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How Solvers Navigate Sharing-protecting Tensions in Crowdsourcing

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Reconceptualizing the paradox of openness: How solvers navigate sharing-protecting tensions in crowdsourcing

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ABSTRACT

The paradox of openness describes the fundamental tension between knowledge sharing and knowledge protection in open innovation. While sharing is vital for value creation, protecting is critical for value appropriation. Prior research has examined this paradox of openness from the perspective of the seeking firm, focusing on the firm-level challenges of inbound open innovation. In this article, we complement that research by illuminating the tensions between sharing and protecting in individual-level outbound open innovation, where we argue that the paradox of openness is most prevalent, yet much less well understood. Drawing on the experience of individual participants, or solvers, in intermediated crowdsourcing contests, we analyze textual data from 2,149 answers to five open-ended narrative questions embedded in a large-scale solver survey, as well as 43 in-depth interviews of solvers. Our findings indicate that individual solvers face fundamental sharing-protecting tensions that carry considerable economic and psychological costs. We also document how solvers attempt to navigate the paradox of openness by employing three formal and four informal value appropriation practices. They build elaborate configurations of these practices, which they tailor to the idiosyncrasies of each contest. They also dynamically adjust these configurations over time, as the contest and the interaction with the seeker unfold. We end by outlining how these findings contribute to a more multifaceted conceptualization and a richer understanding of the paradox of openness.

1. Introduction

In times of open innovation (Bogers et al., 2017; Chesbrough, 2003a, 2003b), value appropriation, also referred to as value capture, is becoming vital for firms to sustain their competitive advantage, yet also increasingly complex to manage effectively (Henkel, 2006; Holgersson et al., 2018; Teece, 2018, 2006, 1986). To date, our understanding of value appropriation in the context of open innovation remains limited (Chesbrough et al., 2018; Holgersson et al., 2018; Zobel et al., 2017). Researchers struggle to explain the relationship between knowledge sharing (openness) and protection (control) (Bogers, 2011; Dahlander and Gann, 2010; Lauritzen and Karafyllia, 2019). This issue is encapsulated in what researchers have termed the "paradox of openness"—that sharing is vital for value creation, while protecting is vital for value appropriation (Arora et al., 2016; Bogers, 2011; Laursen and Salter, 2014). The paradox of openness has become a growing theme in the open innovation literature (Arora et al., 2016; Lauritzen, 2017; Laursen and Salter, 2014; Wang et al., 2017). Up to now, research has examined the paradox from the perspective of the seeking firm, widely focusing on the challenges of inbound open innovation (Arora et al., 2016; Laursen and Salter, 2014). Studies in this stream have established that a seeking firm needs to be open in revealing internal challenges to facilitate meaningful knowledge sourcing (Wang et al., 2017), yet protective of its knowledge base to ensure sufficient value appropriation from it (Arora et al., 2016; Laursen and Salter, 2014). This is the crux of the paradox of openness as it has been studied at the firm level.

Although this is an important element, we argue that there is more to the paradox of openness, as there is more to open innovation itself. Recent reviews have highlighted the multi-directional and multi-level nature of open innovation (Bogers et al., 2017; Stanko et al., 2017; West and Bogers, 2014). Dahlander and Gann (2010) have distinguished *inbound open innovation*, i.e. absorbing external knowledge, from *outbound*

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open innovation, i.e. sharing internal knowledge with others. In their review, Stanko et al. (2017) noted that (1) the focus of open innovation research lies on inbound rather than outbound open innovation, and that (2) the dark side – potential performance drawbacks arising from open innovation – remains underexplored. As for open innovation's multi-level nature, its activities are performed at different levels, including, but not limited to, the firm level and the individual level (Bogers et al., 2017). It is against this backdrop that we revisit the paradox of openness, highlighting the two dimensions of *inbound versus outbound* and *individual level versus firm level*.

In our empirical section, we examine *outbound* open innovation at the *individual* level, where we argue that the sharing-protecting tensions expressed in the paradox of openness are most prevalent, yet least understood. For this purpose, we draw on crowdsourcing, the outsourcing of an organizational task to a large group of external individuals (Howe, 2006) as a way to facilitate open innovation activities and bidirectional flows of knowledge (Ghezzi et al., 2018; Lüttgens et al., 2014; Schemmann et al., 2016). Crowdsourcing enables seekers to source external knowledge (Lopez-Vega et al., 2016), and solvers to bring knowledge to new markets, often mediated via an online platform (Afuah and Tucci, 2012; Schäfer et al., 2017). Compared to face-to-face interactions, crowdsourcing is characterized by virtual, anonymous, and fast-paced work practices, which often goes along with low trust (Jeppesen and Lakhani, 2010; Kabo et al., 2014). Especially, but not only, in these settings, the sharing-protecting tension will be stronger for solvers who have to reveal critical (solution) knowledge without immediate financial rewards than for seekers who simply publish their call for solutions on a platform, often even without having to disclose their identity (Ghezzi et al., 2018; Pollok et al., 2019). Crowdsourcing is a special form of open innovation activity that foregrounds the underexplored facets of the paradox of openness. Our focus on crowdsourcing thus allows us to contribute to the debate on effective value appropriation practices in the context of multi-directional and multi-level open innovation activities (Holgersson et al., 2018; Miozzo et al., 2016; Zobel et al., 2017).

For this purpose, we reviewed the literature on the paradox of openness and related themes such as value appropriation in open innovation to map and extend the current conceptualization of sharing-protecting tensions. We then adopted an abductive qualitative approach grounded in multiple datasets. First, we analyzed 2,149 answers to open-ended narrative questions that were part of a large-scale survey among 1,149 solvers participating as providers in crowdsourcing contests for technical solutions organized by one of the largest open innovation intermediaries. These questions helped us to explore solvers' perceptions of sharing-protecting tensions, their value appropriation concerns, and their associated response patterns. Second, we conducted and analyzed 43 semi-structured in-depth interviews with solvers of this group to gain deep insights into their approach towards sharing and protection. Based on this data, we document how solvers navigate sharing-protecting tensions in outbound open innovation.

This article offers three primary contributions to research on the relationship between open innovation and value appropriation. First, we reconceptualize and expand the paradox of openness by highlighting its two key dimensions of inbound versus outbound and firm level versus individual level. This clarification appears critical for better understanding and ultimately managing the paradox of openness. In so doing, we respond to recent calls to explore interdependencies across levels of analysis by uncovering how individual level perceptions shape the effectiveness of firm level open innovation strategies (Bogers et al., 2017; Stanko et al., 2017). Second, we identify sharing-protecting tensions in outbound open innovation at the individual level. Here, we consider the paradox of openness to be most severe, yet least understood. We thus present design factors needed to manage it – not only for seekers, who have traditionally been at the center of attention (Pollok et al., 2019), but also for solvers, which are increasingly recognized as the most critical resource (Schäfer et al., 2017). Third, we document how individual solvers navigate the sharing-protecting tensions in outbound open innovation. Grounded in our empirical findings, we extract patterns by means of which solvers attempt to cope with the paradox of openness. We find that solvers attempt to manage the paradox by combining practices that separate the poles of sharing and protecting structurally and spatially (i.e., across components of their solution and entrusted spaces for discussion) and practices that integrate the poles through balancing degrees of sharing and protecting.

2. Conceptual background

2.1. Value appropriation in open innovation

In recent years, the convergence of technology fields and the emergence of collaborative innovation models have increased the complexity of the innovation process, rendering value appropriation particularly challenging for innovating firms and individuals (Teece, 2018). The concept of value appropriation is at the core of David Teece's seminal work on profiting from innovation (Teece, 1986). In this context, *value appropriation* means obtaining significant economic returns from innovation. Appropriating value from scientific discoveries and technological developments is critical, as it enables firms to reinvest in R&D and ensure their long-term survival (Han et al., 2012; Jacobides et al., 2006). Insufficient value appropriation, or even value expropriation, in contrast, will hurt a firm's commercial viability and give rise to subsequent performance declines and survival threats (Pisano and Teece, 2007). Therefore, firms usually seek to establish legal ownership of IP along the innovation process by using patents, copyrights, trademarks, and/or registered designs (e.g., Han et al., 2012; Laursen and Salter, 2014; Manzini and Lazzarotti, 2016). In addition to these formal value appropriation practices, firms make use of informal practices that provide at least temporary protection through market lead time, secrecy, design complexity, and complementary assets (e.g., Arora et al., 2008; Arora and Ceccagnoli, 2006; Gallié and Legros, 2012; Henkel, 2006; Teece, 1986).

Over the last decades, innovation has shifted from a closed model relying primarily on internal R&D to an open model that allows for collaboration and bidirectional knowledge flows. This phenomenon, first described as "open innovation" by Chesbrough (2003a), has rapidly gained traction in research and practice, yet has also raised strong concerns around the topic of value appropriation (Zobel et al., 2016). Open innovation activities promise to expand and renew a firm's knowledge base (Chesbrough, 2003a; Laursen and Salter, 2006) and to commercialize outputs that would not have been exploited otherwise (Chesbrough, 2003a; Huizingh, 2011). As such, open innovation includes both knowledge inflows (*inbound* open innovation) and knowledge outflows (*outbound* open innovation) (Stanko et al., 2017). While inbound open innovation consists of *acquiring* expertise from the market place and *sourcing* ideas from the external environment, outbound open innovation comprises *selling* internally-developed inventions and technologies and *revealing* internal resources to external actors without direct financial compensation (Dahlander and Gann, 2010). Given the absence of a direct monetary return, sourcing and revealing are particularly exposed to value appropriation concerns and sharing-protecting tensions (Stanko et al., 2017).

Research has begun to analyze open innovation across multiple levels of analysis, ranging from the individual to the project to the overall firm (Bogers et al., 2017; Salge et al., 2013; Stanko et al., 2017). Thereby, elements at various levels of analysis may act as contingencies at higher or lower levels (Bogers et al., 2017). As a case in point, a firm-level decision to engage in inbound open innovation activities is likely to raise challenges for in-house R&D professionals, who might require new coping strategies to deter detrimental behaviors such as the "Not-Invented-Here Syndrome" (Antons and Piller, 2015; Salter et al., 2014). As research to date has focused on inbound open innovation at the firm level (Stanko et al., 2017; West et al., 2014), much remains to be

learned about the perspective of individuals who engage in outbound open innovation, such as the sharing-protecting tensions that occur when revealing technological knowledge to other individuals or firms without a direct monetary return (Franke et al., 2013; Lauritzen, 2017).

Although researchers have identified a shift towards open innovation as generally beneficial for firms' innovative performance (Laursen and Salter, 2006; Salge et al., 2012), opening up the innovation process may also expose the focal firm to additional value appropriation challenges and imitation threats (e.g., Foege et al., 2017; Veer et al., 2016; West, 2003). It is hence not surprising that a firm's degree of openness in the innovation process was found to be positively related to its use of formal value appropriation mechanisms (Zobel et al., 2017). This illustrates the growing importance and complexity of IP management in collaborative R&D (Holgersson et al., 2018).

2.2. The paradox of openness in open innovation

A particularly fundamental challenge in open innovation pertains to the tension between encouraging knowledge sharing and ensuring sufficient protection (Almirall and Casadesus-Masanell, 2010; Dahlander and Gann, 2010). This is widely referred to as the paradox of openness (Arora et al., 2016; Hannigan et al., 2018; Laursen and Salter, 2014; Wang et al., 2017), or the open innovation paradox (Bogers, 2011). While openness may increase the attention that a firm gives to protection, appropriability has been found to decline with increasing openness (Laursen and Salter, 2014). In addition, Wang et al. (2017) found that protection through patenting enables a firm to open up, yet discourages potential external partners from sharing knowledge with it. The paradox of openness therefore encapsulates the complex and interdependent relationship between knowledge sharing and knowledge protection, describing a situation in which firms or individuals seek to "simultaneously share and protect their knowledge in an alliance with other organizations" (Bogers, 2011, p. 93), to enhance the development of innovations while ensuring their successful commercialization (Laursen and Salter, 2014). In many ways, the paradox of openness paraphrases Arrow's (1962) information disclosure paradox, according to which a purchaser of information needs to receive the information for evaluation prior to purchasing it. The information, however, loses its value when shared, leaving the owner of it with a paradoxical tension between sharing the information to receive a reward and protecting it to maintain its value.

Previous studies on the paradox of openness mainly apply a firm-centric, inbound open innovation perspective (Lauritzen, 2017; Miozzo et al., 2016; Wang et al., 2017). Notable exceptions are the work of Salter et al. (2014), who investigate how firms' decision to engage in open innovation affects R&D professionals working for that organization, and Hannigan et al. (2018), who explore how firms trigger product innovation rumours in online forums as means to be selectively open and deal with the paradox of openness. Although prior studies capture important facets of the paradox of openness, we argue that the phenomenon is broader in scope. Indeed, tensions between knowledge sharing and protecting tend to be more prevalent, yet less understood, in *outbound* open innovation at the *individual* level, where solvers as providers of solutions reveal critical solution information without immediate financial rewards, but with exposure to possible opportunistic seeker behavior. As noted by Stanko et al. (2017), there is a scarcity of research in this area of open innovation; "in particular, questions around degree of disclosure are not completely addressed and are particularly relevant given the potential for transparency enabled by online innovation platforms" (Stanko et al., 2017, p. 552).

It is against this backdrop that we reconceptualize the paradox of openness as a multi-directional (inbound and outbound) and multi-level (firm and individual) phenomenon. This reconceptualization has meaningful theoretical and practical implications, as different manifestations of the paradox are associated with different challenges that call for different solutions. Fig. 1 depicts the multi-directional and multi-level nature of open innovation and describes the sharing-protecting tensions occurring for each of the four combinations. As for firm-level inbound open innovation, researchers have found that firms face a paradox of openness reflected in the curvilinear (inverted U-shape) relationship between search breath and protection (Laursen and Salter, 2014) and that technological leaders are more vulnerable to these tensions and patent more than their followers (Arora et al., 2016). In line with this, Miozzo et al. (2016) suggest that the paradox lies within the fact that firms that seek to collaborate have more formal value appropriation mechanisms installed than non-collaborators. As for firm-level outbound open innovation, Hannigan et al. (2018) find that rumors exchanged through technology blogs resemble a form of selective revealing, that help firms to cope with the paradox of openness. In this way, firms can simultaneously deal with sharing-protecting tensions, recognizing that controlling too much is problematic if it deters innovation and controlling too little may prevent value capturing (Henkel et al., 2014). Regarding individual-level inbound open innovation, Salter et al. (2014) found that when coping with firm-level openness, employees need guidance, such as IP modularity and IP training programs, to avoid disclosing too little information and tackle the paradox of openness. Complementing the current literature, we suggest that in the case of individual-level outbound open innovation contributing individuals face the paradox of openness evoked through sharing-protecting tensions regarding the knowledge embedded in their solutions. Individuals need to share their knowledge, which is often the most critical asset for success, to attract collaborators, but also need to protect their knowledge to ensure value appropriation and avoid negative psychological consequences, such as feeling loss of control over ideas and R&D processes (Franke et al., 2013; Salter et al., 2015, 2014).

To broaden the scope and deepen our understanding of the dynamics of the paradox of openness, including its management, we cross-fertilize open innovation research and paradox research within organization studies (Lewis, 2000; Poole and Van de Ven, 1989; Schad et al., 2016; Smith and Lewis, 2011). While paradoxes include persistent and often painful contradictions (e.g., between sharing and protecting), paradox research has drawn attention to the interdependent and complementary nature of opposites, which also holds the potential for synergies (Lewis, 2000; Schad et al., 2016). Following these studies, we argue that if solvers (and seekers) use practices that allow for opposing efforts of sharing and protecting to coexist, they can introduce virtuous cycles into the collaborative process (Smith and Lewis, 2011). These, in turn, may contribute to improved learning and creativity (Lewis and Smith, 2014), innovation (Lauritzen and Karafyllia, 2019; Mironspektor et al., 2011), and organizational performance (Ferdman, 2017).

Importantly, paradox research (e.g., Jarzabkowski et al., 2013; Lauritzen and Karafyllia, 2019; Lewis et al., 2014) suggests that a combination of differentiation and integration approaches is needed to manage paradoxes. Differentiation enables the co-existence of opposite poles by separating them across temporal, spatial, and structural areas (Poole and Van de Ven, 1989; Smith and Tushman, 2005). While differentiation honors the distinct benefits of each pole and prevents conflictual interactions, it still presents the two poles as irreconcilable by requiring separation in time, space, or structure. Therefore, an emphasis on differentiation can also limit potential synergies by encouraging some preferred innovation mode among solvers at different stages in the crowdsourcing process that either favors protecting or sharing. Integration appears to provide an antidote to the limitations of differentiation, as integration recognizes the complementary effects of the opposing poles by employing them simultaneously in time and space (Poole and Van de Ven, 1989; Smith, 2014).

For example, open innovation studies have shown that an intermediary organization can help actors acknowledge paradoxes by exposing and mediating between conflicting demands arising from open innovation collaborations (e.g., Lauritzen, 2017; Sieg et al., 2010) As integration approaches seek to balance tensions through compromise, such as by positioning the opposite poles as extremes on a continuum

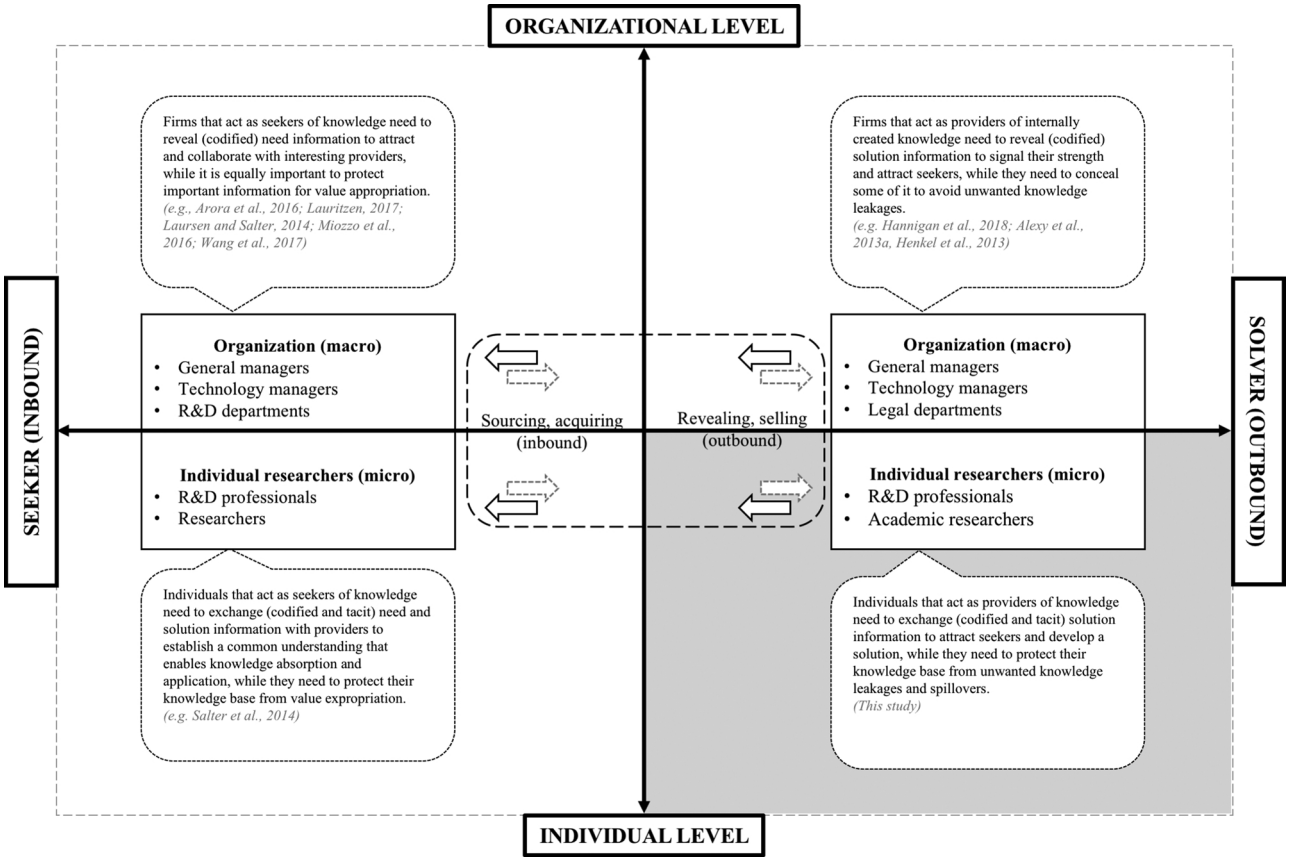

Fig. 1. The paradox of openness for different actors in open innovation (this study focuses on the grey shaded quadrant).

and pushing for an appropriate mix (e.g., Gilbert, 2013), they also tend to dilute the intensity of each pole. This points to the need for combining integration with differentiation to overcome the individual limitations of each. While differentiation honors sharing and protecting as equally important yet distinct and fully separate elements, integration emphasizes their complementarities through blending their opposite aspects (see Lauritzen and Karafyllia, 2019).

2.3. Crowdsourcing and the promise of intermediation

As digitally enabled and often anonymous marketplaces for the exchange of ideas and solutions, crowdsourcing contests tend to be shaped by physical distance, diverging interests, and competing incentives between seekers and solvers (Franke et al., 2013; Pollok et al., 2019, 2018). These factors can create a lack of trust (Jeppesen and Lakhani, 2010; Kabo et al., 2014). With remote interactions replacing face-to-face interactions, behavioral uncertainty and concerns about value appropriation are likely to multiply (Harland and Nienaber, 2014; Jeppesen and Lakhani, 2010; Lüttgens et al., 2014; Teece, 2018). If knowledge is unintentionally leaked on either side, it may end up in the hands of a broad, anonymous, and uncontrollable audience (Nambisan et al., 2017; Schäfer et al., 2017). Even though crowdsourcing provides solvers with a mediated platform to bring their internal knowledge to new markets (Chesbrough, 2003b; Huizingh, 2011), participation also exposes them to the risk of losing IP to seekers without being adequately compensated. Consider the possible case of an individual solver who submits a detailed, carefully crafted solution proposal, but fails to win the contest and – in the absence of adequate IP protection – is unable to counteract the unauthorized use of his solution by a seeker engaging in opportunistic behavior. These substantial value appropriation concerns challenge the implicit assumption in crowdsourcing research and practice that individual solvers will share their solution information without hesitation and restriction in the hope of winning a contest (Franke et al., 2013; Piezunka and Dahlander, 2018). Instead, it seems that individual solvers are the parties most strongly exposed to sharing-protecting tensions, highlighting the salience of the paradox of openness in individual-level outbound open innovation (Bogers, 2011; Laursen and Salter, 2014).

The reasonable concerns of solvers place high demands on the formal and informal governance of crowdsourcing contests. While we expect solvers to employ established strategies to manage the paradox of openness – including legal and strategic IP protection techniques (Arora et al., 2016; Arora and Ceccagnoli, 2006), selective revealing (e.g., Alexy et al., 2012; Henkel, 2006; Henkel et al., 2014), prior publication (Bruneel et al., 2010), and resource bundling (Sirmon et al., 2011) – these are limited in their ability to build trust, given the nature of crowdsourcing contests, which tend to be digitally-enabled, large-scale, and often anonymous. Against this backdrop, intermediation moves into the foreground as a means to manage the paradox of openness (Pollok et al., 2019). In the best possible case, a crowdsourcing intermediary will offer professional legal advice, conflict resolution, and insurance services, as well as a state-of-the-art communication infrastructure, so as to establish a functional marketplace for ideas and solutions that solvers and seekers can trust and that ensures a fair distribution of the value created among seeker, intermediary, and solver (Pollok et al., 2019; Schäfer et al., 2017). In the worst case, however, a crowdsourcing intermediary further increases the distance between seeker and solver and turns the contest into a black-box, amplifying appropriation concerns, especially on the side of the solver. In addition, crowdsourcing sites often set rules that protect the seekers' rights more than those of solvers (Ghezzi et al., 2018). When it comes to the paradox of openness, then, intermediation might be a double-edged sword. This makes intermediated crowdsourcing a truly interesting setting to explore how individuals perceive and navigate sharing-

protecting tensions in outbound open innovation.

3. Methods

3.1. Setting

We locate our study in the context of intermediated crowdsourcing for technical solutions, where seekers outsource a task they have often not been able to solve internally to a large crowd of individuals in form of a contest (Boudreau and Jeppesen, 2015; Howe, 2006). Existing intermediary-managed crowdsourcing platforms differ in a number of ways (Diener and Piller, 2013), including their participation requirements (e.g., open access versus community of registered users), collaboration dynamics (e.g., cooperative versus competitive) and reward mechanisms (e.g., fixed versus variable) (Pollok et al., 2019). For the purposes of our study, we partnered with one of the world's leading intermediaries for technical crowdsourcing, which organizes competitive, one-shot online contests to solve technical problems for major international companies. Its key value proposition consists in matching seekers with solvers—or, more specifically, seeker problem statements with solver solution proposals. Topics of contests include underwater wireless communication in the oil exploration industry, algorithmic knowledge management systems in the automotive industry, automated object recognition in global manufacturing, and new adhesion technologies for fractured bone repair in medical care. Given the considerable domain expertise required, solvers tend to be highly educated, often equipped with a PhD and a position in R&D within or outside of academia. From a solver perspective, a crowdsourcing contest typically unfolds across four sequential stages. In the *orientation phase*, a seeker posts a call for solutions on the platform, which solvers from various fields routinely scan for interesting challenges, perhaps assisted by automated alerts. In the *submission phase*, solvers self-select into contests, prepare and submit solution proposals, and await the seeker's evaluation and selection decision. If the seeker considers the proposed solution to be potentially valuable, the solver and the seeker connect directly and discuss collaboration and/or knowledge transfer in the *negotiation phase*. In the *completion phase*, solver and seeker conclude the process by selecting a suitable form of innovation collaboration and exchange possible rewards, which can include a fixed prize money, a job offer, a research contract, a licensing agreement, or a joint venture.

3.2. Research design and data collection

Due to the exploratory nature of our research and our aim to gain rich in-depth insights, we collected and analyzed two complementary datasets. First, we analyzed 2,149 answers to five open-ended narrative questions that were part of a larger survey among solvers. Assisted by the open innovation intermediary, we accessed archival data on 8,604 solvers who participated in at least one crowdsourcing contest between 2009 and 2013. We used this data to set up a personalized online questionnaire about the solvers' most recent contest participation up to the end of 2013. The questionnaire comprised topics such as solvers' general problem-solving behavior, knowledge sharing strategies, ownership of knowledge, concerns about imitation, and protection mechanisms. The data collection took place from November 2014 to January 2015. After an initial invitation via email to participate in the survey, we sent four reminders. 1,149 of the 8,604 solvers returned complete questionnaires, yielding a response rate of 13.4 percent. The questionnaire contained five open-ended narrative questions on solvers' IP infringement experiences, general crowdsourcing experiences, and value appropriation concerns, such as: "are you familiar with cases where a seeking organization utilized a solution without involving the solver?" and "have you experienced infringement of your intellectual property?" 823 of the 1,149 solvers who participated in the survey (61.6 percent) chose to answer at least one of the five narrative questions (mean 2.61, min 1, max 5, sd 0.93 questions). In sum, we analyzed 2,149 answers with a total of 54,985 words (mean per answer 66.81, min 1, max 981, sd 87.87 words).

Second, we complemented the textual survey data with rich interview data (e.g., Eisenhardt, 1989; Eisenhardt and Graebner, 2007). 227 solvers were randomly selected among our survey respondents and asked to participate in a follow-up interview conducted via phone or Skype. 43 (18.9 percent) solvers agreed and were interviewed between mid-2015 and mid-2016. The interviews lasted an average of 43 min and were fully transcribed, yielding a text corpus of 214,429 words. These interviews were semi-structured and were based on an interview guide that was informed by the literature and insights from the survey (Flick, 2014). In addition to a short introduction, the interview guide comprised questions on four topics: solvers' imitation experience, solvers' value appropriation practices, distances in innovation contests, and the composition and role of solver teams. After crafting a draft interview guide, we iteratively refined it in our research team (e.g., Charmaz, 2014; Flick, 2014).

3.3. Data analysis

Analysis of the survey data. To analyze the 2,149 answers, we read and coded the entire text corpus of 54,985 words following the techniques described by Gioia (2004), and Gioia et al. (2013). The open coding process yielded three broad themes emerging from the data: (1) solvers' value appropriation concerns, (2) consequences for solvers' motivation, and (3) actions that solvers take. We used these to investigate and elaborate on how solvers perceive the sharing-protecting tension when participating in crowdsourcing contests for technical solutions.

Analysis of the interviews. Following Silverman (2006), we worked in a team of three researchers using an abductive approach, iterating between our data and codes on the one hand, and, on the other hand, the relevant literature on open innovation (e.g., Laursen and Salter, 2014; West and Bogers, 2014), crowdsourcing (e.g., Afuah and Tucci, 2012; Jeppesen and Lakhani, 2010), and value appropriation (e.g., Teece, 2006, 1986). Two of the authors of this study independently coded the interviews using Gioia et al.'s (2013) technique. The goal was to identify and understand (1) solvers' perceptions of the tension between sharing and protecting, as well as (2) the formal and informal value appropriation practices they use. This allowed us to determine the circumstances under which specific value appropriation practices – or combinations thereof – are most prevalent and perhaps most effective when coping with the sharing-protecting tension in crowdsourcing. During first order analysis, we adhered to informant terms for open coding and did not attempt to distill aggregated categories (Gioia et al., 2013; Gioia and Chittipeddi, 1991). To avoid getting lost in the data (Gioia, 2004), we iteratively discussed and refined the codes against our conceptual background. We then started to identify similarities and differences among the emerging categories in form of a more focused coding, as part of which we reduced the number of codes to approximately 100 (Gioia et al., 2013). Using this initial codebook, the interviews were recoded. During second order analysis, the codes were further reduced, aggregated, and condensed, resulting in the identification of seven value appropriation practices, namely (1) patent thicketing, (2) patent pending, (3) agreeing on non-disclosure, (4) selective revealing, (5) solution black-boxing, (6) controlling complementary assets, and (7) intermediary bypassing. We also identified relevant contingencies that influence the effectiveness and timing of these value appropriation practices in the crowdsourcing process. Fig. 2 illustrates our analytical approach, moving from first order terms to second order themes and finally aggregate dimensions (Pratt, 2008). In the end, we compared our matches in the final coding, i.e., the co-occurrence of the codes, in order to assess the degree of inter-coder reliability, which was satisfying, with a value of 90.5 percent (Flick, 2014).

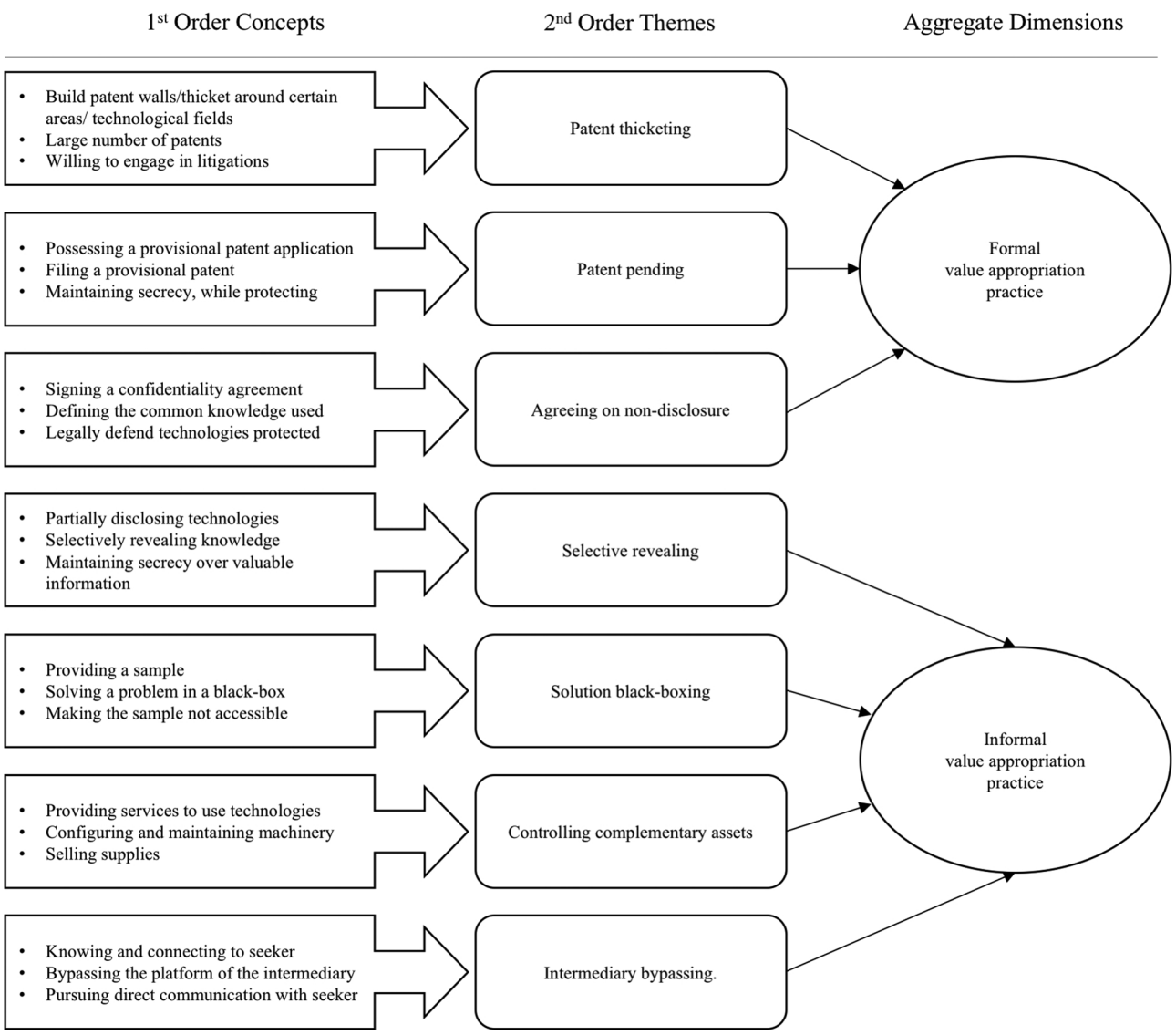

Fig. 2. The data structure in accordance to Gioia et al., 2013.

3.4. Sample description

Table 1 provides an overview of the demographics of the solvers who participated in the survey (N_1) and in the interviews (N_2). All participating solvers were academic or professional researchers, and they worked in a total of 30 different STEM-related fields. Most of the solvers who were part of the survey sample demonstrated both high expertise and considerable experience. This is reflected in the fact that almost a third (29.8 percent) of the survey respondents were between 48 and 57 years old, whereas only a small percentage (0.4 percent) were younger than 27 years. Moreover, 62.6 percent held a doctorate degree, and 97.5 percent had graduated from university. In addition,

Table 1
Sample description.

Attributes of the solvers *Solvers' demographics*	*Survey*	*Interviews*		*Survey*	*Interviews*
18-27 years	0.4%	0%	No degree	0.4%	0%
28-37 years	9.7%	9.3%	High school (or comparable)	2.2%	11.6%
38-47 years	21.7%	14.0%	Bachelor's degree (or comparable)	12.5%	9.3%
48-57 years	29.8%	48.8%	Master's degree (or comparable)	22.4%	20.9%
58-67 years	26.0%	14.0%	Doctorate	62.6%	58.1%
> 67 years	12.4%	14.0%			
Number of years in profession[a]	26.9	27.2	Female	10.6%	20.9%
Number of years with current employer[a]	14.4	12.6	Practitioner	60.4%	67.4%
Total number of submitted solutions[a]	2.2	3.8	Success[b]	16.9%	27.9%
Time to prepare a solution proposal[a]	16.3	17.5	Product solutions	75.4%	90.7%

Notes: N_1 = 1,149 survey participants; N_2 = 43 interview participants; [a]Mean values; [b]Did one of your submitted solutions result in an agreement with the seeker? (1 = yes).

solvers in the sample had spent an average of 26.9 years in their profession and had been part of their current organization for around 14.4 years. As for the subset of solvers who were interviewed, 48.8 percent were between 38 and 47 years old, with an average total professional experience of 27.2 years. 58.1 percent of them were PhDs. Regarding their crowdsourcing experience, the interviewees had, on average, submitted 3.8 solutions and invested 17.5 days in crafting each solution proposal.

4. Findings

4.1. Solvers' experiences of the paradox of openness

An implicit assumption in most crowdsourcing research to date was that participating individuals would freely share their ideas and solution proposals (Franke and Shah, 2003; Lilien et al., 2002). Complementing recent studies that discuss the paradox of openness in firm-level inbound open innovation (e.g., Bogers, 2011; Lauritzen, 2017; Laursen and Salter, 2014), our data, however, indicated a similar tension between sharing and protecting for individuals who submit solutions as part of crowdsourcing contests. We share below two exemplary solver perceptions of the paradox of openness in individual-level outbound open innovation:

> [Y]ou need to share knowledge in order to find the best problems to be solved and a best way to solve them. At the same time, you need protected knowledge to prevent unwanted competition. We are walking the path of doing both intensively.
> (Practitioner, material science, interview)
> I think it is a mixture of both [sharing and protecting]. I don't think that keeping things a big secret is the way to go, but I don't think that putting everything out there for the whole world to see is a good idea either. Both of those concepts need to be integrated [so] you get the best result depending on what particular client you are working with.
> (Practitioner, coatings, interview)

For solvers who successfully combine sharing and protecting, the long-term rewards can be substantial:

> I have been successful with a proposal to [name of intermediary]. As a result, I built a very strong partnership with the seeker (a large multinational). The partnership lasted for four years and just ended last month. The outcomes of the partnership have resulted in a licensing agreement [and] two patent applications are being processed. The personal relationship that I have built with the management team […] is now very strong.
> (Practitioner, material science, survey)

Despite such accounts about collaborative value creation, our results also point to cases where solvers perceived the sharing-protecting tension as unmanageable. One solver emphasized how *"it is not possible to get somebody interested in a proposal without revealing contours of the idea and it takes only a dumb seeker to not know or guess the solution and develop it further*" (Practitioner, analytics and testing, survey). In a similar vein, one solver cynically remarked that for seeking firms "[crowdsourcing] is just a vehicle to collect ideas" (academic, material science, survey) and another solver described crowdsourcing as "*a black hole: I submit my proposed solutions and never hear from anyone again*" (academic, metallurgy, survey). Even solvers who have successfully submitted a solution are sometimes not sure what happens to shared IP, as one solver explained:

> There have been follow-ups on several [proposals that] left me uncomfortable. The request came from a [foreign] corporation […] I provided a far more cost-effective solution. One that could be implemented quickly. We sent samples produced at our cost. They were received. Follow up by email, talking to [name of intermediary], and telephone calls to an English speaker in the department of the corporation. Nothing. I would not know if my solution was taken or ignored. I suspected it might be stolen because of its value and my inability to determine if it had been.
> (Practitioner, industrial engineering, survey)

This excerpt shows that an individual solver can be left with nothing but a feeling of unease, not knowing if his or her solution has been *"taken or ignored"*, a situation another solver described as *"depressing due to the hard work that went in"* (academic, biology, interview). This issue is of particular concern for individual inventors, whose ideas are often their most valuable asset, which they fear to lose to large firms with an aggressive IP management (Salter et al., 2014). The paradox of openness might thus appear even more critical at the individual level than at the firm level, as solvers may face considerable economic and psychological losses. One solver expressed his bad feelings after having shared too much unprotected knowledge:

> They […] asked very detailed questions. My answers would have provided them enough knowledge about the solution, so that a person or group of persons competent in the topic could have deployed the solution without my help or involvement. […] I felt cheated or abused […] I had the feeling that the questions went far beyond the need to dispel any reasonable doubts about my ability to carry out the proposed work [and] that the intent of the questions was to harvest all possible additional technical details […] for free.
> (Practitioner, computer science, survey)

Such experiences, as illustrated in the above excerpts, sow mistrust among solvers, as some seekers seem merely interested in freely sourcing ideas to stimulate their own in-house R&D. Indeed, solvers' motives go beyond fun, learning, sense of belonging, and recognition (Harhoff et al., 2003) to a fair compensation for their creative efforts (Franke et al., 2013). In the worst case, the seeker can even terminate the relationship after the solver has transferred enough solution information leaving the solver with no compensation at all. For instance, one solver *"worked […] for three months and then was dumped after the […] customer had learned enough"* (Practitioner, physics, survey). Even more tragic, another solver reported:

> Once they were able to start production, they decided that they did not need us anymore and that they owned all my technologies. It took my high-powered lawyers over 2 years to get them to realize the error of their ways; I was persuaded to grant them a full license to produce the product for an initial fee of £100,000, most of which went to the lawyers. Due to their actions I had to lay off all my staff and downsize our facilities and revert to seeking licensees only instead of running our own research, development and manufacturing facilities.
> (Practitioner, environmental engineering, survey)

Our findings show that the digital and often anonymous nature of crowdsourcing, along with the lack of trust and durable structures for interaction (Nambisan et al., 2017; Pollok et al., 2019), exposes individual solvers to severe value appropriation challenges and a fundamental struggle with sharing-protecting tensions. We thus find strong evidence for an apparent paradox of openness in individual-level outbound open innovation. While previous studies showed that crowdsourcing contests can be very beneficial for commercializing IP (Afuah and Tucci, 2012; Jeppesen and Lakhani, 2010), our findings indicate that solvers indeed experience value expropriation, which makes them not only very cautious in future knowledge sharing, but also lose interest and abandon crowdsourcing. For instance, a solver who experienced a crowdsourcing-induced infringement of his IP stated that *"[s]ince that time, three to four years ago, I have never submitted another proposal to [the crowdsourcing platform]"* (practitioner, material science, survey). As such, the paradox of openness in individual-level outbound open innovation may threaten not only the legitimate interests of

Table 2
Value appropriation practices.

Practice	*O.*	*Selected quotes*	*Circumstances*	*Enactment of sharing and protecting*
Patent thicketing (differentiation) establishing an impenetrable wall of patents around the solution. ***Related literature:*** Arora and Ceccagnoli (2006) Arundel (2001) Holgersson and Granstrand (2017) Neuhäusler (2012); Somaya (2012)	49%	"[Our lawyers] will try to build a patent thicket. They apply this and built a patent thicket around it […]. We have a large number of applied patents […]." (Practitioner, physics, interview)	(1) Large solver corporation (2) Strong financial resources (3) Strong legal resources (4) Strong appropriability regimes	**Sharing** (1) Make IP public and fully transparent (2) Enable transfer of ownership rights
		"We have a patent strategy to build patent walls around certain areas and certain markets […] that restricts the damage you can get from reverse engineering." (Practitioner, material science, interview)		**Protecting** (1) Publicly allocate ownership rights (2) Impede inventing around through patents
Patent pending (integration) possessing a provisional patent application (valid for up to 3 years). ***Related literature:*** Somaya, (2012); Henkel and Jell (2010, 2009)	37%	"The patent is more about prevention or breeding some question of risk in their mind and […] design around it is difficult, because they don't know what - it hasn't been published yet. […] they can't look at a specific set of claims and design around it." (Practitioner, mechanical engineering, interview)	(1) Fast changing environments (2) Weak financial resources (3) Weak legal resources (4) Avoidance of inventing around	**Sharing** (1) Create uncertainty by breeding expectations about the solution's value in the seekers mind (2) Respond quickly to emerging business opportunities
		"Then I take provisional patent [application] that gives me one year. I am […] in that period trying to seal the deal. Otherwise, when you do not use it, then it basically elapses, and you have to start again." (Practitioner, industrial engineering, interview)		**Protecting** (1) Maintain temporal secrecy (2) Signal potential property rights and breed litigation risk in seeker's mind
Agreeing on non-disclosure (differentiation) putting down a confidentiality contract in writing. ***Related literature:*** Hertzfeld et al. (2006) Bogers (2011)	67%	"I […] ask the client whether they are prepared to sign the confidentiality agreement for full disclosure. […] Then it can still be taken away but at least you got something to […] take them to court." (Practitioner, industrial engineering, interview)	(1) Extensive experience (2) Strong appropriability regimes (3) Strong legal resources	**Sharing** (1) Enable free knowledge sharing among the signers for specified internal purpose
		"If the seeker and I […] have an NDA, we can share everything with open hearts and with open minds. […] If there is not any agreement, then there will be no open discussion." (Academic, material science, interview)		**Protecting** (1) Keep shared IP as legal property of the owner (2) Signal risk of litigation in case of breach
Selective revealing (integration) partially disclosing relevant knowledge, while maintaining some of it as a secret. ***Related literature:*** Alexy et al. (2012); Henkel (2006); Henkel et al. (2014)	91%	"I didn't put everything in there, because I wanted to give enough information to get some interest and […] then I would be getting to more details and more information about the [solution]." (Practitioner, mechanical engineering, interview)	(1) Complex knowledge (2) Modular knowledge (3) With formal mechanisms (4) Marketing technologies	**Sharing** (1) Share "enough" knowledge to trigger seeker's interest
		"What we try to do is to reduce the amount of information that we supply about the solution. Basically, we are talking about benefits." (Practitioner, electrical engineering, interview)		**Protecting** (1) Conceal relevant knowledge needed to fully understand the technology
Solution black-boxing (differentiation) providing a sample solution without disclosing the process or concealing the sample in a way that it is not accessible.	30%	"Oh, very simple, it is called a black-box solution. We are asking samples. We are doing something with these samples, overcoat them […] and provide a black-box solution. They can take this sample back, test it, and if they feel that it is promising, then we sign an NDA and we go further." (Practitioner, chemical engineering, interview)	(1) Solvers from practice (2) Low geographical distance (3) Small solver firms (4) Difficult to reverse engineer	**Sharing** (1) Share physical product for (a) solving something or (b) performing the requested purpose
		"We are […] using mechanical locks or physical locks, so that you cannot uncover it without destroying it." (Practitioner, electrical engineering, interview)		**Protecting** (1) Prevent reverse-engineering (2) Avoid full observation (3) Keep processes a secret
	47%			

(*continued on next page*)

Table 2 (*continued*)

Practice	*O.*	*Selected quotes*	*Circumstances*	*Enactment of sharing and protecting*
Controlling complementary assets (differentiation) providing products, services, and supplies that are necessary to use the technology and are only available from the solver. ***Related literature:*** Arora and Ceccagnoli (2006) Teece (2018, 2006, 1986)		"The method is there, but to extract the data and to optimize the right water flowing concentration data is an act. […] We can explain to you how it works." (Academic, chemical engineering, interview) "The client cannot. The terms ultrasounds and ultrasound are out there. The term photonic is out there. Configuring those devices or those screens and bulbs in the right way, it is something that they would not know how to do. It would take a lot of time." (Practitioner, physics, interview)	(1) Strong know-how required (2) Difficult to imitate (3) Weak appropriability regimes	**Sharing** (1) Share solution-relevant knowledge freely **Protecting** (1) Capture value through required services, skills, products, and supplies that can be only purchased from the solver
Intermediary bypassing (integration) identifying the seeking organization and directly contact them without using the platform service of the intermediary.	23%	"I did know who the end user was. It was 3 M, and, in this case, they were interested in speaking with us. They were open to speak with us […] and I was able to ultimately make some connections there." (Practitioner, material science, interview) "The only way, I am not going to get any information in an RFP. I really need to be able to see someone in the eyes and talk to them." (Practitioner, mechanical engineering, interview)	(1) With formal mechanisms (2) Small solver firms	**Sharing** (1) Share knowledge freely **Protecting** (1) Enable physical contact (2) Build trust by building personal relationship

Notes: N = 43; O. = Occurrence in interviews.

individual solvers, but also the effectiveness of crowdsourcing platforms as a whole and their value proposition to seekers.

4.2. Solvers' attempts to navigate the paradox of openness

Our analyses indicated that solvers attempt to navigate the fundamental sharing-protecting tension with a set of both formal and informal value appropriation practices (Holgersson et al., 2018; Zobel et al., 2017). Formal value appropriation practices are actions and measures taken by the solver that are legally encoded (e.g., patents and contracts) (Zobel et al., 2016). The effectiveness of these depends on the willingness and ability of the infringed party to enforce their legally encoded IP rights in the event of a violation (Laursen and Salter, 2014). Informal value appropriation practices are measures employed by solvers to protect solution-relevant knowledge through strategic actions, such as secrecy, lead time, and complementary assets (Holgersson et al., 2018; Laursen and Salter, 2014; Teece, 1986).

As a result of our two-stage coding process, we identified three formal practices, which we call *patent thicketing*, *patent pending*, and *agreeing on non-disclosure,* as well as four informal practices, which we call *selective revealing*, *solution black-boxing*, *controlling complementary assets*, and *intermediary bypassing*. In the following, we describe these practices, relate them to value appropriation mechanisms used at the firm-level and for inbound open innovation, and explain how individual solvers use these practices to navigate the paradox of openness in outbound open innovation. Table 2 presents each practice and its occurrence (percentage) in the interviews, the circumstances under which it is used, and related literature if available.

Patent thicketing. Patents have long been acknowledged as a value appropriation mechanism used in firm-level open innovation (Arora and Ceccagnoli, 2006; Wang et al., 2017, 2017). Yet, research remains inconclusive on whether patents facilitate or hinder value creation and appropriation in open innovation (Alexy et al., 2009; Laursen and Salter, 2014; Zobel et al., 2016). In our sample, some solvers engage in patent thicketing when they seek to establish an impenetrable patent barrier around their idiosyncratic knowledge base (see Table 2), which will legally protect any solution that incorporates such knowledge. Patent thicketing also renders inventing around the solution more difficult, as it offers protection *"where there are aspects of the technology that are obvious and can be reverse engineered"* (practitioner, chemistry, interview). However, patent thicketing is not perfect, as one solver explained: *"As of now, there are 112 US patents that list my name. [Yet] patents are only as strong as their owners' ability to defend them anyway. Also, mine are not international patents, which leaves the rest of the world as almost completely unknown"* (practitioner, electrical engineering, survey). Indeed, it is very difficult to detect and counteract infringement on global markets (Keupp et al., 2010; Schmiele, 2013). Ultimately, patent thicketing is only valuable, if the solver, or alternatively the intermediary, is willing and able to start and win a patent litigation case (James et al., 2013). Sometimes, *"patent infringements are too hard to prosecute due to the size and wealth of the infringer"* (academic, physics, survey). Furthermore, because of maintenance fees, patents are *"costly to keep"* (academic, civil engineering, interview). For these reasons, patent thicketing requires strong financial resources (Alexy et al., 2009; Arora and Ceccagnoli, 2006; Arundel, 2001; Neuhäusler, 2012). Unsurprisingly, individual solvers tend to have fewer patents and a lower ability to enforce legal rights than corporate seekers (Zhao, 2006). We argue that patent thicketing works as a *differentiation* practice by establishing clear boundaries between what is protected and what can be shared. Through defining ownership, patent thicketing thereby deals with the openness paradox by separating sharing and protecting across structural areas (Table 2).

Patent pending. Not least given the cost of patent thicketing, solvers make use of patent pending. Here, solvers file a provisional patent application, which is valid for up to *"three years"* (practitioner, chemical engineering, interview). During this period, typically neither the patent

application nor the solution information is publicly available, as pending applications are not published until the patent is issued and hence becomes effective (Henkel and Jell, 2009). Such delay can be beneficial, as it maintains secrecy over a longer period (Henkel and Jell, 2010, 2009). Accordingly, solvers can signal that they have applied for a patent related to their solution, yet they do not have to disclose the exact content of the application. Thereby, patent pending enables protection through maintaining *"corporate secrecy"* and *"priority"* over subsequent applicants with closely related or identical designs (practitioner, physics, interview) over the technology at least for some time. Patent pending also signals the potential value of the solution. In our sample, patent pending appears an interesting alternative for solvers with weak financial and legal resources, as it is *"not a matter of cost"* (practitioner, industrial engineering, interview) compared to maintaining a number of patents. Moreover, patent pending goes beyond providing legal protection in the future by immediately introducing a strategic element (Henkel and Jell, 2010). As external parties do not know the exact content of the pending patent, it *"creates enough road blocks"* (practitioner, chemical engineering, interview) to distract imitators. Therefore, seekers are typically cautious when using a technology without a clear statement about what is protected, which renders copying and *"designing around it difficult"* (practitioner, mechanical engineering, interview). Some solvers even *"recommend that it is best to submit only patent pending solutions"* (practitioner, mechanical engineering, survey), or solutions *"well protected through patents pending"* (practitioner, chemical engineering, survey). As a first step towards formal protecting, patent pending introduces an element of secrecy because it is not yet published, while also conferring value to the solution and allowing for degrees of sharing around these elements. As such, patent pending seems to balance degrees of sharing and protecting, thereby resembling an *integrative* practice (Table 2).

Agreeing on non-disclosure. Agreeing on non-disclosure involves both parties' signing a confidentiality contract – i.e., a non-disclosure agreement (NDA) – before sharing any solution-relevant knowledge (Hertzfeld et al., 2006). As one solver explained, *"First, we have an NDA, and then we can talk"* (practitioner, chemistry, interview). In principle, NDAs enable free sharing of knowledge among the signers through stipulating that what is shared remains legal property of the owner (Bogers, 2011), as *"nobody is allowed to share the knowledge with a third party"* (academic, textile engineering, interview). As illustrated in Table 2, two-thirds of the solvers in our study indicated they used NDAs to legally regulate the usage of shared IP. The effectiveness and legal enforceability of these terms and conditions, however, depend to a large degree on the legal environment in the specific country, as one solver described: *"In India, we have to be very sure about the […] paragraphs […], because sometimes in India even an NDA is of no use in the court of law"* (academic, chemical engineering, interview). Agreeing on non-disclosure helps create a safe and trusted space for discussion within which knowledge can be openly shared (ensuring its full protection outside this space). As such, this practice seems to mainly *differentiate* and separate sharing and protecting by assigning each element to different spatial (inside and outside) areas.

Selective revealing. In line with Alexy et al. (2013a), we use this term to mean partially disclosing IP relevant to the solution without contractual requirements, while concealing other parts important to maintain control over the IP. In line with evidence from the firm-level open innovation literature (Henkel, 2006; Henkel et al., 2014), more than 90 percent of our interviewees indicated that they used this practice. Selective revealing appears particularly useful, if the solution knowledge is *"complex"* and *"modular"* (practitioner, material science, interview). Under these circumstances, solvers can partially disclose sufficient information to *"get [seekers] interested"* (academic, civil engineering, interview) and win the contest, while *"keeping critical knowledge"* (practitioner, chemistry, interview) that is needed for the seeker to fully understand the solution. These statements correspond to Alexy et al.'s (2013a) considerations that selective revealing should support firms in their effort to attract partners for collaborative efforts while maintaining knowledge proprietary to ensure value appropriation. The solvers in our sample further elaborated on this balancing act between sharing some parts of the solution and concealing other parts: *"You have to give enough that people get interested and keep enough secret that they […] ask for more"* (practitioner, material science, interview), and you *"clearly have to balance enough disclosure detail about the solution without revealing too much about the technology"* (practitioner, mechanical engineering, survey). Considering this function, selective revealing can also be used as a marketing mechanism (Henkel et al., 2014) to attract seekers' attention. Nevertheless, it is always a balancing act, as revealing *"too much"* can lead to unwanted knowledge spillovers and *"getting copied"* (practitioner, material science, interview). To reduce this risk, solvers in our sample frequently combine selective revealing with formal practices such as NDAs and patents. As one solver explained, *"Patents and secrecy? They are complements, they work together"* (academic, chemistry, interview). We argue that selective revealing can work as an *integrative* practice by encouraging an appropriate mix between knowledge sharing and protecting. Selective revealing describes the balancing act of partially disclosing sufficient knowledge (i.e., enough to trigger interest and a basis for collaboration/winning the contest), while maintaining some of it as a secret (i.e., critical knowledge needed to fully understand the solution and/or technology) (Table 2).

Solution black-boxing. We also found solvers engaging in solution black-boxing, as part of which they provided the seeker with a sample solution without disclosing the underlying processes or core technology. One solver reported, *"We make solvents and adhesive agents for [the seeker] and they don't expect us to tell them what is in it"* (practitioner, chemistry, interview). Depending on the nature of the specific technical challenge, the solver might ask the seeker to send a sample of the problem, which is then solved and sent back to the seeker. One solver described communications with the seeker this way: *"Do not ask us too many questions and […] to submit too many information [sic]. We will show you that it works"* (practitioner, chemical engineering, interview). This approach can be effective when the solution is *"too complex to reverse engineer"* (practitioner, industrial engineering, interview). Our findings suggest that solution black-boxing is used more by practitioners (86.0 percent) than by academics (14.0 percent). Sharing black-box solutions also depends on the geographical distance between the seeker and the solver. For instance, it is less likely *"in an overseas situation where there might be a lot of logistic concerns"* (practitioner, material science, interview). Thus, solution black-boxing tends to be used more frequently in local markets, where the costs of transportation and monitoring are relatively low (see also Bartlett and Ghoshal, 1998; Zhao, 2006). In our sample, solution black-boxing serves as a means of *differentiation,* because it separates sharing of the sample solution and protecting its underlying processes and core technology across structural areas, such as through product complexity and/or built-in barriers that protect these elements from disclosure (Table 2).

Controlling complementary assets. This practice refers to a solver's effort to capture value by establishing and controlling resources that enhance the customer value of the focal solution (Teece, 2006, 1986). These might come in the form of additional products, services, or processes. It is the co-specialized combination of the solution with closely-associated assets that is assumed to reduce solvers' risk of value expropriation. Creating and managing complementary assets is particularly challenging in times of the digital economy, as they are not only value-capture mechanisms but often needed for the technology to function (Teece, 2018). According to our interviewees, controlling complementary assets is especially effective if the process to use or instantiate the technology requires considerable *"know-how"* and *"implementation and application services"* (practitioner, material science, interview) as well as a *"holistic approach – methods and culture"* (practitioner, computer information science, interview). These statements correspond to Miozzo et al. (2016) findings that firms indeed engage in

complementary service development as a form of strategic protection. When value appropriation relies not so much on the shared solution information, but rather on the complementary assets required to unleash the full potential of the solution, such as *"the service and maintenance side [and] the initial installation side"* (practitioner, coatings, interview), solvers can decouple solution-relevant knowledge and the risk of IP infringement by capturing value through the necessary complementary assets and not through the solution itself (see Table 2). As a solver stated, *"[we may] try to make our system proprietary"* (practitioner, coatings, interview) rather than only the solution. As controlling complementary assets is used to decouple sharing (of the solution) from protecting (the complementary resources, methods, and needed by-products), we categorize this practice as *differentiation* (Table 2).

Intermediary bypassing. Given the promise of intermediation as a way to balance sharing-protecting tensions in crowdsourcing, we were particularly surprised to see some solvers engaging in intermediary bypassing (23.0 percent). Here, solvers who know the identity of the seeker will directly contact the seeker without using the digital platform or the services of the intermediary. Our interviews indicate that solvers use intermediary bypassing to reduce the downsides of digital, asynchronous, and often impersonal interactions, so *"that they can speak openly […] making the cooperation much more effective"* (academic, chemistry, interview). Contacting a seeker directly by phone or in a face-to-face meeting prior to sharing knowledge generates knowledge about the partner and helps establish mutual trust. One of the solvers asserted, *"We always win the business when we talk directly to the end user"* (practitioner, chemical engineering, survey). Moreover, these contacts can be used to *"ask the client whether they are prepared to sign the confidentiality agreement for full disclosure"* (practitioner, industrial engineering, interview), which in turn enables both parties to talk more openly about the problems and solution requirements. Thus, solvers seem to use intermediary bypassing to create a personal and contractual relationship prior to exchanging any detailed solution information as part of the more formal contest. In our sample, intermediary bypassing is often combined with signing of NDAs. It can create trust between seekers and solvers yet erodes the position of the intermediary and challenges its promise to solve the paradox of openness. In our sample, solvers use intermediary bypassing to establish trust and create a more open dialogue with seekers in the initial phase. This form of entrusted dialogue shows the potential to expose both parts to their conflicting demands between sharing and protecting. Thereby, intermediary bypassing appears as an *integration* practice encouraging mutual trust that enables compromises and common goals (Table 2).

4.3. Configurations of solvers' navigation attempts

As illustrated in Table 2, the identified value appropriation practices help solvers to navigate the paradox of openness in outbound open innovation (i.e., deal with sharing and protecting, simultaneously) by structurally or spatially separating the efforts of sharing and protecting (i.e., *differentiation*) or by blending their opposite aspects through finding an appropriate mix or compromise (i.e., *integration*). For instance, practices such as *patent thicketing* and *agreeing on non-disclosure* create a common language and consent about how to treat shared knowledge through explicating formal ownership and terms and conditions. As such, these practices allow for a simultaneous enactment of sharing and protecting by assigning them to different structural and spatial areas that clearly distinguish between knowledge that can be shared and knowledge that is protected. Different from these apparent differentiation practices, practices such as *patent pending* and *selective revealing* reflect integration by balancing degrees of sharing and protecting and encouraging an appropriate mix, such as concealing critical knowledge while still sharing sufficient knowledge to trigger interest.

Importantly, the practices we identified differ in terms of the nature of the proposed strategy to manage the paradox of openness, i.e., reflecting differentiation and integration, respectively. Practices such as *patent thicketing, agreeing on non-disclosure,* and *controlling complementary assets* enable solvers to share their knowledge more openly while enhancing their value appropriation prospects. Thereby, these practices honor and emphasize the distinct characteristics of sharing and protecting. Practices such as *selective revealing* and *patent pending*, in contrast, involve more limited forms of sharing that intentionally exclude critical elements of the solution that might otherwise be appropriated by the other party. As these more integrative practices seek to balance degrees of sharing and protecting, they might dilute the intensity of each pole, thereby, reducing the distinct benefits of sharing and protecting. This points to the need for combining differentiation and integration approaches to overcome their individual limitations and effectively manage the paradox of openness (Lauritzen and Karafyllia, 2019).

We have observed that solvers explicitly seek to leverage such complementarities among value appropriation practices to build more elaborate configurations that are tailored to the specific sharing-protecting tension at hand. This is tellingly reflected in the following quote:

> I can insert or inject my own level of what I feel as my protection, as I go along and kind of feel out the client.
> (Practitioner, coatings, interview)

Another solver pointed to the critical role played by the type of knowledge to be shared:

> If something [is] really easily reproduced, normally, people will not want to patent or file it, or put it in the papers. So, it depends on the situation. Some technology has to be treated as a trade secret. It is the only way. It is all depending.
> (Practitioner, chemistry, interview)

These statements illustrate how different boundary conditions pertaining to the characteristics of the collaborating parties (e.g., firm size and university involvement), the nature of the solver-seeker relationship (e.g., culture, trust, geographical distance), the type of knowledge to be shared (e.g., codified or tacit), and the environment (e.g., sector setting) in which the collaboration takes place, shape the specific nature of the sharing-protecting tension and call for different configurations of value appropriation practices. As depicted in Table 2, appropriation practices can be adapted to reflect changing circumstances. For instance, one solver explained how *"in some of the projects, we use all approaches [appropriation practices]. So, they can be effective in many situations"* (practitioner, electrical engineering, interview). Other solvers described the different practices as merely *"tools in a tool box"* (practitioner, chemical engineering, interview) that can be *"[…] combined as the process moves ahead"* (practitioner, coatings, interview).

Accordingly, our data indicates that time and timing are critical factors for solvers seeking to tailor their configuration of appropriation practices to the specific case at hand. For instance, one solver stated that *"timing is important - how you disclose, how much information, and when you disclose it"* (practitioner, chemical engineering, interview). Indeed, our analyses indicate that the prevalence of certain value appropriation practices differs systematically across the four stages of the crowdsourcing process, i.e., orientation, submission, negotiation, and completion. Thereby, solvers seem to navigate the openness paradox by dynamically using and combining differentiation and integration practices across the crowdsourcing phases.

This is also reflected in Fig. 3, which depicts a stylized process model of how solvers tend to select value appropriation practices and build elaborate configurations thereof along the distinct phases of a crowdsourcing contest. In the orientation phase, solvers who have identified a suitable call for solutions go through a set of questions to determine how to respond to the call and navigate the associated sharing-protecting tension. They evaluate not only *"if it is worth the risk"* (practitioner, industrial engineering, interview), but also if they know the seekers in advance, *"facilitating direct exchange at early stages of the crowdsourcing process"* (academic, chemistry, interview), and if their

knowledge is (or can be on short notice) formally protected *"with patents or patents pending"* (practitioner, consumer products, interview), or informally protected through *"partially revealing it to establish a basis into a two-way confidentiality agreement"* (practitioner, environmental engineering, interview). Given these considerations, solvers will submit a solution proposal if they feel sufficiently protected. If protection is unavailable, but they know the seeker well enough to attempt to establish a direct personal relationship, the solvers in our sample would typically choose to bypass the intermediary and submit a proposal anyway.

In the negotiation phase, a solver decides if the seeker is *"trustworthy"* and *"limit[s] the information that [the solver] exchanges"* (practitioner, material science, interview) accordingly. When solvers deal with large corporations, they need to consider their bargaining power. They typically decide to use formal protection practices such as NDAs to prevent the other party from *"extracting non-protectable know-how"* (practitioner, agriculture, interview). Our data also showed that solvers may consider solution black-boxing as an informal protection practice, for instance by *"send[ing] material to the seeker that cannot be reverse-engineered"* (academic, chemistry, interview).

Overall, our empirical material indicates that solvers tend to approach opposing sharing-protecting demands as both distinct and complementary. That is, solvers seek to navigate the paradox of openness and allow for a simultaneous enactment of sharing and protecting by using distinct sharing and protecting efforts across structural and spatial configurations and by using integrative efforts that emphasize their interdependencies (see Table 2). Keeping opposing poles separate seems to strengthen focus and reduce the risk of confusion, because it upholds a strict distinction between sharing and protecting. Such a strategy of differentiation honors the distinct benefits of each pole and prevents conflictual interactions (Jay, 2013; Smith and Tushman, 2005). Nevertheless, differentiation also presents the two poles as irreconcilable by requiring their separation in time, structure and/or space. Therefore, a sole emphasis on differentiation as reflected in four of the identified practices (patent thicketing, non-disclosure, solution black-boxing, complementary assets) can also limit potential synergies by encouraging some preferred innovation mode among solvers at different stages in the crowdsourcing process that either favors protecting or sharing. An emphasis on differentiation when navigating the paradox of openness might, therefore, restrict coordination between seekers and solvers and potentially trigger new conflicts (Jay, 2013; Lauritzen and Karafyllia, 2019; Poole and Van de Ven, 1989; Smith and Tushman, 2005). As the antidote to differentiation, it seems that the solvers from our sample also use a strategy of integration, which is apparent from the other three identified practices (patent pending, selective revealing, and intermediary bypassing). Emphasizing the complementarities of conflicting sharing and protecting demands, integrative efforts might help solvers move beyond a rivalrous logic of competition that emphasizes value appropriation, attack, and retaliation against competitors towards a more relational logic that also seeks to lift the boats of all stakeholders in their ecosystem (Chen and Miller, 2015). In addition, our findings show *how* solvers combine the different (differentiation and integration) practices across the crowdsourcing phases by reflecting boundary conditions, such as firm size, trust, geographical distance, and the type of knowledge to be shared.

5. Discussion

5.1. Implications for research

Scholars have increasingly discussed the tensions between knowledge sharing and protecting in open innovation. This phenomenon is termed the paradox of openness (Arora et al., 2016; Bogers, 2011; Laursen and Salter, 2014; Wang et al., 2017). Initial evidence has shown that firm-level openness can indeed be associated with higher risks of unintended knowledge leakage and intellectual property infringement (Foege et al., 2017; Schmiele, 2013; Veer et al., 2016). Consequently, scholars have pointed to the importance of effective value appropriation mechanisms to cope with these tensions and have begun to shift their research focus from value creation to value capture (Holgersson et al., 2018; Zobel et al., 2017). Given the absence of a direct monetary return, sourcing and revealing are particularly exposed to sharing-protecting tensions (Stanko et al., 2017). Research has primarily examined this fundamental paradox from the perspective of sourcing firms (e.g., Arora et al., 2016; Laursen and Salter, 2014) and largely ignored its role in individual-level outbound open innovation. Table 3 provides an overview of the paradox of openness, reconceptualizes it, and offers new insights on how the paradox manifests for individual solvers in outbound open innovation.

Our study contributes to the understanding of the paradox of openness and value appropriation in three primary ways.

First, we expand the conceptualization of the paradox of openness by incorporating the multi-level and multi-directional nature of open innovation. This clarification is critical, given the strong interdependencies between the different facets of the paradox. As shown in Table 3, the paradox of openness differs for inbound and outbound activities. Comparing the two, firms that source knowledge (inbound open innovation) need to reveal relevant knowledge to articulate (codify) their needs and requests (need information) (Laursen and Salter, 2014; Wang et al., 2017), while firms that practice outbound open innovation need to reveal knowledge relevant for solving a solution (solution information) (Tranekjer and Knudsen, 2012). The latter is arguably more valuable, as it incorporates technological details that are often directly applicable to the problem itself and are close to the core of the provider's knowledge base. Accordingly, seeker and solver firms are both exposed to the paradox of openness, yet, the value of solution knowledge for each of the two renders the paradox of openness even more prevalent for knowledge providers. Building on this reasoning, our study contributes to the literature on open innovation more generally, as we not only examine crowdsourcing for technical solutions as an inbound form of open innovation as suggested by Ghezzi et al. (2018), but also point to its outbound component with solvers seeking to bring their knowledge to new markets. As such, we understand crowdsourcing as consisting of bidirectional knowledge flows across organizational borders. In so doing, we also point to practices that seek to actively manage these bidirectional knowledge flows (Chesbrough and Bogers, 2014; West et al., 2014). In particular, we show and elaborate on how solvers as external contributors to seekers' innovation activities (Ghezzi et al., 2018) attempt to ensure value capture in view of a fair value distribution among seeker, solver, and intermediary in open innovation (Chesbrough et al., 2018). As for the multi-level nature of open innovation, the paradox of openness affects firms differently than individuals. At the individual level, inbound open innovation requires the exchange of tacit and codified knowledge (need and solution information) to create a common understanding for effective knowledge sharing (Alexy et al., 2013b; Salter et al., 2015). In that regard, individuals are often insecure about the amount of knowledge that they can share, fear a loss of control and perceive a gap between their individual search efforts and those of their employing organization (Salter et al., 2015, 2014). This higher-level dependency might create substantial behavioral uncertainty among individuals reducing the potential of open innovation within their organization (Salter et al., 2014). A further point is that firms have simply more resources available, e.g., technological, legal, and financial, than individuals. Thus, firms are better positioned to compensate value expropriation in one project by diversifying their efforts over a number of R&D projects. Individual solvers, especially in outbound open innovation, in contrast, strongly depend on their knowledge assets and their ability to leverage them successfully, while appropriating returns from them. Individual solvers are not only economically dependent on their solution information, but also potentially exposed to negative psychological consequences related to a fear of losing control over their core assets or the perception of

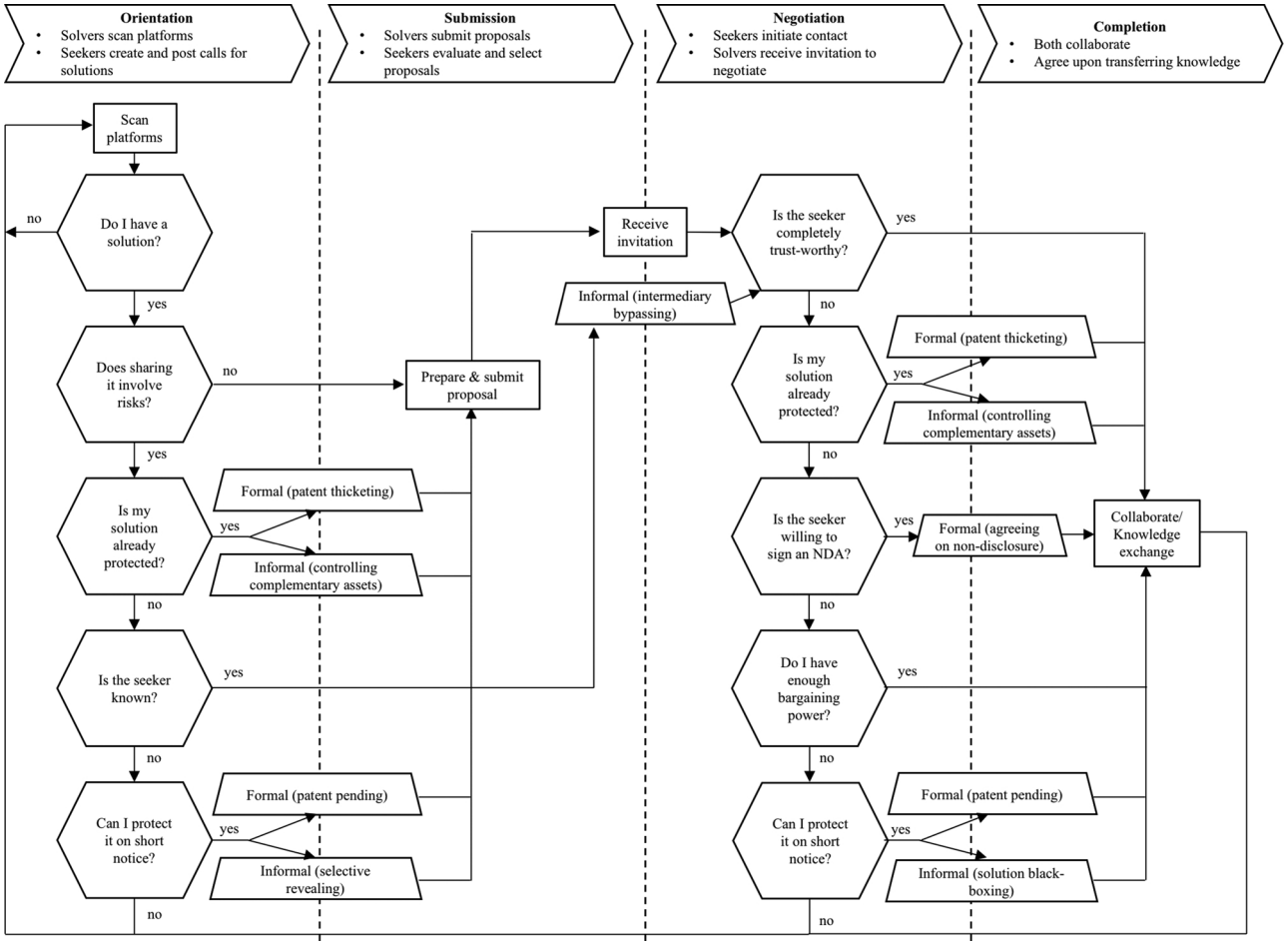

Fig. 3. Solvers' value appropriation practices in the crowdsourcing process.

simply being unfairly treated (Franke et al., 2013). With our re-conceptualization, we respond to recent calls to explore inter-dependencies across levels of analysis by uncovering how individual level perceptions shape the effectiveness of firm level open innovation strategies (Bogers et al., 2017) and to examine the underexplored side of outbound open innovation, including its dark side (Stanko et al., 2017). Notwithstanding notable similarities across the four manifestations, e.g., with regards to possible solutions to the paradox of openness, our work indeed shows pronounced differences between inbound and outbound, and firm level versus individual level open innovation that lays the foundations for future research to yield a more nuanced picture of the paradox of openness.

Second, focusing on outbound open innovation at the individual level, we identify key sharing-protecting tensions and patterns employed to navigate the paradox of openness. Although seekers have traditionally been at the center of attention (Lopez-Vega et al., 2016; Lüttgens et al., 2014; Pollok et al., 2019), we argue that solvers are the increasingly critical resource in open innovation activities, as they reveal solution-relevant knowledge. While the paradox of openness is difficult to manage for sourcing firms (Arora et al., 2016; Laursen and Salter, 2014), we find that this is even more prevalent and difficult for individuals in outbound open innovation. Our findings demonstrate that individual solvers associate participation in crowdsourcing contests with considerable sharing-protecting tensions. Extending Franke et al.'s (2013) work on individual fairness perceptions, our findings show that a loss of control not only leads to feelings of helplessness, frustration, and anger, but can also have tangible and far-reaching negative economic consequences, as illustrated by the case of one solver having to *"lay off all [his] staff" and "downsize [his] facilities"* (practitioner, environmental engineering, survey). Importantly, our work also sheds light on the effectiveness of intermediaries as a solution to the paradox of openness. As our findings showcase, severe sharing-protecting tensions surface even in presence of a dedicated intermediary. To contain the paradox of openness, the simple presence of an intermediary hence does not suffice. Instead, it is only the set of elaborate intermediation practices (e.g., virtual meeting, insurance, or conflict resolution services) and their fit with the multifaceted tensions inherent in the paradox of openness as unpacked in our study that will make a difference in ensuring equitable value distribution among all stakeholders involved in a crowdsourcing initiative.

Finally, the scholarly understanding of individual level protective behaviors to cope with the paradox of openness has long been limited, as solvers in crowdsourcing, for instance, were generally assumed to freely share their knowledge (Franke et al., 2013). We present a more nuanced picture by showing that solvers not only experience unwanted knowledge leakage, and fear it, but also engage in carefully crafted value appropriation practices for their open innovation projects, some of which have been used in organizational level inbound open innovation (Holgersson et al., 2018; Laursen and Salter, 2014; Zobel et al., 2017). We find solvers employing three formal and four informal value appropriation practices that they tailor to the idiosyncrasies of each contest and dynamically reconfigure over time as the contest and the interaction with the seeker unfold. Our data reveals that solvers seek to reconcile sharing and protecting as two opposing poles of the paradox by separating them both structurally and spatially (e.g., across solution components and entrusted spaces for discussion) and by integrating them (e.g., through acts of balancing). As for the latter, patent pending, selective revealing, and intermediary bypassing all combine

Table 3
The four manifestations of the paradox of openness.

	Organizational inbound open innovation	Individual inbound open innovation	Organizational outbound open innovation	Individual outbound open innovation
Focal stakeholder	General managers, technology managers, R&D departments	R&D professionals, researchers	General managers, technology managers, legal departments	R&D professionals, academic researchers
Primary information	Need information (codified knowledge)	Need and solution information (codified and tacit knowledge)	Solution information (codified knowledge)	Solution information (codified and tacit knowledge)
Description of tension	Firms that act as seekers of knowledge need to reveal (codified) need information often in an online call for solutions to attract and collaborate with suitable solvers, yet also need to protect important information for value appropriation.	Individuals that act as seekers of knowledge need to exchange (codified and tacit) need and solution information with providers to establish a common understanding that enables knowledge absorption and application, while they also need to protect their knowledge base from value expropriation.	Firms that act as providers of internally created knowledge need to reveal (codified) solution information to signal their strength and attract seekers, while they need to conceal some of it to avoid unwanted knowledge leakages.	Individuals that act as providers of knowledge need to exchange (codified and tacit) solution information to attract seekers and develop a solution, while they need to protect their knowledge base from unwanted knowledge leakages and spillovers, simultaneously.
Manifestation of tension	• Fearing unintended knowledge spillovers and leakage • Providing poor problem descriptions • Keeping distance to partners • Broadcasting anonymously • Pursuing a no patent, no talk policy	• Perceiving a gap between individual and organizational search efforts • Expecting (partial) loss of behavioral control over personal R&D processes • Disclosing too little or no knowledge • Having insecurity about legal issues • Falling victim to myopic loss aversion	• Providing too unspecific knowledge • Competing in strategies of secrecy and legal exclusion rights • Fearing of imitation and loss of competitive advantage • Establishing not-shared-here (NSH) • Refusing to cede ownership rights	• Providing only partial solution description • Fostering imprecise disclosure • Pursuing generic disclosure • Deciding to not participate
Consequences of tension	• Threat of rigidity and inertia • Focus on internal R&D • Forfeit valuable external knowledge • Poor solution-problem fit • Low submission or collaboration rates • Low implementation probabilities	• Difficulties starting new conversations • Perceived personal and professional risk of unplanned disclosure • Lack of attention to external sources • Hostility and nervousness • Rejection of the potential of openness (Not-Invented-Here tendencies)	• Failure to attract partners or engage in collaboration • Forfeit technology market opportunities • Engage in excessive patenting • Very generic solution description	• Forfeit collaboration and market opportunities • Poor solution presentation • Low success probability • Negative psychological consequences • Exit crowdsourcing and outbound open innovation
Value appropriation practices and coping mechanisms	• Selective revealing or partial disclosure • Intermediation • Trust building • Patenting • Limited knowledge exchange • Anonymous request for proposals • Secrecy, complexity, and lead time	• Confidentiality agreements • Partial disclosure / selective revealing • Establish trusting relationships • Providing IP training programs with less legalistic/defensive mode • Organizational approval for individual engagement in external sources • Training to accept loss of control	• Waiving IPRs and secrecy • Engaging in open innovation with selective revealing • Leveraging IP modularity • Redesign IP strategies and restructure legal department, and job and skill profiles of involved employees • Seeking intermediation	• Patent thicketing • Patent pending • Agreeing in non-disclosure • Selective revealing • Solution black-boxing • Controlling complementary assets • Intermediary bypassing
Selected studies	Alexy et al. (2009); Arora et al. (2016); Laursen and Salter (2014); Pollok et al. (2019)	Alexy et al. (2013b, 2012); Antons et al. (2016); Antons and Piller (2015); Salter et al. (2015, 2014)	Henkel et al. (2014); Holgersson and Granstrand (2017); Manzini and Lazzarotti, (2016); Mazzola et al. (2018); Tranekjer and Knudsen (2012)	This study

degrees of sharing and protecting by balancing forms of knowledge. As for the former, the other practices we identified address sharing-protecting tensions by favoring one end of the spectrum, such as patent thicketing that signals clear ownership in collaborative innovation (Bogers, 2011). By showing how these practices differ and complement each other in managing the paradox of openness, we also offer a more dynamic perspective on secrecy. While secrecy is usually considered in a static way, meaning the simple non-disclosure of information, such a view fails to ask how secrecy requires a dynamic and continuous management process (Bos et al., 2015). Our findings extend current discussions about secrecy and paradox management (Lauritzen and Karafyllia, 2019) by revealing how solvers dynamically combine different practices and sharing and protecting efforts across the crowdsourcing process (Fig. 3 and Table 2).

Overall, the identified value appropriation practices and their configurations can help solvers to cope with the challenges of knowledge sharing in virtual settings, and navigate the openness paradox so that positive collaboration and engagement can emerge between disparate parties (Bogers, 2011; Dahlander and Gann, 2010).

5.2. Implications for practice

Our findings have several practical implications for intermediaries, solvers, and seekers. First, intermediaries need to be aware of the fact that many solvers perceive crowdsourcing as challenging and at times even threating with regard to its inherent sharing-protecting tensions. The perceived imbalance in value distribution can become a serious liability for all parties involved and the intermediary in particular, since losing solvers reduces the number of submissions per call for solutions (Pollok et al., 2019) and ultimately makes a platform less attractive. Importantly, intermediaries can only contain such tensions if they design their platforms in such a way that they provide solvers with the ability to securely exchange and safeguard their most vulnerable asset: their solution knowledge. One way to pursue this would be through introducing open, direct, and fast communication (Schäfer et al., 2017), and encouraging seekers to reveal more information in their problem statement about their firm, intentions, and the problem itself (Pollok et al., 2019). Intermediaries could also supervise seekers and solvers for fair play, provide clear rules in form of general business terms, offer infringement insurance, and step in with mediation services when needed. One solver proposed that through retaining a *"small amount [of money, intermediaries] would ensure adequate insurance to cover any misappropriate actions taken by those who request responses"* (practitioner, environmental engineering, survey).

Second, we find that solvers can actively shape their crowdsourcing experience using a set of formal and informal practices that help them to ensure appropriate value appropriation. We document how, when, and in what way solvers employ specific configurations of these practices to deal with the poles of sharing and protecting, simultaneously. Thereby, our findings and stylized process model presented in Fig. 3 support solvers in their effort to navigate the paradox of openness across the different stages of the outbound open innovation process in crowdsourcing. The path model includes exemplary questions that arise from our sample solvers' perception of the paradox at the different stages of the process. We encourage practitioners interested in leveraging their knowledge to new markets by taking on the role of solvers in technical crowdsourcing contests to study Fig. 3 prior to engaging in such endeavors. In this way, they might successfully anticipate the potential tensions arising from the paradox of openness at different stages of the crowdsourcing process and have a suitable coping mechanism at hand.

Finally, seekers might wish to consider revealing their identity and clearly stating their intentions for future collaboration (Pollok et al., 2019), and provide feedback to all solvers even in form of a rejection (Piezunka and Dahlander, 2018). This is of particular importance in crowdsourcing that goes beyond the execution of simple tasks such as Amazon Mechanical Turks towards finding complex solutions to major R&D challenges of firms (Ghezzi et al., 2018). In these settings, we consider the paradox of openness to be more severe for solvers that actually share valuable technological knowledge that is often essential for their future viability. Therefore, we encourage seekers to foster a fair distribution of the value created to establish and maintain trust and engagement on the solvers' side and retain them as a critical resource. In that sense, we find actions such as being visible, clarifying intentions, and providing transparency to be promising for enhancing solvers' willingness to participate, which can ultimately lead to an increased number and quality of submitted solutions (e.g., Afuah and Tucci, 2012; Bayus, 2013; Poetz and Schreier, 2012).

5.3. Limitations and future research

Irrespective of its implications for research and practice, this study has its limitations. First, we examined value appropriation and the paradox of openness only from the solver's perspective. However, crowdsourcing includes two additional parties, seekers and intermediaries. Both have a strong interest in maintaining the viability of the platform and are also exposed to their own sharing-protecting tensions. It is likely, however, that the efforts on the side of the solver will be interdependent with simultaneous actions taken by the intermediary or the seeker. We encourage future studies to shed light on this blind spot in extant research on the paradox of openness and elaborate on how the complementary actions of seekers and intermediaries present relevant contingencies that shape the behavior of solvers.

Second and related, the behavior of seekers and solvers and the effectiveness of value appropriation practices in crowdsourcing contests depend greatly on the platform provider and the contest design (Pollok et al., 2019). Prior research has found that innovation intermediaries can improve the communication between seekers and solvers, and help to improve the outcomes of open innovation (Lüttgens et al., 2014; Schäfer et al., 2017). Future research should isolate the idiosyncrasies of crowdsourcing platforms and the measures taken by intermediaries that reduce or enhance value appropriation challenges for participating solvers and seekers. Indeed, seekers posting requests for technical solutions are also exposed to the paradox of openness (Boudreau and Lakhani, 2013; de Beer et al., 2017). As one solver remarks, *"Actually, these websites are just good to show problems that we can solve and patent for ourselves"* (academic, medicine, survey). Hence, by revealing internally unsolved problems, seekers may give away important information on market needs, technological developments, and internal skill gaps that would have been kept secret otherwise, again highlighting the multi-directional and multi-level nature of the paradox of openness.

Third, we used qualitative data to inform our study. This was necessary due to the exploratory nature of our research questions. Our data, however, did not allow us to formally test the prevalence of these practices in the broader population of solvers, or indeed to quantify their effect in managing sharing-protecting tensions. Future research along these lines could collect longitudinal quantitative data to test the effect of value appropriation practices on solvers' success in navigating sharing-protecting tensions and appropriating value from their knowledge.

Finally, all solvers in our sample had submitted at least one solution proposal to a crowdsourcing contest. Accordingly, potential solvers who decided not to participate in crowdsourcing in the first place were not part of our study. It is likely that in some cases, the decision not to participate was related to a lack of suitable value appropriation practices, and thus to solvers' perceived inability to manage the tension between sharing and protecting their solution information. It is therefore important for future research to include non-participants to better understand how value appropriation concerns and protection practices jointly determine whether solvers decide to participate in crowdsourcing contests or not.

5.4. Conclusion

In this article, we contribute to the literature on the interplay between open innovation and value appropriation by introducing two important dimensions, i.e., outbound versus inbound and firm-level versus individual-level open innovation, to the paradox of openness. This reconceptualization is important, as we consider that the paradox of openness is most prevalent, yet least understood, for individual-level outbound open innovation. By examining crowdsourcing from the solvers' perspective as a form of individual-level outbound open innovation activity, we identified how solvers experience the paradox of openness in this endeavor. Our findings suggest that solvers are exposed to fundamental sharing-protecting tensions that can be associated with considerable economic and psychological costs. Furthermore, we document how solvers actively navigate the sharing-protection tensions in intermediated crowdsourcing by employing a set of three formal and four informal value appropriation practices. We provide insights into how dynamic configurations of these practices over time support solvers in navigating the sharing-protecting tensions in outbound open innovation. These findings seek to contribute to a more multifaceted conceptualization and richer understanding of the paradox of openness and stimulate future research in this field and the growing literature on value capture more generally.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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