capabilities can also be performed directly by the members themselves in virtual and in-person forums available to the community. Both OSDD and LOHAS Asia have online collaboration portals where members can find each other and connect. OnCorps 2.0 developed a platform for real-time benchmarking, analytics, and functionality enabling members to connect with expert members with the consent of both parties. In the DigiFam case, direct member-to-member interaction was enabled by in-person forums, such as shared office space, lunch seminars, and parties.

Mediation facilitates new combinations of actors, knowledge, and resources, enabling value creation on both actor and community levels (Kogut and Zander, 1992); however, it also creates

possibilities for opportunistic brokerage behavior (Burt, 1992; Simmel, 1950). Brokerage relationships in their simplest form have a principal-agent-principal structure, where the broker is the agent (Marsden, 1982). Actors in brokerage positions may choose to act in their own self-interest, making the connections they will profit from themselves and exploiting their position to over-appropriate value (Burt, 1992; Cook and Emerson, 1978). Interestingly, the inverse of this problem seems to be more common in the case material, that is, that the actors benefiting from mediation services could choose to bypass the broker, and avoid sharing the benefits with either the broker or the community that enabled the exchange. This was DigiFam's core problem and toward the end of the company's lifetime it was happening on a regular basis. Members met and connected in the community, developed ideas and opportunities, sold and delivered projects, booked the revenues directly, and refrained from sharing revenues according to the revenue-sharing model. One member described this practice:

"There were a couple of new projects that came through DigiFam where I had some of my own clients and involved some others from DigiFam without doing the projects within the frame of DigiFam. I delivered the projects with the other members directly. […] I think this was a common practice. Everybody had their own businesses, nobody worked exclusively through DigiFam. [The revenue sharing model] didn't work that well for me because I could handle my assignments on my own. I had nothing to gain by leaving them to DigiFam. I believe many kept their clients to themselves because they didn't think there were incentives for bringing them into the network."

Such bypassing has been a concern for OnCorps as well, but there has been no account of it happening in practice.

Insert Table 3 about here

In summary, the case studies reveal three multiple agency structures, which are summarized in Table 3 and in proposition 1.

Proposition 1: Agency problems in collaborative communities are characterized by commons, team production, and brokerage structures.

The structures coexist and interact in the communities. Adding new members, resources, and collaborative relationships to this, causes dynamic, multiplex, and embedded patterns of agency relationships to emerge.

Governance mechanisms

As the case narratives show, the communities in this study use a variety of governance mechanisms. I identified the mechanisms during data collection and analysis and compared and contrasted them with broad streams of literature, defining them and grouping them in the main categories. Where the mechanisms have been adequately defined and described previously, I adopt existing terminology in order to avoid adding to the plethora of overlapping terms and concepts in studies of new organizational forms (Child and McGrath, 2001). Below, I provide some brief descriptions and case illustrations of each category. Definitions of the governance mechanisms, their presence and degree of use in each case, and selected examples from the cases are summarized in Table 4.

Insert Table 4 about here

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1) Mutual monitoring. OSDD takes mutual monitoring the farthest in terms of transparency and peer review. An OSDD principal investigator (PI) stated, "It's like living in a reality show," humorously alluding to the extensive transparency in the community. In principle, all data, problems, results, and comments are available to all members. Open peer review permeates all evaluation and selection processes, such as assessment of ideas, data, findings, project proposals, as well as financial resource allocation: "The projects which require funding need to be placed online. These projects are subject to peer review. So the community has a say whether this project should be funded or not. So that's democratization of the grant release process" (Project director). Information systems are essential in enabling OSDD's extensive transparency and mutual

monitoring of highly distributed work and collaboration and the case shows that mutual monitoring can be very effective in mitigating commons problems (O'Mahony, 2007; Ostrom, 1990). OnCorps 1.0 represents the polar opposite: discretion, anonymity, and data confidentiality were prime concerns.

Mutual monitoring—that is, actors (agents, principals, or both) monitoring each other—enables self-regulation and peer-based control and reduces information asymmetries (Child and Rodrigues, 2003; Ostrom, 1990; Varian, 1990). In the agency literature, mutual monitoring has been found to be effective in mitigating team production problems as it simplifies the process of tracing contributions and efforts back to individuals (Fama and Jensen, 1983; Holmstrom, 1982; Welbourne et al., 1995). My findings corroborate this as well as the inverse where insufficient mutual monitoring may lead to unmitigated team production and brokering problems such as in the case of DigiFam as well as in OnCorps 1.0 where the lack of transparency in membership could harm the willingness to share knowledge: "[How much knowledge I would share] depends on how transparent the community is to me. If the community can be completely transparent, in other words; if I knew exactly who the community was talking to and what kinds of advice it was giving the community, then I would know how much to share, but it's a pretty opaque community in many ways. So I would initially be not willing to give much at all. You know, I want to understand and I want to learn. I want to see what they can give me but not necessarily what I can give them, so to speak. There is an element of building trust over time, which again is a part of that relationship-building piece that takes a lot of time." (Advisory board member)

2) Membership restrictions. Membership restrictions refer to criteria and processes that regulate admission to the community and termination of membership, if necessary. Again OSDD and OnCorps 1.0 are polar cases. OSDD practices open membership, or membership by self-selection, conditional only on acceptance of the OSDD terms of use. OnCorps 1.0 had very strict requirements for admitting new members and highly centralized processes for approving membership as shown in the community member agreement (fall 2011):

"Membership in the OnCorps Community will be by invitation only. All new members must be referred by an existing member. Generally, persons will be considered for membership in the Community based on three factors: distinguished leadership achievement; impeccable peer reviews; and a distinct defined contribution to the technology industry. […] Final admission must be accepted by OnCorps management."

In the 2.0 stage, OnCorps relaxed membership criteria when it launched its Analytic Collaboration Engine, allowing a wider group of IT executives and project managers to join. All new LOHAS Asia members are assessed by the community organizers on their environmental and social sustainability performance upon application. Member selection practices provide ex-ante quality assurance of members, but may also reduce member diversity, which is important in complex problem solving (Hong and Page, 2001; Page, 2007). OnCorps moving from phase 1.0 to 2.0 illustrates how relaxing some member selection criteria allowed a larger and more diverse community—enabling the new benchmarking services.

3) Shared purposes and rules. All the communities studied advance clear and articulated values and communicate them frequently. LOHAS Asia member firms have to make "the LOHAS pledge" when they register at the Hub, committing to LOHAS values and practices. It is not possible to register without making the pledge. Values align members around common purposes and beliefs (Rokeach, 1968; Rokeach, 1979), contributing to goal congruence and mitigating the risks of conflicting interests. The founder and chief mentor of OSDD repeatedly emphasizes that OSDD is "an emotional enterprise rather than a professional enterprise," pointing toward the higher cause of curing neglected diseases and providing "affordable healthcare for all." Every single interviewee cites the importance of their shared purpose of curing TB and malaria and that it is a key motivating factor for them personally. In the case of DigiFam, purposes and values were not fully shared by everyone—particularly not by members joining after the initial stage—and were clearly not sufficient to mitigate agency problems, indicating the need for combining shared purpose with other mechanisms to be effective.

Formal and informal rules are important governance mechanisms in OSDD, OnCorps, and LOHAS Asia, with rules understood as "guides to action" (Knight, 1992: 67) analogue to rules in team sports, where the rules define the game but allow for a large variation in strategies, tactics, and forms of interaction (Grehaigne et al., 1997; North, 1990: 4). OSDD has a detailed authorship policy regulating who is to be attributed as the author of academic work and in what order names are presented. The attribution rules do not distinguish on the basis of researchers' seniority, but rather on their contribution. These rules and their consistent application reportedly have a motivational effect on students and junior researchers. Rules designed to mitigate role conflicts were important in OnCorps 1.0. In LOHAS Asia, members are required to self-report their compliance with LOHAS principles and practices on an annual basis or membership may be terminated. However, the community has not sanctioned or suspended any members for failing to do so thus far. Despite the lack of formalization, we have seen that DigiFam expelled a member for unprofessional behavior. Rules guide actions and specify what can be expected from fellow members, creating a basis for trust and self-organization (Fjeldstad et al., 2012; North, 1990; Ostrom, 1990; Ostrom, 2000). The agreements used in the communities are mostly social arrangements. Two agreements discussed here are legally binding: the OnCorps 1.0 membership agreement and the OSDD terms of use. Neither DigiFam nor LOHAS Asia had legally binding membership agreements, but both would write legal contracts when making commercial transactions such as a consulting project for DigiFam and facilitating an investment for LOHAS.

4) Property rights and incentives. Property rights and incentives regulate rights to community resources and distribution of rewards. Monetary and non-monetary incentives are present in all four communities and provide members with actual or potential private benefits. Both OnCorps (1.0 and 2.0) and DigiFam had detailed revenue-sharing arrangements with specified percentages allocated to different roles and contributions; both also allowed and encouraged members to earn advisory fees. The LOHAS Asia funding initiative matches investors with member firms seeking investment implying financial as well as non-financial incentives for the involved parties. Active contributors in OSDD gain status and social rewards in formal and informal ways (Stewart, 2005). The

community's Micro-Attribution Score system keeps track of participants' contributions and provides a ranked list of participants based on these scores. This system is a deliberate effort to recognize participants' contributions and advance meritocratic norms. Learning and professional recognition benefits are significant in all four cases.

The four communities deal differently with property rights. LOHAS Asia and DigiFam have few joint resources and do not have specified property rights mechanisms. In OnCorps, users retain rights to their own data. OSDD combines open source and property right principles, including patenting (Sugumaran, 2012). The community requires any addition or improvement of the data on SysBorg to be referred back to OSDD (terms of use §3.2). Serious violations of the property rights could lead to legal prosecution, but such abuses have not been observed to date. Members can patent their contributions provided that they "grant an unencumbered worldwide non-exclusive right to the OSDD for use of such rights for further research" (§3.6). OSDD's patenting policy enables open sharing and use within the community combined with restricted private appropriation outside the community, and is a novel form of the private-collective innovation model (von Hippel and von Krogh, 2003). Patenting is generally considered an economic appropriation mechanism (Teece, 1986). In OSDD, patenting is also used to keep knowledge open and provides some protection from exploitation by third parties as well as it can be seen as an attribution mechanism. This is particularly the case for chemists, as patenting is viewed as an important form of publication and a success indicator for scientists in this domain.

In dealing with commons issues it is crucial to have general property rights rules for the whole community—or anyone with access to the commons—and they have to be specified ex ante to provide potential contributors with the assurance they need to decide to contribute. Here, OSDD is a case in point. General, community-wide property rights mechanisms would be useful in situations with team production and brokering issues as well, but one can argue that it is less critical in such contexts as property rights issues could be dealt with on a project-by-project or exchange-by-exchange basis which is largely the case with LOHAS Asia, OnCorps 1.0, and DigiFam.

Taken together, these governance categories comprise the major governance mechanisms operating across the four case studies. In each case they need to match the underlying agency structures and the social, technological, and institutional contexts in which the communities are embedded (Lubatkin et al., 2007; Wiseman et al., 2012). Changes in any of these factors may have an impact on the nature of the agency problems and the effectiveness of the governance mechanisms. The case narratives reveal that each community employs a different mix of governance mechanisms. The variations and consistencies are not random, and in the following section I identify and explain three such contingency patterns. I also summarize how the governance mechanisms mitigate each of the three agency problems and synthesize the theoretical implications of my findings in a set of propositions. My propositions are rooted in previous literature but made plausible and specified further through my empirical study, though further testing and refinement by future research are needed.

Contingencies

Mutual monitoring and membership restrictions. The extent of mutual monitoring appears to be inversely related to strictness of community member selection criteria and processes, i.e. membership restrictions, in the case set. This can be observed in the comparative statics across cases and in the dynamics of the OnCorps case. OSDD combines open membership, i.e. self-selection, a high degree of transparency, and extensive peer review. This is consistent with accounts of OSS communities and Wikipedia (Garud et al., 2008; Puranam et al., 2014). Applicants for LOHAS Asia membership have to show integrity in terms of the environmental, health, and social impact of their businesses. This is combined with a moderate degree of transparency and peer review enabled by the Hub portal. DigiFam partly fits the pattern with some extent of informal membership selection and peer review. OnCorps 1.0 had very tight membership criteria and centralized selection processes and a low degree of mutual monitoring before the launch of the new technology platform. In the OnCorps 2.0 stage, the community invited its members to share their IT project data and get instant and anonymous benchmarking in return. This allowed greater transparency of data and system-enabled peer comparisons. Membership was opened to enterprise

IT project managers. Greater variation in expertise and performance was desirable to obtain realistic benchmarking. Expert matching was done on the basis of project performance and track record in the system; hence strict member selection processes were not required. The extent of mutual monitoring and membership restrictions across cases are illustrated in Figure 1.

Insert Figure 1 about here

Mutual monitoring and membership restrictions are alternative, but not mutually exclusive, ways of assuring quality. Membership restrictions assures input quality, whereas mutual monitoring assures process and output quality. Depending on the relative cost and effectiveness of the mechanisms, we can expect a high level on one of the mechanisms and a low level on the other, or a moderate level on both in a collaborative community. Low levels on both mutual monitoring and membership restrictions could lead to inadequate quality assurance, while high levels on both could lead to infeasible governance costs. Whether this relationship holds for all collaborative communities cannot be concluded based on the case studies presented here. There are examples in literature suggesting that the combination of extensive mutual monitoring and strict member selection may occur, e.g. in the case study of Myelin Repair Foundation, a foundation facilitating and funding an elite community of researchers on Multiple Sclerosis (Backler, 2010), but the combination of open membership and little mutual monitoring is less likely to be sustainable. Collaboration in a community requires some mechanisms to either ensure the quality of the participants or assess their actions and performance, a criterion that open membership and little mutual monitoring does not fulfill (ref. propositions 2a and 2b below). The combination is, however, known from other organizational forms such as open innovation marketplaces (Bingham and Spradlin, 2011) that do not require collaboration among the participants.

> Proposition 2a: Strong form: The extent of mutual monitoring is inversely related to the extent of membership restrictions in collaborative communities.

Proposition 2b: Weak form: Open membership (self-selection) in collaborative communities requires extensive mutual monitoring, if not the risk of agency problems will increase.

***Rules, incentives, and agency problems*.** The cases suggest that community performance is contingent upon shared values that align beliefs and purposes, rules that regulate sharing and interaction, incentives to contribute, and effective enforcement of these. Where these are inadequate, the risk of agency problems and failure will increase. In the communities here, the values and rules support self-organization rather than hierarchical compliance, and they have to be truly shared as they cannot be imposed (in contrast to "fiat is a distinguishing feature of internal organization" in Williamson, 1991: 274). The condition of autonomous and interdependent actors and the associated lack of—or limited presence of—hierarchy changes what can constitute effective enforcement. Enforcement in communities is typically by way of peer-based control and self-regulation following extensive transparency.

OSDD and DigiFam are polar cases. OSDD has so far shown remarkable growth—from a handful to about 8000 members in five years—and significant process results in terms of curating massive volumes of genomic data, identifying multiple novel drug targets, building diverse repositories of chemical compounds, and starting a clinical trial. Despite DigiFam's initial growth and relative financial success it failed to survive. A more detailed investigation of DigiFam's demise compared to OSDD's relative success suggests some insights into the impact of community values, rules, incentives, and their enforcement (ref. proposition 3 below).

DigiFam interviewees point to a number of agency and governance issues as the primary causes of the community's decline, rather than challenging market conditions. First, free-riding was a problem; a large proportion of the participating members received more from the community than they contributed. According to several interviewees this was to a large extent due to an imbalanced incentive model, e.g. providing office space for its members free of charge at a premium location in

downtown Stockholm. Second, some members thought the distribution of project roles and revenues from some of the projects was unfair. Third, it became increasingly common and accepted to bypass DigiFam when members did joint projects together, avoiding the revenue sharing originally intended. Free-riding has not been a problem in OSDD. Most members are volunteers and project funding is awarded through a transparent process, on the basis of open peer reviews. There has been some fear of plagiarism due to the open source model, but such behavior has not been observed in practice. No accounts of unfairness in access to opportunities and resources, attribution, or rewards surfaced in the interviews.

OSDD's relative success compared to the three profit-oriented communities here warrants the question whether the profit motive is complicating community governance. It may complicate the balancing of the common and self-interest as it makes the economic self-interest explicit, but there is no reason to conclude from the case studies here that the profit motive deters effective collaboration and governance. The analysis of DigiFam's demise shows that the main problem was an imbalanced incentive model, i.e. lacking correspondence between contributions and benefits, as well as insufficient enforcement of the revenue-sharing model, not the presence of financial incentives per se. Other studies, such as the study of Blade.org, which was a community of firms dedicated to commercialization of blade server technology (Snow et al., 2011), provides examples of well-functioning collaborative communities with profit-oriented members. In summary, DigiFam's demise, compared to OSDD's relative success, suggests:

> Proposition 3: Community performance is contingent upon shared values that align beliefs and purposes, rules that regulate sharing and interaction, incentives to contribute, and effective enforcement of these. Where these are inadequate, the risk of agency problems and failure will increase.

Embeddedness, formalization, and scale. All four communities studied here were characterized by high degree of embeddedness from the outset. The founders mobilized their own extensive

networks when establishing the communities with the first members knowing each other or having shared contacts. These are conditions conducive to trust (Coleman, 1988; McEvily et al., 2003), but as the communities grow social cohesiveness diminishes and have to be complemented with other mechanisms. The cases here suggest that formalization of rules as well as transparency supported by technical infrastructures are more readily scalable, allowing the communities to grow while maintaining effective governance. The level of trust among OnCorps 1.0 members was high, mainly because all members up to sometime in 2012 knew the co-founder and CEO personally and would trust anybody he vouched for. At that point in time he expressed concerns that he was becoming a bottleneck, that they needed more scalable mechanisms, and as a result initiated the development of the collaboration platform.

One reason for the agency problems surfacing in DigiFam was the lack of formalization of the community's rules and protocols. The founding team, particularly the key co-founder and first CEO of DigiFam, opposed most forms of formalization and as the community rapidly grew, the new members did not necessarily have the same level of commitment as the founders. The norm of sharing revenues from joint business was neither formalized (beyond a non-binding revenue-sharing model) nor consistently enforced by organizers and regular members. With OSDD, on the other hand, there is significant degree of formalization of rules. In order to register as a user on the SysBorg portal, members have to accept a number of rules on IPR and attribution. The same portal is a key factor in creating transparency, as the identity of contributors and time of posting are tagged automatically to all comments and contributions, which are visible to all members. The positive relationship between formalization and organizational size is well-known in organization theory (e.g. Mintzberg, 1979), but in the case of OSDD it is not coupled with bureaucratization. Here formalization of rules and transparent infrastructures enable self-organization at scale.

> Proposition 4: Formalization of rules and transparent infrastructures are necessary to govern self-organization in large-scale collaborative communities, if not the risk of agency problems will increase.

Matching agency problems with governance mechanisms. The governance mechanisms presented here mitigate commons, team production, and brokering-related agency problems in various ways. There is, however, not an exclusive one-to-one relationship between the agency problems and the mitigating governance mechanisms, but the discussion above has highlighted some important patterns which I summarize in Table 5 where I match governance mechanisms with agency problems.

Insert Table 5 about here

DISCUSSION AND IMPLICATIONS

This study has explored collaborative community governance through an agency lens and found important problems, patterns, and mechanisms. The governance mechanisms mitigate the source conditions of agency problems, information asymmetry and differential interests, in different ways. Mutual monitoring reduces information asymmetries (Ostrom, 1990; Varian, 1990). Values and rules, as well as property rights and incentives, reduce the extent of divergent interests by increasing goal congruence and incentive alignment, respectively. Membership restrictions introduce a filtering mechanism that may limit the divergence in interests, while collecting information about members' capabilities and objectives. I believe these four governance categories represent the main forms of governance in the communities studied here and expect my findings to be applicable to other collaborative communities, but that will be up to further research to determine.

This study contributes to the literature on comparative forms and the role of agency perspectives in these. I build on the perspective that views community as a third ideal-type governance structure that complements hierarchy and market structures in line with Adler (2001) and others (Bradach and Eccles, 1989; Ouchi, 1980; Powell, 1990), and that collaborative communities are close to the community ideal type (Benkler, 2002; Snow et al., 2011). Hierarchy, market, and community are characterized by different sets of dominant agency problems. The hierarchy is defined by cascading

principal-agent relationships between owners and managers as well as managers and subordinates (Fama, 1980; Jensen and Meckling, 1976). Team production issues are also well-known problems within units and teams (Alchian and Demsetz, 1972; Eisenhardt, 1989a; Holmstrom, 1982). The principal-agent logic has been applied extensively to market contracting as a representation of buyer-supplier relationships (Akerlof, 1970; Zsidisin and Ellram, 2003). Markets also perform information aggregation, matching, and price-formation functions (Felin and Zenger, 2011) that in a stylized form can be viewed as brokering. The brokerage logic applies to direct mediation among transacting parties such as stock brokers and agents, but also to actors who are market makers, such as stock and commodity exchanges, and information aggregators such as credit rating agencies (Abolafia, 2001; Burt, 2005; Pollock et al., 2004). Finally, this study identifies commons, team production, and brokering as the dominant agency structures in communities.

This brief overview of agency structures in the three ideal-type forms of organizing highlights the diversity of multiple-agency problems present in most organizational forms (Child and Rodrigues, 2003), which is both a challenge and opportunity to agency theory. It needs to extend beyond the conventional principal-agent structure to be applicable to other forms of economic organization than hierarchy and market contracts, but herein also lies a big opportunity for renewing the relevance of agency theoretic perspectives on governance to new community and hybrid organizational forms of which this study is an attempt. This discussion also shows that commons issues may be specific to, or at least characteristic for, community forms of organizing (Benkler, 2002; Fjeldstad et al., 2012). If we tighten the criteria for defining an organization as a collaborative community to also include extensive use of commons, self-organization, and mutual monitoring, OSDD come out as very close to the ideal type of community. OnCorps and LOHAS Asia can be viewed as collaborative community hybrids with some traits of hierarchy such as centralized decision making on key issues, whereas DigiFam involved more self-organization and informal mutual monitoring but had very little developed commons.

This study points to possible complementarities between agency and trust perspectives on organizational governance in collaborative community organization forms (Puranam and Vanneste, 2009). Behavior in these communities is highly stewardship-oriented (Davis et al., 1997) with high degrees of shared purpose and trust (Heckscher and Adler, 2006). Nevertheless, agency problems exist and opportunistic behavior has been observed, particularly in the DigiFam case. The formal and informal governance mechanisms identified seem both to nurture trust and mitigate agency problems. Hence, my results are in line with other studies finding a mutually reinforcing relationship between trust and formal governance (e.g. Gulati and Nickerson, 2008; Poppo and Zenger, 2002). One example is transparency, which encourages reciprocity and reduces information asymmetry. Another is the complementarity of values and incentives. Values and community purpose stimulate intrinsic motivation. Incentive structures accommodate legitimate self-interest and fairness in the distribution of rewards, and (perhaps paradoxically) increase trust, as participants' potential fears of exploitation and being subject to opportunistic behavior are reduced. Studies advocating community as a third ideal-type organizational form typically highlight trust as the main organizing principle (Adler, 2001; Bradach and Eccles, 1989). While my study is compatible with such a view, it extends it by specifying the mechanisms governing collaboration and inducing trust in such organizational settings, most notably mutual monitoring and shared purposes and rules.

Two of the main categories of governance mechanisms specified in this study, i.e. values and rules, and property rights and incentives, are institutional in nature. In most of the communities covered in this study these mechanisms are formalized, analogously to macro-level institutions studied in institutional economics and political science (North, 1990; Ostrom, 1990). Governance by institutional mechanisms guides, but does not direct, member behavior and is conducive to proactivity and self-organization among members (Fjeldstad et al., 2012). This study highlights how the different institutional arrangements are combined and work in communities. However, more research is needed in this area, particularly in terms of identifying patterns in institutional

arrangements, similarities with and differences from the functioning of macro-level institutions, and the role of institutional mechanisms in other organizational forms.

An important limitation of this study is that the agency lens enables us to focus on governance costs and the costs of unmitigated agency problems, but is less useful in representing and understanding the value implications of governance (parallel to the criticism of transaction cost economics in Zajac and Olsen, 1993). Collaborative communities are network phenomena where a relationship or an exchange cannot be viewed in isolation as it is influenced by and is influencing other relationships and exchanges. The positive, self-reinforcing network effects from contributing to the commons and participating in the large and diverse OSDD community is a case in point. Failure to mitigate agency problems limits communities' ability to develop the levels of trust and motivation participants need to join, collaborate, and share which may slow or reverse the self-reinforcing processes that characterize thriving, value-creating communities. The multiple-agency approach presented here captures more of the multiplex and embedded nature of collaboration in communities than conventional dyadic agency approaches would do (Child and Rodrigues, 2003), but has limitations in capturing systemic network effects and value implications. I believe, however, that this limitation does not diminish the importance and relevance of applying an agency lens in community contexts, but that it may benefit from being complemented by other theoretical perspectives in future studies, specifically network perspectives.

Network theory has contributed greatly to organization theory by specifying how different network structures within and across organizational boundaries impact cooperation, competition, and outcomes such as innovation, creativity, trust, and information advantages (Burt, 1992; Hansen, 1999; Obstfeld, 2005; Powell et al., 1996; Uzzi and Spiro, 2005). This study sheds light on how collaborative communities—a particular type of network organization—are governed, in terms of institutional arrangements, i.e. values, rules, incentives, property rights, coupled with mutual monitoring. These mechanisms positively affect members' willingness and ability to find each other, form relationships, share knowledge and resources, assure quality, share benefits, and avoid

opportunistic behavior, suggesting that governance mechanisms and network structure and behavior influence each other (Owen-Smith and Powell, 2008). One such example is how OSDD's formalized rules and transparent internet-based infrastructure encourage and enable members to share resources in the commons and form collaborative relationships even with strangers. Empirical studies of the relationship between governance mechanisms, network structure, and outcomes in collaborative community is a promising alley of research that could capture both the cost and value implications of governance. My findings on community governance complement the literature on network governance (Capaldo, 2014; Jones et al., 1997; Larson, 1992; Podolny and Page, 1998), particularly the branch on governance on whole networks and alliance constellations (Das and Teng, 2002; Provan and Kenis, 2008). They align well on the importance of social governance mechanisms, but differ in two important ways. First, the network governance literature focuses on networks (or dyads) of organizations—such as firms, public agencies and institutions—whereas collaborative communities are not limited to organizations as actors. Second, Jones et al. (1997) propose that restricted access is one of the key characteristics of network governance. As shown here, this is not a necessary condition for collaborative communities where it is a key design choice variable and many communities, such as OSDD, have open membership as a key principle (O'Mahony, 2007; Puranam et al., 2014).

This study points to the common agency and governance challenges in collaborative communities of which community entrepreneurs and organizers should be aware. The mechanisms and contingencies identified here provide some alternatives for how communities can be governed in practice. The proposed tradeoff between mutual monitoring and membership restrictions is one such choice. Membership restrictions also represents an inherent tradeoff between assuring the quality of members and allowing diversity and variation. Another lesson is the importance of developing the institutional design in terms of values, rules, incentives, and property rights and an appropriate degree of formalization. These motivate participation and contribution, enable collaboration and self-organization, provide a basis for trust, and balance member contributions

and benefits. Although beyond the scope of this study, the findings may also provide inspiration to managers in more conventional organizations who seek to enable and enhance collaboration.

CONCLUSION

The growing number and importance of collaborative communities and other forms of crowd organizing (Boudreau and Lakhani, 2013; Heckscher and Adler, 2006; O'Mahony and Lakhani, 2011), and more generally the move from hierarchical to more collaborative organization forms (Child and McGrath, 2001; Fjeldstad et al., 2012; Lewin and Volberda, 1999), is creating new opportunities and challenges. Opportunities include enabling and enhancing knowledge creation and combination, problem solving, innovation, and commercialization (Adler et al., 2008; Lee and Cole, 2003; Snow et al., 2011). This study has focused on governance challenges, in particular agency problems, and identified three distinct multiple-agency structures and their associated challenges. Collaborative community designs, as identified in this study, present a novel combination of governance mechanisms that mitigate such challenges. This is an interesting and important space for future organizational research and practice.

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TABLES AND FIGURES

Table 1 Variation on key case characteristics

Case	*Direct*	*Collaboration Exchange*	*Indirect*	Value appropriation	Geography	Sector	Size (# members)
OnCorps	(X)	X	X	Private	Boston, US	Enterprise IT	300*
LOHAS Asia	(X)	X		Private (public)	Singapore, Asia	Sustainable products & services	900**
OSDD	X	(X)	X	Public	India, worldwide	Drug discovery	7900
DigiFam	X	(X)		Private	Stockholm, Scandinavia	Digital marketing & communication	100
Total	X	X	X	Private & public	3 continents, worldwide	4 major sectors	

Legend: X = present, (X) = present to some degree. Geography: hub city/country, geographical scope
* Fall 2011, end of stage "1.0"
** Firms

Table 2 Data types and volumes

Case	# interviewees	# interviews	# on site interviews	Hours:mins avg./total	# days observation	Virtual observation	Documents	Duration of study (mo)
OnCorps	7	12	5	1:21/16:09	Na	Limited	Yes	29
LOHAS Asia	12	17	9	1:07/19:02	Na	Yes	Yes	20
OSDD	54	36	32	1:13/43:37	8	Yes	Yes	20
DigiFam	10	10	10	1:39/16:25	Na	Na	Yes	12
Total	**83**	**75**	**56**	**1:16/95:13**	**8**	**2/4**	**4/4**	**12-29**

Table 3 Overview of agency structures and presence per case

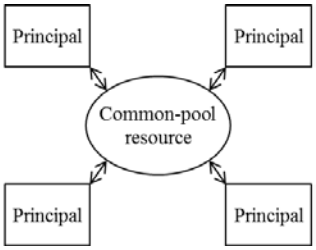
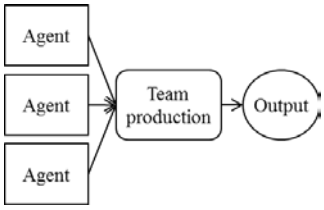
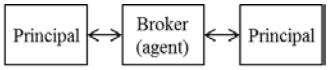
Agency structure	**Commons**	**Team production**	**Brokering**
Definition/ description	Multiple actors (principals) build, maintain, and use a common-pool resource (Ostrom, 1990). A principal may not always act in the best interest of the collective of principals.	Multiple actors (agents) cooperatively produce joint outcomes. It implies that multiple types of resources are used in a production process, outcomes are not a separable sum of outputs from each resource, and not all resources belong to one actor (Alchian and Demsetz, 1972). An agent may not always act in the best interests of the other coproducing agents.	Facilitate exchange between two or more parties. Brokerage relationships have a principal-agent-principal structure, where the broker is the agent (Marsden, 1982). The broker may not always act in the best interests of the principals and the principals may bypass the broker.
Cooperative process	Indirect collaboration: jointly build, maintain, and use a common resource	Direct collaboration: coproduce joint outputs	Direct exchange: facilitate contact, exchange, and resource combination
Illustration			
Presence of agency problem per case			
OnCorps	*Moderate:* Maintaining data confidentiality	*Limited/none:* No team production	*Significant:* Risk of bypassing in deals (OnCorps 1.0)
LOHAS Asia	*Limited:* Only member lists and discussion forum	*Moderate:* Team decision making in funding panel	*Significant:* Risk of brokerage and bypassing in investment deals
OSDD	*Significant:* Large-scale commons, risk of plagiarism and private appropriation	*Moderate:* Extensive team production, but no problems have surfaced	*Limited:* Mainly connecting people who choose how much to share
DigiFam	*Limited:* Shared offices, brand	*Significant:* Shirking and over-approriation in project teams	*Significant:* Extensive bypassing of community, non-compliance with revenue-sharing model

Table 4 Definitions and descriptions of governance mechanisms, their presence and degree of use in each case, and examples from the case studies*

Governance category	Governance mechanism	Definition/description	OC 1.0	OC 2.0	LOHAS	OSDD	DigiFam	Case examples & quotes
Mutual monitoring	Transparency	Transparency implies openness, communication, and accountability. It makes it easy to see what is done and contributed by whom, the resources used, and the benefits they reap. Degree of transparency increases with real-time visibility of action and traceability over time.	L	M	M	H	L	OSDD: all contributions in terms of data, results, reviews, comments, questions, and ideas on the SysBorg portal are tagged with name and time stamp. All project proposals are posted publicly on the portal and all reviews, decisions, and grants are posted, along with the identities of reviewers and decision makers.
	Peer review	Peer review refers to any arrangement where work is reviewed by peers, typically with the purpose of quality assurance. It can be formal or informal and open or closed, depending whether the identities of reviewer(s) and reviewee(s) are openly known. Peer reviewing is an institutionalized practice in e.g. academic research and publishing (Zuckerman & Merton, 1971) and open source software (OSS) (Lee & Cole, 2003).	L	M	M	H	L	OSDD: open peer review of contributions and project proposals. Proposals for project funding have to be publicly available on SysBorg for open peer review for 15 days and at least three reviews have to be posted before funding decisions are made. Final funding decisions are made by a three-member committee of two OSDD/CSIR employees and a senior volunteer principal investigator (PI).
Membership restrictions	Membership restrictions	Membership restrictions refers to rules, requirements, and processes for identifying and admitting members to a community, and for terminating membership if necessary.	H	M	M	L	M	OSDD: practices open membership, i.e. no other membership requirements than acceptance of OSDD's "terms of use." OnCorps 1.0: practices very strict membership selection criteria and processes (by invitation only, must be referred by an existing member, and strong track record).
Values & rules	Shared purpose & values	Values can be defined as beliefs that "guide actions and judgments across specific objects and situations" (Rokeach, 1968:160).	H	H	H	H	H	OSDD: Professor Brahmachari, the founder and chief mentor: "OSDD is an emotional enterprise rather than a professional enterprise." LOHAS Asia: participant firms have to make "the LOHAS pledge" when they register at the Hub committing to LOHAS values and practices such as "I/We shall apply LOHAS principles of social justice and environmental protection when choosing our suppliers."

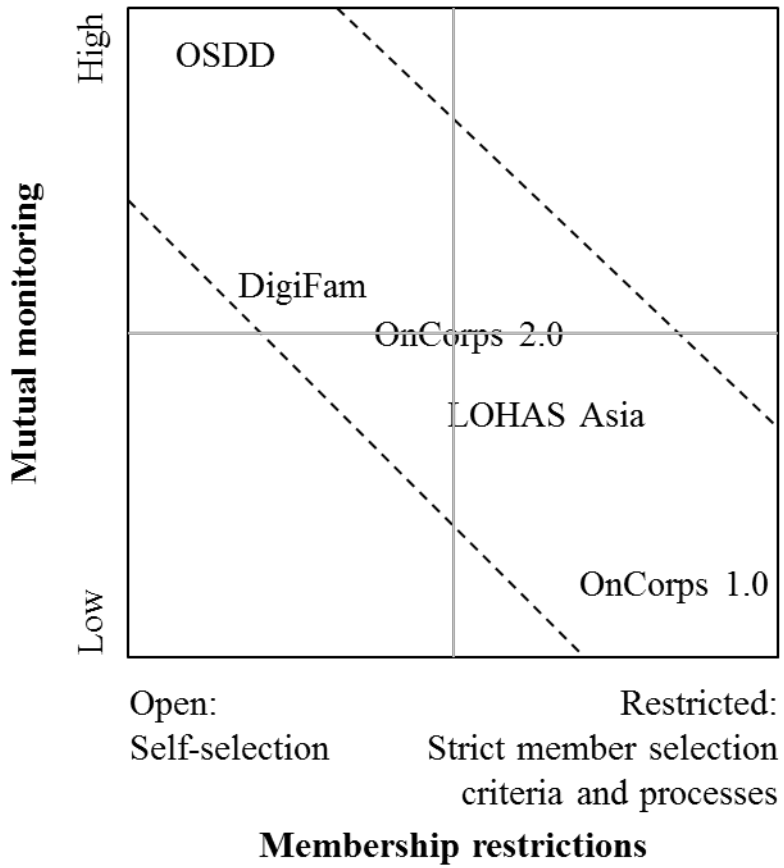
Governance category	Governance mechanism	Definition/description	OC 1.0	OC 2.0	LOHAS	OSDD	DigiFam	Case examples & quotes
	Rules	Rules are guides to action (Knight, 1992:67). They can be constitutive and regulatory (Searle, 1969:33), enabling (Hart, 1994:57, 255) and constraining (Pettit, 1990:2). Rules provide actors with the guiding principles to self-organize; effectively identify and mobilize collaborators and resources; collaborately solve problems; share knowledge and ideas; and distribute rewards (Fjeldstad et al., 2012).	H	H	H	H	M	OSDD: has a detailed authorship policy regulating the attribution of authors of academic work and in what order their names are listed. The attribution rules distinguish on the contributions of researchers rather than their seniority. LOHAS Asia: "I/We agree to produce and publish an Annual LOHAS Statement (ALS) reporting on progress on the above points. The ALS will be published on our profile in THE HUB by LOHAS and is available for all other members of the network to view. The ALS will become due on the anniversary of our membership and must be published within two months, or membership will be suspended." (LOHAS Pledge §4)
Property rights & incentives	Property rights	Property rights regulate how actors control, benefit from, and transfer tangible and intangible resources (Demsetz, 1967).	M	M	L	H	L	OSDD: combines open source and patenting principles (Sugumaran, 2012). OSDD requires that any addition to or improvement of the data on SysBorg have to be added to the OSDD commons (OSDD Terms of Use §3.2). "Protected Collective Information" on SysBorg belongs solely to OSDD (§3.1). OSDD encourages patenting and the contribution of patented information. Members may patent their contributions provided they "grant an unencumbered worldwide non-exclusive right to the OSDD for use of such rights for further research" (§3.6).
	Incentives	Incentives refer to reward structures influencing participants' extrinsic and/or intrinsic motivation, and include actual and potential economic, professional, social, and psychological rewards (Kreps, 1997; Sansone and Harackiewicz, 2000).	H	H	H	M	M	LOHAS Asia: its Funding Initiative/Accelerator is a structured process for matching LOHAS start-ups and investors. Selection and coaching of companies is a staged process supported by a funding panel that consists of representatives from investors, LOHAS organizers, and large multinationals like Ogilvy, Google, and Accenture. There are clear financial incentives in this process related to potential and actual investments. There are learning outcomes for non-selected as well as selected companies. OSDD: provides opportunities for academic recognition for students and scientists through its attribution policies, collaboration infrastructure, and patenting policies.

* Legend: H = high, i.e. consistent high presence, use, and importance; M = medium; L = low, i.e. limited/low presence, use, and importance.

Table 5 Matching agency problems with governance mechanisms

		|---------- Agency problems ----------		----------|
Governance category	**Governance mechanism**	**Commons**	**Team production**	**Brokering**
Mutual monitoring	Transparency	Community-wide transparency is essential. Supports self-regulation. Prerequisite for peer review. Need to be supported by technical infrastructures to accommodate transparency in large-scale commons and communities.	Team level transparency is essential. Community-wide transparency useful as it supports self-regulation and peer-based selection/ mobilization of team members.	Exchange level transparency is essential. Community-wide transparency useful as it supports self-regulation and peer-based selection/ mobilization of exchange partners.
	Peer review	Essential. Primary quality assurance mech.	Important on team level	Important on exchange level
Membership restrictions	Membership restrictions	Less important if extensive mutual monitoring.	Important if mutual monitoring is not sufficient to determine team selection.	Important if mutual monitoring is not sufficient to determine selection of exchange partners.
Values & rules	Purpose & values	Essential; shared purpose of common good and supporting values.	Important, particularly on team level.	Important, particularly on exchange level.
	Rules	Shared community-wide rules essential. Regulate access to, contribution to, and use of commons, as well as collaboration.	Shared rules important, but can also be agreed on team level (increasing governance costs). Regulate team mobilization, collaboration, sharing, and dissolving.	Shared rules important, but can also be agreed on exchange level (increasing governance costs). Regulate identification, execution, and responsibilities in brokering relationships.
Property rights & incentives	Property rights	Essential with general community-wide property rights rules. Have to be specified ex ante to provide contributors with the assurance they need to contribute.	Useful, but not critical with general community-wide IPR. Need clarity on team/project level.	Useful, but not critical with general community-wide IPR. Need clarity on exchange level.
	Incentives	Important for motivation and fairness.	Important for motivation and fairness.	Important for motivation and fairness.

Figure 1 Extent of mutual monitoring and membership restrictions across cases (illustrative)



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AUTHOR BIOGRAPHY

Vegard Kolbjørnsrud is an assistant professor at BI Norwegian Business School and a Senior Research Fellow at Accenture. He received his PhD in Strategic Management from BI Norwegian Business School. His research interests include governance and organization design, crowds and communities, collaborative problem solving, artificial intelligence, and digital strategy.