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CROWDSOURCING FOR INNOVATION: UNDERSTANDING THE ROLE OF IPR, GOVERNANCE AND FAIRNESS IN CROWDSOURCING CONTESTS

IL DOTTORE
ING. MARIANGELA PIAZZA

IL COORDINATORE
CHIA.MO PROF. ING. ANTONIO CHELLA

IL TUTOR
CHIA.MO PROF. ING GIOVANNI PERRONE

IL CO TUTOR
PROF.SSA ING. ERICA MAZZOLA

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PREFACE

This dissertation is submitted for the degree of Doctor of Philosophy at the Università degli Studi di Palermo. The research described herein was conducted under the supervision of Professor Giovanni Perrone and Dr. Erica Mazzola of the Università degli Studi di Palermo (Italy), and the external advisory of Professor Nuran Acur Bakir of the Adam Smith Business School – University of Glasgow (UK).

Particularly, this thesis presents the results of three research papers I worked on during my three years of Ph.D. studies:

- Mazzola, E., Acur, N., Piazza. M, and Perrone, G. (2018). "To Own or Not to Own?" A study on the Determinants and Consequences of Alternative Intellectual Property Right Arrangements in Crowdsourcing for Innovation Contests. *Journal of Product Innovation Management*, 35(6), 908-929.

- Piazza. M, Mazzola, E., Acur, N., and Perrone, G. (2018). Considerations on seeker and solver relationship in innovation contests. *British Journal of Management*. DOI: 10.1111/1467-8551.12327.

- Mazzola, E., Piazza. M, Acur, N., and Perrone, G. (in review – 1st round). Treating the Crowd Fairly: Increasing the attractiveness of crowdsourcing challenge. Submitted to *Journal of Product Innovation Management*.

The earlier versions of these published and under-review articles have been presented at the following international and national conferences:

- Mazzola E., Piazza M., Acur, N., and Perrone, G. (2017). The role of Intellectual Property Rights in the value capturing of crowdsourcing for innovation contests, presented at XXVIII Riunione Scientifica Annuale dell'Associazione Italiana di Ingegneria Gestionale AiIG, 19th October – 20th October, Bari (Italia).

- Mazzola E., Piazza, M., Acur, N., Perrone, G. (2017). Intellectual property management between buyer-supplier in the crowdsourcing context, presented at 24th EurOMA – European Operations Management Association Conference, 1st July – 5th July, Edinburgh, United Kingdom.

- Mazzola, E., Piazza M., Acur, N., and Perrone G. (2017). The role of IPR arrangements in the crowdsourcing for innovation contest: An empirical investigation of the InnoCentive challenges, presented at 24th IPDM Conference, 11th June - 13th June, Reykjavik, Iceland.

- Piazza M., Mazzola, E., Acur, N., and Perrone G. (2016). How do I rule my solver's relationship? An empirical investigation of governance structures in crowdsourcing contests, presented at 23rd IPDM Conference, 12th June - 14th June, Glasgow, United Kingdom.

- Mazzola, E., Piazza, M., Acur, N., and Perrone G. (2016). The impact of fairness on the performance of crowdsourcing: an empirical analysis of two intermediate crowdsourcing platforms, presented at 23rd Euram, 12th June - 14th June, Paris, France. The paper was also awarded as the *"Most inspirational conference paper"* of the 23rd Euram conference.

- Mazzola E., Piazza M., and Perrone G. (2015). Is fairness really improving my challenge success?. The impact of fairness on the performance of crowdsourcing contest, presented at R&D Management Conference 2015, 23rd June - 26th June, Pisa, Italy.

Mariangela Piazza

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TABLES OF CONTENTS

TABLES

Chapter 1

INTRODUCTION

1.1 Introduction

Crowdsourcing for innovation is one of the most powerful Open Innovation (OI) mechanisms that companies are increasingly engaging in to access new knowledge and technologies from external sources (Chesbrough, 2003; Tucci et al., 2018). Particularly, companies seeking innovation (*seekers)* through crowdsourcing for innovation broadcast their innovation problems through contests and rely on a crowd of potential unknown external solution providers *(solvers*) for solutions (Boudreau and Lakhani, 2013). The relevance of this phenomenon is proved by several examples of well-known companies that use crowdsourcing contests for sourcing new knowledge and innovative technologies from external providers. To mention a few, NASA, Procter & Gamble, Eli Lilly, IBM, Lego and General Electric constitute emblematic examples of companies that rely on crowdsourcing to feed their innovation processes (Gustetic et al., 2015; Majchrzak and Malhotra, 2013; Schenk and Guittard, 2011; Tucci et al., 2018). Moreover, the relevance of crowdsourcing for innovation phenomenon emerges also by the increasing number of scholars that, in the last 10 years, have investigated this topic within several management and information systems disciplines (Ghezzi et al., 2018).

The aim of this first chapter is to give an overview of the crowdsourcing for innovation and outline the structure of the thesis. Specifically, section two briefly presents existing research. Literature gaps are presented and transformed into the research questions that this thesis aims at answering in section three. Section four outlines the methodology applied. Finally, the structure of the thesis and a quick overview of the contents are presented in the last section of this chapter.

1.2 Literature review, gap and research questions of the thesis

By reviewing the most influential theoretical and empirical studies on crowdsourcing, it is possible to identify the main topics that scholars have addressed in this context. One of the main topics investigated by crowdsourcing scholars is the seekers' decision whether to crowdsource or not (e.g. Afuah and Tucci, 2012; Jeppesen and Lakhani, 2010; Lang et al., 2016; Lu et al., 2015; Thuan et al., 2016; Ye and Kankanhalli, 2015). Another topic that researchers have deeply investigated in this context is the implementation process of crowdsourcing for innovation. (e.g. Lüttgens et al., 2014; Marjanovic et al., 2012; Saxton et al., 2013; Schenk and Guittard, 2011; Sieg et al., 2010). Furthermore, crowdsourcing scholars largely analyzed the diverse crowdsourcing for innovation platforms, since recognizing the critical role that these platforms can play in ensuring the success of crowdsourcing contests (e.g. Blohm et al., 2018; Colombo et al., 2013; Feller et al., 2012; Kosonen et al., 2014; Schenk et al., 2017). Moreover, crowdsourcing scholars amply investigated the performance of crowdsourcing in terms of quality and quantity of solutions (e.g. Bockstedt et al., 2015, 2016; Boudreau et al., 2011; Füller et al., 2011; Jeppesen and Lakhani, 2010; Poetz and Schreier, 2012; Pollok et al., 2018; Schuhmacher and Kuester, 2012; Terwiesch and Xu, 2008). Finally, the self-selection process that guides the solvers' participation represents the most investigated topic addressed in the crowdsourcing for innovation literature (e.g. Boons et al., 2015; Brabham, 2010; Franke et al., 2013; Frey et al., 2011; Jeppesen and Lakhani, 2010; Shao et al., 2012; Ye and Kankanhalli, 2017; Zheng et al., 2011).

So far, what has been overlooked by crowdsourcing scholars is the design of the contest. Designing appropriate contests is critical for seekers in order to capture value from the crowd (Tucci et al., 2018). Particularly, when designing crowdsourcing for innovation contest, the seeker company has to deal with a series of decisions. For example, the seeker has to decide whether to broadcast their innovation problems through an open external crowdsourcing platform or a proprietary one (Schenk et al., 2017). Moreover, the seeker has to choose either to remain anonymous or to reveal their company's identity to the crowd (Pollok et al., 2018). However, beyond these decisions the design of crowdsourcing contests has been disregarded and some other relevant decisions that seekers have to take when designing crowdsourcing for innovation contests have been overlooked. Thus, this thesis aims at investigating the crowdsourcing for innovation context to provide an answer to the following question: *how seekers can design appropriate contests in order to capture value from crowdsourcing for innovation?*

When designing crowdsourcing for innovation contests seeker companies take several important decisions and they have to declare these decisions in the problem statement of the contest (de Beer et al., 2017; Lüttgens et al., 2014). The problem statement is the means through which seekers can attract the crowd and it must contain all the relevant information for solvers to decide whether to self-select and participate in that contest or not. Particularly, beyond the description of the innovation problem to be solved, the problem statement should contain information related to the seekers' choices about the management of IPR of the winning solution, the governance structure of a possible collaboration with the seeker, the award the winning solvers will receive and the rules that regulate the contests (Bauer et al., 2016; de Beer et al., 2017; Lopez-Vega et al., 2016; Lüttgens et al., 2014). Thus, when designing contests, i.e. when making decisions about, for example, the management of the IPR, governance considerations or the monetary award, seekers must be mindful. In fact, since inappropriate decisions may reduce the self-selection of solvers or can lead the seeker to establish unsuitable working relationships, being inaccurate in designing the contest can jeopardize the value seekers can capture from engaging in crowdsourcing. As such, investigating the design of crowdsourcing for innovation contests may be relevant to understand how seeker companies can effectively use crowdsourcing to capture value from external knowledge providers.

To address the design of crowdsourcing for innovation contests this thesis focuses on the seekers' point of view and it addresses three important under-investigated decisions that seekers have to take when designing a crowdsourcing for innovation contest. Specifically, this doctoral thesis examines the seekers' decision about the IPR arrangement to acquire intellectual property from the crowd (Mazzola et al., 2018), the seekers' choice between different governance structures to regulate the working relationships with winning solvers (Piazza et al., 2018), and the seekers' decision to use specific fairness leverages to design a fair crowdsourcing for innovation contest (Mazzola et al., in review).

As such, the aforementioned research question can be decomposed into three relevant research questions that are addressed in this thesis:

1) What guides seekers in choosing a level of ownership of IPR arrangements to acquire intellectual property from the crowd when designing crowdsourcing for innovation contests? How this decision, in turn, influences the performance of crowdsourcing for innovation contests?
2) What influences seekers in deciding the governance structure of the working relationship they will establish with the winning solver when designing crowdsourcing for innovation contests?

3) How seekers can boost the self-selection of a large pool of solvers and spread the participation of highly skilled ones by designing fair crowdsourcing for innovation contests?

1.3 Purpose and relevance of the thesis

The overall purpose of this thesis is to investigate the design of crowdsourcing contests from the seekers' perspective. Particularly, as shown in the conceptual model depicted in Figure 1, this thesis gathers three issues related to the decisions seekers take when designing crowdsourcing for innovation contests with the aim to understand how seekers can appropriately design contests in order to capture value from crowdsourcing for innovation. These three issues, i.e. the IPR, the governance modes and the fairness, have been investigated in the three research articles on which this doctoral thesis is based.

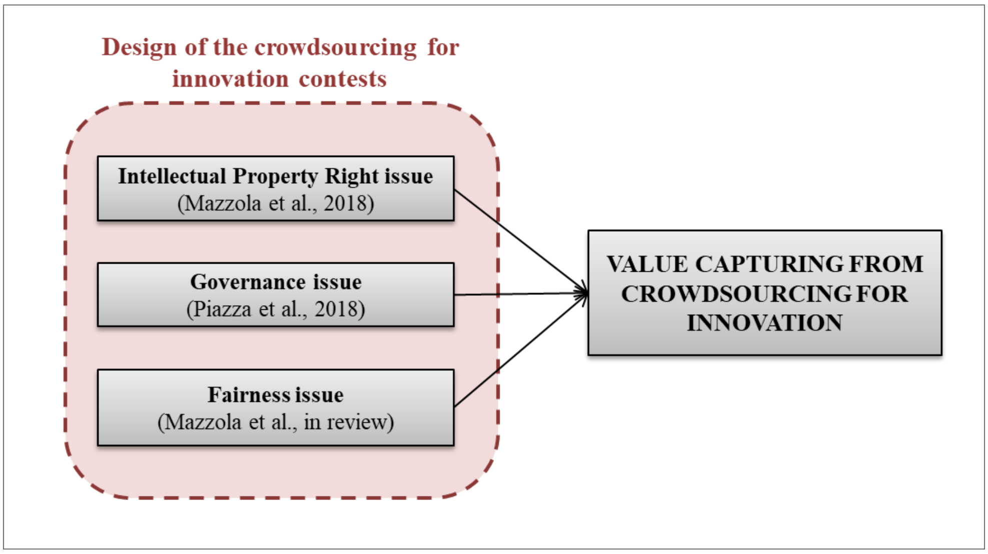

Figure 1. Conceptual model of the investigated issues in the thesis

The first issue has been investigated in the research article titled "'To Own or Not to Own?' A study on the Determinants and Consequences of Alternative Intellectual Property Right Arrangements in Crowdsourcing for Innovation Contests" and it concerns the management of Intellectual Property Rights (IPR) of the winning solution, i.e. who, between the seeker and solver, should own and control the IPR associated with the winning solution (Mazzola et al., 2018). In fact, it is the seeker that, when designing the crowdsourcing for innovation contest, decides which party, either the seeker or the solver, will own the IPR of the winning solution. Specifically, seekers can decide whether to licensing-in or fully acquire the IPR of the winning solutions (de Beer et al., 2017). Despite research on IPR is gaining a critical role in the crowdsourcing literature (e.g. Bauer et al., 2016; de Beer et al., 2017; Tietze et al., 2015), however, such decision represents an unexplored issue in this context. Seekers must be mindful when deciding about the ownership level of the IPR arrangement. From one hand, seekers need to fully acquire IPR to capture value from the innovation generated in the contests (James et al., 2013; Pisano and Teece, 2007; Schenk et al., 2017; Zobel et al., 2017). However, choosing to fully acquire the IPR could jeopardize the value creation during an innovation contest since solvers are afraid to share or cede their ownership and usage rights (de Beer et al., 2017; Ye and Kankanhalli, 2017). Thus, investigating this issue is critical for understanding how seekers should design IPR arrangements that balance the solvers' concerns about sharing or ceding their IPR and the seekers' need to capture value from crowdsourcing contests (Mazzola et al., 2018).

The second issue has been explored in the research article titled "Considerations on seeker and solver relationship in innovation contests" and it is related to the governance structures that regulate the crowdsourcing relationship established between the seeker and the winning solver at the end of an innovation contest (Piazza et al., 2018). When designing the crowdsourcing for innovation contest, indeed, the seeker should express her/his preferences about establishing a working relationship with the winning solver through a unilateral governance structure (e.g., licensing arrangements and research contracts) or through a bilateral one (e.g., technology partnerships, cross-licensing agreements, and joint ventures). Despite establishing inappropriate relationships could result in missing opportunities, wasting resources and compromising seekers' reputation (de Beer et al., 2017; Sampson, 2004; Stanko and Calantone, 2011), such a governance structure decision represents an unexplored issue in the crowdsourcing for innovation context. Thus, exploring the governance structure issue is relevant for understanding how organizations may increase the value captured from their crowdsourcing for innovation contests through appropriate working relationships (Piazza et al., 2018).

The third issue has been addressed in the research article titled "Treating the Crowd Fairly: Increasing the attractiveness of crowdsourcing challenge" and it focuses on the role of fairness (Mazzola et al., in review). When designing the crowdsourcing for innovation contest, indeed, the seeker should increase the solvers' perception of both distributive and procedural fairness (Boons et al., 2015; Faullant et al., 2017; Fieseler et al., 2017; Franke et al., 2013; Di Gangi et al., 2010). Perceptions of fair treatment generally lead to greater willingness to participate in contests and higher commitment to them. Conversely, a perception of unfairness may jeopardize the initiative, reducing the number of solvers that self-select to solve a problem (Franke et al., 2013). Even if previous research has demonstrated the importance of the role of fairness, however, crowdsourcing literature has overcome to investigate how seeker can influence such solvers' fairness perceptions by choosing appropriate fairness characteristics for their contests (Mazzola et al., in review). Thus, the set of decisions that shape the design of a fair crowdsourcing contest constitutes another unexplored issue in the crowdsourcing for innovation literature. Deepening the understanding on this issue may be relevant since having a large pool of solvers allows the seeker to receive more diverse and creative solutions, so increasing the overall performance of the contest (Jeppesen and Lakhani, 2010; Terwiesch and Xu, 2008).

By addressing these three issues, this thesis attempts to offer contributions to the crowdsourcing for innovation literature and propose managerial implications to seeker companies engaging in crowdsourcing activities to boost their innovation performance.

1.4 Methodologies

The main aspects of a research are the theory and the empirical analysis. The interaction between these two elements is essential for generating contributions to existing knowledge. This reasoning is also followed in this thesis for conducting the investigation of the three crowdsourcing issues. To investigate these issues three research frameworks are developed leveraging on different theoretical approaches and perspectives (i.e. Problem-solving perspective, Property Right Theory, Knowledge-Based View, and Fairness theory). Without a solid theoretical understanding of the crowdsourcing for innovation phenomenon, in fact, the study would lack to answer to the research questions outlined. However, the theoretical frameworks also need empirical analysis to be assessed and validated.

The empirical analyses in this thesis are based on secondary data collection. Secondary data is data that already exists, such as books, archival data, documents and journals. Secondary data can be obtained from various sources (Hussey and Hussey,

1997) and they are one of the cheapest and easiest means of access to information. This thesis uses secondary data collected from three different crowdsourcing for innovation platforms, i.e. InnoCentive, NineSigma and 99designs. Specifically, data are collected from the problem statements that seekers write to solicit innovative ideas and technologies from the crowd. Thus, using real-world secondary data about crowdsourcing for innovation contests the unexplored issues are studied by using an ex-post data point of view. Using the ex-post data approach increases the internal validity of results since, differently from previous crowdsourcing studies (e.g. Franke et al., 2013), the data focuses on real events and behaviors rather than intentions (Bickman and Rog, 2008).

As regards the methods that enable to make tests and determine relations they are found in the statistical theory. Specifically, econometric models such as negative binomial, probit, probit with sample selection correction, ordered logit and OLS models are developed. Moreover, several additional analyses are used to provide robustness to the results obtained from previous model estimation. And finally, since accounting for endogeneity concerns is one of the best practices encouraged in quantitative management research (Echambadi et al., 2006), post-hoc endogeneity analyses are performed to assess the research frameworks.

1.5 Thesis outline

This thesis is organized into seven chapters. Chapter 1 gives an overview of the crowdsourcing for innovation topic and explains why crowdsourcing for innovation contests are important in today's business environment. Moreover, Chapter 1 briefly outlines the thesis.

Chapter 2 presents an overview of crowdsourcing labeling the different definitions that are used in literature to explain the crowdsourcing phenomenon and the different crowdsourcing taxonomies that describe the different types of crowdsourcing. This chapter also reviews the previous research literature on the topic and it defines the three unexplored crowdsourcing issues related to the design of crowdsourcing contests that represent the research objectives of the thesis.

Chapter 3 examines the theoretical perspectives used in this thesis describing how they contribute and support the investigation of the three crowdsourcing issues.

Chapter 4 is based on the research article by Mazzola et al. (2018) and it addresses the role of IPR in crowdsourcing for innovation contests. The chapter begins with the definition of the research framework and the development of hypotheses. Then, it moves on the empirical investigation of the IPR issue by exploring the research context, presenting sample data, empirical analysis and results. Finally, it also discusses the achieved results.

Chapter 5 is based on the research article by Piazza et al. (2018) and it explores the governance structures of the working relationships between seekers and winning solvers in crowdsourcing for innovation contests. Specifically, the chapter firstly defines the research framework and develops a set of hypotheses. Secondly, it empirically investigates the governance structure issue by exploring the research context, presenting sample data, empirical analysis and results. Finally, the chapter discusses the results.

Chapter 6 is based on the research article by Mazzola et al. (in review) and it investigates the leverages a seeker can use to design fair crowdsourcing for innovation contests. This chapter starts introducing the research framework and the development of the hypotheses. Then, the empirical investigation of the fairness leverages is presented. Specifically, this section explores the research context, presents the sample data and shows empirical analysis and results. Finally, the results are discussed in the last section of the chapter.

The final chapter of the thesis begins with the summary and conclusions of the research and then it presents the main theoretical contributions of the thesis. Furthermore, the chapter presents the implications provided to seekers companies and contests' organizers. Finally, the limitation of the thesis and the directions for future researches are outlined.

Chapter 2

UNDERSTANDING THE CROWDSOURCING PHENOMENON: DEFINITION, LITERATURE REVIEW, GAPS AND RESEARCH OBJECTIVES

2.1 Introduction

Innovation has long been considered a critical capability for companies to gain sustainable competitive advantage. The traditional approaches suggest companies develop innovation by leveraging on internal research and development (R&D) capabilities (Baldwin and Hippel, 2011; Chesbrough, 2003). Instead, today there is a broad awareness of the role of Open Innovation (OI) as a determinant of such a competitive advantage (Enkel et al., 2009). The OI paradigm focuses on the management of the innovation of companies and it suggests that, rather than rely only on their own R&D activities, companies can leverage external sources to search for new and innovative knowledge and technologies (Chesbrough, 2003).

Social and economic changes, new market structures and technological advances have pushed companies to increasingly move towards such open models of innovation to obtain better performance (Boudreau et al., 2011; Chesbrough, 2003; Dahlander and Gann, 2010; Enkel et al., 2009). Scholars have extensively highlighted how companies can benefit from opening up their boundaries recognizing the importance to leverage on external sources such as customers, suppliers, competitors, universities and other institution, for increasing companies' innovativeness. Particularly, according to previous literature, using ideas, technologies and knowledge from external sources, interacting and collaborating with external parties and searching for new opportunities beyond organizational boundaries lead to better innovation performance (e.g. Asakawa et al., 2010; Lau et al., 2010; Laursen and Salter, 2006; Vanhaverbeke et al., 2015; Van De Vrande et al., 2011; West and Bogers, 2014; Zeng et al., 2010).

Companies can access external and innovative knowledge through several OI mechanisms in order to foster innovation, such as alliance and joint venture, corporate venture capital investments, licensing and outsourcing agreements (Felin and Zenger, 2014). Today, an emerging mechanism for implementing OI which offers great potential is *crowdsourcing for innovation*. This specific OI mechanism, enabled by the internet and the advance of communication technologies bring several opportunities for companies to tap into diverse ideas, knowledge creativity and innovation from all over the world. Particularly, instead of collaborating with a select few known external actors (as suggested by the OI paradigm), companies seeking innovation (*seekers)* through crowdsourcing for innovation can rely on a crowd of potential unknown solution providers *(solvers)* as innovation partners (Boudreau and Lakhani, 2013).

Recognizing the advantages of this OI mechanism, several companies are shifting their businesses to crowdsourcing for innovation obtaining higher innovative performance (Agerfalk and Fitzgerald, 2008; Tucci et al., 2018). This thesis explores this OI mechanism and, specifically, it aims at investigating relevant unexplored issues for companies engaging in crowdsourcing for innovation activities.

The remainder of this chapter is organized as follow. The next section presents an overview of the broad crowdsourcing definitions that are present in the literature. The third section outlines the different types of crowdsourcing (including the crowdsourcing for innovation). Finally, the last section defines the unexplored crowdsourcing for innovation issues that constitute the focus of this thesis.

2.2 Defining crowdsourcing

The term crowdsourcing, a combination of the words "crowd" and "outsourcing", was introduced in a Wired Magazine article in 2006 by Jeff Howe who defined it as (2006:1)

> *"the act of a company or institution taking a function once performed by employees and outsourcing it to an undefined (and generally large) network of people in form of open call".*

Since Howe coined the term, research on crowdsourcing has increasingly flourished (Ghezzi et al., 2018). Particularly, scholars within several management and information systems disciplines studied crowdsourcing looking at this phenomenon from different points of view and so generating many possible interpretations and applications to the concept. Therefore, in literature, different definitions of crowdsourcing arose. For instance, when conceptualizing crowdsourcing, some scholars focused on the role of the internet as an enabler of crowdsourcing activities, such as Schenk and Guittard (2011: 95) who defined crowdsourcing as *"a form of outsourcing not directed to other companies but to the crowd by means of an open call mostly via an Internet platform".*

In this same vein, Saxton et al. (2013: 2) suggested crowdsourcing is

"a sourcing model in which organizations use predominantly advanced Internet technologies to harness the efforts of a virtual crowd to perform specific organizational tasks".

Furthermore, conceptualizing crowdsourcing as a practice that allows a company to gain access to skills that are distant from its core business activities, Afuah and Tucci (2012: 355) defined crowdsourcing as

"the act of outsourcing a task to a 'crowd' rather than to a designated 'agent' (an organization, informal or formal team, or individual), such as a contractor, in the form of an open call"

In order to develop an integrated definition of this practice, Estellés-Arolas and González-Ladrón-De-Guevara (2012: 197) analyzed more than two hundred documents and identified all the elements that distinguish crowdsourcing from any other internet initiative. They defined crowdsourcing as

"A type of participative online activity in which an individual, an institution, a nonprofit organization, or company proposes to a group of individuals of varying knowledge, heterogeneity, and number, via a flexible open call, the voluntary undertaking of a task. The undertaking of the task, of variable complexity and modularity, and in which the crowd should participate bringing their work, money, knowledge, and/or experience, always entails mutual benefit. The user will receive the satisfaction of a given type of need, be it economic, social recognition, self-esteem, or the development of individual skills, while the crowdsourcer will obtain and utilize to their advantage that what the user has brought to the venture, whose form will depend on the type of activity undertaken."

In defining crowdsourcing, some other scholars generally conceptualize it as a model for solving problems, such as Brabham et al. (2014: 179) suggesting that

"Crowdsourcing is an online, distributed problem-solving and production model that leverages the collective intelligence of online communities for specific purposes. Crowdsourcing can help strengthen the connections among organizations, communities, and populations by facilitating active and collaborative problem solving".

More recently, scholars highlight the need to develop an updated and more usable definition of crowdsourcing that reflects current and future trends characterizing this phenomenon. For example, Kietzmann (2017: 152) proposed crowdsourcing could be defined as

> *"the use of IT to outsource any organizational function to a strategically defined population of human and non-human actors in the form of an open call".*

In sum, so far, there is no unique common definition of crowdsourcing. However, for the main purpose of this thesis, it is important to identify the recurring elements that characterize the crowdsourcing phenomenon in the aforementioned definitions. Specifically, four main elements are identified and summarized in Table 1. First, a problem is broadcasted to an undefined set of people: *the crowd*. This suggests that the company does not identify a person or a contractor and does not assign the task to him/her under any kind of agreement. The crowd is composed of a big number of heterogeneous individuals. The heterogeneity of the crowd in the knowledge, skills, languages, and origins of individuals that have different perspectives has a positive influence on the problem-solving effectiveness of crowdsourcing (Jeppesen and Lakhani, 2010). Moreover, the crowd is anonymous a priori meaning that the seeker company cannot identify its members (Pénin and Burger-Helmchen, 2011).

Second, the call to solve the problem broadcasted is *open*. As such, there is no ex-ante commitment to solving the problem broadcasted; solvers voluntarily self-select to solve the problem (Afuah and Tucci, 2012). This means that everybody from the crowd can answer the open call and provide solution proposals. Not only individuals but also groups of individuals, firms, and non-profit organizations can decide to self-select and submit a solution proposal.

Third, crowdsourcing is *fostered by the internet* since the internet enables two-way and public communications. Usually, the seeker company broadcasts the problem to the crowd through an internet crowdsourcing platform. Crowdsourcing platforms can be proprietary platforms if they are managed by the seeker company, or they can be external and open platforms managed by third parties (Schenk et al., 2017). In both cases, crowdsourcing platforms act as intermediaries between the seeker company and the crowd. Particularly, the crowdsourcing platform allows the company to broadcast their needs in form of problems and it allows people to make up the crowd and to respond to the company's needs by solving its problems (Pénin and Burger-Helmchen, 2011).

Finally, three different kinds of actors are involved in the crowdsourcing definition: the *seeker company* that crowdsources a problem, the crowd of *solvers* that solve the problem and the *crowdsourcing platform* that acts as a broker between the two former actors.

Crowdsourcing peculiarities	Implications	Key definitions
Problems are broadcasted to an undefined set of people: the crowd.	Seeker companies do not identify a person or a contractor and do not assign the task to him/her under any kind of agreement. The crowd is a large pool of anonymous and heterogeneous individuals.	Howe (2006); Schenk and Guittard (2011); Afuah and Tucci (2012).
The call to solve the problems broadcasted is open	Solvers voluntarily self-select to solve the problem and there is no ex-ante commitment to solving the problem.	Afuah and Tucci (2012).
Crowdsourcing is fostered by the internet	The seeker company broadcasts the problem to the crowd through an internet crowdsourcing platform that acts as an intermediary between the seeker and the crowd.	Brabham et al. (2014); Saxton et al. (2013); Kietzmann (2017).
Crowdsourcing involves three different kinds of actors	The crowdsourcing involves the seeker company that crowdsources a problem, the crowd of solvers that solve the problem and the crowdsourcing platform that acts as a broker between the two former actors.	Howe (2006); Schenk and Guittard (2011).

Table 1. Crowdsourcing peculiarities emerging from definitions

2.3 Analyzing types of crowdsourcing

Different types of crowdsourcing can be distinguished in the literature by either considering the problems broadcasted by the seeker or considering how solvers from the crowds can self-select to solve the problems. According to the first classification criteria related the problem broadcasted, it is possible to consider three different kinds of crowdsourcing: routine crowdsourcing, crowdsourcing of content and crowdsourcing for innovation (Bauer et al., 2016; Majchrzak and Malhotra, 2013; Malhotra and Majchrzak, 2014; Pénin and Burger-Helmchen, 2011; Schenk and Guittard, 2011). Crowdsourcing of routine activities consists of broadcasting very simple and routine problems that do not require specific competencies to be solved (Pénin and Burger-Helmchen, 2011; Schenk and Guittard, 2011). In such a circumstance, since each solver can solve the problem by performing a routine task the diversity and the heterogeneity of the crowd do not assume critical importance for the problem-solving efficacy of crowdsourcing. Moreover, often, in this case, the broadcasted problems can be decomposed in sub-problems in order to be solved independently by different solvers from the crowd. A peculiar example of crowdsourcing of routine activities is Interneteyes. Interneteyes is a system of security video in which members of the crowd can watch, on their own computer, several security cameras and, as soon as they identify an offense, alert the platform that immediately alerts the security firm in charge of that specific camera about the offense (Pénin and Burger-Helmchen, 2011).

Crowdsourcing of content consists in leveraging on the crowd to solve problems that need stocks of data and information to be solved (Schenk and Guittard, 2011). Stocks of data collected from the crowd are more valuable if they contain complete and more diverse sets of information. Thus, in such a circumstance, the diversity and the heterogeneity of the crowd assume a more relevant role for the problem-solving efficacy of crowdsourcing. In fact, solvers with different educational backgrounds, skills and experiences, languages and origins can offer more diverse and exhaustive information to the seeker company. An example of crowdsourcing of content is the Great War Archive Project. This project was developed by the University of Oxford and it consists of asking the crowd to digitalize and send artifacts, such as documents and pictures, related to the First World War (Pénin and Burger-Helmchen, 2011).

Crowdsourcing for innovation consists in obtaining innovative solutions from the crowd. Innovative solutions include, for example, creative ideas, innovative products or technologies, and even entire new businesses (Bauer et al., 2016; Majchrzak and Malhotra, 2013; Malhotra and Majchrzak, 2014). Solvers that aim at participating in this type of crowdsourcing have to possess specific competencies and knowledge to solve the problem broadcasted by the seeker company. In such a circumstance, the diversity of the crowd assumes critical importance. In fact, solvers that are diverse in expertise and experiences can provide a greater quantity and variety of solutions to the problem and this ideally results in more innovative solutions. A famous example of Crowdsourcing for Innovation is the InnoCentive platform (Pénin and Burger-Helmchen, 2011). InnoCentive connects firms aiming at solving innovation problems with a crowd of solution providers who have the appropriate skills and expertise for solving their innovation problems.

According to the second classification criteria related to the self-selection of solvers, it is possible to distinguish other three different kinds of crowdsourcing: tournament-based crowdsourcing, collaboration-based crowdsourcing and hybrid crowdsourcing (Afuah and Tucci, 2012; Bauer and Gegenhuber, 2015; Blohm et al., 2013; Franzoni and Sauermann, 2014; Lüttgens et al., 2014; Tucci et al., 2018). In tournament-based crowdsourcing, also known as broadcast search (Afuah and Tucci, 2012; Blohm et al., 2013; Lüttgens et al., 2014), solvers that self-select compete with each other. Each solver self-selects to generate its own solution proposal that solves the problem broadcasted. Then, the best solution proposal is selected by the seeker company as the winning solution of the tournament.

In collaboration-based crowdsourcing, solvers that self-select collaborate and work together to solve the problem broadcasted by the seeker company (Bauer and Gegenhuber, 2015; Franzoni and Sauermann, 2014). In fact, each solver provides a partial solution to the problem, and the final solution to the problem results from the aggregation of all the different solutions submitted by the self-selected members of the crowd.

Finally, crowdsourcing can also by a hybrid composition of both tournament-based and collaboration-based crowdsourcing (Tucci et al., 2018). In such a circumstance, solvers from the crowd compete with each other in multiple contests. The winning solutions of each contest are aggregated to generate the solution of the problem broadcasted by the seeker company.

As it is possible to notice, crowdsourcing can be conducted in different ways and it has several application areas, but recently, it has raised a growing interest among firms seeking new and innovative ideas by conducting innovation contests (Bauer et al., 2016; Malhotra and Majchrzak, 2014; Natalicchio et al., 2017; Simula and Ahola, 2014). Thus, the focus of this thesis is on the typology of *crowdsourcing for innovation contests.* A crowdsourcing for innovation contest can be considered as a process consisting of different stages (Afuah and Tucci, 2012; Lüttgens et al., 2014). The process, shown in Figure 2, starts when a seeker company broadcasts a problem to the crowd through a crowdsourcing platform in form of open call (Lüttgens et al., 2014). Solvers that want to participate in the contests self-select and submit their innovative solution proposals through the crowdsourcing platform (Afuah and Tucci, 2012). Then, the seeker company selects the best solution proposal as the winning one and, finally, such a solution is transferred from the winning solver to the seeker in exchange of an award (Franke et al., 2013). The crowdsourcing platform acts as a broker in the exchange of the award and the winning solution (Lüttgens et al., 2014). Such platform, in fact, serves as technical and organizational infrastructure for managing the crowd of potential contributors and it defines how seekers and solvers can interact with each other (Blohm et al., 2018).

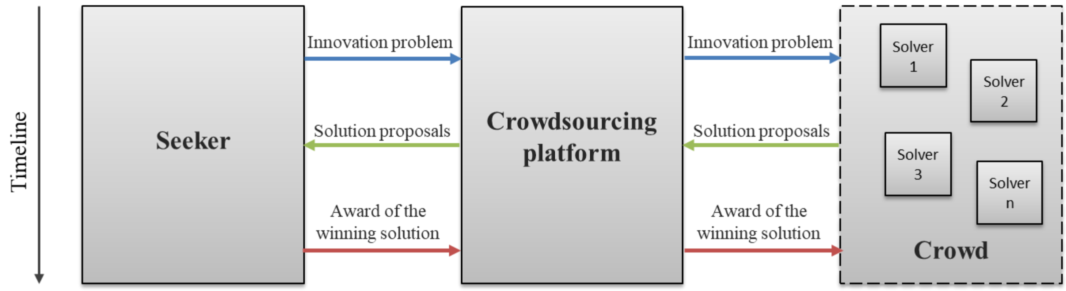

Figure 2. Crowdsourcing for innovation process

2.4 Literature review on crowdsourcing for innovation

By reviewing the most influential theoretical and empirical studies on crowdsourcing, it is possible to identify the main topics that scholars have addressed in this context. One of the main topics investigated by crowdsourcing scholars is the *seekers' decision whether to crowdsource or not* (Thuan et al., 2016) revealing that a crowdsourcing contest can be more efficient and effective than internal sourcing or contracting (e.g. Afuah and Tucci, 2012; Jeppesen and Lakhani, 2010; Lang et al., 2016; Lu et al., 2015; Ye and Kankanhalli, 2015). Among these scholars, for example, Afuah and Tucci (2012) highlighted that seekers' decision to crowdsource is related to the characteristics of the problem broadcasted, the characteristics of knowledge required for solving the problem, the characteristics of the crowd and the level of complexity in evaluating the solution proposals submitted by solvers.

A second topic that researchers have deeply investigated in this context is the *implementation process of crowdsourcing for innovation*. These scholars, particularly, analyzed the process of crowdsourcing for innovation identifying factors that may jeopardize or improve the success of crowdsourcing contests and highlighting the importance played by the crowdsourcing for innovation platforms in their brokering role between seekers and solvers (e.g. Lüttgens et al., 2014; Marjanovic et al., 2012; Saxton et al., 2013; Schenk and Guittard, 2011; Sieg et al., 2010). For example, Sieg et al. (2010) conducted an exploratory case study analysis to identify the crowdsourcing practices that seekers implement to solve the main managerial challenges they face when working with crowdsourcing for innovation platform intermediaries.

A third main topic explored by crowdsourcing scholars is related to the *crowdsourcing for innovation platforms*. Particularly, recognizing the critical role that crowdsourcing platforms can play in ensuring the success of the crowdsourcing contest, crowdsourcing scholars examine the differences and analogies between diverse crowdsourcing platforms developing several taxonomies and analyzing the antecedents that guide seekers in choosing the most appropriate platform to broadcast their contests (Blohm et al., 2018; Colombo et al., 2013; Feller et al., 2012; Kosonen et al., 2014; Schenk et al., 2017). For instance, the possibility for the seeker to rely either on a proprietary crowdsourcing platform (such as the Connect and Develop platform owned by P&G) or on an open crowdsourcing platform (i.e. a platforms managed by third parties such as InnoCentive) is considered by Kosonen et al. (2014) and by Schenk et al. (2017). Specifically, Shenk et al. (2017) suggest seeker should choose the most appropriate crowdsourcing platform by engaging in a decision-making process that takes into account the role of transaction costs, network externalities and their internal competencies.

A fourth main topic largely addressed by crowdsourcing scholars is *the efficiency and efficacy of crowdsourcing*. In this context, scholars investigated the drivers influencing the quality and quantity of the solutions proposals (e.g. Bockstedt et al., 2015, 2016; Boudreau et al., 2011; Füller et al., 2011; Jeppesen and Lakhani, 2010; Poetz and Schreier, 2012; Pollok et al., 2018; Schuhmacher and Kuester, 2012; Terwiesch and Xu, 2008). As result of these studies, the principal driver increasing the performance of crowdsourcing for innovation contests is represented by the number of solvers that decide to self-select and participate in the contest submitting one or more solution proposals (Jeppesen and Lakhani, 2010; Boudreau et al., 2011; Bockstedt et al., 2016).

The importance of the number of solvers that decide to self-select and submit solution proposals introduces the motivations of solvers as the fifth main topic that crowdsourcing for innovation scholars have extensively focused on. Indeed, *solvers' participation* represents the most investigated topic in the crowdsourcing for innovation literature (Bauer and Gegenhuber, 2015). In this context, crowdsourcing researchers analyzed factors influencing solvers' participation such as financial rewards and job opportunities (i.e. extrinsic motivations) or opportunities such as social interaction, developing new skills, building a reputation, feeling pride or even having fun (i.e. intrinsic motivations) (Boons et al., 2015; Brabham, 2010; Frey et al., 2011; Jeppesen and

Lakhani, 2010; Langner et al., 2014; Shao et al., 2012; Ye and Kankanhalli, 2017; Zheng et al., 2011). In the same vein, another research highlighted that solvers' decision to participate in crowdsourcing for innovation contests is also influenced by their fairness perception about the rewards and the procedures of the contest (Franke et al., 2013).

Summarizing, the five main topics investigated so far in the crowdsourcing literature are: (1) the antecedents of the seekers' decision whether or not to crowdsource, (2) the implementation of the crowdsourcing for innovation contest, (3) the taxonomies of crowdsourcing platforms, (4) the crowdsourcing performance and (5) the motivations that push solvers in self-selecting to participate in a crowdsourcing for innovation contest.

Crowdsourcing topic	Description	Key literature
Crowdsourcing antecedents	Analysis of the seekers' decision whether or not to crowdsource.	Afuah and Tucci (2012); Lang et al. (2016); Lu et al. (2015); Jeppesen and Lakhani (2010); Ye and Kankanhalli (2015).
Crowdsourcing process	Analysis of the implementation of crowdsourcing for innovation process and identification of the main criticalities and success factors.	Lüttgens et al. (2014); Marjanovic et al. (2012); Saxton et al. (2013); Schenk and Guittard (2011); Sieg et al. (2010).
Crowdsourcing platforms	Analysis of different kinds of crowdsourcing platforms and their role in the crowdsourcing process.	Blohm et al. (2018); Colombo et al. (2013); Feller et al. (2012); Kosonen et al. (2014); Schenk et al. (2017).
Crowdsourcing performance	Investigation about the drivers influencing the performance of the contest in terms of number and quality of the solution proposals.	Bockstedt et al. (2016); Boudreau et al. (2011); Füller et al. (2011); Jeppesen and Lakhani (2010); Poetz and Schreier (2012); Pollok et al. (2018); Schuhmacher and Kuester (2012); Terwiesch and Xu (2008).
Solvers' self-selection	Analysis of motivations (intrinsic motivations, extrinsic motivations and fairness perception) influencing the solvers' decision to self-select and participate in a crowdsourcing contest submitting solution proposals.	Boons et al. (2015); Brabham (2010); Franke et al. (2013); Frey et al. (2011); Jeppesen and Lakhani (2010); Langner et al. (2014); Shao et al. (2012); Ye and Kankanhalli (2017); Zheng et al. (2011).

Table 2. Main crowdsourcing topics investigated by the literature so far

2.5 Defining unexplored crowdsourcing issues

Several authors have highlighted the potential of the crowd, because of its size and diversity, to find inventive and creative solutions for innovation problems (Afuah and Tucci, 2012; Jeppesen and Lakhani, 2010; Poetz and Schreier, 2012). Particularly, crowdsourcing scholars identified several conditions under which the seeker should decide to rely on a large pool of potential contributors instead of designated contractors (Afuah and Tucci, 2012; Lang et al., 2016; Malhotra and Majchrzak, 2014; Pénin and Burger-Helmchen, 2011; Poetz and Schreier, 2012; Thuan et al., 2016). Moreover, in order to capture value from a pool of solution providers, companies that decide to rely on crowdsourcing should appropriately organize their crowdsourcing for innovation activities to access new knowledge and technologies solving their innovation problem (Tucci et al., 2018). Particularly, once a seeker decides to organize a crowdsourcing for innovation contest, the company has to deal with a series of decisions. For example, the seeker company has to decide whether to broadcast their innovation problems through an open crowdsourcing platform or a property one (Schenk et al., 2017). Furthermore, the seeker has to choose either to remain anonymous or to reveal their company's identity to the crowd (Pollok et al., 2018). In addition to these examples, however, there are many other seekers' decisions related to the design of crowdsourcing for innovation contests, which have been overlooked by previous crowdsourcing scholars (Schenk et al., 2017).

Thus, the overall aim of this thesis is to investigate the design of crowdsourcing for innovation contests taking the perspective of the seeker companies. Specifically, as shown in Figure 3, this thesis considers the design of the crowdsourcing contest as a set of three decisions that seekers have to take once the decision to crowdsource an innovation problem and the selection of the crowdsourcing platform have been made. Among the most important decisions that seekers take when designing crowdsourcing for innovation contest, those addressed in this thesis are related to three crowdsourcing issues that have been disregarded so far in the literature. The first issue concerns the *management of the Intellectual Property Rights (IPR)* of the winning solution and it is related to the seekers' decision to acquire or licensing-in the IPR from the crowd (Mazzola et al., 2018). The second issue addresses the *governance structures* and it is linked to the seekers' decision between establishing unilateral or bilateral relationships with the winning solvers at the end of the contest (Piazza et al., 2018). The third issue concerns the fairness and it is related to the seekers' decision about *how to design fair* *crowdsourcing* for innovation contests (Mazzola et al., in review). These three unexplored issues characterizing the design of crowdsourcing for innovation contests are analyzed in the following of thesis.

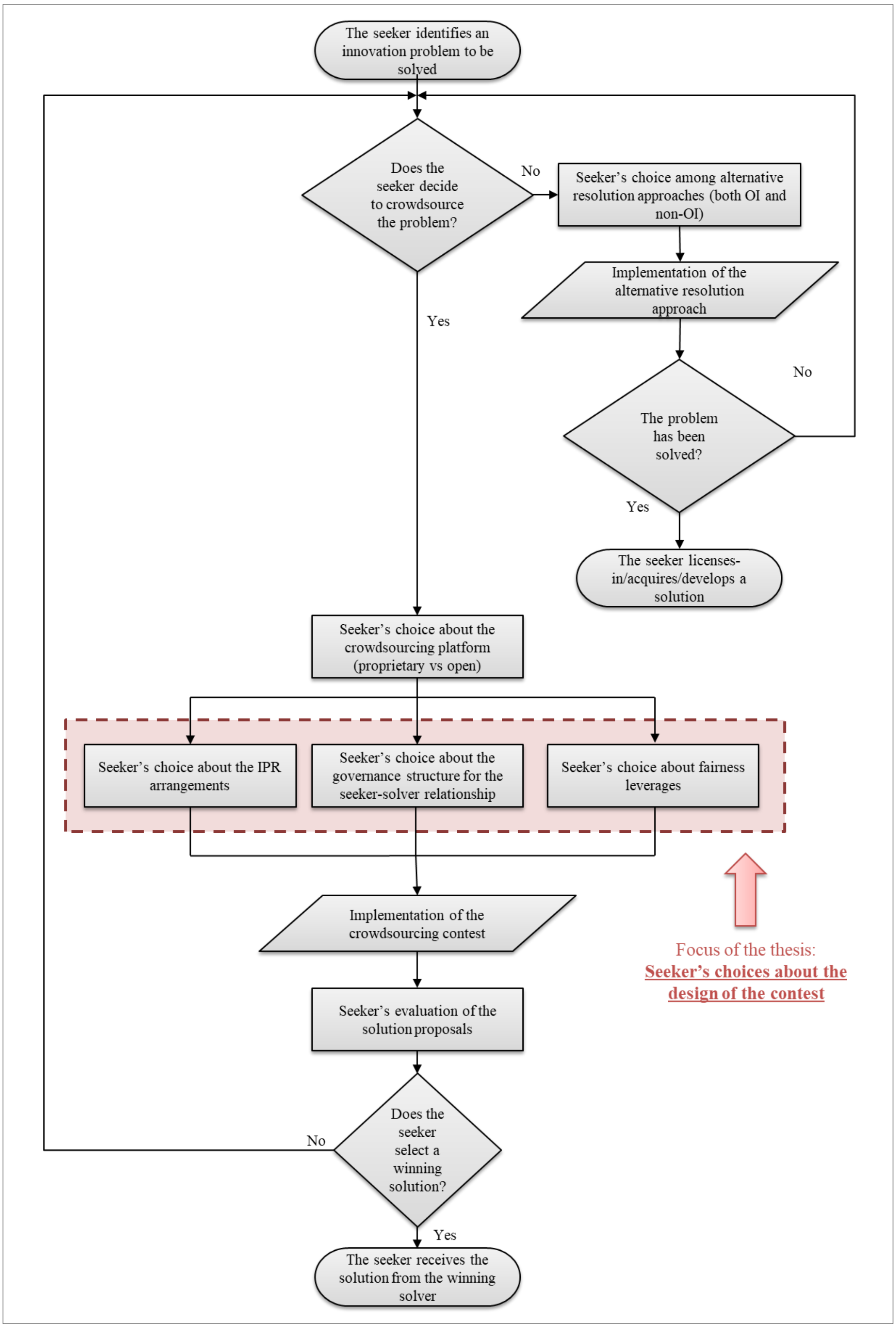

Figure 3. Seekers' decisions flow in the crowdsourcing context

2.5.1 The role of Intellectual Property Right in crowdsourcing contests

Crowdsourcing for innovation is a knowledge-intensive process since solvers that self-select from the crowd generate intellectual assets such as ideas, designs, technologies, commercialization plans, business processes, and business models in order to solve the problem broadcasted by a seeker company (Afuah and Tucci, 2012; Mount and Garcia Martinez, 2014). The intellectual assets produced by solvers can be used as value capture mechanisms by seekers (James et al., 2013; Pisano and Teece, 2007). These assets are protected as Intellectual Property (IP), and so grant to the asset's owner a bundle of Intellectual Property Rights (IPR) that include ownership and usage rights to exploit the generated assets (Ayerbe et al., 2014; Brem et al., 2017; Chen et al., 2017). Despite research on IPR is gaining a critical role in the innovation and idea generation context (e.g. Bauer et al., 2016; de Beer et al., 2017; Tietze et al., 2015), scholars are still no closer to understanding what guides seeker firms in choosing the extent to which acquire rights from solvers. Moreover, scholars disregarded to investigate the effect that this choice has on the performance of crowdsourcing contests.

Previous crowdsourcing research has investigated the protection issues of IPR, highlighting how seekers and solvers are concerned about protecting their intellectual property when broadcasting problems and submitting solution proposals, respectively (Bauer et al., 2016; Feller et al., 2012; Garavelli et al., 2013). Whilst some scholars have focused on the role played by crowdsourcing platforms in protecting the IPR of both seekers and solvers (Feller et al., 2012; Garavelli et al., 2013), some others have investigated the rules that manage the usage of IPR among solvers (Bauer et al., 2016). So far, crowdsourcing scholars disregarded to investigate the ownership issues of IPR that concern who, between the seeker and solver, owns and controls the IPR associated with the winning solution. The only exception is a recent study by de Beer et al. (2017) that focuses on the legal problems a seeker company faces when acquiring IPR from the crowd. Thus, the decision of a seeker company about the IPR arrangement, i.e. the arrangement that regulates the acquisition of rights from the winning solver, is an unexplored issue in the crowdsourcing literature (Mazzola et al., 2018).

Choosing the IPR arrangement is a relevant and non-trivial decision for seekers. Seekers need to use IPR arrangements with a high degree of ownership to capture value from the innovation generated in the contests (James et al., 2013; Pisano and Teece, 2007; Zobel et al., 2017), since a solution proposal is a source of competitive advantage only if it is not usable by other companies (Schenk et al., 2017). However, using tighter IPR arrangements could jeopardize the value creation during an innovation contest since solvers afraid to share or cede their ownership and usage rights do not self-select for that contest (de Beer et al., 2017; Ye and Kankanhalli, 2017). Thus, seekers must be mindful when deciding about the ownership level of the IPR arrangement in crowdsourcing for innovation contests. Specifically, it could be helpful for contest organizers to find guidance about how to design IPR arrangements that balance the solvers' concerns about sharing or ceding their IPR and the seekers' need to capture value from crowdsourcing contests.

Thus, this thesis aims to examine the seekers' choice about the IPR arrangement (Mazzola et al., 2018). Specifically, this thesis studies the antecedents that guide seekers in choosing a level of ownership of IPR arrangements (acquiring or licensing-in) when designing crowdsourcing for innovation contests in order to acquire IPR from the winning solvers. In addition, the thesis investigates how such a choice between acquiring and licensing-in IPR, in turn, influences the performance of the contest. Thus, considering both the antecedents and the consequences of IPR arrangement choices, this thesis explores the mediating role of IPR in the crowdsourcing for innovation context (Mazzola et al., 2018).

2.5.2 The governance structures regulating crowdsourcing relationships

Seekers that aim to solve a given innovation problem look for solvers that, possessing specific knowledge and expertise, are able to solve the problem broadcasted. After the evaluation of the solution proposals, the seeker selects the winning one, and joins in a working relationship (i.e., governance structure decision) with the winning solver to transfer and implement the winning solution (Lüttgens et al., 2014). Such a working relationship can range from unilateral (e.g., licensing arrangements and research contracts) to bilateral relationships (e.g., technology partnerships, cross-licensing agreements, and joint ventures) (Hagedoorn, 1990; Leonard-Barton, 1995). However, to date, how seekers can better understand and insource new knowledge from winning solvers by establishing appropriate working relationships remains an unexplored research area. In particular, what has been overlooked by scholars are the antecedents of the seekers' choice among different governance structures to manage the working relationship they will establish with the winning solver.

As more companies access external knowledge through crowdsourcing for innovation contests, determining how to govern the working relationships with solvers from the crowd has increasingly become strategically important (Lüttgens et al., 2014; Majchrzak and Malhotra, 2013). If seekers choose inappropriate governance structure of the working relationship, this may result, for example, in missing opportunities and wasting resources due to delays in the new product development process and in decreasing the innovation outcome rates (Sampson, 2004; Stanko and Calantone, 2011). Furthermore, choosing inappropriate governance structures may also lower the value of future contests, since unfair and poorly designed crowdsourcing contests may reduce the self-selection of solvers damaging the reputation of the seeker company (de Beer et al., 2017). Thus, deepening the understanding of the governance structure of the working relationships established between seekers and solvers is critical for organizations looking for appropriate relationships that may increase the value captured from their crowdsourcing for innovation contests.

The second aim of this thesis, thus, is to examine the seekers' choice about the governance structure that regulates the working relationship with the winning solver (Piazza et al., 2018). Particularly, this thesis investigates the antecedents that guide seekers in deciding the governance structure (unilateral or bilateral) when designing crowdsourcing for innovation contests in order to better understand and integrate the knowledge related to the winning solution (Piazza et al., 2018).

2.5.3 The importance of fairness for improving the performance of crowdsourcing contests

The success of crowdsourcing contests depends on attracting several and highly skilled solvers. The challenge for seeker companies is, thus, to design contests, which significantly and appropriately affect the self-selection process of solvers, and especially of the highly skilled ones. The size and the heterogeneity of the crowd, in fact, lessen the effects of solvers' underinvestment whilst increase the possibility of receiving, at a minimum, one suitable solution (Terwiesch and Xu, 2008). Thus, having a large pool of both professional and amateur solvers allows the seeker to receive more diverse and creative solutions (Heimans and Timms, 2014; Prpić et al., 2015; Schemmann et al., 2016).

In crowdsourcing for innovation contests, solvers' beliefs, feelings, and behaviors are affected by their perception of fairness (Boons et al., 2015; Faullant et al., 2017; Fieseler et al., 2017; Franke et al., 2013; Di Gangi et al., 2010). Specifically, perceptions of fair treatment generally lead to greater willingness to participate in contests and higher commitment to them. Conversely, a perception of unfairness may jeopardize the initiative, reducing the number of solvers that self-select to solve a problem (Franke et al., 2013). Although previous scholars have explored the solvers' perceptions of fairness as a mechanism for increasing solvers' participation to contests (e.g. Boons et al., 2015; Franke et al., 2013; Zou et al., 2015), scholars did not offer explanations about how seekers can design crowdsourcing for innovation contests which utilize specific fairness leverages to affect solvers' self-selection. In fact, since solvers' fairness perceptions depend on the characteristics of the contests designed by the seekers, the seeker can leverage such terms and conditions to increase the self-selection of a large pool of solvers.

Since scholars' considerations on fairness do not take into account the design of the crowdsourcing contest from the seekers' perspective, both seekers and solvers cannot fully benefit from the academic debate. Moreover, solvers can differ in their level of expertise, such as highly skilled (e.g., professional designers) versus amateur or ordinary solvers, and it has been debated that the solver's expertise can influence their involvement in crowdsourcing contests (Poetz and Schreier, 2012; Schemmann et al., 2016). As such, when investigating the role of fairness in crowdsourcing contests, it would be relevant to include also considerations about solver's expertise to better understand how fairness improve the self-selection of solvers and, more specifically, the self-selection of highly skilled solvers.

Then, the third objective of this thesis is to investigate the seekers' decision about the design of specific fairness leverages (Mazzola et al., in review). More in particular, the thesis explores how seekers should design fair crowdsourcing for innovation contests in order to attract a large pool of solvers and increase the self-selection of the high-skilled ones (Mazzola et al., in review).

2.6 Conclusion

Several definitions describe the term crowdsourcing and different kind of crowdsourcing are encompassed in previous crowdsourcing literature. This thesis specifically focuses on the contest-based crowdsourcing for innovation. Moreover, this thesis defines the crowdsourcing for innovation through three main elements: (1) a problem is broadcasted to an undefined set of people, i.e. the crowd; (2) the call to solve the problem broadcasted is open; (3) crowdsourcing is fostered by the internet since the internet enables two-way and public communications. According to this perspective, three different kinds of actors are involved in the crowdsourcing for innovation and will be considered in this thesis: the seeker company that crowdsources an innovation problem, the crowd of solvers that solve the problem and the crowdsourcing platform that acts as a broker between seekers and solvers.

After defining the focus of the thesis and considering previous crowdsourcing literature, this chapter has identified a relevant unexplored research area related to the decisions seekers should evaluate once they decide to crowdsource. Specifically, considering the research articles on which this thesis is based, three unexplored issues related to the design of crowdsourcing contests are identified in this thesis. The first concerns the management of the Intellectual Property Rights (IPR) and it is related to the seekers' decision to acquire or licensing-in the IPR related to the winning solution from the crowd (Mazzola et al., 2018). The second issue addresses the governance structures and it is linked to the seekers' preference between establishing unilateral or bilateral relationships with the winning solvers at the end of the contest (Piazza et al., 2018). The third issue concerns solvers' fairness perceptions it is related to the seekers' set of decisions about how to use specific fairness leverages to design fair crowdsourcing for innovation contests (Mazzola et al., in review).

The three neglected issues will be further explored in the remainder of this thesis.

Chapter 3

THEORIES UNDERLYING THE UNEXPLORED RESEARCH ISSUES IN CROWDSOURCING FOR INNOVATION

3.1 Introduction

Several theoretical paradigms can be used to investigate and understand the crowdsourcing for innovation phenomenon (Palacios et al., 2016). For example, some scholars highlight the use of crowdsourcing by anchoring this phenomenon within the Behavioral and Evolutionary theory of organizations (e.g. Afuah and Tucci, 2012; Pénin and Burger-Helmchen, 2011). Moreover, since crowdsourcing can be a source for the generation of ideas that solve innovation problems, scholars have addressed this phenomenon adopting the Knowledge-Based View and the Problem-solving perspectives to explore the effectiveness of crowdsourcing as a market mechanism that allows companies to draw out knowledge from the crowd (e.g. Jeppesen and Lakhani, 2010; Nickerson et al., 2017). Other scholars relate crowdsourcing with Organizational Ambidexterity suggesting that through crowdsourcing seeker companies can perform both exploration and exploitation activities (e.g. Afuah and Tucci, 2012; Cabiddu et al., 2012). Another stream of research leveraged on the Transaction Costs Economics to examine the antecedents of firms' decision whether to conduct crowdsourcing for innovation activities (e.g. Pénin and Burger-Helmchen, 2011; Ye and Kankanhalli, 2015). Some other scholars used applied theories, such as the Fairness theory of extrinsic and intrinsic motivations or the theory of job design, to investigate the behavior of seekers and solvers during the crowdsourcing process (e.g. Franke et al., 2013; Zheng et al., 2011). Finally, previous crowdsourcing scholars have studied the crowdsourcing for innovation also within the context of the Agency theory with the aim to investigate the information asymmetries between seekers and solver, and the resulting risks they face during the crowdsourcing process (e.g. Gefen et al., 2016; Schenk and Guittard, 2011).

All these approaches have great potential in explaining and envisaging various features about the crowdsourcing for innovation phenomenon. In this thesis, some of the aforementioned approaches, which have already been used in literature, and other new theoretical approaches that could be used to investigate the crowdsourcing phenomenon, have been considered and the most appropriate ones have been chosen to pursue the three objectives of this thesis. Specifically, to address the research questions presented in the first chapter, this thesis takes advantage of several theoretical approaches. Particularly, the Problem-solving perspective constitutes the overarching theoretical approach since it is common to the three crowdsourcing issues explored in this thesis. Moreover, to capture the specificity of each crowdsourcing issue and investigate the seekers' decisions about the different aspects of the contests' design this thesis also leverages on the Property Right theory, the Knowledge-based view perspective and the Fairness theory. These theoretical approaches are presented in the following sections of the chapter.

3.2 Problem-solving perspective in crowdsourcing for innovation context

Since crowdsourcing for innovation contests can be considered as problem-solving processes where users are invited to contribute with their problem-solving skills by generating creative and innovative ideas (Jeppesen and Lakhani, 2010), the problem-solving perspective seems an appropriate lens to investigate this phenomenon. The problem-solving perspective, indeed, is an effective perspective to understand how to efficiently organize crowdsourcing problem-solving processes (Nickerson et al., 2017; Nickerson and Zenger, 2004).

When launching a crowdsourcing for innovation contest, the seeker's objective is to insource valuable knowledge from the crowd to solve the problem broadcasted. The seeker, however, cannot simply ask for the new knowledge to be acquired because the desired knowledge is frequently hard to communicate or it has not been developed yet (Nickerson and Zenger, 2004). Instead, seekers must define valuable problems that, through their attributes, formalize the knowledge required. Then, the attributes of the problem broadcasted are the means through which seekers can solicit knowledge from the crowd and solve their innovation problems.

Leveraging on the problem-solving perspective it is possible to advance that seekers could rely on the attributes of the problem broadcasted, for example, when deciding about the ownership level of the IPR arrangement. Particularly, the problem-solving perspective could be used to provide arguments on how seekers catalyze the value capturing from crowdsourcing by considering the attributes of the problems broadcasted and matching these attributes with the modes of acquiring IPR from the crowd. Moreover, seekers could also rely on the attributes of the problem broadcasted, for example, when deciding about the governance structure to manage the working relationship with winning solvers. In this circumstance, the problem-solving perspective could be used to develop reasoning about how seekers match the attribute of the problem broadcasted with appropriate governance modes that allow them to better acquire the knowledge related to the winning solution. Finally, seekers could also consider the attributes of the problem broadcasted to design fair crowdsourcing contests. For instance, when deciding about the monetary prize to award the winning solver, seekers should consider the complexity of the problem broadcasted in order to design an appropriate and fair reward. In this vein, the problem-solving perspective could be used to develop reasoning about how seekers match the attribute of the problem broadcasted with appropriate distributive and procedural fairness leverages that allow them to increase the self-selection of solvers.

3.3 Property right theory in crowdsourcing for innovation context

When considering the issue related to the ownership of an asset, such as the IP of the winning solution in the crowdsourcing for innovation context, considerations drawn from the Property Right Theory (PRT) are appropriate (Kim and Mahoney, 2005). In fact, PRT considers the ownership of an asset as the residual control right over it, i.e. the right to use the resources and gain profit from it, and it defines the contractual party that should retain such a residual control right (Grossman and Hart, 1986; Hart and Moore, 1990; Kim and Mahoney, 2002).

According to de Beer et al. (2017: 210) *"[...] acquiring is a critical legal aspect of crowdsourcing intellectual property"* and they defined it *"[...] as the degree (low to high) to which an organization seeks to acquire the intellectual property rights of crowd solutions"*. Seeker companies decide the degree of ownership they desire to acquire from the winning solver when designing the crowdsourcing for innovation contest. In fact, they have to declare the rules underlying the degree of ownership of the bundle of rights related to the winning solution, that is the IPR arrangement, before the beginning of the contest in the problem statements (de Beer et al., 2017; Lopez-Vega et al., 2016; Lüttgens et al., 2014). Under the lens of PRT, the IPR arrangement defines the party (seeker or solver) that has the residual control right to the winning solution, that is the ownership and control of the IPR associated with the winning solution (de Beer et al., 2017; Grossman and Hart, 1986; Hart and Moore; 1990).

In the crowdsourcing context *"common types of IPR include patents, trademarks, copyrights, design rights, and technical or commercial information (trade secrets)"* (Hagedoorn and Zobel, 2015: 1051). Owning the residual control right to the winning solution grants several benefits to the owner, such as excluding non-owners from accessing the winning solution, appropriating economic rents from the use of that solution, and selling or otherwise licensing rights to others (Kim and Mahoney, 2002). Moreover, such ownership advantages, which are monopolistic in nature, can be used to influence the market and hinder competition (Kim and Mahoney, 2002). Thus, determining the party (seeker or solver) that should benefit from retaining the ownership of the winning solution is a central concern in the crowdsourcing for innovation context (Kim and Mahoney, 2005).

According to the PRT, the contractual party that should retain the residual control rights is the party that has the most to gain from owning them (Kim and Mahoney, 2005). Both the seeker and the solver could benefit from owning the residual control rights to the winning solution. If the seeker owns the control rights, she/he could deny the use of the solution to potentially interested competitors and so achieve a monopolistic position for that innovation. If the solver owns the residual control rights, she/he could license-out the IPR related to the solution to other interested parties or use it to participate in another crowdsourcing contest, thereby gaining additional earnings beyond the seeker's prize award. However, it is the seeker that, when designing the crowdsourcing contest, decides which party, either the seeker or the solver, will own the residual control rights and will obtain the benefits related to the ownership of the winning solution. If the seeker chooses an IPR arrangement with a high degree of ownership, she/he fully acquires the IPR related to the winning solution, thereby gaining the residual control rights to it (Alchian and Demsetz, 1972; de Beer et al., 2017; Grossman and Hart, 1986; Hart and Moore, 1990). In this scenario, the seeker possesses the exclusive right to use the winning solution, while the solver can no longer use or authorize others to use it (de Beer et al., 2017). In contrast, through IPR arrangements with a low degree of ownership seekers obtain a license to use the winning solution (de Beer et al., 2017). In this circumstance, the seeker does not gain the residual control rights related to the winning solution, which are retained by the solver who can continue using that solution and license it out to other parties (Alchian and Demsetz, 1972; de Beer et al., 2017; Grossman and Hart, 1986; Hart and Moore, 1990).

3.4 Knowledge-based view in crowdsourcing for innovation context

Since crowdsourcing for innovation may be viewed as a way to find access to external knowledge from solvers (Jeppesen and Lakhani, 2010), when considering how to manage and integrate such external knowledge through appropriate relationships with solvers, considerations from the Knowledge-based view (KBV) perspective may be relevant. The KBV, indeed, focuses mainly on the stock of knowledge resources and, more specifically, on understanding what knowledge is, on defining knowledge typologies and on how companies can integrate it in the best way (Easterby-Smith and Prieto, 2008).

According to the KBV, knowledge comprises information, processes, technologies, know-how, experiences, and skills, and it can be obtained from external sources, e.g. the crowd (Grant and Baden-Fuller, 1995; Malhotra and Majchrzak, 2014). The core idea of the KBV is that knowledge access is the key driver to gain a sustainable competitive advantage (Grant, 1996; Grant and Baden-Fuller, 1995; Kogut and Zander, 1992). Organizations (i.e. seekers) should increase their level of knowledge access and integrate knowledge from external sources (i.e. solvers) through appropriate governance structures depending on the knowledge they want to access (Grant and Baden-Fuller, 1995; Gulati and Singh, 1998).

Within the framework of the KBV, knowledge is differentiated into tacit and explicit knowledge (Grant and Baden-Fuller, 1995). Explicit knowledge is known by facts, laws, and theories, and it can be easily codified, stated or documented; contrarily, tacit knowledge is more practice-based, it is difficult to transfer and it is obtained through imitation and observation (Nonaka and von Krogh, 2009; O'Dell and Grayson, 1998). To access tacit knowledge seeker organizations should leverage on a bilateral governance structure to manage the relationship with the winning solvers (Grandori, 2001; Grant and Baden-Fuller, 1995). Compared to the unilateral ones, bilateral governance structures allow seekers and solvers to work closely with each other. In fact, bilateral governance structures offer a formal system of coordination that allows seekers to set-up a common language to work with winning solvers and share knowledge elements through mutual observation (Cummings and Teng, 2003; Grandori, 2001; Squire et al., 2009). Conversely, unilateral governance structures are more efficient when the knowledge seekers aim to access from the crowd is explicit since explicit knowledge is easy to be shared and copied (Casciaro, 2003; Grant and Baden-Fuller, 1995).

Moreover, according to the KBV, when reasoning about the governance structures to better access knowledge from the crowd it is appropriate to consider whether the seeker is accessing knowledge through exploration or exploitation (Grant and Baden-Fuller, 1995; Zack, 1999). Exploration refers to the introduction of new knowledge distant from seekers' existing capabilities, while exploitation refers to the access to knowledge similar to the seekers' existing knowledge base (March, 1991). To access novel and distant knowledge seeker organizations should manage the relationship with the winning solvers through a bilateral governance structure (Grandori, 2001; Grant and Baden-Fuller, 1995). Compared to the unilateral ones, bilateral governance structures are more beneficial to integrate distant knowledge from winning solvers. In fact, bilateral governance structures offer a set of organizing principles that provide to the seekers the coordination mechanisms needed to understand and absorb distant and unfamiliar knowledge (Grant and Baden-Fuller, 1995; Oxley and Sampson, 2004). Conversely, unilateral governance structures might be preferable when the knowledge seekers aim to access from the crowd is similar to the seekers' existing capabilities since familiar knowledge is more easy to understand and integrate (Casciaro, 2003; Cohen and Levinthal, 1990; Grant and Baden-Fuller, 1995).

3.5 Fairness theory in crowdsourcing for innovation context

Within crowdsourcing for innovation contests solvers have concerns about fairness and they clearly favor fair over unfair treatments (Franke et al., 2013). Thus, when addressing the crowdsourcing for innovation phenomenon it is worthwhile to leverage on fairness theory in order to investigate the self-selection process of solvers and, more in general, the performance of contests.

Fairness theory considers two aspects of social fairness: distributive and procedural. Distributive fairness concerns the perceived justice of the outcomes of a process (Adams, 1965). Perceptions of distributive fairness comprise solvers' assessment about whether the prize award is a deal and, more in general, an assessment about whether the crowdsourcing outcomes they obtained are fair compared with their efforts (van den Bos et al., 1997; Feller et al., 2012; Lambert, 2003). When the outcomes of specific crowdsourcing for innovation contests are perceived to be unfair, solvers experience an "inequity aversion", which may influence solvers' behavior, (Cohen-Charash and Spector, 2001; Fehr, Ernst Schimidt, 1999). Procedural fairness is the perception of fairness regarding the procedures and rules that regulate the crowdsourcing for innovation contest (Gilliland, 1993; Leventhal, 1980). It also refers to the perceived fairness of the process by which the winning solutions are selected by the seeker companies (Lind and Tyler, 1988). In fact, regardless of the outcome, solvers usually desire the crowdsourcing process to be transparent (Franke et al., 2013; Di Gangi et al., 2010).

Solvers looking for contests on a crowdsourcing for innovation platform evaluate many contests and decide whether to join a specific contest and submit a solution (Afuah and Tucci, 2012). Lack of both procedural and distributive fairness can reduce solvers' participation or causing their migration to other crowdsourcing contests (Di Gangi and Wasko, 2009). In fact, from a distributive perspective, if solvers perceive that the reward is not fair compared to the value and effort they provide to the seeker, solvers will not self-select for that contest (Feller et al., 2012). Moreover, from a procedural perspective, if solvers perceive that the contest procedures and rules' are not transparent and, so, they cannot trust the seeker, solvers will not participate to that contest (Di Gangi et al., 2010; Franke et al., 2013).

Consequently, seekers should care about the solvers' perception of fairness; the more fairly the seeker offer incentives and transparency about the rules regulating the contest when designing it, the higher the solvers' willingness to participate to that contest. Having a limited number of participants in a crowdsourcing contest due to the lack of fairness, indeed, may decrease seeker's prospects of discovering a good and relevant solution, so reducing the overall performance of the contest (Boudreau et al., 2011).

3.6 Conclusion

The review of the crowdsourcing for innovation literature shows how the increasing importance of innovation contests results in growing interest from scholars in theorizing about this phenomenon. The different facets of the phenomenon, particularly, challenged scholars' ability to develop a thorough understanding of the crowdsourcing for innovation phenomenon encompassing several theories.

The variety of theories used by previous scholars in investigating the crowdsourcing for innovation phenomenon have all made valuable contributions to the crowdsourcing literature. To address the design of crowdsourcing for innovation contests, this thesis leverages on some theoretical perspectives that have already been used in the crowdsourcing for innovation context and some other theoretical approaches that are new in investigating this phenomenon. Specifically, this thesis leverages on the Problem-solving perspective as overarching theory, meaning that this theoretical lens is used to explore all the three crowdsourcing issues related to the contests' design. Moreover, together with the Problem-solving perspective, this thesis relies on the Property Right Theory to investigate the role of Intellectual Property Right, the Knowledge-based view to investigate the governance structures regulating the crowdsourcing relationships and the Fairness theory to understand the importance of designing fair contests.

Table 3 summarizes these theoretical perspectives, which are used later on in the thesis to develop the research frameworks related to the three crowdsourcing issues.

Theoretical lens	Theoretical focus	Crowdsourcing issue investigated	Key literature
Problem-solving perspective	Organizations can efficiently organize problem-solving processes by matching problem attributes with governance modes.	IPR issue, Governance issue and Fairness issue	Nickerson and Zenger (2004); Nickerson et al. (2017).
Property Right Theory	The ownership of an asset as the residual control right over it, i.e. the right to use the resources and gain profit from it. The contractual party that should retain the residual control rights is the party that has the most to gain from owning them.	IPR issue	Grossman and Hart (1986); Hart and Moore (1990)
Knowledge-based view	Knowledge access is the key driver to gain sustainable competitive advantage. Organizations (i.e. seekers) should increase their level of knowledge access and integrate knowledge from external sources (i.e. solvers) through appropriate governance structures depending on the knowledge they want to access.	Governance structure issue	Grant (1996); Grant and Baden-Fuller (1995); Kogut and Zander (1992).
Fairness Theory	Perception of both distributive and procedural fairness can influence people behavior.	Fairness issue	Adams (1965); Leventhal (1980); Van den Bos et al. (1997); Gilliand (1993).

Table 3. Summary of the main theoretical approaches used in the thesis

Chapter 4

INTELLECTUAL PROPERTY RIGHT IN CROWDSOURCING FOR INNOVATION CONTESTS

4.1 Introduction

This chapter is based on the research article titled "'To Own or Not to Own?' A study on the Determinants and Consequences of Alternative Intellectual Property Right Arrangements in Crowdsourcing for Innovation Contests" and it aims to explore the role played by IPR in the crowdsourcing for innovation context (Mazzola et al., 2018). Specifically, in this chapter are explored both the antecedents that guide seekers in choosing IPR arrangements with alternative levels of ownership and the consequence that this choice has, in turn, on the performance of the contest. Exploring this topic is relevant since the choice between alternative IPR arrangements represents a double-edged sword for seekers. From one hand, seekers need to use IPR arrangements with a high degree of ownership to capture value from the innovation generated in the contests (James et al., 2013; Pisano and Teece, 2007; Zobel et al., 2017). However, from the other hand, choosing IPR arrangements with a high degree of ownership could jeopardize the value creation of solvers (de Beer et al., 2017; Ye and Kankanhalli, 2017).

To investigate the role of IPR in crowdsourcing for innovation contest, this chapter conceptualizes a research framework that hypothesizes a set of relationships by leveraging on both PRT and problem-solving perspective. Moreover, the chapter empirically assesses the research framework through secondary data. Specifically, an ad-hoc dataset is built by gathering data from the InnoCentive crowdsourcing platform. InnoCentive constitutes an appropriate research context where to study the IPR issue since emphasizes the management of IPR as critical for its business model. Then, hypotheses are validated through an econometric analysis and a series of robustness checks further support the obtained findings.

The chapter is organized as it follows. The chapter begins with the definition of the research framework and the development of hypotheses. It moves on the empirical investigation of the IPR issue by exploring the research context, presenting sample data, empirical analysis and results. Finally, the last section discusses the achieved results.

4.2 Defining a research framework to investigate the role of Intellectual Property Right in crowdsourcing contests

Seeker companies take their decision about the IPR arrangements when designing the crowdsourcing contest, and they have to declare this decision in the problem statements before the beginning of the contest (de Beer et al., 2017; Lüttgens et al., 2014). The problem statement of a crowdsourcing for innovation contest, in fact, contains all the information that is relevant for solvers when deciding whether to self-select and participate in that contest or not. Particularly, beyond the IPR arrangement, the problem statement describes the attributes of the problem to be solved, the performance criteria the winning solution must meet, the governance structure of a possible collaboration with the seeker, and the award the winning solvers will receive in exchange for sharing or ceding their IPR (Lopez-Vega et al., 2016; Lüttgens et al., 2014).

Following the distinction made by de Beer et al. (2017), it is possible to characterize IPR arrangements with a high and low degree of ownership. IPR arrangements with a high degree of ownership determine a situation in which the seeker fully acquires the IPR related to the winning solution from the winning solver; IPR arrangements with a low degree of ownership describe a situation in which the seeker licenses-in it. In developing a research framework to explore the antecedents that influence seekers in taking these decisions, this thesis relies on the PRT (Alchian and Demsetz, 1972; Grossman and Hart, 1986; Hart and Moore, 1990) suggesting that seeker companies decide between alternative degrees of ownership by considering the value they expect to capture from the knowledge and technologies developed by solvers. Moreover, in exploring the decision about alternative IPR arrangement, the thesis also leverages on the problem-solving perspective arguing that the antecedents that guide seekers in taking this decision are the attributes of the problem broadcasted (Nickerson et al., 2017; Nickerson and Zenger, 2004). Then, since solvers may be afraid to share or cede their ownership and usage rights (de Beer et al., 2017; Ye and Kankanhalli, 2017), the research framework also considers how the seekers' choice between alternative IPR arrangements influences the performance of the contest by affecting the self-selection of solvers. As such, the framework developed to investigate the role of the IPR arrangement in the crowdsourcing for innovation context considers that the IPR arrangement plays a mediating role between the attributes of the problem broadcasted and the performance of the crowdsourcing contest (Mazzola et al., 2018). Figure 4 shows the research framework and the relationships hypothesized later in this chapter.

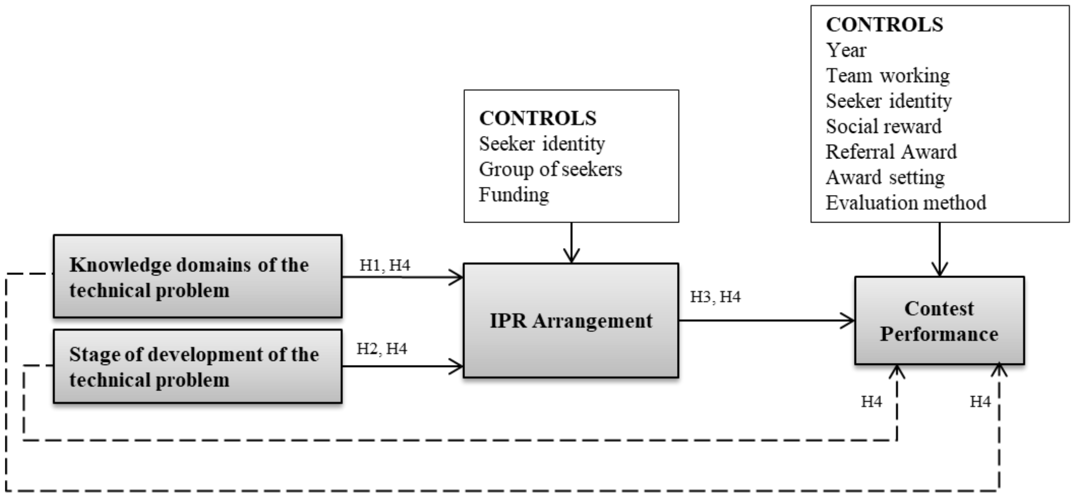

Figure 4. Research framework investigating the role of IPR (Mazzola et al., 2018)

4.2.1 Hypothesis 1 and hypothesis 2: The antecedents of the IPR arrangement

Adopting a problem-solving perspective, it is possible to argue that the attributes of the technical problem act as antecedents guiding seekers in choosing the most appropriate IPR arrangements to source intellectual assets from the crowd (Nickerson et al., 2017). Particularly, two attributes of the problem broadcasted are considered in the following as drivers of the seekers' choice whether to acquire or license-in the IPR related to the winning solution: the knowledge domains of the problem broadcasted and the stage of development of the problem when it is broadcasted (Mazzola et al., 2018).

With regard to the first attribute, in a crowdsourcing for innovation contest seeker companies can broadcast problems that vary in the knowledge required to find a possible solution (Afuah and Tucci, 2012). Particularly, the innovation problems to be solved can involve a different number of knowledge domains (Boudreau et al., 2011; Mayer et al., 2012). Problems that involve a high number of knowledge domains are more complex and their solutions involve the interaction of several and different competencies (Kavadias and Sommer, 2009). Thus, when developing a solution proposal that draws on several knowledge domains, solvers have to adopt a solution search process along a frontier of different paths or trajectories (Boudreau et al., 2011). For example, a complex problem related to the development of a novel methodology to recycle cotton materials requires solvers to find solutions that recombine knowledge from different domains including chemistry, engineering, agriculture, life sciences and physical sciences (InnoCentive 2013 – ID contest: 9933196). Conversely, problems involving a low number of technical domains are less complex since they require a low degree of interaction among different knowledge domains (Kavadias and Sommer, 2009). In this circumstance, even if problems involving few knowledge domains are nontrivial problems, any solver that wants to develop an effective solution proposal can adopt a solving approach which *"can often be somewhat standardized, and even possibly 'routinized', at least to some extent"* (Boudreau et al., 2011: 11). By way of example, a technical problem related to the development of a new drug molecule; it requires potential solvers to find solutions that draw only on routine synthesis processes related to the chemistry knowledge domain (InnoCentive 2014 – ID contest: 9933600).

The potential benefits that a seeker can obtain from retaining the IPR to the winning solution could depend on the number of knowledge domains related to the problem they broadcast to the crowd. In fact, the resolution process that explores multiple paths across different domains increases the likelihood for seeker companies to obtain novel and innovative outcomes compared to solution proposals related to problems straddling a lower number of knowledge domains (Boudreau et al., 2011). This suggests that the value captured by the seeker from solution proposals related to problems that draw on a higher number of knowledge domains might be higher than that captured by the seeker from solutions related to a lower number of knowledge domains. Thus, when the crowdsourcing for innovation contest is related to a problem involving several distinct knowledge domains, the seeker will have greater interests to own the residual control to the related bundle of rights (Grossman and Hart, 1986; Hart and Moore, 1990). In fact, by acquiring the full ownership of the IPR to such a higher-value winning solution, the seeker company could achieve a monopolistic position by hindering the use of that solution to its competitors (Kim and Mahoney, 2002, 2005).

In light of the previous reasoning, the following hypothesis is stated.

Hypothesis 1: Technical problems involving a higher number of knowledge domains are positively related to IPR arrangements with a high degree of ownership.

The second problem attribute that may affect seekers in choosing the IPR arrangement is the development stage of the problem at that moment it is broadcasted to the crowd. Seeker companies can broadcast problems at different stages of the innovation development process (Jeppesen and Lakhani, 2010; Zogaj et al., 2014). Specifically, ideation and theory development contests concern problems related to the early stage of the innovation development process. In such contest, in fact, seeker companies solicit solvers to find novel possible approaches to solve a problem and ask them to ground those approaches theoretically. Reduction-to-practice (RTP) contests, in turn, concern problems related to the later stage of development. Through this kind of contest, indeed, seekers solicit solvers to provide prototypes and empirical evidence of ideas and theory already developed (Zogaj et al., 2014). For instance, *"An enzyme stabilizer at high pH is required"* is a possible problem statement of RTP contests, whereas *"Can you formulate a simple, stable, and safe injectable suspension placebo that has no pharmacological and biological activity"* is a possible request of theoretical contests (Jeppesen and Lakhani, 2010: 1020). As such, in ideation and theoretical contests seeker companies ask solvers to perform more simple tasks compare to that related to RTP contests. In fact, when participating in RTP contests solvers have to present physical evidence that proves their solution proposals work according to the seekers' specific needs, decision criteria, and manufacturing parameters. The potential benefits seekers can obtain from retaining the IPR to the winning solution, thus, depend on the stage of the innovation development process of the problem broadcasted (Chen and Chang, 2010; Kermani and Bonacossa, 2003).

Because the innovation development process is a risky and expensive process, characterized by several technological hurdles and successive investments, the later the stage of development, the higher the likelihood that the developed innovation will succeed and reach the market (Kermani and Bonacossa, 2003). To better understand this reasoning, it is possible to consider, for example, the development of a new drug. In fact, in the later stage of the new drug development, the molecule has already overcome the riskiest step of development, i.e. the phases related to the pre-clinical and clinical trial, which could compromise the drug's approval. Thus, the risk that the new drug development process fails, and the new drug cannot reach the market, is lowest during the later stages of the development process. Moreover, in the development process of a new drug, the effort and money spent by the company increase tremendously as the process moves forward in later stages. Therefore, the value captured by seekers from solutions related to RTP contests might be higher than that captured from solutions related to theory development and ideation contests. In light of this reasoning, when the problem broadcasted is related to later stages of the innovation development process, the seeker will have a greater interest in appropriating the residual control to such a bundle of rights (Grossman and Hart, 1986; Hart and Moore, 1990; Kim and Mahoney, 2002, 2005)

Based on the above argumentations the following hypothesis arises.

Hypothesis 2: Technical problems related to later-stage development are positively related to IPR arrangements with a high degree of ownership.

4.2.2 Hypothesis 3: Consequences of the IPR arrangements on crowdsourcing performance

Previous crowdsourcing literature has highlighted how the wideness of the number of solvers that self-select to participate in an innovation contest increases the overall performance of that contest (Boudreau et al., 2011; Jeppesen and Lakhani, 2010; Terwiesch and Xu, 2008). In fact, a large pool of solvers by submitting a large number of solution proposals increases the likelihood for seekers to find at least one good solution (Terwiesch and Xu, 2008). Seekers, then, should care about the effect that their choices between IPR arrangements with different degrees of ownership (high or low) have on the performance of their crowdsourcing for innovation contests.

IPR arrangements may affect the performance of crowdsourcing contests for two main reasons (Mazzola et al., 2018). First, IPR arrangements may touch solvers' extrinsic motivations for participating in a contest, i.e. motivations related to the financial earnings derived from performing and winning a contest (Ye and Kankanhally, 2017). If seekers acquire the IPR related to the winning solution, they deny to solvers the possibility of gaining additional financial earnings, for example, by using those solutions to submit other proposals in different crowdsourcing contests (Afuah and Tucci, 2012). Moreover, if seekers decide to fully acquire the IPR of the winning solution, solvers could perceive that the effort they spent into the resolution of the problem is being underestimated (de Beer et al., 2017). In fact, solvers may believe that by taking advantage of fully acquiring the IPR related to the winning solution, seekers could gain greater future earnings related to the ownership of those solutions than the prize awarded to the winning solvers (Ye and Kankanhally, 2017). Thus, an IPR arrangement with a high degree of ownership, by limiting solvers' future business opportunities, reduces the probability solvers self-select for those contest (Ye and Kankanhally, 2017).

Second, IPR arrangements may also touch solvers' intrinsic motivations, i.e. motivations associated with the fulfillment of the contest itself (Ye and Kankanhalli, 2017; Zhao and Zhu, 2014). Deciding to acquire the IPR to the winning solution, seekers deny solvers the possibility to use the solutions they have generated to signal their competencies (Hagedoorn and Zobel, 2015; Kim and Mahoney, 2002, 2005). This prohibition represents a loss of potential social earnings for solvers, such as approval, status and respect. For instance, through the ownership of the IPR related to the solution solvers could be socially recognized as an innovation partner of the seeker firm (Majchrzak and Malhotra, 2013). Thus, IPR arrangements with a high degree of ownership, by limiting the solvers' possibilities of building and enhancing their reputation, reduce solvers' willingness to self-select for those contests (Ye and Kankanhally, 2017; Zhao and Zhu, 2014).

On the basis of these arguments, the following is hypothesized.

Hypothesis 3: IPR arrangements with a high degree of ownership decrease the performance of the contest.

4.2.3 Hypothesis 4: The mediating role of Intellectual Property Right

Previous crowdsourcing scholars have empirically demonstrated that the characteristics of the problem broadcasted, such as the number of knowledge domains and the stage of development, by influencing the solvers' self-selection process, affect the performance of the contests (Boudreau et al., 2011; Franke et al., 2013; Jeppesen and Lakhani, 2010; Terwiesch and Xu, 2008). Specifically, the effect of problem attributes on contest performance is due to several reasons, such as how these attributes influence the solvers' intrinsic and extrinsic motivations (Franke et al., 2013; Ye and Kankanhalli, 2017; Zheng et al., 2011). This suggests that, although it could be expected that the attributes of the problem affect the overall performance of the contest, there are questions related to how this effect occurs and what intervenes between the antecedents and the consequences (Mazzola et al., 2018).

Considering the argumentations underlying previous hypotheses, the IPR arrangement may act as the mediator of the relationship between the attributes of the technical problem and the performance of crowdsourcing for innovation contests. As previously theorized, the seekers' decision about the IPR arrangement could depend on the attributes of the technical problem. In fact, since the problem attributes are the only available information seekers have when designing the contest, they serve seekers in assessing the value they can gain from owning the winning solution (Nickerson and Zenger, 2004), thereby affecting the decision whether to fully acquire or to license-in the IPR to the winning solution. As such, it could be an underestimation to suggest that seekers simply broadcast technical problems characterized by specific attributes and expect these attributes to deliver superior or inferior performance for their contest. Rather, the attributes of the technical problem shape the IPR arrangement, and it is the IPR arrangement that, in turn, by affecting the solvers' extrinsic and intrinsic motivations, shapes the performance of the contest. That is, the IPR arrangement could act as the means through which the attributes of the problem affect the performance of the contest (Mazzola et al., 2018). Therefore, when considering the impact of the attributes of the technical problem on the performance of the contest, it should be considered that such attributes could influence the contest's performance both directly and by shaping the seeker's decision about the IPR arrangement.

Thus, reflecting the arguments above, the following is hypothesized.

Hypothesis 4: IPR arrangements mediate the relationship between the attributes of the technical problem (number of knowledge domains and stage of development) and the performance of the contest.

4.3 Empirical investigation of the Intellectual Property Right issue through secondary data analysis

4.3.1 Research context: the InnoCentive crowdsourcing platform

InnoCentive, created in 2001 as a spinoff from Eli Lilly, is an emblematic example of a crowdsourcing for innovation platform, (Schenk et al., 2017). The InnoCentive platform takes the form of a website where seeker companies can launch their contests to ask researchers or other solution-oriented people to solve their innovation problems. In fact, InnoCentive structures its activities as "challenge problems" for anyone willing to solve them in exchange for money. Particularly, problems broadcasted through InnoCentive are related to different technical domains such as engineering, computer science, chemistry, mathematics, life sciences, business, and physical sciences. To solve the problem broadcasted, InnoCentive clients can count on a network of almost 400 thousand solvers from about 190 different countries with 60% educated to Master's level or above (InnoCentive, 2018). Winning solvers are rewarded by an average prize varying from 5 thousand dollars to 100 thousand dollars, and InnoCentive has awarded more than 20 million of dollars hosting over 2000 challenges, to date (InnoCentive, 2018).

InnoCentive offers additional services to seekers that go beyond the matching of seekers with solvers, such as consulting services, assistance in the formalization of technical problems, and the management of IPR issues (Shenk et al., 2017). Specifically, InnoCentive clients can take advantage of three specific services that constitute the pillars of the InnoCentive business model. The first service is related to the InnoCentive expertise in assisting seeker companies to design their contests and to define the problem statement. Indeed, to have a successful contest is essential to target the right solvers by appropriately broadcasting the innovation problem and expressing the problem statement in the right way (Sieg et al., 2010). The second service is related to the selection of the winning solution. In fact, once the contest has been launched and the time to submit solution proposals is up (about 30 to 60 days), InnoCentive gathers and filters all the solution proposals and assists seekers in selecting the winning one (Feller et al., 2012). Finally, the third service is related to the management of IPR between seekers and solvers. As a matter of fact, '*InnoCentive acknowledges that management of intellectual property is of paramount importance to its business model'* (de Beer et al., 2017: 216). Specifically, the architecture of the platform and the set of contractual mechanisms it takes in place allow appropriate management of the IPR reducing the asymmetric information and legal problem between seekers and solvers. As such, supporting the research direction of this thesis, InnoCentive constitutes a suitable research context where to investigate the role of IPR in crowdsourcing for innovation contests.

4.3.2 Sample, secondary data collection and measures

To empirically investigate the role of IPR in crowdsourcing for innovation contest an ad-hoc database was built. The unit of analysis is the contest, and the sample consists of 729 crowdsourcing for innovation contests hosted and awarded on the InnoCentive crowdsourcing platform in a seven-year time window, from 2010 to 2016. The database contains secondary data gathered from the problem statements of the sampled contests. Each contest is observed at the awarding date, thus, the dataset is structured as cross-sectional and does not require a study across time.

The dependent variable, *Contest performance*, is measured as the number of active solvers that self-select and submit at least one solution proposal to the contest (Boudreau, et al., 2011; Jeppesen and Lakhani, 2010; Terwiesch and Xu, 2008). Indeed, as previously suggested, the greater the number of solvers who participate by offering a solution, the higher the performance of the contest (Zheng, et al., 2011).

Concerning the mediator, the variable *IPR arrangement* measures the degree of ownership as declared in the problem statement of the contest (de Beer et al., 2017). InnoCentive's terms and conditions allow seekers to choose between two different degrees of ownership of the IPR arrangement: high ownership in order to acquire the IPR of the winning solution and low ownership in order to license-in the IPR of the winning solution. Thus, *IPR arrangement* is operationalized as a binary variable assuming the value 1 if the seeker company chooses an IPR arrangement with a high degree of ownership (acquiring IPR), 0 otherwise (licensing-in IPR).

Focusing on the explanatory variables, the *Knowledge domains* of the problem measures the number of different technical and knowledge areas related to the problem broadcasted as declared by the seeker in the problem statement of the contest ('Business & Entrepreneurship', 'Chemistry', 'Computer and Information Technology', 'Engineering and Design', 'Food and Agriculture', 'Life Sciences', 'Math and Statistics', 'Physical Sciences', and 'Social Innovation'). Specifically, *Knowledge domains* is operationalized as a count variable that measures the number of different areas related to the problem broadcasted (Boudreau, et al., 2011). The *Stage of development* of the problem is measured by considering the typology of the contests. In the InnoCentive platform, seekers can broadcast contests related to both the early-stages (i.e. ideation and theoretical challenge) and the later-stages (i.e. reduction-to-practice challenge) of the technical problem (Jeppesen and Lakhani, 2010). Thus, the *Stage of development* of the problem broadcasted is a binary variable that assumes the value 1 if the challenge is a later-stage challenge, 0 otherwise.

Because both the seekers' decisions between alternative IPR arrangements and the performance of a contest could be influenced by factors other than those under investigation, several control variables are also included in the analysis. Considering the variable *IPR arrangement*, it was controlled for the possibility of the solvers accessing funding opportunities that would provide them financial support in solving the technical problem; *Funding* is a binary variable that assumes the value 1 if solvers could access financial support in solving the contest, 0 otherwise. It was also included for the possibility that two or more seeker firms decide to broadcast a contest together; *Seeker group* is a binary variable that assumes the value 1 if the contest is broadcast by a group of firms, 0 otherwise. Finally, it was also added the binary variable *Seeker identity*, which assumes the value 1 if solvers know the identity of the seeker, 0 otherwise to control for if the seeker reveals her/his identity to solvers.

When considering the variable *Contest performance*, it was controlled for if the seeker company reveals its identity to solvers using the aforementioned binary variable, *Seeker identity*. Moreover, it was added the variable *Team working* that controls for the possibility for a group of solvers collaborating and submitting a solution proposal as a team. *Team working* is a binary variable that assumes the value 1 if solvers could work as a team to solve the problem broadcasted, 0 otherwise. Moreover, it was included the variable *Social reward* to control for the effect that offering additional social rewards has on the performance of the contest (e.g. future collaboration with the seeker firm and the possibility of participating in conferences or meetings). *Social reward* is a binary variable that assumes the value 1 if the seeker offers a social reward beyond the prize award, 0 otherwise. *Evaluation method* controls for whether the seeker evaluates the solution proposal internally or delegates such activity to external experts. The InnoCentive platform provides a specific service that allows seekers to entrust the assessment of the solution proposals to a judging panel of experts that helps them in determining the best proposals and select the winning one (Feller et al., 2012). The *Evaluation method* is operationalized as a dichotomous variable, assuming the value 1 if the seeker refers to the external judging panel of expert evaluation, 0 otherwise. In addition, a variable was added to control for the effect of the contest referral program on the performance of the contest. The referral program consists in rewarding a solver that exposes the contest to another solver who is able to solve it and submit the winning solution proposal (InnoCentive, 2018); *Referral award* is a binary variable that assumes the value 1 if the solver can receive an award referring the winner solver, 0 otherwise. Moreover, three dummy variables ('High Award', 'Low Award', 'Undeclared Award') were included to control for the effect that the *Award of the contest* has on the solvers' decision to self-select for that contest (Ye and Kankanhalli, 2017). Finally, by using seven dummy variables ('*Year 2010'*, '*Year 2011'*, '*Year 2012*', '*Year 2013', 'Year 2014', 'Year 2015', 'Year 2016*') it was controlled for the effect that broadcasting the contest in a different *Year* has on the performance of the contest.

4.3.3 Testing hypotheses: econometric analysis and findings

The descriptive statistics and the pairwise correlation values for all the variables of the model are provided in Table 4.

	Mean	**St.Dev**	**VIF**	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
(1)Contest performance	356.9	395.4	2.42	1								
(2)IPR arrangements	0.26	0.44	2.13	-0.11*	1							
(3)Knowledge domains	2.72	1.27	1.27	0.16*	-0.33*	1						
(4)Stage of development	0.18	0.39	1.86	-0.12*	0.61*	-0.34*	1					
(5)Funding	0.03	0.17	1.30	0.02	-0.07	0.05	-0.06	1				
(6)Seeker group	0.06	0.24	1.22	0.18*	-0.11*	0.09*	-0.08*	0.09*	1			
(7)Seeker identity	0.27	0.45	1.50	0.21*	-0.22*	0.07*	-0.15*	0.23*	0.36*	1		
(8)Team working	0.68	0.47	2.43	-0.03	-0.11*	0.16*	0.001	0.10*	0.06	0.11*	1	
(9)Social reward	0.13	0.34	1.44	0.12*	-0.13*	0.10*	-0.08*	0.43*	0.21*	0.39*	0.10*	1
(10)Evaluation method	0.02	0.14	1.09	0.02	-0.06	0.06	-0.07	0.15*	0.09*	0.18*	0.01	0.21*
(11)Referral award	0.14	0.35	2.02	-0.02	0.06	-0.09*	0.20*	-0.05	0.04	-0.06	0.22*	-0.04
(12)Year 2010	0.17	0.38	4.40	0.01	0.19*	-0.25*	-0.02	-0.08*	-0.04	-0.13*	-0.61*	-0.11*
(13)Year 2011	0.13	0.34	3.35	-0.01	0.07*	0.0001	0.14*	-0.05	-0.04	-0.11*	-0.33*	-0.05
(14)Year 2012	0.13	0.34	3.76	0.05	0.02	-0.03	0.08*	-0.05	0.02	-0.06	0.19*	-0.01
(15)Year 2013	0.12	0.34	2.82	0.07	-0.08*	0.13*	-0.05	0.002	0.15*	-0.01	0.23*	0.001
(16)Year 2014	0.20	0.40	3.31	-0.09*	-0.06	0.09*	0.01	-0.01	-0.01	0.02	0.29*	0.03
(17)Year 2015	0.14	0.35	2.65	0.03	-0.04	0.07*	-0.11*	-0.03	-0.07*	0.04	0.12*	-0.05
(18)Year 2016	0.08	0.27	3.48	-0.04	-0.13*	-0.002	-0.05	0.27*	0.004	0.32*	0.13*	0.24*
(19)Low award	0.43	0.50	3.26	-0.03	-0.48*	0.17*	-0.34*	-0.07	0.04	0.04	0.10*	-0.02
(20)High award	0.16	0.37	1.79	0.09*	-0.11*	0.12*	-0.07	0.27*	0.08*	0.27*	0.15*	0.26*
(21)Not declared award	0.40	0.49	3.08	-0.03	0.55*	-0.24*	0.36*	-0.13*	-0.10*	-0.25*	-0.22*	-0.18*
	(10)	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**	**(16)**	**(17)**	**(18)**	**(19)**	**(20)**	**(21)**
(10)Evaluation method	1											
(11)Referral award	0.0001	1										
(12)Year 2010	-0.06	-0.19*	1									
(13)Year 2011	-0.06	-0.02	-0.18*	1								
(14)Year 2012	0.004	0.67*	-0.18*	-0.15*	1							
(15)Year 2013	-0.06	-0.04	-0.18*	-0.15*	-0.15*	1						
(16)Year 2014	0.05	-0.11*	-0.23*	-0.20*	-0.20*	-0.20*	1					
(17)Year 2015	0.03	-0.17*	-0.19*	-0.16*	-0.16*	-0.16*	-0.21*	1				
(18)Year 2016	0.10*	-0.12*	-0.14*	-0.12*	-0.12*	-0.12*	-0.15*	-0.12*	1			
(19)Low award	-0.02	0.02	-0.17*	-0.03	0.08*	0.12*	0.16*	-0.09*	-0.11*	1		
(20)High award	0.18*	-0.10*	-0.13*	-0.13*	-0.09*	-0.10*	0.01	0.21*	0.30*	-0.39*	1	
(21)Not declared award	-0.12*	0.04	0.27*	0.13*	-0.03	-0.04	-0.16*	-0.07	-0.12*	-0.71*	-0.35*	1

* $p < 0.05$ Source: Mazzola et al. (2018)

Table 4. Descriptive statistics and correlations (IPR issue)

The pairwise correlation values reveal some criticalities for model estimations. The variable *Team working* is correlated with the dummy '*Year 2010*'; thus, the variable *Team working* was not included in the models' estimation. Moreover, a strong correlation between '*Year 2012*' and *Referral award* was found; in subsequent analyses, the dummy '*Year 2012*' is used as the baseline level of the control *Year* so the two variables are not used in the same regression, as clearly evidenced in Table 5. Moreover, for all the models estimated and reported in Table 5, the variance inflation factor (VIF) values were calculated, a more advanced measure of multicollinearity than simple correlations (Stevens, 1992). The VIF values of the variables are below the critical level, indicating that the explanatory variables can simultaneously be included in the models (Gujarati, 1995). Once such precautions are taken, multicollinearity is not a problem for this thesis.

Table 5 illustrates the results of the regressions performed.

	Negative binomial regression		**Probit regression**		**Negative binomial regression**	
	Contest performance		IPR arrangement		Contest performance	
	Model 1.1	Model 1.2	Model 2.1	Model 2.2	Model 3.1	Model 3.2
Year 2010	-0.316*	-0.195			-0.195	-0.185
	(0.137)	(0.129)			(0.129)	(0.129)
Year 2011	-0.355**	-0.287*			-0.287*	-0.312**
	(0.128)	(0.121)			(0.121)	(0.121)
Year 2013	-0.218	-0.237			-0.237	-0.270*
	(0.133)	(0.124)			(0.124)	(0.125)
Year 2014	-0.641***	-0.617***			-0.617***	-0.637***
	(0.128)	(0.117)			(0.117)	(0.117)
Year 2015	-0.470***	-0.514***			-0.514***	-0.542***
	(0.141)	(0.131)			(0.131)	(0.131)
Year 2016	-0.780***	-0.703***			-0.703***	-0.766***
	(0.153)	(0.143)			(0.143)	(0.145)
Seeker identity	0.469***	0.480***	-0.685***	-0.538***	0.480***	0.456***
	(0.0674)	(0.0642)	(0.142)	(0.159)	(0.0642)	(0.0646)
Social reward	0.136	0.0767			0.0767	0.0794
	(0.0876)	(0.0840)			(0.0840)	(0.0837)
Referral award	-0.362**	-0.302**			-0.302**	-0.343**
	(0.114)	(0.105)			(0.105)	(0.106)
Evaluation method	-0.139	-0.204			-0.204	-0.197
	(0.205)	(0.197)			(0.197)	(0.196)
Low award	-0.0463	-0.185**			-0.185**	-0.253***
	(0.0629)	(0.0644)			(0.0644)	(0.0698)
High award	0.172	0.0688			0.0688	0.0405
	(0.0894)	(0.0863)			(0.0863)	(0.0866)
Knowledge domains		0.145***		-0.218***	0.145***	0.141***
		(0.0233)		(0.0512)	(0.0233)	(0.0231)
Stage of development		-0.375***		1.820***	-0.375***	-0.286***
		(0.0740)		(0.152)	(0.0740)	(0.0809)
Seeker group			-0.416	-0.459		
			(0.306)	(0.389)		
Funding			-0.271	-0.136		
			(0.404)	(0.459)		
IPR arrangement						-0.213**
						(0.0808)
Costant	6.123***	5.816***	-0.482***	-0.371*	5.816***	5.929***
	(0.126)	(0.136)	(0.0571)	(0.155)	(0.136)	(0.143)
N	729	729	729	729	729	729
Log-likelihood	-4907.38	-4873.38	-393.73	-273.48	-4873.38	-4869.94
Prob>chi^2	0.000	0.000	0.000	0.000	0.000	0.000
Log-likelihood ratio test		68.00***		240.49***		6.89**
**p<0.05, **p<0.01, ***p<0.001*						

Source: Mazzola et al. (2018)

Table 5. Regression results (IPR issue)

In order to test the research framework investigating the IPR issue in crowdsourcing contests, the mediation analysis procedure proposed by Baron and Kenny (1986) was applied. Meeting the condition of this procedure, it is possible to test the mediating role of IPR arrangement in the relationship between the attributes of the technical problem (the independent variables) and the performance of the contest (the dependent variable). Specifically, a three-model system is used to analyze the mediation relationship (Muller et al., 2005), and following the stepwise approach (Rosenzweig et al., 2003), each model is first estimated using only the control variables (Model 1.1, 2.1, 3.1 of Table 5) and then adding the variables of interest (Model 1.2, 2.2, 3.2 of Table 5).

In Table 5, Model 1.1 and Model 1.2 examine the impact of the attributes of the technical problem on the performance of the contest, without including the mediator, to find confirmation of Baron and Kenny's first condition. In particular, considering the nature of the dependent variable *Contest performance,* these two models are negative binomial regressions. Count data frequently follow a Poisson distribution and over-dispersion is a likely downside with Poisson regression, thus the Poisson assumption is tested alongside the negative binomial model via the goodness-of-fit (gof) test (Cameron and Trivedi, 1998; Hausman et al., 1984). Examined in contrast to the Poisson predictions for an equivalent model ($\chi 2 = 205188.6$, $p = .000$), the significant value for chi-square in the gof test indicates that the Poisson distribution was not appropriate. Consequently, the result supports the use of the negative binomial specification for the group of models 1 (Green, 2000). Through Model 1.2, it was found confirmation for Baron and Kenny's first condition since both *Knowledge domains* (0.145, $p<0.001$) and *Stage of development* (-0.375, $p<0.001$) affect the *Contest performance* without controlling for *IPR arrangement*.

Model 2.1 and Model 2.2 in Table 5 test the impact of the contest attributes *Knowledge domains* and *Stage of development* on the mediator *IPR arrangement* (H1 and H2 of the research framework investigating the IPR issue) assessing the second condition of Baron and Kenny's procedure. In particular, considering the dichotomous nature of the variable *IPR arrangement*, a probit model was used for these two models. Probit and logit models are both appropriate when the dependent variable models an alternative between two possible occurrences and convenience and convention determine the choice between them (Hoetker, 2007). Starting with the control variables, in Model 2.1, the variables *Seeker group* and *Funding* are not significant. Moreover, the variable *Seeker identity* is significant and has a negative coefficient, meaning that when disclosing their identities seekers choose an IPR arrangement with a low degree of ownership. The impact of the attributes of the technical problem on the IPR arrangement is represented by the coefficients of *Knowledge domains* and *Stage of development* in Model 2.1. Specifically, the coefficient for *Knowledge domains* is significant ($p<0.001$) and negative (-0.218). Thus, in contrast to H1, contests concerning problems involving several technical areas reduce the likelihood of an IPR arrangement with a high degree of ownership. *Stage of development* has a significant ($p<0.001$) and positive (1.820) coefficient. This means that later-stage contests increase the probability a seeker will choose an IPR arrangement with a high level of ownership, thus supporting H2. Moreover, since the attributes of the technical problem affect the IPR arrangement, Model 2.2 confirms Baron and Kenny's second condition.

Finally, Model 3.1 and Model 3.2 in Table 5 assess the impact of the attributes of the technical problem and the IPR arrangement on the *Contest performance*, testing both H3 and H4. Following the same reasoning of Models 1.1 and 1.2, a negative binomial specification model for Models 3.1 and 3.2 (gof test: $\chi2$ = 202212.1, p = .000) was applied. Starting with the control variables, in Model 3.1, the dummy variables indicating the awarding *Year* of the contest are all significant and negative, except for '*Year 2010*' and '2013', meaning that contests awarded in '*Year 2011*', '*Year 2014*', '*Year 2015*' and '*Year 2016*' attracted a lower number of solvers than those awarded in '*Year 2012*' (used as baseline). Moreover, the performance of the contest increases when seekers disclose their identities, as shown by the significant and positive coefficient of S*eeker identity*. *Referral award* is significant and has a negative coefficient, meaning that solver's participation is inhibited when seekers utilize the referral program. The dummy variable indicating a '*High award*' is not significant, while '*Low award*' is significant and has a negative coefficient, meaning that contest performance is lower in a contest with a low prize award than in a contest in which the award is not declared. The variables *Social reward* and *Evaluation method* are not significant. Finally, as previously discussed, the attributes of the technical problem *Knowledge domains* and *Stage of development* affect the performance of the contest, respectively, enhancing and inhibiting the participation of solvers. The effect of a different *IPR arrangement* on the *Contest performance* can be assessed by the coefficient of *IPR arrangement* in Model 3.2. *IPR arrangement* has a negative and significant coefficient (-0.158; $p<0.05$), suggesting that IPR arrangements with a high degree of ownership reduce the *Contest performance* as hypothesized in H3. Moreover, the significant effect of *IPR arrangement* on *Contest performance*, when regressed together with the attributes of the technical problem, also confirms the third condition of Baron and Kenny's procedure. Thus, the mediating role of the IPR arrangement can be assessed.

According to Baron and Kenny (1986), once verifying the previous condition, the mediating role of IPR arrangement can be assessed by highlighting that the IPR arrangement renders the effect of the attributes of the technical problem on Contest performance. The results showed in Table 5 suggest that the coefficient for both *Knowledge domains* and *Stage of development* in Model 3.2 are smaller than in Model 3.1, confirming H4. However, the magnitude of the impact of the attributes of the technical problem on *Contest performance* has barely been reduced by the introduction of IPR arrangement. Thus, to validate the results on the mediating role of the IPR arrangement, some procedures for robustness were adopted as discussed in the following.

4.3.4 Robustness check

Following certain recent literature (e.g. Lin et al., 2013; Wan and Sanders, 2017), it was conducted a significance test to assess the indirect effect of the attributes of the technical problem on the performance of the contest. Such indirect effects only capture the effect of the independent variables on the dependent variable through the mediator (Fritz and MacKinnon, 2007; Hayes, 2009). The Sobel method is an easy approach for testing the significance of the indirect effect. However, the assumption of normality in Sobel's is not satisfied in this model. Hence, the bootstrapping method was employed (Bollen and Stine, 1990; Fritz and MacKinnon, 2007; Hayes, 2009). The test shows that the 95% confidence interval of the indirect effect for both the *Knowledge domains* (1.046; 1.161) and the *Stage of development* (0.389; 0.943) does not include zero, suggesting that the indirect effect of both the attributes of the technical problem are significant. Thus, the IPR arrangement mediates the relationship between the attributes of the technical problem and the Contest performance, offering more strengthened support for H4.

Moreover, when examining simultaneous effects, a path structural modeling approach could be useful beyond the regression options for testing (Iacobucci, 2009). Thus, as performed by Chen et al. (2017), to evaluate the robustness of the results a Structural Equation Modelling (SEM) analysis, an approach that allows to simultaneously examine all the hypothesized relationships among the focal constructs, was also conducted. The standardized path coefficients and their statistical significances for the main relationships are provided in Table 6. Before proceeding to assess the SEM results, it is good form to verify that the model fits reasonably well (Iacobucci, 2009). The model fits nicely according to the recommendations provided by the literature (Byrne and Stewart, 2006; Hair et al., 1998). Table 6 shows that the results based on the path analysis are the same as that obtained with Baron and Kenny's (1986) procedure, supporting the stability of the hypotheses testing.

Path	Coefficient	Std. Error	p-value
Knowledge domains → IPR arrangement	-0.0485	0.0104	0.000
RTP → IPR arrangement	0.6127	0.0347	0.000
IPR arrangement → Contest performance	-105.514	38.811	0.007

Source: Mazzola et al. (2018)

Table 6. Main path coefficient of the SEM analysis

4.4 Discussion about the Intellectual Property Right issue

This chapter aimed at deepening the understanding about the role of IPR in crowdsourcing for innovation contests (Mazzola et al., 2018). First, to explore this issue, in this chapter, a research framework was developed leveraging on the PRT and on the problem-solving perspective. The research framework investigates the influence of the attributes of innovation problems on the seekers' decision about the level of ownership of the IPR arrangement (high versus low ownership) when the crowdsourcing contest is broadcasted and it also evaluates the consequences that this choice, in turn, has on the performance of a contest. Then, the research framework was assessed with data from a sample of 729 crowdsourcing for innovation contests broadcasted on the InnoCentive platform.

The empirical analysis mainly confirms the relationships conceptualized in the research framework through hypotheses H1, H2, H3 and H4, yielding to the following four findings. The first hypothesis argued that the number of knowledge domains involved in the problems broadcasted affects the seekers' preference toward different ownership levels of IPR arrangements. In contrast to H1, the results did not suggest a positive relationship between the knowledge required for a problem and seekers' preference towards IPR arrangements with high ownership level. Thus, alternative reasoning could explain the unexpected result. When the problems require expertise in a unique knowledge domain, the successful approach for solving that problem may require significant and specific human capital (Mayer et al., 2012). In such a circumstance, the solution developed by a solver could be related to its own niche technologies. Thus, it would be more valuable for seekers to fully acquire the IPR associated with this solution even if it is related to a unique knowledge domain. Moreover, solutions related to more challenging problems concerning several knowledge domains may suffer from high variability since it may not be clear what approach should be taken for solving the problem, how many possible approaches there are and what is the return associated to each approach (Boudreau et al., 2011). Thus, seekers could face this uncertain circumstance choosing a less tight IPR arrangement with a low level of ownership. As such, seekers might take their decision about the IPR arrangements considering the opportunity to gain IP related to specific and unique knowledge skills and the drawbacks they could face since they might not be familiar with resolution approaches adopted by solvers (Kogut and Zander, 1992).

The second hypothesis claimed that the stage of development of the problem broadcasted affects the seekers' preference toward different ownership levels of IPR arrangements. In accordance with H2, findings suggest that when broadcasting a problem related to the later stages of the innovation development process, seekers prefer to acquire the IPR related to the winning solution in order to gain monopolistic benefits and so hinder competitors. As such, this result underlines the importance of considering the development stage of innovation within the IP value chain (Reitzig and Wagner, 2010). Specifically, solvers from the crowd play a critical role not only in the ideation stages but also, and more importantly, in the prototype testing and commercialization phases of innovation (Baldwin et al., 2006; Franke and Shah, 2003). Thus, seekers might aim to obtain ideas from outsiders to realize economies of scale whilst reducing the time and cost of extensive R&D processes for the development of their innovation (Veer et al., 2016).

The third hypothesis suggested that IPR arrangements with a high level of ownership, claiming the acquisition of the IPR, reduce the performance of the contest compared to an IPR arrangement with a low level of ownership. Even though crowdsourcing offers an important option to lead innovation, capturing value from the contests and attracting solvers to participate is challenging. In line with H3, the result supports the idea that solvers have concerns about losing beneficial proprietary knowledge by sharing and transferring the IPR to their submission to the seeker. As such, when seekers announce the acquisition of IP, solvers may have feelings of powerlessness since they experience a loss of unique and proprietary knowledge that constitutes their source of power (Afuah and Tucci, 2012; Davenport and Prusak, 1998). This may result in potential solvers not self-selecting to participate in that crowdsourcing for innovation contest.

The fourth hypothesis argued that the attributes of the technical problem affect the seekers' decision about the ownership level of the IPR arrangement, and it is the IPR arrangement that in turn, by affecting the solvers' extrinsic and intrinsic motivations, shapes the performance of the contest. The result showed that problem attributes could increase the impact of the performance of the contest as a motivational force for solvers to participate in a contest. However, the effect of problem attributes also depends on the level of the IPR arrangement. For the seeker, the positive effect of anticipated participation in the contest becomes significant in contests where diverse knowledge is required for the problem as well as the development stage of innovation, when the difficulties of technical innovation may be sufficiently mitigated by clearly stating the IP arrangements during broadcasting. This suggests the existence of a level of IPR arrangement above which the effect of problem attributes becomes significant in attracting more solvers. Thus, in accordance with H4, the IPR arrangement mediates the relationship between the attributes of the technical problem broadcast and overall performance of the contest.

The set of findings here discussed have the potential to offer several contributions to previous literature and important implications to seekers organizing crowdsourcing for innovation contests. Such potential contributions and implications are discussed in the final chapter of this thesis.

Chapter 5

GOVERNANCE STRUCTURES OF CROWDSOURCING RELATIONSHIPS IN CROWDSOURCING FOR INNOVATION CONTESTS

5.1 Introduction

The main purpose of this chapter is to investigate the seeker's decision about the governance structure that regulates the working relationship with the winning solver. This chapter, particularly, is based on the research article titled "Considerations on seeker and solver relationship in innovation contests" and it aims at exploring the antecedents that guide seekers in choosing between unilateral governance structures (e.g., licensing arrangements and research contracts) and bilateral governance structures (e.g., technology partnerships, cross-licensing agreements, and joint ventures) at that moment the contest is broadcasted (Piazza et al., 2018). Investigating this issue is important since choosing an inappropriate governance structure of the working relationship seeker companies could miss opportunities and wasting resources so decreasing the outcome rates of their innovation processes (Sampson, 2004; Stanko and Calantone, 2011). Moreover, establishing an inappropriate relationship with winning solvers could be perceived as unfair and may damage the reputation of the seeker company lowering the value of future contests (de Beer et al., 2017).

To investigate the seekers' preferences toward alternative governance structures, this chapter conceptualizes a research framework and develops a set of hypotheses by leveraging on both KBV and problem-solving perspectives. Moreover, the chapter empirically validates the research framework through secondary data gathered from the NineSigma crowdsourcing platform. This research context has been choose since, differently from other crowdsourcing platforms in which winning solvers receive a monetary prize for selling their IP outright (e.g., InnoCentive), NineSigma allows seekers and solvers to engage in a working relationship (Lopez-Vega et al., 2016). Then, hypotheses are assessed through econometric analysis. Finally, a series of robustness check and the endogeneity analysis have been conducted to provide additional support to the obtained results.

The chapter is organized as it follows. Firstly, the chapter defines the research framework and develops a set of hypotheses. Secondly, it empirically investigates the governance structure issue by exploring the research context, presenting sample data, empirical analysis and results. Finally, the chapter discusses the results obtained.

5.2 Defining a research framework to investigate the governance structures of crowdsourcing relationships

Seeker companies take their decision about the governance structure that regulates the seeker-solver working relationship when designing the crowdsourcing contest since they have to declare their decisions before the beginning of the contest in the problem statements (de Beer et al., 2017; Lüttgens et al., 2014). As already suggested, the problem statement of a crowdsourcing for innovation contest provides all relevant information for solvers deciding whether to self-select and participate to that contest or not. One of the relevant information, indeed, is the governance structure regulating the collaboration with the seeker (Lopez-Vega, et al., 2016; Lüttgens et al., 2014). Governance structures can range from unilateral (e.g., licensing arrangements and research contracts) to bilateral structures (e.g., technology partnerships, cross-licensing agreements, and joint ventures).

To develop a research framework investigating the antecedents that influence the seekers' decision about the governance structure for the working relationship with winning solvers, this thesis relies on the KBV perspective (Grant, 1996; Grant and Baden-Fuller, 1995; Kogut and Zander, 1992). Under this theoretical perspective, particularly, this thesis suggests seekers decide the most appropriate governance structure that allows them to better insource the knowledge from winning solvers (Piazza et al., 2018). Moreover, in exploring the decision between unilateral and bilateral governance structures, the thesis also leverages on the problem-solving perspective arguing that the antecedents that guide seekers in taking this decision are the attributes of the problem broadcasted (Nickerson et al., 2017; Nickerson and Zenger, 2004). As showed in Figure 5, the framework developed matches problem attributes with governance forms that differently support knowledge insourcing (Piazza et al., 2018). To enable this matching, and according to with previous studies, the framework considers three key characteristics of problems that may influence seekers' knowledge-based governance considerations: the decomposability, the formulation, and the search space of the problem broadcast (Afuah and Tucci, 2012; Felin and Zenger, 2014; Natalicchio et al., 2017).

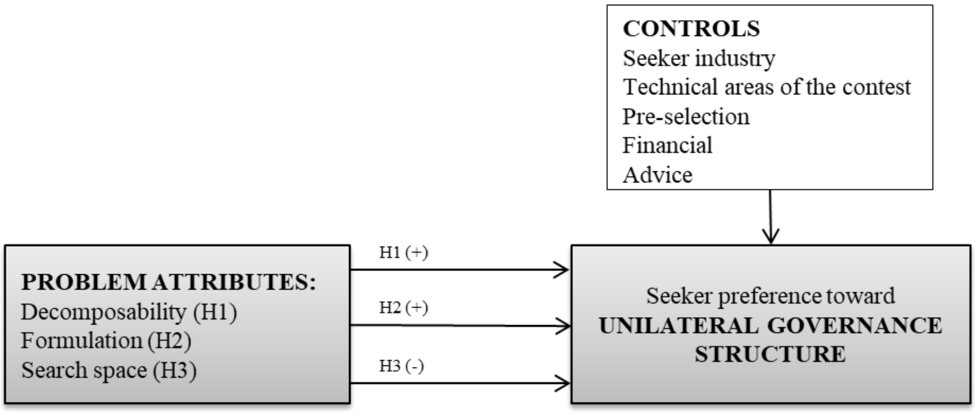

Figure 5. Research framework investigating the governance issue (Piazza et al., 2018)

5.2.1 Hypothesis 1: The decomposability of the problem as an antecedent of governance structures of the seeker-solver relationship

The decomposability of the problem represents the number of knowledge elements composing the innovation problem and the number of interdependencies among them (Afuah and Tucci, 2012; Casciaro, 2003; Kosonen and Henttonen, 2014). Problems' decomposability ranges from high levels (i.e., suitable modularity, known knowledge elements, or explicit knowledge required with less interaction with partners) to low levels (i.e., less modularity, unknown knowledge elements, or requiring a high level of interactions) (Nickerson and Zenger, 2004; Jeppesen and Lakhani, 2010). The level to which a problem can be decomposed into smaller knowledge components (i.e., the structure of the problem) reflects the possibility for solvers to utilize their expertise to solve an innovation problem by decomposing it in subsets of smaller problems (Jeppesen and Lakhani, 2010). Thus, unlike problems characterized by high level of decomposability, low-decomposable problems may involve unexpected and unknown interactions among different sets of knowledge required to formulate a solution by solving several smaller problems.

According to the problem-solving and the KBV perspectives, high-decomposable problems are more amenable to market-based problem-solving governance structures (i.e., unilateral governance structures) because they require a more clear process to develop solutions and extensive knowledge sharing is not needed to transfer the solution from the winning solvers to the seeker (Nickerson and Zenger, 2014). Indeed, the resolution of high-decomposable problems requires solvers to perform sequential choices processes. In such a circumstance, solvers have to process clear and simple information coming from few or even a unique knowledge domain (Afuah and Tucci, 2012; Natalicchio et al., 2017). Moreover, since the knowledge related to high-decomposable problems can be easily embedded into a product or a service, seekers can more easily assess the resolution process by evaluating the quality and efficacy of a product or service (Casciaro, 2003; Gulati and Singh, 1998). Thus, to assess and understand the resolution process of high-decomposable problems seekers do not need to work with the winning solvers strictly (Felin and Zenger, 2014). The seeker can economize the knowledge transfer, building a seeker-solver relationship with a unilateral governance structure that requires a lower level of investment than that required to build a bilateral one (Hsieh et al., 2007). Unilateral governance structures are, indeed, more efficient and less costly to deal with high-decomposable problems since they do not require an onerous formal system for communication and engage in joint decision-making processes, which are not required for evaluating and transferring the knowledge in such circumstances (Casciaro, 2003). Contrarily, engaging in a relationship with a bilateral governance structure, seekers can strictly cooperate with the winning solver and set-up a specific common language to overcome the difficulties arising, for example, from the exchange of different and interdependent knowledge elements related to low-decomposable problems (Nickerson and Zenger, 2004). Moreover, when a seeker can work more closely with the winning solver, the flow of detailed and specialized knowledge concerning the value of the solution transferred overcomes the intrinsic difficulties of evaluating the nature of low-decomposable problems (Gulati and Singh, 1998; Felin and Zenger, 2014).

Summarizing, more complex and onerous bilateral governance structures can better support seekers to insource knowledge related to the solution of problems with a low level of decomposability, whereas less costly and simpler unilateral governance structures are more efficient in transferring knowledge related to the solution of high-decomposable problems. As a result, the degree of problem decomposability seems to be a driver for choosing among different governance structure options (Piazza et al., 2018). Specifically, the decomposability of the problem allows seekers to take decisions about problem-solving governance structures because it provides a criterion to deal with complexity.

Accordingly, the following hypothesis is posited.

Hypothesis 1: High-decomposable (low-decomposable) innovation problems are positively related with the seeker's preference toward unilateral (bilateral) governance structures.

5.2.2 Hypothesis 2: The formulation of the problem as an antecedent of governance structures of the seeker-solver relationship

Once the problem to broadcast has been identified, seekers have to formulate it by describing the requirements that the desired solution must fulfill (Afuah and Tucci, 2012; von Hippel et al., 2016). Because solvers rely exclusively on information provided by seekers in the problem statement, the formulation of the problem is a critical activity for seekers aiming at finding effective and valuable solutions (Natalicchio et al., 2017). Describing an innovation problem is not an easy task and the problems broadcasted to the crowd can be delineated poorly or well (Simon, 1962). A problem is poorly-delineated when the seeker company fails in communicating or describing the knowledge elements that are valuable for solving it (Afuah and Tucci, 2012; Natalicchio et al., 2017). The accuracy in the formulation of the problem depends on both confidentiality issues and on the amount of tacit knowledge connected to the problems, i.e., knowledge that cannot be codified or captured in drawings or writing but through observation and practical experience (Martin and Salomon, 2003; Natalicchio et al., 2017; Nonaka and von Krogh, 2009; Sieg et al., 2010).

The formulation of the problem may affect the value of the solution proposals submitted by solvers (Piazza et al., 2018). In fact, since solvers may not possess certain knowledge elements and cannot follow a formalized and unambiguous problem-solving process, under these circumstances they could develop poor quality and defective solutions (Fernandes and Simon, 1999; von Hippel et al., 2016). As such, the formulation of the problem may affect the governance structure choice for the working relationship, which allows seekers to increase the value of the insourced (Leiblein and Macher, 2009; Nickerson and Zenger, 2004).

From one hand, bilateral governance structures provide seekers with specific tools to manage the difficulties arising from poorly-delineated problems by overcoming the deficiencies of the problem formulation (Felin and Zenger, 2014; Lam, 2000). In fact, bilateral governance structures offer seekers a formal system of coordination that allows seekers and solvers to set-up a common language and strictly work with each other (Casciaro, 2003). By establishing such close cooperation, seekers and solvers can share tacit knowledge elements related to the innovation problem through mutual observation of their work, compensating for the poor formulation of the problem broadcasted (Cummings and Teng, 2003; Grandori, 2001; Squire et al., 2009). Moreover, when the seekers can closely work with the winning solvers, trust arises between them, so they are more inclined to share elements of knowledge omitted in the problem statement due to confidentiality reasons (Moorman et al., 1992; Nickerson and Zenger, 2004; Nooteboom, 1996).

From the other hand, unilateral governance structures may represent a proper choice when broadcasting a well-delineated problem since the accurate formulation of the problem increases the value of solution proposals submitted by solvers (Natalicchio et al., 2017). In such a case, to formulate the innovation problem seekers have to communicate explicit knowledge elements that are easy to codify and share by using drawing and writing structures (Nonaka and von Krogh, 2009). The description of the knowledge elements related to a well-delineated problem does not require seekers organizational mechanisms to share tacit knowledge and develop mutual trust (Gulati and Nickerson, 2008). Thus, when broadcasting well-delineated problems, the seeker can benefit from more efficient unilateral governance structures that are less costly due to the simpler administrative structure (Casciaro, 2003).

In sum, more complex and onerous bilateral governance structures can better support seekers to insource knowledge when broadcasting poorly-delineated problems, whereas less costly and simpler unilateral governance structures are more efficient in transferring knowledge related well-delineated problems.

In accordance with this reasoning, the following hypothesis is stated.

Hypothesis 2: Well-delineated (poorly-delineated) innovation problems are positively related with the seeker's preference toward unilateral (bilateral) governance structures.

5.2.3 Hypothesis 3: The search space of the problem as an antecedent of governance structures of the seeker-solver relationship

The search space of the problem indicates the knowledge and fields of expertise required to deal with the resolution process of the problem broadcasted (March, 1991). Seekers may or may not be familiar with the knowledge and expertise characterizing the search space of the problem they broadcast in a crowdsourcing for innovation contest (von Hippel, 1994; Lopez-Vega et al., 2016). Particularly, if the search space overlaps the seekers' existing knowledge capabilities, seekers perform local searches aiming at insourcing and implementing innovations that are similar to their knowledge base (March, 1991; Natalicchio et al., 2017). In turn, if the search space of the problem does not overlap the seekers' existing knowledge capabilities, seekers perform distant searches aiming to explore and absorb innovations that are different from their knowledge base (March, 1991; Natalicchio et al., 2017). The search space of the problem, then, can influence the level of coordination essential between seekers and solvers to understand and transfer the knowledge related to the solutions (Piazza et al., 2018). When problems require distant searching processes, transferring the related knowledge is more difficult, costly and time-consuming, since seekers have to deal with unfamiliar knowledge and they may, therefore, lack the absorptive capacity needed to assess and insource the knowledge related to the solution (Cohen and Levinthal, 1990; Nooteboom, 2000). Moreover, lacking the capacity to evaluate the unfamiliar knowledge, seekers may overvalue the quality of the solutions received, facing the risk of awarding and insourcing poor quality or even ineffective solutions (Afuah and Tucci, 2012; Mayer and Salomon, 2006). Thus, the search space of the problem may impact the governance structure choice on the working relationship that can support seekers in understanding and insourcing the new knowledge from winning solvers (Cohen and Levinthal, 1990; Nickerson and Zenger, 2004).

Bilateral governance structures are more beneficial for managing the challenging coordination requirements seekers face when the search space of the problem broadcasted does not overlap their existing knowledge capabilities (Sampson, 2004). In fact, bilateral governance structures are characterized by a set of organizing principles and mechanisms through which is possible to codify the knowledge into a language accessible to a wider range of individuals (Kogut and Zander, 1992). Thanks to these mechanisms, then, bilateral governance structures make transferring and sharing knowledge easier and less costly for seekers dealing with distant and unfamiliar elements of knowledge (Conner and Prahalad, 1996). Moreover, whether unexpected contingencies occur, bilateral governance structures are more flexible and provide seekers the possibility to more easily renegotiate a relationship unlike the unilateral ones (Conner and Prahalad, 1996). Such flexibility is critical when seekers perform distant searches, since they may incur in renegotiation costs due to learning opportunities and difficulties related to unfamiliar knowledge that seekers are not able to foresee (Sampson, 2004).

Unilateral governance structures might be preferable when the problem space overlaps the seekers' knowledge capabilities since in these circumstances seekers do not face difficulties in understanding and assessing the quality of the solutions and absorbing the knowledge related to the winning one (Cohen and Levinthal, 1990). In such a case, to insource the knowledge elements related to the winning solutions, in fact, seekers can leverage their existing capabilities and do not need to strictly cooperate with the winning solvers to understand the knowledge and build new capabilities (Kogut and Zender, 1992; Sampson, 2004). Thus, when broadcasting problems with a near search space, seekers can exploit the efficiency of less costly unilateral governance structures that are indeed less committed and can offer to the solver a level of investment that is commensurate with what the innovation problem requires (Casciaro, 2003; Contractor and Ra, 2002).

In sum, more complex and onerous bilateral governance structures can better support seekers when insourcing knowledge related to the solution of problems with a distant search space; whereas, less costly and simpler unilateral governance structures are more efficient in transferring knowledge related to the solution of problems with a near search space.

Accordingly, the following is hypothesized.

Hypothesis 3: Innovation problems with a distant search (near search) space are negatively related with the seeker's preference toward unilateral (bilateral) governance structures.

5.3 Empirical investigation of the governance structure issue through secondary data analysis

5.3.1 Research context: the NineSigma crowdsourcing platform

The governance structure issue in the crowdsourcing for innovation context is investigated in the NineSigma platform. NineSigma is one of the larger crowdsourcing for innovation platform reaching out to more than 2 million solvers (Hossain, 2012; NineSigma, 2018). Specifically, solvers include global corporations, university and government laboratories, inventors and consultants. It was founded as a private platform in 2000 and it has several offices distributed in America, Europe, Korea, Australia and Japan. The principal objective of NineSigma is to connect, through its website *NineSights*, seeker companies with solution providers able to solve innovation problems across many disciplines and, so far, it has arranged over 2500 crowdsourcing for innovation contests (Huston and Sakkab, 2006; NineSimga 2018). In contrast to other crowdsourcing platforms in which winning solvers receive a monetary prize for selling their IP outright (e.g., InnoCentive), NineSigma allows seekers and solvers to engage in a working relationship (Katzy et al., 2013; Lopez-Vega et al., 2016). The seeker-solver working relationship can be managed through different forms of governance structures ranging from unilateral governance structures (e.g., a licensing agreement) to bilateral governance structures (e.g., a joint development agreement).

NineSigma provides services to support seeker companies in the whole crowdsourcing for innovation process from problem definition, to assessing and filtering the quality of the proposed solutions, to supporting successful negotiations between seekers and winning solvers (Hossain, 2012). On the NineSigma platform, a contest is launched through a problem statement called Request for Proposal (RFP) (Lüttgens et al., 2014). The RFP describes the attributes of the innovation problem to be solved and it informs solvers about the governance structures that the seeker prefers to manage the working relationship with the winning solver at the end of a contest (Franke et al., 2013; Lopez-Vega et al., 2016; de Beer et al., 2017). NineSigma supports its seeker clients in formulating the RFP since it is an important task for seekers aiming at finding valuable knowledge since it may affect the output of the contest (Sieg et al., 2010; Lopez-Vega et al., 2016; Natalicchio et al., 2017). Moreover, NineSigma offers its support and closely work with their seeker clients to assist them in managing the negotiation phase between seeker and solvers in order to maximize the potential value of every collaboration and addressing possible confidentiality requirements (Hossain, 2012). As such, NineSigma supports the research direction of this thesis and, so, it constitutes an appropriate research context where to explore the governance structure of the seeker-solver working relationship.

5.3.2 Sample, secondary data collection and measures

To test the hypotheses about the relationship between problem attributes and governance structure in the crowdsourcing context, an ad-hoc database was built. The database considers all the crowdsourcing for innovation contests broadcasted on NineSigma in a five-year time window from 2010 to 2014. During the observation period, 787 crowdsourcing for innovation contests were broadcast on the platform; however, some observations were removed because, following an update to the platform's archive, some problem statements were not accessible. The final sample, thus, consists of 582 contests. Secondary data were collected from the RFP of the contests, and the contest is the unit of analysis. Each contest is observed at the fixed date it is broadcasted. Thus, the dataset is structured as a cross-sectional database and the analysis does not require a study across time.

The variable *Unilateral governance structure* measures the governance structure preferred by the seeker to manage the working relationship with the winning solver. The seeker can propose one or more governance structures ranging from unilateral (i.e., licensing agreements, technology/patent/product acquisition, consulting, supply agreements and contracted research) to bilateral (i.e., joint development and partnerships). If in the RFP a seeker proposes only a type of unilateral governance structure (or even more than one), she/he has a preference toward unilateral governance structures. Instead, if the seeker proposes only a type of bilateral governance structure (or even more than one), or if the seeker proposes both unilateral and bilateral governance structures, she/he does not have any preference toward unilateral governance structures. Thus, *Unilateral governance structure* is modeled as a binary variable that assumes the value 1 if the seeker has a preference toward unilateral governance structures, 0 otherwise.

The explanatory variable *Decomposability* of the problem is a count variable measuring the number of technical areas (e.g., engineering, chemistry or healthcare science) to which the problem broadcasted can be decomposed, as described in the RFP by the seeker (Natalicchio et al., 2017). For example, considering the problem related the development of a system to improve visibility during bad weather (NineSigma, 2012 – ID contest REQ9172895) it involves several and distinct knowledge elements, ranging from mechanical engineering, electrical/electronic engineering to information science. In such a case, the variable *Decomposability* assumes a value equal to 3.

Formulation of the problem is operationalized as a count variable that measures the number of requirements that the winning solution must fulfill, as expressed by the seeker in the RFP (Sieg et al., 2010; Wielens, 2013). These conditions may be related to physical characteristics (e.g., the dimension or weight of a new product/material) or to the functionality of the solution (Arranz and de Arroyabe, 2012; Lopez-Vega et al., 2016). For example, focusing on a request for a new transparent material replacing glass in automobiles (NineSigma, 2014 – ID contest REQ0247749). In the related RFP, the seeker company specified that the new material must have (1) no performance degradation even after being used outdoors for 15 years; (2) a hardness rating greater than H; (3) a weight lower by 40% or more compared to glass; and (4) a visible light transmittance rate equal to 80% or more. Thus, in such a case, the variable *Formulation* assumes a value equal to 4. Moreover, because of the skewness of the data, the logarithm of the variable *Formulation* was used.

The *Search space* of the problem is a binary variable, measured by comparing the industry to which the seeker belongs and the technical areas of the contest (Afuah and Tucci, 2012; Lopez-Vega et al., 2016). If the knowledge related to the technical area of the problem does not overlap the knowledge possessed by the seeker, *Search space* assumes the value 1, 0 otherwise. Consider, for instance, the request for improving the properties of a resin (NineSigma, 2011 – ID contest REQ1172128). Since this problem involves knowledge related to the chemical area, its search space overlaps the knowledge possessed by a seeker that operates to the chemical industry. In such a case, the variable *Search space* assumes the value 0. Furthermore, consider a problem related to the development of a new technology to print labels on cardboard containers used for shipping a company's product (NineSigma, 2013 – ID contest REQ7141960). Because this problem requires knowledge from mechanical engineering and information science, its search space does not overlap the knowledge possessed by a seeker belonging to the chemical industry. Thus in such a circumstance, the variable *Search space* assumes the value 1.

The analysis also includes a number of control variables in the model. The variable *Seeker industry* controls for the effect that the seeker's industry has on their governance considerations (Oxley, 1997). Specifically, *Seeker industry* is operationalized through seven dummy variables representing the core activities of NineSigma seeker clients (Automotive and transportation, Chemicals and materials, Electronics and semiconductors, Food and beverage, Healthcare, Manufacturing and Other industries). Moreover, through four dummies representing the main knowledge elements of the innovation problems broadcasted on NineSigma (Engineering, Chemistry and material science, Healthcare science and Other areas), the variable *Technical area of the contest* controls for the effect of the knowledge related to the problem. Moreover, since a seeker may prefer to address its contests to a restricted pool of solvers according to their knowledge capabilities (Simula and Ahola, 2014), the control variable *Pre-selection* is added. Particularly, *Pre-selection* is a binary variable assuming the value 1 when the seeker decides to open its call to a smaller group of solvers opportunely selected, 0 otherwise. Furthermore, the variable *Advice* controls whether the seeker reveals to the solvers their preferences toward possible approaches to adopt in solving technical problems (Wielens, 2013; Lüttgens et al., 2014). *Advice* is operationalized as a continuous variable measuring the natural logarithm of the number of advice statements expressed by the seeker. Finally, the control variable *Financial* assesses for the possibility that seekers provide financial support to the winning solver. *Financial* is a binary variable that assumes the value 1 if the seeker provides financial support to the winning solver, 0 otherwise.

5.3.3 Testing hypotheses: econometric analysis and findings

Unilateral governance structure models an alternative between two possible occurrences, so both logit and probit models are appropriate; convenience and convention determine the choice between them (Long, 1997; Hoetker, 2007). It was applied a probit model. Moreover, as a robustness check, the model was tested using a logit model regression, obtaining the same results.

The descriptive statistics and the correlation values are provided in Table 7. The pairwise correlation matrix does not reveal any criticalities. Moreover, the variance inflation factors (VIFs) test was performed to check for multicollinearity. No variable had a VIF greater than 6, then, multicollinearity is not a problem for the analysis (Stevens, 1992).

	Mean	Std. dev.	VIF	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)Unilateral governance structure	0.13	0.34	1.11	1							
(2)Automotive and transportation	0.12	0.33	1.60	-0.05	1						
(3)Chemicals and materials	0.14	0.35	1.66	0.0003	-0.15*	1					
(4)Electronics and semiconductors	0.12	0.32	1.58	-0.06	-0.14*	-0.15*	1				
(5)Food and beverage	0.11	0.31	1.63	0.08	-0.13*	-0.14*	-0.13*	1			
(6)Healthcare	0.14	0.31	2.12	-0.10*	-0.15*	-0.16*	-0.14*	-0.14*	1		
(7)Manufacturing	0.19	0.39	1.78	-0.07	-0.18*	-0.20*	-0.18*	-0.17*	-0.19*	1	
(8)Engineering	0.35	0.48	2.63	-0.03	0.19*	-0.12*	0.22*	-0.19*	-0.24*	0.13*	1
(9)Chemistry and material science	0.33	0.47	2.62	0.008	-0.007	0.29*	-0.13*	-0.12*	-0.15*	0.05	-0.51*
(10)Healthcare science	0.15	0.36	2.34	-0.08	-0.14*	-0.06	-0.14*	-0.04	0.57*	-0.08*	-0.31*
(11)Pre-selection	0.14	0.35	1.25	0.09*	0.03	0.002	-0.09*	0.02	0.05	0.05	-0.07
(12)Advice	1.44	0.70	1.13	-0.10*	0.001	0.06	-0.07	0.05	-0.11*	0.06	0.03
(13)Financial	0.80	0.40	4.68	-0.07	-0.08*	-0.04	-0.04	-0.03	-0.02	0.10*	0.03
(14)Decomposability	1.13	0.37	1.05	-0.02	0.01	0.05	0.11*	-0.06	-0.01	-0.06	0.04
(15)Formulation	2.00	0.72	1.10	0.04	-0.08	0.02	-0.04	-0.08	0.06	0.02	0.06
(16)Search space	0.20	0.40	1.12	0.10*	0.06	0.03	-0.07	0.04	-0.02	-0.08	0.002
(17)Timeline phases	1.84	0.63	1.20	-0.04	-0.008	0.04	-0.04	-0.09*	-0.07	0.0009	0.07
(18)Words	4.26	1.27	4.41	0.01	-0.06	0.02	-0.04	-0.06	0.05	0.03	0.04

	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(9)Chemistry and material science	1									
(10)Healthcare science	-0.29*	1								
(11)Pre-selection	-0.05	0.16*	1							
(12)Advice	0.06	-0.10*	-0.17*	1						
(13)Financial	0.04	-0.04	-0.12*	0.17*	1					
(14)Decomposability	-0.01	-0.01	0.02	0.12*	-0.05	1				
(15)Formulation	0.07	-0.02	-0.35*	0.12*	0.19*	0.04	1			
(16)Search space	-0.05	-0.15*	-0.07	-0.03	0.04	-0.02	0.12*	1		
(17)Timeline phases	0.10*	-0.11*	-0.17*	0.10*	0.25*	0.001	0.31*	0.03	1	
(18)Words	0.08	-0.01	-0.35*	0.10*	0.13*	0.03	0.88*	0.09*	0.23*	1

* $p < 0.05$ Source: Piazza et al. (2018)

Table 7. Descriptive statistics and correlations (governance issue)

The probit estimation results are illustrated in Table 8. Starting with the control variables, in Model 1, dummy variables indicating the *Industry* of the seeker are all significant and negative, except for "Food and beverage", meaning that seeker firms belonging to the significant industries do not have a preference toward unilateral governance structures compared to seekers operating in Other industries (omitted since used as a baseline category). Dummy variables indicating the *Technical area of the contest* are not significant. Furthermore, *Pre-selection* is significant and has a positive impact, meaning that when seekers address the contest to a restricted group of solvers according to their knowledge capabilities, they have a preference toward unilateral governance structures. The control variable *Advice* is significant and has a negative coefficient, suggesting that seeker companies that provide suggestions about possible approaches to solve an innovation problem do not have a preference toward unilateral governance structures. Finally, the control variable *Financial* is not significant.

Considering Model 2, the independent variable *Decomposability* is not significant, thus H1 is not supported. Model 3 supports H2 since the coefficient of the independent variable *Formulation* is significant and positive. In Model 4 the coefficient of the independent variable *Search space* is significant and positive, contrary to what hypothesized in H3. Finally, Model 5, which includes all of the independent variables, confirms the previous results by supporting hypothesis H2 but not H1 or H3.

	Preference toward unilateral governance structure				
	Model 1	Model 2	Model 3	Model 4	Model 5
Seeker industry					
Automotive and transportation	-0.861^{**}	-0.863^{**}	-0.820^{**}	-0.888^{***}	-0.844^{**}
	(0.265)	(0.265)	(0.272)	(0.267)	(0.272)
Chemicals and materials	-0.532^{*}	-0.530^{*}	-0.546^{*}	-0.567^{*}	-0.567^{*}
	(0.233)	(0.233)	(0.232)	(0.228)	(0.228)
Electronics and semiconductors	-0.916^{***}	-0.913^{**}	-0.882^{**}	-0.874^{**}	-0.842^{**}
	(0.278)	(0.279)	(0.278)	(0.278)	(0.281)
Food and beverage	-0.306	-0.312	-0.283	-0.293	-0.284
	(0.247)	(0.247)	(0.249)	(0.245)	(0.248)
Healthcare	-1.023^{***}	-1.019^{**}	-1.108^{***}	-1.055^{***}	-1.132^{***}
	(0.311)	(0.310)	(0.311)	(0.310)	(0.313)
Manufacturing	-0.818^{***}	-0.820^{***}	-0.814^{***}	-0.805^{***}	-0.806^{***}
	(0.223)	(0.223)	(0.225)	(0.223)	(0.225)
Technical area of the contest					
Engineering	-0.113	-0.114	-0.231	-0.0702	-0.193
	(0.218)	(0.218)	(0.219)	(0.213)	(0.216)
Chemistry and material science	-0.105	-0.107	-0.182	-0.0248	-0.117
	(0.218)	(0.218)	(0.221)	(0.214)	(0.220)
Healthcare science	-0.434	-0.435	-0.515^{+}	-0.318	-0.415
	(0.298)	(0.298)	(0.289)	(0.296)	(0.290)
Pre-selection	0.336^{+}	0.339^{+}	0.567^{**}	0.358^{+}	0.576^{**}
	(0.184)	(0.183)	(0.201)	(0.185)	(0.201)
Financial	-0.226	-0.233	-0.305^{+}	-0.250	-0.333^{*}
	(0.164)	(0.162)	(0.166)	(0.164)	(0.163)
Advice	-0.225^{*}	-0.220^{*}	-0.257^{**}	-0.214^{*}	-0.240^{*}
	(0.0950)	(0.0974)	(0.0971)	(0.0950)	(0.0996)
Decomposability		-0.0624			-0.113
		(0.198)			(0.203)
Formulation			0.349^{**}		0.327^{**}
			(0.110)		(0.109)
Search space				0.312^{*}	0.255^{+}
				(0.163)	(0.165)
_cons	-0.0151	0.0545	-0.591^{+}	-0.138	-0.525
	(0.258)	(0.309)	(0.318)	(0.260)	(0.365)
N	582	582	582	582	582
Log-pseudolikelihood	-204.33	-204.29	-200.22	-202.68	-199.06
Wald chi^2	46.54	47.74	54.90	48.56	59.39
Pseudo R^2	0.1015	0.1017	0.1196	0.1088	0.1247
Prob>chi^2	0.0000	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses; $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Piazza et al. (2018)

Table 8. Probit regression results (governance issue)

The dataset suggests that some seekers do not have a preference between unilateral and bilateral governance structures at that moment the contest is broadcasted since they both indicate unilateral and bilateral governance structures in the RFP. However, choosing a specific governance structure to manage the working relationship with the winning solver is predicated on the development of a preference. Because the RFP documents are examined at the time the contest is broadcasted, previous regression analysis does not take into account later self-selection for a preferred governance structure and this may result in biased coefficient estimates due to omitted variables that affect both the development of a preference and the resulting outcome (Hamilton and Nickerson 2003). Thus, following Jeppesen and Lakhani (2010), it is appropriate to control for sample selection bias using a probit model with sample selection correction (Van de Ven and Van Praag, 1981). This model is an extension of the Heckman model (Heckman, 1979). The original Heckman model assumes a binary choice for selection into the sample and a continuous outcome for the main dependent variable, while its extension takes into account the statistical properties of a two-stage discrete choice estimation (Heckman 1979). Given that governance considerations about the seeker-solver working relationship consist of two binary outcomes – (1) the presence or absence of a preference toward a specific governance structure and (2) having a preference toward a unilateral or bilateral governance structure – the adapted version of the Heckman model will be more appropriate than its traditional version in this context. The results of two-stage probit estimations with the Heckman correction are reported in Table 9.

The first stage models the process of the selection into the sample, i.e., the presence or absence of a preference toward a specific governance structure; the second stage models the binary choice between a unilateral or bilateral governance structure and includes an error correction term obtained from the first stage estimation. Performing the Heckman correction, the same results of the probit estimation shown in Table 4 without controlling for the self-selection bias are obtained.

Specifically, focusing on the second stage, in Model 4 the independent variable *Decomposability* is not significant, thus H1 is not supported. Model 5 supports H2 since the coefficient of the independent variable *Formulation* is significant and positive, meaning that when the problem is easy to formulate, seekers develop a preference toward a unilateral governance structure compared to a bilateral one. In Model 4 the coefficient of the independent variable *Search space* is significant and positive meaning that, contrary to what hypothesized in H3 when searching for solutions that are distant from their knowledge bases, seekers prefer unilateral governance structures over bilateral ones.

	First stage: developing a preference			**Second stage: unilateral vs. bilateral preference**		
	Model1	Model2	Model3	Model4	Model5	Model6
Seeker industry						
Automotive and transportation	-0.321	-0.328	-0.343	-2.757***	-2.570**	-2.182***
	(0.232)	(0.229)	(0.234)	(0.621)	(0.867)	(0.571)
Chemicals and material	-0.432^{+}	-0.435^{+}	-0.457*	-1.843**	-2.245*	-1.077^{+}
	(0.225)	(0.226)	(0.221)	(0.699)	(0.961)	(0.621)
Electronics and semiconductors	-0.713**	-0.719**	-0.685**	-2.640**	-2.758*	-1.486*
	(0.257)	(0.256)	(0.256)	(0.918)	(1.185)	(0.683)
Food and beverage	-0.045	-0.041	-0.031	-1.538*	-1.912**	-1.440*
	(0.228)	(0.228)	(0.226)	(0.602)	(0.678)	(0.625)
Healthcare	-1.040***	-1.040***	-1.052***	-2.480*	-2.297	-0.877
	(0.287)	(0.287)	(0.284)	(1.139)	(1.719)	(0.774)
Manufacturing	-0.668**	-0.667**	-0.654**	-2.112**	-2.181^{+}	-1.008^{+}
	(0.209)	(0.209)	(0.209)	(0.751)	(1.174)	(0.609)
Technical area of the contest						
Engineering	-0.228	-0.220	-0.183	-0.329	-0.715	0.082
	(0.208)	(0.209)	(0.205)	(0.511)	(0.712)	(0.447)
Chemistry and material science	-0.164	-0.158	-0.103	-0.305	-0.840	0.047
	(0.207)	(0.209)	(0.204)	(0.529)	(0.727)	(0.476)
Healthcare science	-0.053	-0.049	0.036	-1.435*	-2.516***	-1.181*
	(0.254)	(0.256)	(0.255)	(0.571)	(0.763)	(0.553)
Pre-selection	0.529**	0.516**	0.547***	0.399	1.030	-0.497
	(0.163)	(0.171)	(0.165)	(0.717)	(0.940)	(0.361)
Financial	-0.251	-0.243	-0.265^{+}	-0.569	-0.787	-0.069
	(0.155)	(0.157)	(0.155)	(0.469)	(0.555)	(0.363)
Advice	-0.218*	-0.222*	-0.214*	-0.446	-0.686	-0.073
	(0.092)	(0.090)	(0.090)	(0.311)	(0.510)	(0.226)
Decomposability	-0.066			-0.241		
	(0.189)			(0.452)		
Formulation		-0.015^{+}			1.407***	
		(0.090)			(0.338)	
Search space			0.265^{+}			0.694^{+}
			(0.154)			(0.355)
Selection correction term				5.406	3.739	7.258***
				(3.657)	(5.268)	(0.469)
Constant	0.115	0.068	-0.061	-0.083	-0.644	-3.850***
	(0.300)	(0.283)	(0.247)	(2.103)	(2.794)	(0.599)
N	582	582	582	129	129	129
Log-pseudolikelihood	-248.20	-248.25	-246.89	-45.89	-33.53	-46.17
Wald chi^2	54.21	53.18	55.02	29.95	40.19	90.38
Prob>chi^2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses; $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Piazza et al. (2018)

Table 9. Results of probit estimations with sample selection correction (governance issue)

5.3.4 Endogeneity analysis and robustness check

Endogeneity occurs for several reasons, such as measurement errors, simultaneity or reverse causality, and omitted variable bias (Wooldridge, 2002; Abdallah et al., 2015). In this investigation, reverse causality is not plausible; it would not be possible for seekers that prefer to manage the working relationship through specific governance structures to change the attributes of the technical problem they are attempting to solve. In fact, the attributes of the technical problem, such as the decomposability, the formulation and the search space of the problem (Afuah and Tucci, 2012; Felin and Zenger, 2014), are intrinsic characteristics of the problem itself; they are given and cannot be changed by seekers. In turn, omitted variables bias may be a real concern in this model and could increase the effect that *Decomposability*, *Formulation* and *Search space* have on the dependent variable.

To adequately address endogeneity concerns related to the aforementioned independent variables, it is appropriate to use the instrumental variable (IV) method (Wooldridge, 2002; Hamilton and Nickerson, 2003). Specifically, two different instruments are used to apply such a method, *Timeline phases* and *Words*. *Timeline phases* exogenously influence *Formulation* and *Search space,* but it does not affect the dependent variable, *Unilateral governance structure*. *Timeline phases* measures the number of phases through which the seeker regulates the timeline for the winning solver to develop the proposed solution. Each phase of the timeline is defined by intermediate results the solver has to reach, allowing seekers to assess the solvers' knowledge and skills step-by-step; this enables the seeker to assess if the solution effectively solves the technical problem and whether the solver possesses the knowledge required to solve the innovation problem (Koza and Lewin, 2000). The instrument can be validated following Plourde et al. (2014); *Timeline phases* significantly and negatively affects the variables *Decomposability* (β=0.28 with p-value=0.000) and *Search space* (β=0.32 with p-value=0.002), while *Unilateral governance structure* does not (p-value=0.320). Similarly, the second instrument, *Words*, exogenously influences the variable *Formulation* but does not affect the dependent variable *Unilateral governance structure*. Particularly, *Words* measures the number of words used by a seeker to express the conditions that the solution must fulfill. As stressed by (Gefen et al., 2016), the seeker uses the length of the description of requirements to better describe the innovation problem. *Words* is a valid instrument since it significantly and positively affects *Formulation* (β=0.49 with p-value=0.000) while *Unilateral governance structure* does not (p=0.73).

Because *Search space* is a binary variable, while *Decomposability* and *Formulation* are not, different IV techniques, tailored to these variables, should be used to perform the endogeneity analysis. Specifically, the IV probit estimation procedure is suitable to treat endogeneity related to *Decomposability* (H1) and *Formulation* (H2) (Wooldridge, 2002), as also shown in previous studies (e.g., Plourde et al., 2014).

Results for the endogeneity analysis are reported in Table 10.

	IV probit (H1)	**IV probit** (H2)	**Bivariate probit** (H3)	
	Unilateral governance structure	Unilateral governance structure	Unilateral governance structure	Search space
Seeker industry				
Automotive and transportation	-0.860**	-0.822**	-0.835**	0.282
	(0.264)	(0.272)	(0.257)	(0.227)
Chemicals and materials	-0.540*	-0.546*	-0.584**	0.283
	(0.232)	(0.232)	(0.209)	(0.216)
Electronics and semiconductors	-0.937***	-0.884**	-0.642*	-0.429^{+}
	(0.276)	(0.278)	(0.302)	(0.260)
Food and beverage	-0.308	-0.285	-0.194	-0.153
	(0.247)	(0.249)	(0.246)	(0.263)
Healthcare	-1.022***	-1.108***	-1.079***	0.149
	(0.309)	(0.311)	(0.303)	(0.276)
Manufacturing	-0.812***	-0.815***	-0.653**	-0.181
	(0.222)	(0.225)	(0.236)	(0.218)
Technical area of the contest				
Engineering	-0.126	-0.231	0.142	-0.647***
	(0.215)	(0.219)	(0.219)	(0.195)
Chemistry and material science	-0.112	-0.182	0.272	-0.833***
	(0.217)	(0.221)	(0.234)	(0.203)
Healthcare science	-0.440	-0.517^{+}	0.0907	-1.446***
	(0.296)	(0.288)	(0.332)	(0.355)
Pre-selection	0.332^{+}	0.557**	0.397*	-0.0896
	(0.183)	(0.203)	(0.175)	(0.199)
Financial	-0.227	-0.304^{+}	-0.288^{+}	0.181
	(0.161)	(0.166)	(0.150)	(0.156)
Advice	-0.232*	-0.253**	-0.158^{+}	-0.137
	(0.0990)	(0.0962)	(0.0940)	(0.0914)
Decomposability	0.0879			
	(0.320)			
Formulation		0.330**		
		(0.116)		
Search space			1.630**	
			(0.617)	
Phase timeline				0.376***
				(0.105)
Constant	-0.0909	-0.557^{+}	-0.620^{+}	-0.404^{+}
	(0.401)	(0.336)	(0.325)	(0.241)
N	582	582	582	582
Log-pseudolikelihood	-303.69	-212.33	-459.51	
Wald chi^2	46.99	53.72	163.43	
Prob>chi^2	0.0000	0.0000	0.0000	
Wald exogeneity test	0.36	0.09	2.06	

The critical value of the Wald exogeneity test at a significance of 0.05 is 3.84; the null hypotheses are exogenesis of *Decomposability*, *Formulation* and *Search space*. In the IV probit estimations, *Decomposability* is instrumented with the variable *Phase timeline*, while *Formulation* is instrumented with the instrumental variable *Words*.

Standard errors in parentheses; $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Piazza et al. (2018)

Table 10. Results of endogeneity analysis (governance issue)

Table 10 indicates that IV probit estimations produce the same results as the standard probit estimation (Table 8). Moreover, the insignificant Wald test also indicates in this case that endogeneity concerns do not affect Decomposability and Formulation (Wooldridge, 2002). Moreover, following previous scholars (e.g. Fairlie, 2006), the bivariate probit estimation approach (Angrist, 2001) is appropriate to treat endogeneity related to Search space (H3). Bivariate probit estimation solves the potential endogeneity concerns by simultaneously estimating two probit models, as shown in the last two columns of Table 10. Bivariate probit produces the same results as the standard probit estimation (Table 8). Most importantly, such a procedure also returns a Wald test to check for the existence of exogeneity (Monfardini and Radice, 2008); the Wald exogeneity test is insignificant, meaning that endogeneity concerns do not affect Search space (Wooldridge, 2002). Thus, the post-hoc endogeneity analysis provides consistency with previous results and so validates previous interpretations.

5.4 Discussion about the governance issue

The objective of this chapter was exploring the seekers' decision about the governance structure to manage the working relationship with winning solvers (Piazza et al., 2018). To pursue this objective, a research framework, which leverages on KBV and problem-solving perspectives, has been developed. Particularly, the framework investigates the effect that three specific attributes of the problem broadcasted, i.e. decomposability, formulation and search space of the problem, have on the seekers' decision between unilateral and bilateral governance structures. Further, the relationships conceptualized in the research framework through hypotheses H1, H2, H3 were assessed using data gathered from a sample of 582 crowdsourcing for innovation contests launched on the NineSigma platform.

Three main results emerge from the analysis. First, results do not confirm the effect that the decomposability of the innovation problem has on seekers' preference toward alternative governance structures hypothesized in H1. Such a non-significant result could be related to the support service offered by the NineSigma crowdsourcing platform in the evaluation process of the received solution proposals. In fact, NineSigma managers assist their seeker clients in screening all solution proposals and selecting the winning one. Thus, trusting the intermediary role played by the platform in understanding the knowledge related to the solutions and assessing their quality, seeker companies may not be influenced by the decomposability of the problem when deciding about the governance structure of the crowdsourcing relationship.

Second, results provide confirmation to H2 suggesting that well-delineated innovation problems lead seekers to prefer unilateral governance structures to manage the working relationship with the winning solver. This finding suggests that if it is possible to formulate in detail the problem to broadcast, resorting to more complex organizational structures that allow the integration of omitted tacit knowledge is unnecessarily onerous. Thus, under the circumstance where the seeker does not need to offer additional information to the description of the problem in the problem statement for increasing the value of the solution proposals, they can benefit from a more efficient and less costly unilateral governance structure.

Finally, findings do not offer support for the negative relationship between an innovation problem characterized by a distant search space and the seeker's preference toward unilateral governance structures, as hypothesized in H3. On the contrary, a positive relationship between the search space and the preference toward unilateral governance structures has been found. This result suggests that when seekers engage in crowdsourcing activities to acquire knowledge distant from their existing capabilities, they have preferences toward unilateral governance structures. A possible explanation for this counterintuitive finding may be that crowdsourcing contests are often used by seeker companies to more effectively and efficiently search for and absorb unfamiliar knowledge (Afuah and Tucci, 2012). Developing new capabilities in novel knowledge areas may be very difficult, costly, and time-consuming (March, 1991). In fact, when dealing with a solution related to a search space that is relatively distant from their knowledge bases, seekers cannot leverage their existing capabilities and so face the risk of being unable to absorb and integrate the new knowledge from the crowd (Cohen and Levinthal, 1990). In such a case, seekers may prefer not to enter into a committed, costly and time-consuming relationship with a bilateral governance structure, but prefer the unilateral ones. This is in accordance with the Real Options theory that encourages firms to delay demanding and highly uncertain investments by establishing less committed relationships that enable companies to withdraw from the investment at any point in time, if necessary (Dalziel, 2009; Folta, 1998). Unilateral governance structures allow the seeker to learn about the new and unfamiliar knowledge while, at the same time, developing the absorptive capacity needed to integrate it without engaging in a time and cost consuming relationship

(Cohen and Levinthal, 1990; Kogut and Kulatilaka, 2001; Van De Vrande et al., 2006). As such, facing the risks related to a distant knowledge search seekers may prefer unilateral governance structures to approach the new and the unfamiliar knowledge while evaluating the decision to enter into more committed relationships with a bilateral governance structure (Folta and Miller, 2002; Kogut, 1991). Thus, when engaging in crowdsourcing exploratory activities, lower levels of commitment offered by unilateral governance structures may overcome the benefits related to the more refined mechanisms of knowledge transfer offered by the bilateral ones (Folta, 1998; Mayer and Salomon, 2006).

From the results discussed in this chapter, critical contributions to previous literature and several managerial implications for seekers organizing crowdsourcing for innovation contests can be derived. The final chapter of this thesis discusses such potential contributions and implications.

Chapter 6

THE ROLE OF FAIRNESS IN CROWDSOURCING FOR INNOVATION CONTESTS

6.1 Introduction

This chapter is based on the research article titled "Treating the Crowd Fairly: Increasing the attractiveness of crowdsourcing challenge" and it attempts to address the role of fairness in crowdsourcing for innovation contests (Mazzola et al., in review). Particularly, this chapter investigates how seekers can design fair crowdsourcing contest by using specific procedural and distributive fairness leverages that increase the self-selection of solvers and attract the most competent ones. Exploring this issue is critical since having a large pool of both high-skilled and low-skilled solvers allows the seeker to receive a large number of solution proposals and more diverse and creative solutions increasing the overall performance of the innovation contest (Heimans and Timms, 2014; Prpić et al., 2015; Schemmann et al., 2016 Terwiesch and Xu, 2008).

This chapter presents a netnography analysis that investigates the fairness perceptions of solvers about the design of crowdsourcing for innovation contests in a real crowdsourcing platform, i.e. 99designs. This platform constitutes a suitable research setting since it has its own discussion board where solvers actively debate about their experiences and concerns. Leveraging on results from the netnography analysis and the fairness theory, the chapter then conceptualizes a research framework and develops a set of hypotheses. Moreover, using secondary data collected from the 99designs platform, the chapter empirically validates the framework. Specifically, hypotheses are validated through an econometric analysis and a series of robustness check and an endogeneity analysis further supports the results.

The chapter is organized in four sections. The chapter starts introducing the research framework and the development of the hypotheses set. Then, the empirical investigation of the fairness leverages is presented. Specifically, this section explores the research context, presents the sample data and shows empirical analysis and results. Finally, the results are discussed in the last section of the chapter.

6.2 Defining a research framework to investigate the role of fairness in the crowdsourcing contest: Netnography on 99designs community

According to crowdsourcing literature on fairness, when launching an innovation contest seekers provide the information that allows them to be viewed in a favorable light (Boons et al., 2015; Dahlander and Piezunka, 2014; Franke et al., 2013). This suggests that fairness is used as an instrument through which seekers can satisfy the solvers' expectations about the outcome and rules of crowdsourcing contests. Since the seeker decides the outcome and sets the rules of contests, solvers can develop fairness judgments on the contests by evaluating seeker's actions (Long et al., 2011). If the solvers' evaluations about seeker's actions are inaccurate, then misalignment in crowdsourcing mechanisms may occur, generating unattractive crowdsourcing contexts. As such, the perception of fairness in a crowdsourcing for innovation contest can influence the contest performance in terms of individuals' willingness to participate and contribute with their creative and innovative ideas. However, so far, little is known about what influences the solvers' perception of fairness in a crowdsourcing contest. Given the lack of empirical crowdsourcing research on this topic, a netnography analysis was conducted in the 99designs community (Kozinets, 2002; Kozinets et al., 2014).

A netnography is a relatively new naturalistic unobtrusive method that allows the interpretation of an empirical context by gathering and analyzing non-elicited data retrieved by the observation of people socializing and interacting in the online discussion board (Kozinets, 2010). Considering the crowdsourcing for innovation context the netnography focuses on the observation of the platform's community members, that is solvers, also called designers in the 99designs platform, seekers and staff from the platform. Following Bauer et al. (2016), discussion board data were collected and then analyzed through an iterative process. Specifically, data were collected from conversations in which community members discussed fairness issues. The 99designs discussion board community contains more than 8700 discussions, with billions of posts published from February 2015 until now. In order to deal with such a large amount of information, relevant cases were systematically searched. In a multiple step process, a heuristic search was performed in the 99designs community based on a list of 10 keywords, i.e., 'fair', 'justice', 'equity', 'honest', 'right', 'correct', 'wrong', 'justness', 'integrity' and 'transparency'. This initial search resulted in a database of 167 discussions that were subsequently screened in order to remove any false positive cases, i.e., search results that did not relate to the fairness issue. Finally, 54 discussions containing 857 posts were identified. Then, these relevant posts were analyzed and a label was assigned to each post using an open coding scheme in order to identify the themes regarding the fairness issues that consistently recurred throughout the analyzed discussion posts (Strauss and Corbin 1990). Then, the themes were grouped in major topics using the axial coding procedure (Strauss and Corbin, 1990). This analysis provided three distinct fairness-related trend topics, i.e., the prize award, the seeker commitment, and the transparency of the contest. Finally, as a check, the fairness-related discussions were analyzed again without finding any additional topics, suggesting that the set of topics identified is exhaustive.

The first trend topic encompasses all of the fairness-related posts where designers discuss the prize award of the contest, such as the amount of the prize award, the distribution of the prize and whether they feel rewarded for their effort in developing a solution proposal. This topic indicates that designers really care about the fairness of the prize award the seeker set. The post by designer ‘HanibalRiborn’ nicely captures the essence of this topic

> “I see more and more 3D designers joining 99designs, but also, more and more of them are quitting. Main reason is we, 3D designers are underpaid for our job, and prizes on contests here are far too low than they should be. At first chance to earn some serious money, every designer will leave this forever.[…] I tried several freelancing communities and to be honest, only 99designs suits me fine, but that’s not good reason to stay here when I can’t earn some decent money and be payed fairly for job I’m doing.”

Moreover, when debating the equity of the prize award, designers make a comparison between the money the seeker will pay to acquire the winning solution and the effort of the designer who submits it. In particular, depending on the amount of the prize award, the designers perceive whether or not their work and effort are fairly remunerated.

Secondly, another largely discussed fairness-related topics concerns the seeker commitment. This topic builds on all the conversations related to the involvement and the rightness of the seeker and most of them are related to whether or not the seeker is committed to guaranteeing the payout of the award at the end of a contest. This is reflected in the following post by designer ‘Cloud_9’

> “Today I was pleasantly surprised. Got a private message from a CH with an invite to join his contest cause he liked my work and there was only one designer to enter his contest. I told him that many designers tend to avoid non guaranteed contest and that is

> one of the reasons he could have few entries. And voila, he made the contest guaranteed and thanked me for the suggestion."

By reading all the posts focusing on the commitment of the seeker in paying out the prize, it emerges that designers are concerned about the possibility that a seeker broadcasts a contest in order to take advantage of their submitted solutions (for example by taking a design concept to further develop) without awarding any designer. Thus, when the seekers are not committed to guaranteeing the payout of the prize at the end of a contest, designers feel the contest is unfair.

Finally, the third trend topic highlights that designers strongly care about the transparency of the contest. This topic aggregates all the fairness-related posts that focus on the transparency and the correctness of contests' procedures and rules. By analyzing the posts of this topic, it seems that the transparency of the contest has a controversial effect on the designers' perception of fairness. Some designers consider transparent contests as fair since, for example, they have the possibility of seeing the proposals submitted by other designers during the contest, and so compare these submissions with their proposals. The following quotation of designer 'green_in_blue' highlights this point

> "Transparency is important here. It builds confidence and trust. […] If the rules, guidelines and actions are unclear, or viewed as secret and unfair, or rules are apparently broken and no one knows how or why, people will react".

Other designers, instead, consider transparent contests as unfair because in this kind of contest designers can easily steal ideas submitted by others and then compete with them. The following post from designer 'Creativeiyke' explains this view well

> "I really feel bad when I see in an open contest, designers copying inspiration from a designer whose design was rated 4 or 5 stars, and in the end, the designers who copied are selected as winners".

Previous research on fairness (e.g. Adams, 1965; Gilliland, 1993) distinguishes several dimensions of fairness, thus a factor analysis was performed to understand how many dimensions of fairness are represented by the three trend topics identified. The factor analysis supported a two-factor structure. Specifically, the first factor grouped together the award and the seeker commitment, so by leveraging previous research (e.g. Faullant et al., 2017; Franke et al., 2013), it is possible to explain this factor through the concept of distributive fairness. In fact, the perception of distributive fairness concerns the prize of the crowdsourcing contests and comprises solvers' assessments about the commitment of the seeker in distributing the contest's outcome. The second factor is related only to the transparency of the contest and this factor is explained through the concept of procedural fairness perception (e.g. Faullant et al., 2017; Franke et al., 2013). Procedural fairness is in regard to the contest procedures and refers to solvers' assessments of the clarity and transparency of the selection process of the winning solution.

All thing considered, a research framework investigating how seekers can increase the contests' attractiveness is developed leveraging on both the netnography results and the fairness theory (Grant, 1996; Grant and Baden-Fuller, 1995; Kogut and Zander, 1992). Under this perspective, particularly, this thesis suggests the contests performance are influenced by contests attribute that act as both distributive fairness leverages, those related to the award and the seekers' commitment, and procedural fairness leverages related to the transparency of the contest.

Moreover, since crowdsourcing contests can attract different levels of talents from the crowd (Schemmann et al., 2016), from inexperienced designers to professionals, the framework developed investigates the effect that distributive and procedural fairness leverages have on the participation of high and low-skilled designers. Considering that designers differ in their level of competencies is important when investigating the fairness issue. Since crowdsourcing platforms do not have a process in place to separate designers based on their skill level, high-skill and low-skill designers are considered parts of the same group and this circumstance can influence their perception of fairness. In fact, on the 99designs platform seekers select the winning solvers considering only the designs they have submitted to that contests, but irrespective of the designer's skill level or amount of work.

From the netnography analysis, it has emerged that some designers have complaints about that, as apparent by comments made by a professional designer stating that

> "Being a designer, I know how much effort and time we spend on each and every design but you will see not a single client will respect or bother to give you a feedback to your designs before they declined it even we provide it free, that's pathetic experience".

Another highly skilled designer complained about fairness adds that

> "This is a breach of contest rules and unfair to all other designers. We apologize to all the legitimate designers that probably could have won the contest with designs that were much better than this garbage. It's an unfair process and 99designs needs to declare the contest unfair and rigged".

Figure 6 shows the framework developed to investigate how seekers should design crowdsourcing contests in order to attract a large pool of solvers and increase the self-selection of the high-skilled ones by choosing fair contests' characteristics (Mazzola et al., in review).

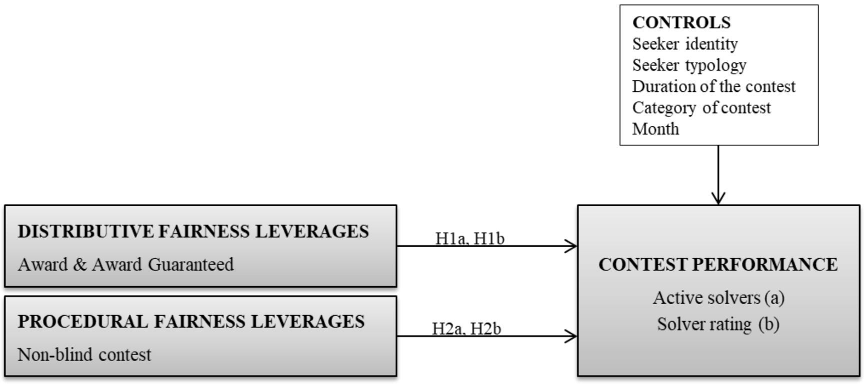

Figure 6. Research framework investigating the fairness issue (Mazzola et al., in review)

6.2.1 Hypothesis 1 set: contests' attributes as distributive fairness leverages increasing the crowdsourcing performance

From a distributive perspective, solvers are concerned about the equity of the prize. The following post by 'GlowFX' supports this argument

> "The thing that I can't understand is why pricing for banner ads now is much lower? In 'Web & app design > Banner ad' I now see many contests with a price tag of 95, 60 or even 40$. […] How is this fair? It is disrespectful to ask a designer to create Google Ads for a chance of winning 40$".

In order to increase solvers' participation in a contest, seekers thus have to deal with this perception and fairly set the amount of the prize award (Faullant et al., 2017). If the solver perceives that the award is fair compared to the value of their solutions, they will feel a sense of justice (Fehr, Ernst Schimidt, 1999; Feller et al., 2012). Consequently, solvers will become fulfilled and encouraged to submit proposals to that contest (Faullant et al., 2017; Franke et al., 2013),.

Moreover, always considering a distributive fairness perspective, solvers are concerned about the commitment of the seeker in paying out the award. The following post by solver 'miremi_design' highlights this view

> “And yes, any reason is better than no reason at all. I understand that there might be lot of things behind this [referring to refunds, i.e. seeker asking to receive back her/his money if she/he does not find a suitable design]…but what if the CH [Contest Holder] just wanted some ideas…I don’t think this is fair, and I know that many designers (if not all of them) think the same”.

Seekers aiming to enhance the self-selection of a large pool of solvers have to deal also with this perception. Particularly, they should fairly guarantee to pay out the prize at the end of a contest (Fehr, Ernst Schimidt, 1999; Wooten and Ulrich, 2017). In fact, by fairly guaranteeing to pay out the award, seekers signal they are committed and they care about the distribution of prizes (Feller et al., 2012). Consequently, solvers will be encouraged to participate in that contest (Franke et al., 2013; Faullant et al., 2017).

Accordingly, the following hypothesis is stated.

H1a. Setting fair award and guaranteeing to pay out the award increase the self-selection of solvers.

Moreover, considering the differences between professional high-skilled and amateur low-skilled solvers, the amount of the prize considered as fair by a high-skilled solver is higher compared to that of an amateur solver (Mazzola et al., in review). In fact, assuming equal effort by a professional and an amateur solver in developing an idea, for example, the number of working hours, the solution proposed by a professional solver is expected to be generally more valuable than that of an amateur one. Therefore, the amount of the prize award that a high-skilled solver will perceive as fair will be higher than an amateur one. This reasoning is reflected in a post written by the solver ‘Ink_d’ who stated

> “Yep hence I will not touch illustration contests on 99D. It’s insulting to some of the amazing talent out there. It’s hours and hours of work, it’s a very unique skill and the hours that go into that level of skill should be paid in kind”.

Moreover, the prize award is the reason why professional high-skilled solvers take part in a crowdsourcing contest, unlike amateur solvers who mostly participate to have fun and increase their abilities (Brabham, 2008). Thus, a high-skilled solver may be more concerned about the seekers’ commitment to pay out the award at the end of the contest than an amateur one. This reasoning is reflected in another post written by ‘Vesper’, who stated that

> "If it was about fun then there are sites like Deviant Art you can join. For me to be on 99designs is to have fun getting better but make no mistake money is the primary reason and joining open non guaranteed contest makes no sense to me anymore".

Consequently, to the aforementioned reasoning, the following hypothesis is suggested.
H1b. Setting fair award and guaranteeing to pay out the award increase the self-selection of high-skilled solvers.

6.2.2 Hypothesis 2 set: contests' attributes as procedural fairness leverages increasing the crowdsourcing performance

From a procedural perspective, solvers are worried about the transparency of the contests' procedures and rules. The following post by 'bundsta' supports this argument

> "I think blind contests are disrespectful of designers. The client is allowed to choose the design/designer, but the designer doesn't get to know the taste level of who they are working with. […] I like to see what they are giving four or five stars to, so I can see if I even want to participate in their contest. Sometimes they give five stars to designs that I think are awful, so that would allow me to pass over that contest and find one I'd rather enter. I don't think it's fair to designers to make us work for a CH who may have horrible taste".

Seeker companies can increase the participation of solvers by designing fair non-blind contests. In a non-bind contest, all the ideas submitted by solvers and the feedback provided by seekers are available and visible to everybody (both participant and not in the contest) during the whole competition (Wooten and Ulrich, 2017). If the contest is non-blind, by comparing the submissions of the other solvers with their own proposals and rating, solvers can evaluate the system of judgment that the seeker will use in selecting the winning idea (Mazzola et al., in review). As a consequence, solvers will perceive non-blind contests as fair because favoritisms or issues related to the possibility that some unqualified solver win the contest are avoided, and they will be encouraged to participate in that contest (Faullant et al., 2017; Franke et al., 2013; Leventhal, 1980; Schaubroeck et al., 1994).

In accordance with the reasoning above, the following hypothesis is proposed.
H2a. Designing non-blind contests increase the self-selection of solvers.

However, even if non-blind contests increase the transparency in the selection process of the winning solution, it may also feed the phenomena of copying by solvers. In fact, when submitting a design in a non-blind contest all the submissions are visible to everyone and the intellectual property of the solutions is protected only by a system of informal norms self-organized by the crowdsourcing community (Bauer et al., 2016). Thus, non-blind contests may also produce a perception of unfairness. The post written by 'Laurence_keane' explains this point

> "[99designs should make all contests 'BLIND'] Yes. That would be fair for us. I really value originality and creativity. It is not easy to come up with a unique idea, and in the end, other designers just 'copy' your idea and create designs based on your own work. It is plagiarism. If this system would continue, then let's call these contest as the best copycat design contest. There will be no intellectual properties anymore. That would be unhealthy for designers. We are called 'designers', not copycats".

Copying and getting inspirations from the ideas submitted by other solvers may be more fruitful for low-skilled solvers since taking cues from professionals with high skill levels allows them to avoid the costs of trial-and-error learning and enhance their creativity (Bauer et al., 2016; Schemmann et al., 2016). Thus, high-skilled solvers would perceive the non-blindness of a contest as unfair (Mazzola et al., in review). High-skilled solvers, indeed, may be more concerned about protecting their ideas from being stolen than benefiting from viewing the solutions of others but at the same time exposing their ideas to the communities' judgment in order to enhance creativity.

Accordingly, the following hypothesis is stated.

H2b. Designing non-blind contests decrease the self-selection of high-skilled solvers.

6.3 Empirical investigation of the fairness issue through secondary data analysis

6.3.1 Research context: the 99design crowdsourcing platform

99designs platform constitutes the empirical setting to test the framework investigating the issue of fairness in the crowdsourcing for innovation context. Founded in 2008, 99designs claims to be the world's largest crowdsourcing platform for innovation contests that focus on design tasks such as logos, business cards and web design (99designs, 2018). 99designs allows seeker companies to submit design contests and seek innovative ideas for the development and/or refinement of a design from the global community of (professional) solvers. The company is headquartered in Oakland, California, and has operations in Germany, Brazil, Japan, and Australia.

This empirical setting has appeared to be an appropriate candidate for analyzing how fairness perceptions influence the attractiveness of contests for two main reasons. First, this platform has its own discussion board where designers actively debate about their experiences and their main issues. Thus, it was possible to conduct the netnography analysis to investigate the behavior of solvers when dealing with fairness. Second, 99designs holds possible measures of contest self-selection, such as the number of active designers, and it has a designers' quality rating system (Sun et al., 2015). Thus, to support the research direction of this thesis, 99designs appears to be a suitable candidate to address how the design of fairness leverages impacts the performance of a crowdsourcing contest, particularly, distinguishing the self-selection process of solvers with different level of skills and abilities.

6.3.2 Sample, secondary data collection and measures

To investigate the fairness issue an ad-hoc dataset was built by gathering secondary data from the problem statements of contests broadcasted in 99designs platform between January 2014 and October 2014. Specifically, since the platform does not have an archive collecting all the contests broadcasted, during each day of the data collection period (270 days) a sample of five contests was randomly selected. The sample collection resulted in 1350 contests. From these, contests withdrawn by the seeker before the end of the contest were removed, since it was not possible to collect data about the solvers' participation to the contest. The final sample, thus, contains 1067 contests. The contest represents the unit of analysis and each observation is fixed at the due date of submission, thus the dataset is structured as cross-sectional.

Two dependent variables that operationalized the self-selection of solvers and the level of skill of the self-selected pool of solvers are considered. Focusing on the first dependent variable, the solvers' self-selection is operationalized as a count variable *Active solvers* that measures the number of solvers that at least submit one proposal to the contest (Boudreau et al., 2011; Jeppesen and Lakhani, 2010; Terwiesch and Xu, 2008). Considering the second dependent variable, the level of skill and competencies of the self-selected solvers is operationalized through the categorical variable *Solver rating*.

This variable measures the rating, as a number of stars (from 1 to 5), which was assigned to the winning solver when participating in the contest.

Concerning explanatory variables, the *Prize* of the contest is operationalized as a continuous variable measuring the amount of money that the winning solver will receive at the end of the contest as set by the seeker. Moreover, the commitment of the seeker was operationalized through the binary variable *Award guaranteed*, which assumes the value 1 if the seeker guarantees to pay out the prize at the end of the contest even if she/he has not found a suitable design, 0 otherwise. Finally, *Non-blind* is a binary variable that operationalizes the transparency of the contest. Specifically, *Non-blind* assumes the value 1 if the solution proposals submitted to that contest are visible to everyone, 0 otherwise.

Some control variables are also considered in the analyses. The control variable *Seeker identity* controls whether the seeker reveals her/his identity to the solvers using a binary variable that assumes the value 1 if solvers know the identity of the seeker; 0 otherwise. *Seeker typology* controls for the effect that different kind of seeker companies have on the attractiveness of a contest. This variable is operationalized by using four dummies representing the typology of seekers: ‘Firm’, ‘Private’, ‘Non-profit’ and ‘Unknown’. Moreover, *Duration of contest* controls for the effect that the period in which the proposals can be submitted has on the number and skills of the self-selected solvers. This control variable indicates how long the contest lasts, and it is measured as the natural logarithm of the number of days between the beginning and the deadline of a contest. In addition, since the platform places contests in different categories, four dummy variables (‘Logo’, ‘Website & Application’, ‘Art, Book & Merchandising’, and ‘Packaging & Advertising’) are used to understand the impact that each *Category of contest* has on the contest attractiveness. Finally, by using ten dummy variables (‘January’, ‘February’, ‘March’, ‘April’, ‘May’, ‘June’, ‘July’, ‘August’, ‘September’ and ‘October’) the effect of the Month in which the contest is launched on the self-selection of solvers is controlled.

6.3.3 Testing hypotheses: econometric analysis and findings

An in-depth analysis of the data was performed to choose the most appropriate approach for testing the research framework investigating the fairness issue in the crowdsourcing for innovation context.

The dependent variable *Active solvers* takes the form of an event count variable, which has only discrete, nonnegative and integer values. Count data frequently follows a Poisson distribution and over-dispersion is a likely downside with Poisson regression (Cameron and Trivedi, 1998; Hausman et al., 1984), thus some tests should be used to assess the over-dispersion of data (Salter et al., 2015). First of all, the Poisson assumption alongside the negative binomial model was tested via the goodness-of-fit (gof) test. Examined in contrast to the Poisson predictions for a model equivalent to Model 1 in Table 12 (Model 1: $\chi 2$ = 37956.38, p = .000), the significant value for chi-square in the gof test is a gauge that the Poisson distribution was not appropriate. This result was double-checked by triangulating the gof test result with the likelihood ratio test, a test of the over-dispersion parameter alpha offered in the output of the negative binomial regression. In this case, the alpha is significantly different from zero (chibar2 = 1.9e+04 p =.000), reinforcing that the Poisson distribution was not a good choice. Consequently, considering the results of the previous tests (gof and likelihood ratio test), the use of the negative binomial specification for estimating the models concerning the dependent variable *Active solvers* was supported.

The dependent variable *Solver rating* takes the form of an event count variable, which has only discrete, nonnegative and integer values. Thus, an ordered logistic model was used. The ordinal logistic model relies upon the proportional odds assumption, which assumes that the odds ratios are constant between each pair of categories in the outcome. This assumption was satisfied for all explanatory variables using the Brant test (Long and Freese, 2006).

Descriptive statistics and correlations are depicted for all variables in Table 11. The pairwise correlation matrix does not reveal any criticalities with respect to the two models estimated. Moreover, for all the models reported in Table 12 and Table 13 the variance inflation factor (VIF) values were calculated (Stevens, 1992). The VIF values of the variables are below the critical level, indicating that the explanatory variables can simultaneously be included in each model.

Regression results are reported in Table 12 and Table 13. These two tables also show the likelihood ratio tests to prove the improvement of the model fit when considering the full models. Table 12 concerns the dependent variable Active solvers. Here, Model 1 operates as a baseline and includes only the control variables. Models 2 and 3 respectively introduce the independent variables Prize and Award guaranteed to test H1a. Then, including the independent variable Non-blind, Model 4 tests H2a. Finally, Model 5 estimates the full model considering all the independent variables.

Table 13 focuses on the dependent variable Solver rating. Here, similarly, Model 6 operates as a baseline and includes only the control variables. Models 7 and 8 respectively introduce the independent variables Prize and Award guaranteed to test H1b. Further, Model 9 tests H2b by including the independent variable Non-blind. Finally, Model 10 estimates the full model considering all the independent variables.

Variable	Mean	SD	Max	Min	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1)Active solver	38.7	51.61	1078	1	1														
(2)Submitted ideas	147.1	181.38	3510	2	0.94*	1													
(3)Rating solver	2.2	1.8	5	0	-0.03	0.01	1												
(4)Firm	0.54	0.50	1	0	0.06	0.09*	0.13*	1											
(5)Private	0.05	0.22	1	0	-0.002	0.01	-0.0005	-0.25*	1										
(6)No profit	0.19	0.40	1	0	-0.02	-0.01	0.02	-0.54*	-0.11*	1									
(7)Unknown	0.21	0.41	1	0	-0.05	-0.11*	-0.18*	-0.56*	-0.12*	-0.25*	1								
(8)Logo	0.64	0.48	1	0	0.31*	0.32*	0.01	0.08*	-0.07*	0.08*	-0.14*	1							
(9)Website&APP	0.11	0.31	1	0	-0.16*	-0.16*	0.14*	-0.03	-0.02	0.08*	-0.04	-0.46*	1						
(10)Packaging&ADV	0.13	0.33	1	0	-0.19*	-0.20*	-0.03	0.12*	-0.05	-0.12*	-0.01	-0.51*	-0.13*	1					
(11)Art,Book&Merch.	0.12	0.33	1	0	-0.11*	-0.11*	-0.11*	-0.21*	0.18*	-0.08*	0.24*	-0.51*	-0.13*	-0.14*	1				
(12)Duration	5.44	6.35	1	100	0.13*	0.11*	0.03	-0.03	-0.02	0.01	0.04	-0.03	0.10*	-0.02	-0.03	1			
(13)Client identity	0.77	0.42	1	0	0.04	0.10	0.18	0.23	0.52	0.08	0.24	0.92	0.11	0.04	0.03	0.23	1		
(14)January	0.10	0.30	1	0	-0.08*	-0.08*	-0.02	-0.04	0.03	0.005	0.03	-0.24*	0.05	0.07*	0.22*	-0.03	0.03	1	
(15)February	0.10	0.29	1	0	0.05	0.07*	-0.03	0.02	0.02	-0.08*	0.04	0.03	-0.004	0.005	-0.04	0.08*	0.02	-0.11*	1
(16)March	0.10	0.30	1	0	0.02	0.01	-0.03	0.004	0.008	-0.003	-0.01	0.03	-0.04	0.01	-0.01	0.04	0.06	-0.11*	-0.11*
(17)April	0.10	0.30	1	0	-0.01	0.01	-0.04	0.02	0.03	0.03	-0.07*	0.07*	-0.02	-0.03	-0.05	-0.02	0.01	-0.11*	-0.11*
(18)May	0.12	0.33	1	0	-0.01	-0.02	0.03	-0.01	-0.05	0.008	0.03	0.002	0.02	0.01	-0.03	-0.05	0-06	-0.12*	-0.12*
(19)June	0.11	0.31	1	0	0.14*	0.13*	-0.001	-0.02	0.005	-0.02	0.04	0.07*	-0.05	-0.004	-0.06	0.05	0.04	-0.11*	-0.11*
(20)July	0.10	0.30	1	0	-0.02	-0.01	-0.01	0.06	-0.02	-0.001	-0.06	0.03	-0.05	0.03	-0.02	-0.05	0.04	-0.11*	-0.10*
(21)August	0.10	0.28	1	0	-0.05	-0.07*	0.006	-0.02	0.03	0.02	-0.01	0.03	0.01	-0.05	0.0004	-0.02	0.04	-0.11*	-0.11*
(22)September	0.10	0.31	1	0	-0.03	-0.04	0.03	-0.03	-0.02	0.03	0.01	-0.002	0.05	-0.02	-0.03	-0.02	0.03	-0.11*	-0.11*
(23)October	0.08	0.28	1	0	-0.001	0.002	0.05	0.02	-0.02	-0.002	-0.01	-0.02	0.03	-0.02	0.02	0.01	0.002	-0.10*	-0.10*
(24)Award	325,1	278.4	3500	20	0.13*	0.15*	0.14*	0.03	-0.04	0.05	-0.07*	-0.14*	0.50*	-0.10*	-0.16*	0.12*	0.07	-0.02	-0.02
(25)Award guaranteed	0.82	0.38	1	0	0.03	0.10*	0.16*	0.28*	0.08*	0.17*	-0.55*	-0.02	0.02	-0.03	0.03	-0.01	0.52	0.004	-0.06
(26)Non-blind	0.68	0.46	1	0	0.15*	0.13*	-0.22*	0.007	-0.01	-0.01	0.01	0.39*	-0.50*	-0.06	-0.04	-0.12*	0.01	-0.06	0.04

	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
(17)April	-0.11*	1									
(18)May	-0.13*	-0.12*	1								
(19)June	-0.12*	-0.11*	-0.13*	1							
(20)July	-0.11*	-0.11*	-0.12*	-0.11*	1						
(21)August	-0.11*	-0.11*	-0.12*	-0.11*	-0.11*	1					
(22)September	-0.12*	-0.11*	-0.13*	-0.12*	-0.11*	-0.11*	1				
(23)October	-0.10*	-0.10*	-0.11*	-0.10*	-0.10*	-0.10*	-0.10*	1			
(24)Award	0.02	0.002	0.05	-0.01	-0.02	-0.05	-0.01	0.05	1		
(25)Award guaranteed	-0.02	0.02	-0.01	-0.06*	0.02	0.04	0.04	0.01	0.02	1	
(26)Non-blind	0.02	0.03	-0.02	0.03	0.03	-0.03	-0.02	-0.02	-0.29*	-0.09*	1

Source: Mazzola et al. (in review)

Table 11. Descriptive statistics and correlations for variables analyzing the (fairness issue)

	Active solver				
	Model 1	Model 2	Model 3	Model 4	Model 5
Client identity	0.0539	0.0489	0.0492	0.0493	0.0250
	(0.126)	(0.119)	(0.126)	(0.126)	(0.118)
Firm	0.0774	0.00426	0.0220	0.0853	-0.0667
	(0.133)	(0.125)	(0.136)	(0.133)	(0.128)
Private	0.137	0.106	0.0827	0.144	0.0350
	(0.155)	(0.146)	(0.158)	(0.155)	(0.148)
No profit	-0.0447	-0.0797	-0.0993	-0.0367	-0.151
	(0.139)	(0.131)	(0.142)	(0.139)	(0.133)
Logo	0.694^{***}	0.499^{***}	0.721^{***}	0.680^{***}	0.519^{***}
	(0.0699)	(0.0672)	(0.0713)	(0.0702)	(0.0682)
Website & APP	-0.656^{***}	-1.150^{***}	-0.631^{***}	-0.590^{***}	-1.023^{***}
	(0.0916)	(0.0942)	(0.0924)	(0.0971)	(0.0983)
Packaging & ADV	-0.609^{***}	-0.663^{***}	-0.585^{***}	-0.599^{***}	-0.608^{***}
	(0.0869)	(0.0819)	(0.0876)	(0.0869)	(0.0825)
Duration	0.399^{***}	0.265^{***}	0.382^{***}	0.408^{***}	0.253^{***}
	(0.0527)	(0.0487)	(0.0529)	(0.0529)	(0.0484)
January	-0.102	-0.0876	-0.101	-0.0977	-0.0773
	(0.0975)	(0.0911)	(0.0974)	(0.0973)	(0.0905)
February	0.0881	0.124	0.0956	0.0862	0.133
	(0.0964)	(0.0902)	(0.0964)	(0.0963)	(0.0895)
March	-0.0627	-0.0342	-0.0592	-0.0649	-0.0306
	(0.0946)	(0.0882)	(0.0945)	(0.0944)	(0.0874)
April	-0.145	-0.126	-0.145	-0.143	-0.122
	(0.0951)	(0.0888)	(0.0950)	(0.0950)	(0.0881)
May	-0.0381	-0.0424	-0.0374	-0.0366	-0.0404
	(0.0906)	(0.0846)	(0.0905)	(0.0905)	(0.0839)
June	0.196^{*}	0.174^{*}	0.200^{*}	0.192^{*}	0.176^{*}
	(0.0938)	(0.0874)	(0.0937)	(0.0936)	(0.0867)
July	-0.0966	-0.0690	-0.0950	-0.0945	-0.0642
	(0.0956)	(0.0895)	(0.0954)	(0.0954)	(0.0887)
August	-0.282^{**}	-0.194^{*}	-0.286^{**}	-0.273^{**}	-0.185^{*}
	(0.0959)	(0.0898)	(0.0958)	(0.0958)	(0.0892)
September	-0.142	-0.0669	-0.149	-0.137	-0.0688
	(0.0943)	(0.0883)	(0.0942)	(0.0941)	(0.0876)
Award		0.501^{***}			0.518^{***}
		(0.0400)			(0.0398)
Award guaranteed			0.117^{+}		0.191^{**}
			(0.0629)		(0.0587)
Non-blind				0.101^{*}	0.153^{**}
				(0.0511)	(0.0477)
Constant	2.486^{***}	0.0946	2.442^{***}	2.397^{***}	-0.207
	(0.131)	(0.226)	(0.132)	(0.139)	(0.235)
N	1067	1067	1067	1067	1067
Log-likelihood	-4636.12	-4559.31	-4634.41	-4634.22	-4549.91
Chi-square test	0.0000	0.0000	0.0000	0.0000	0.0000
Log-likelihood ratio test	-	2.18^{***}	0.54^{*}	0.58^{*}	2.24^{***}

Standard errors in parentheses; $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Mazzola et al. (in review)

Table 12. Negative binomial regression results (fairness issue)

	Rating solver				
	Model 6	Model 7	Model 8	Model 9	Model 10
Client identity	0.362	0.338	0.319	0.438	0.369
	(0.349)	(0.350)	(0.346)	(0.353)	(0.352)
Firm	0.953*	0.935*	0.621	0.800*	0.504
	(0.375)	(0.376)	(0.379)	(0.379)	(0.384)
Private	0.856*	0.860*	0.522	0.717+	0.437
	(0.416)	(0.417)	(0.421)	(0.422)	(0.426)
No profit	0.754+	0.755+	0.405	0.635	0.338
	(0.389)	(0.390)	(0.394)	(0.393)	(0.399)
Logo	0.146	0.0674	0.300	0.352+	0.400*
	(0.185)	(0.188)	(0.188)	(0.189)	(0.195)
Website & APP	0.863***	0.595*	1.003***	0.387	0.314
	(0.256)	(0.279)	(0.259)	(0.268)	(0.291)
Packaging & ADV	-0.0830	-0.100	0.0708	-0.0543	0.0572
	(0.227)	(0.228)	(0.230)	(0.228)	(0.232)
Duration	0.126	0.0633	0.0413	0.0230	-0.0900
	(0.148)	(0.150)	(0.149)	(0.148)	(0.152)
January	-0.277	-0.261	-0.280	-0.248	-0.245
	(0.267)	(0.267)	(0.267)	(0.270)	(0.270)
February	-0.489+	-0.473+	-0.477+	-0.445	-0.428
	(0.272)	(0.272)	(0.271)	(0.274)	(0.274)
March	-0.437+	-0.443+	-0.433+	-0.439+	-0.445+
	(0.261)	(0.262)	(0.261)	(0.264)	(0.264)
April	-0.592*	-0.590*	-0.620*	-0.596*	-0.624*
	(0.262)	(0.262)	(0.263)	(0.265)	(0.265)
May	-0.155	-0.154	-0.197	-0.146	-0.191
	(0.255)	(0.255)	(0.256)	(0.258)	(0.258)
June	-0.311	-0.302	-0.286	-0.322	-0.295
	(0.259)	(0.259)	(0.259)	(0.263)	(0.262)
July	-0.443+	-0.443+	-0.454+	-0.427	-0.445+
	(0.265)	(0.265)	(0.265)	(0.269)	(0.269)
August	-0.298	-0.262	-0.336	-0.343	-0.346
	(0.262)	(0.262)	(0.262)	(0.265)	(0.265)
September	-0.190	-0.157	-0.256	-0.148	-0.185
	(0.260)	(0.260)	(0.260)	(0.262)	(0.263)
Award		0.284*			0.252*
		(0.120)			(0.121)
Award guaranteed			0.801***		0.713***
			(0.193)		(0.195)
Non-blind				-0.868***	-0.787***
				(0.142)	(0.143)
Constant	-0.294	1.082	0.0259	-1.059**	0.525
	(0.367)	(0.688)	(0.374)	(0.389)	(0.725)
N	1067	1067	1067	1067	1067
Log-likelihood	-1791.03	-1788.16	-1782.11	-1772.11	-1763.49
Chi-square test	0.0000	0.0000	0.0000	0.0000	0.0000
Log-likelihood ratio test	-	0.76**	1.25***	1.58***	1.74***

Standard errors in parentheses; + $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Mazzola et al. (in review)

Table 13. Ordinal logistic regression results (fairness issue)

Starting with the control variables, results of Model 1 and Model 6 are analyzed. *Seeker identity* is not significant in both Model 1 and Model 6. Model 1 shows that some dummy variables indicating *Seeker type* are significant; in particular, 'Firm' and 'Private' have a positive effect on the number of active solvers respective to 'Unknown' (omitted since used as baseline category). This suggests that when the seeker is a company or a private entity, solvers are more encouraged to self-select than when the typology of the seeker is not declared in the problem statement. Considering the results of Model 6, the coefficient of ‘Firm’, ‘Private’ and ‘Non-profit’ are positive and strongly significant, meaning that high-skilled solvers generally prefer to participate in a contest when they know the typology of the seeker. Dummy variables indicating the Category of contest are all significant in Model 1; specifically this suggests that ‘Logo’ contests attract a higher number of solvers respective to ‘Art, Book and Merchandising’ contests (omitted since used as baseline category), whereas ‘Packaging & advertising’ and ‘Website & application’ contests attract fewer solvers. Considering Model 6, the only significant contest category is ‘Website & Application’, meaning that high-skilled solvers are more attracted by this kind of contest than by ‘Art, Book and Merchandising’ contests. Moreover, the *Duration of the contest* has a positive effect on the number of *Active solvers* (Model 1) but it has no effect of the *Solvers rating* (Model 6). This result suggests that a long-lasting contest attracts more solvers but high-skilled solvers are not influenced by the duration of the contest when deciding whether to participate or not. Finally, since dummy variables indicating the *Month* are significant both in Model 1 and 6, the period of the year during which the contest is broadcast may influence the attractiveness of the contest in terms of the number and the skills of the self-selected solvers.

Considering the variable *Active solvers*, in Model 2, the coefficient of *Award* is significant, and it has a positive effect on the number of solvers that decide to self-select, thus supporting H1a. H1a finds also support in Model 3 since the coefficient of *Award guaranteed* is significant and positive. Moreover, Model 4 shows a positive and significant coefficient of *Non-blind*, thus confirming H2a. When including all of the explanatory variables, Model 5 further confirms both H1a and H2a.

Focusing on the variable *Solver rating*, Model 7 shows that the coefficient of Prize is significant, and it has a positive effect on *Solver rating*, thus supporting H2a. Model 8 further confirms H2a by showing a significant and positive coefficient of the variable *Award guaranteed*. The variable *Non-blind* has a negative and significant coefficient in Model 9, thus supporting H2a. When including all of the explanatory variables, Model 10 offers further support to both H1a and H2a.

6.3.4 Endogeneity analysis and robustness check

To assess the robustness of the results previously derived, a number of additional analyses were performed. First, the model related to the self-selection of solvers was specified with an alternative dependent variable, *Submitted ideas*, measuring the number of solution proposals submitted in a contest. As shown in Table 14, the results of this robustness analysis are consistent with those performed with the variable *Active solvers* (from Model 1 to Model 5 in Table 12).

	Submitted ideas				
	Model 1a	Model 2a	Model 3a	Model 4a	Model 5a
Client identity	0.0813	0.0904	0.0653	0.0784	0.0591
	(0.128)	(0.122)	(0.128)	(0.128)	(0.121)
Firm	0.276^{*}	0.191	0.108	0.280^{*}	0.0113
	(0.135)	(0.129)	(0.139)	(0.135)	(0.132)
Private	0.345^{*}	0.301^{*}	0.182	0.349^{*}	0.123
	(0.161)	(0.153)	(0.164)	(0.161)	(0.154)
No profit	0.152	0.105	-0.0145	0.155	-0.0823
	(0.142)	(0.135)	(0.145)	(0.142)	(0.137)
Logo	0.589^{***}	0.397^{***}	0.685^{***}	0.583^{***}	0.496^{***}
	(0.0736)	(0.0712)	(0.0743)	(0.0739)	(0.0713)
Website & APP	-0.570^{***}	-1.058^{***}	-0.490^{***}	-0.541^{***}	-0.912^{***}
	(0.0949)	(0.0968)	(0.0944)	(0.101)	(0.0999)
Packaging & ADV	-0.674^{***}	-0.743^{***}	-0.590^{***}	-0.669^{***}	-0.626^{***}
	(0.0900)	(0.0855)	(0.0899)	(0.0902)	(0.0850)
Duration	0.352^{***}	0.213^{***}	0.306^{***}	0.356^{***}	0.172^{***}
	(0.0570)	(0.0529)	(0.0552)	(0.0573)	(0.0506)
January	-0.134	-0.0907	-0.127	-0.132	-0.0740
	(0.101)	(0.0955)	(0.100)	(0.101)	(0.0938)
February	0.117	0.192^{*}	0.139	0.116	0.212^{*}
	(0.102)	(0.0962)	(0.101)	(0.102)	(0.0943)
March	-0.0974	-0.0429	-0.0866	-0.0963	-0.0291
	(0.0999)	(0.0938)	(0.0985)	(0.0998)	(0.0918)
April	-0.135	-0.0933	-0.128	-0.134	-0.0806
	(0.101)	(0.0946)	(0.0994)	(0.101)	(0.0926)
May	-0.106	-0.0622	-0.105	-0.105	-0.0631
	(0.0955)	(0.0899)	(0.0943)	(0.0955)	(0.0881)
June	0.152	0.164^{+}	0.172^{+}	0.151	0.186^{*}
	(0.0998)	(0.0937)	(0.0984)	(0.0997)	(0.0916)
July	-0.107	-0.0469	-0.0927	-0.106	-0.0292
	(0.101)	(0.0950)	(0.0995)	(0.101)	(0.0930)
August	-0.386^{***}	-0.265^{**}	-0.388^{***}	-0.382^{***}	-0.253^{**}
	(0.101)	(0.0953)	(0.0996)	(0.101)	(0.0934)
September	-0.227^{*}	-0.122	-0.241^{*}	-0.224^{*}	-0.130
	(0.0991)	(0.0935)	(0.0979)	(0.0992)	(0.0917)
Award		0.492^{***}			0.516^{***}
		(0.0410)			(0.0404)
Award guaranteed			0.374^{***}		0.437^{***}
			(0.0653)		(0.0610)
Non-blind				0.0437^{+}	0.102^{*}
				(0.0538)	(0.0497)
Constant	3.841^{***}	1.473^{***}	3.662^{***}	3.802^{***}	1.040^{***}
	(0.137)	(0.235)	(0.137)	(0.145)	(0.242)
N	1067	1067	1067	1067	1067
Log-likelihood	-6104.00	-6033.24	-6088.50	-6103.67	-6008.21
Chi-square test	0.0000	0.0000	0.0000	0.0000	0.0000
Log-likelihood ratio test	-	3.15^{***}	1.49^{***}	0.66^{*}	2.25^{***}

Standard errors in parentheses; $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Mazzola et al. (in review)

Table 14. Robustness check using the dependent variable Submitted ideas (fairness issue)

Second, the hypotheses were also assessed by using an OLS regression to perform the models related to both the dependent variables Active solvers and Solvers skill. As shown in Table 15, the results of this second check are consistent with those previously performed (from Model 1 to Model 10 in Tables 12 and 13).

	Active Solver					**Solver skill**				
	Model1	Model2	Model3	Model4	Model5	Model6	Model7	Model8	Model9	Model10
Client identity	2.154	0.302	1.938	1.596	-1.107	0.275	0.252	0.248	0.351	0.301
	(9.112)	(8.853)	(9.119)	(9.112)	(8.841)	(0.313)	(0.312)	(0.313)	(0.308)	(0.307)
Firm	4.251	3.840	2.511	4.979	1.363	0.475	0.470	0.259	0.377	0.185
	(9.575)	(9.300)	(9.870)	(9.579)	(9.562)	(0.329)	(0.328)	(0.338)	(0.324)	(0.332)
Private	4.005	4.643	2.333	4.728	2.348	0.412	0.420	0.204	0.314	0.142
	(11.11)	(10.79)	(11.34)	(11.11)	(10.99)	(0.382)	(0.381)	(0.389)	(0.375)	(0.381)
No profit	-3.158	-1.854	-4.993	-2.532	-4.610	0.286	0.303	0.0576	0.201	0.0172
	(9.992)	(9.707)	(10.31)	(9.993)	(9.981)	(0.344)	(0.342)	(0.353)	(0.338)	(0.346)
Logo	40.65***	57.20***	40.66***	36.05***	50.71***	-0.632***	-0.422*	-0.631***	-0.00794	0.132
	(5.041)	(5.316)	(5.042)	(5.826)	(5.926)	(0.173)	(0.188)	(0.173)	(0.197)	(0.206)
Website&APP	2.250	24.36***	2.255	-1.143	20.02**	-0.818***	-0.537*	-0.817***	-0.358	-0.147
	(6.272)	(6.690)	(6.274)	(6.628)	(6.918)	(0.216)	(0.236)	(0.215)	(0.224)	(0.240)
Packaging&ADV	16.47*	40.97***	15.71*	12.98^{+}	35.01***	-0.968***	-0.657**	-1.062***	-0.495*	-0.343
	(6.465)	(6.988)	(6.550)	(6.831)	(7.275)	(0.222)	(0.247)	(0.225)	(0.231)	(0.253)
Duration	21.68***	16.88***	21.37***	22.45***	17.24***	0.0811	0.0203	0.0427	-0.0231	-0.103
	(3.831)	(3.769)	(3.855)	(3.859)	(3.804)	(0.132)	(0.133)	(0.132)	(0.130)	(0.132)
January	-1.650	0.246	-1.579	-1.699	0.399	-0.259	-0.235	-0.250	-0.252	-0.224
	(7.055)	(6.856)	(7.057)	(7.050)	(6.837)	(0.243)	(0.242)	(0.242)	(0.238)	(0.237)
February	4.496	6.408	4.611	4.114	6.131	-0.404^{+}	-0.380	-0.390	-0.352	-0.322
	(7.089)	(6.889)	(7.092)	(7.088)	(6.874)	(0.244)	(0.243)	(0.243)	(0.239)	(0.239)
March	0.473	1.033	0.580	0.407	1.177	-0.402^{+}	-0.395^{+}	-0.388	-0.393^{+}	-0.375
	(6.895)	(6.698)	(6.898)	(6.891)	(6.680)	(0.237)	(0.236)	(0.236)	(0.233)	(0.232)
April	-4.297	-2.963	-4.317	-4.353	-3.032	-0.519*	-0.502*	-0.522*	-0.512*	-0.500*
	(6.962)	(6.764)	(6.963)	(6.957)	(6.744)	(0.239)	(0.239)	(0.239)	(0.235)	(0.234)
May	-0.398	0.474	-0.444	-0.287	0.592	-0.130	-0.119	-0.135	-0.145	-0.139
	(6.622)	(6.432)	(6.623)	(6.617)	(6.414)	(0.228)	(0.227)	(0.227)	(0.224)	(0.223)
June	16.34*	17.45**	16.47*	16.33*	17.75**	-0.242	-0.227	-0.225	-0.240	-0.213
	(6.862)	(6.666)	(6.866)	(6.857)	(6.649)	(0.236)	(0.235)	(0.235)	(0.232)	(0.231)
July	-3.623	-2.162	-3.588	-3.706	-2.153	-0.356	-0.337	-0.351	-0.345	-0.325
	(6.993)	(6.795)	(6.995)	(6.988)	(6.775)	(0.240)	(0.240)	(0.240)	(0.236)	(0.235)
August	-9.661	-5.796	-9.771	-9.379	-5.409	-0.270	-0.221	-0.284	-0.308	-0.276
	(6.969)	(6.786)	(6.972)	(6.966)	(6.770)	(0.240)	(0.239)	(0.239)	(0.235)	(0.235)
September	-3.566	-0.504	-3.757	-3.603	-0.818	-0.147	-0.108	-0.171	-0.142	-0.130
	(6.865)	(6.679)	(6.872)	(6.861)	(6.664)	(0.236)	(0.236)	(0.236)	(0.232)	(0.231)
Award		24.61***			25.71***		0.312**			0.270*
		(3.079)			(3.094)		(0.109)			(0.107)
Award guaranteed			3.484^{+}		7.210			0.434**		0.387*
			(4.779)		(4.656)			(0.164)		(0.162)
Non-blind				5.901^{+}	9.281*				-0.799***	-0.744***
				(3.748)	(3.663)				(0.127)	(0.127)
Constant	-30.80**	-177.1***	-31.49**	-32.41**	-187.6***	2.389***	0.534	2.303***	2.607***	0.910
	(10.64)	(21.01)	(10.69)	(10.69)	(21.28)	(0.366)	(0.741)	(0.366)	(0.361)	(0.739)
N	1067	1067	1067	1067	1067	1067	1067	1067	1067	1067
R^2	0.149	0.197	0.149	0.151	0.204	0.064	0.072	0.071	0.099	0.108
adj. R^2	0.135	0.184	0.134	0.136	0.188	0.049	0.056	0.055	0.083	0.091
F	10.76	14.32	10.19	10.32	13.38	4.243	4.494	4.419	6.368	6.340

Standard errors in parentheses; $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Mazzola et al. (in review)

Table 15. Robustness check using OLS regression (fairness issue)

Finally, following Echambaldi et al. (2006), endogeneity concerns are addressed. Endogeneity occurs when an explanatory variable is not independent of the error term. This circumstance could happen because of measurement errors, simultaneity/reverse causality or omitted variable bias (Wooldridge, 2002). In the relationships investigated, simultaneity/reverse causality is not a concern since the design of the contest precedes the self-selection of solvers and the submission of proposals. On the other hand, omitted variables bias may be a real concern in the model. For example, other critical contests' mechanisms related to the allocation of property rights to the design submitted and the rules regulating the behavior of solvers within the crowdsourcing community could affect the process of solvers' self-selection (Franke et al., 2013; Bauer et al., 2016). Omitting variables from the regressions because they are not available in the dataset about 99designs contests may raise endogeneity concerns, leading to overestimation of the impact of the variables *Award*, *Award guaranteed* and *Non-blind* on the dependent variables *Active solvers* and *Solver skill*.

To adequately address endogeneity concerns related to *Award*, *Award guaranteed* and *Non-blind*, the instrumental variable (IV) method is used (Wooldridge, 2002; Hamilton and Nickerson, 2003). This method seeks to isolate the endogenous part of the explanatory variables to examine their true causal effect on the dependent variables *Active solvers* and *Solvers skill* by using other variables (i.e., the instruments) which predict the two explanatory variables, but not the dependent variable. Specifically, two different instruments are used, i.e. *Seeker experience* and *NDA*. *Seeker experience* predicts the independent variables *Award* and *Award guaranteed, whereas* the instrument *NDA* predicts the independent variable *Non-blind*.

The first instrument, *Seeker experience*, measures whether the seeker has previously broadcasted one or more contests, and it is operationalized as a dichotomous variable that assumes the value 1 if the seeker has previous experience in crowdsourcing contests, 0 otherwise. This instrument is appropriate to predict *Award* and *Award guaranteed* since when revealing their identities, it is more likely that seekers will set a fair prize award and they will be committed to distributing the prize in order to avoid losses in their reputation. The instrument is validated following Plourde et al. (2014); *Seeker experience* significantly and positively affects *Award* (β=47.8 with p-value=0.018) and *Award guaranteed* (β=2.78 with p-value=0.000) while *Active solvers* and *Solver skill* does not (p-value=0.20 and p-value=0.28, respectively).

The second instrument, *NDA*, measures whether solvers have to sign a non-disclosure agreement before participating in that contest. An *NDA* is an official defensible contract that sets rules about sharing information (Hannah and Robertson, 2015; Witman, 2005). In the crowdsourcing for innovation context, the seeker may have important information that she/he needs to reveal to solvers submitting a solution but not to other third parties. Because the *NDA* imposes confidentiality on solvers, it can be considered a measure of information transparency (Zogaj et al., 2014). This instrument, thus, is appropriate to predict *Non-blind* since it is more likely that seekers will set a blind contest when confidentiality is imposed to solvers in order to protect their information. *NDA* is operationalized as a dichotomous variable that assumes the value 1 if the seeker and the solver decide to engage in a confidential relationship, 0 otherwise. The instrument is validated following Plourde et al. (2014); *NDA* is a valid instrument, as it significantly and negatively affects *Non-blind* (β=-0.57 with p-value=0.000) while *Active solvers* and *Solver skill* does not (p-value=0.25 and p-value=0.15, respectively).

Once the instrumental variables were validated, then it is possible to apply a two-stage regression approach (Wooldridge, 2002; Hamilton and Nickerson, 2003). In Stage 1, the explanatory variables are regressed on their respective instruments. The resulting fitted values are then used in Stage 2 (i.e., in the main models) instead of the endogenous variables. Results of the endogeneity analysis are shown in Table 16.

As Table 16 shows, this additional estimation produced the same results as Table 12 (from Model 2 to Model 4) and Table 13 (from Model 7 to Model 9), alleviating endogeneity concerns while providing consistency and thereby validating previous results.

	Active solvers			Solver rating		
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Client identity	0.00339	-0.412	0.0892	0.276	-1.857**	0.393
	(0.127)	(0.256)	(0.148)	(0.349)	(0.705)	(0.347)
Firm	0.0457	0.0952	-0.00632	0.848*	1.100**	0.933*
	(0.133)	(0.132)	(0.154)	(0.375)	(0.386)	(0.373)
Private	0.176	0.193	0.0874	0.934*	1.109*	0.876*
	(0.156)	(0.157)	(0.177)	(0.416)	(0.432)	(0.415)
Other	-0.0755	-0.0205	-0.138	0.646^{+}	0.914*	0.714^{+}
	(0.139)	(0.138)	(0.161)	(0.390)	(0.401)	(0.388)
Logo	0.688***	0.873***	-0.0647	0.151	0.880**	0.151
	(0.0697)	(0.109)	(0.460)	(0.185)	(0.272)	(0.185)
Website & APP	-0.676***	-0.498***	-0.610***	0.829**	1.498***	0.829**
	(0.0916)	(0.117)	(0.101)	(0.256)	(0.310)	(0.256)
Packaging & ADV	-0.609***	-0.411**	-0.565***	-0.0786	0.719*	-0.0786
	(0.0866)	(0.127)	(0.0980)	(0.227)	(0.315)	(0.227)
Duration	0.394***	0.397***	0.374***	0.133	0.130	0.133
	(0.0524)	(0.0524)	(0.0568)	(0.149)	(0.148)	(0.149)
January	-0.0987	-0.0930	-0.0581	-0.247	-0.258	-0.247
	(0.0971)	(0.0974)	(0.109)	(0.267)	(0.266)	(0.267)
February	0.107	0.0941	0.0643	-0.438	-0.461^{+}	-0.438
	(0.0963)	(0.0963)	(0.108)	(0.272)	(0.272)	(0.272)
March	-0.0557	-0.0666	-0.0536	-0.395	-0.424	-0.395
	(0.0943)	(0.0944)	(0.104)	(0.261)	(0.260)	(0.261)
April	-0.150	-0.143	-0.103	-0.593*	-0.615*	-0.593*
	(0.0948)	(0.0950)	(0.103)	(0.262)	(0.262)	(0.262)
May	-0.0470	-0.0399	0.00838	-0.127	-0.173	-0.127
	(0.0903)	(0.0904)	(0.100)	(0.254)	(0.254)	(0.254)
June	0.181^{+}	0.198*	0.144	-0.312	-0.284	-0.312
	(0.0936)	(0.0936)	(0.105)	(0.259)	(0.259)	(0.259)
July	-0.0893	-0.0976	-0.122	-0.422	-0.454^{+}	-0.422
	(0.0952)	(0.0954)	(0.105)	(0.265)	(0.264)	(0.265)
August	-0.267**	-0.283**	-0.266*	-0.268	-0.330	-0.268
	(0.0956)	(0.0957)	(0.105)	(0.261)	(0.261)	(0.261)
September	-0.127	-0.148	-0.133	-0.144	-0.242	-0.144
	(0.0941)	(0.0942)	(0.103)	(0.260)	(0.259)	(0.260)
Award	0.482**			1.208*		
	(0.172)			(0.470)		
Award guaranteed		0.877*			4.285***	
		(0.420)			(1.168)	
Non-blind			1.918^{+}			-2.831*
			(1.128)			(1.102)
Constant	-0.143	1.952***	1.740***	1.074	0.0389	-1.014*
	(0.949)	(0.286)	(0.506)	(0.673)	(0.374)	(0.389)
N	1067	1067	1067	1067	1067	1067
Log-likelihood	-4632.14	-4633.95	-3840.4	-1786.20	-1783.72	-1787.18
Chi-square test	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

The independent variables *Award* and *Award guaranteed* are instrumented with the variable *Seeker experience*, while the independent variable *Non-blind* is instrumented with the variable *NDA*.

Standard errors in parentheses; $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Mazzola et al. (in review)

Table 16. Results of endogeneity analysis (fairness issue)

6.4 Discussion about the fairness issue

This chapter was intended to investigate how seekers can design fair crowdsourcing for innovation contests increasing the self-selection of solvers and, specifically, attracting the most competent ones (Mazzola et al., in review). In order to conduct this investigation, a netnography analysis (Kozinets, 2002; Kozinets et al., 2014) on the solvers' posting in the 99designs crowdsourcing platform was conducted. From this analysis, it has emerged that three fairness characteristics of contests might explain solvers', and especially high-skilled solvers', participation behavior. Then, a research framework was developed leveraging on the findings offered by the netnography together with reasoning drawn from fairness theory (Adams, 1965; Gilliland, 1993). The framework specifically addresses three characteristics of crowdsourcing contests, i.e. award, award guaranteed and non-blind, that seekers can utilize as fairness leverages to increase the self-selection of solvers and attract highly skilled solution providers. Finally, the framework was assessed through a dataset collecting quantitative data from a sample 1067 contests broadcasted on the 99designs platform.

The empirical analysis supports the relationships conceptualized in the research framework through hypotheses H1a, H1b, H2a and H2b, and two main findings can be derived from it. First, results confirm the effect that fair outcome-related crowdsourcing contest characteristics, i.e. the award and the award guaranteed, have a strong impact on the self-selection of solvers from the crowd, as hypothesized in H1a. Both the amount of prize and award influence perceptions of distributive and procedural fairness (Franke et al., 2013; Faullant et al., 2017). There is an obvious relationship between outcome issues and distributive fairness: people generally respond positively to outcomes that are more favorable (van den Bos et al., 1997; Lambert, 2003). For high-skilled solvers, the relationship is more complicated – the prize award could be viewed as too low to match their expertise. In the sample, high-skilled solvers placed a greater emphasis on outcomes than other self-selected solvers in the design contests. As concerns the perceived sense of fairness in distributing incentives to solvers, results confirm that the amount of money awarded and the commitment of seekers in paying out the award signal to high-skilled solvers that the seeker is fair enlarging the number of contest's competitors with a high level of competences. As such, the number of high-skilled solvers that self-select to participate in a contest is higher when the amount of money they can win is greater and guaranteed, as suggested in formulating H1b. This result reveals that high-skilled solvers care about the equity of resource distribution and they perceive that their efforts will be fairly remunerated with a higher award than low-skilled solvers. Furthermore, this result suggests that since high-skilled solvers consider earning money the primary reason to participate in a contest (Brabham, 2008; Schemmann et al., 2016) they are likely more concerned about the commitment of the seeker in paying out the prize than low-skilled solvers.

Second, as suggested in H2a, results show that non-blind contests have a strong impact on the self-selection of solvers. This result reveals that, generally, solvers have concerns about the procedures and rules that regulate crowdsourcing for innovation contests and they are more willing to participate in contests where such procedures are transparent. Solvers, in fact, perceive as fair those contests where the proposals submitted by other solvers are visible to everyone since, for example, in such a case it is possible to assess whether the judgments of seekers about these proposals are fair. Moreover, the results related to the contests' attribute non-blind show important findings concerning the difference between the fairness perception of low-skilled and high-skilled solvers. In fact, in accordance to H2b, results show that high-skilled solvers and low-skilled solvers differ primarily in how they perceive procedural fairness. Particularly, non-blind contests negatively influence the self-selection of high-skilled solvers. A possible explanation of this result is that high-skilled solvers might be afraid that other solvers, especially the low skilled ones, can copy their design (Bauer et al., 2016; Schemmann et al., 2016). This result is line with Cohen-Charash and Spector (2001: 280) research indicating 'solvers create their procedural fairness judgments with regard to their beliefs of how the systems or procedures "should" operate'. Thus, comparing the advantages and disadvantages of non-blind contests, high-skilled solvers perceive openness as an unfair characteristic that exposes them to the possibility other solvers can steal their ideas leading them to prefer blind contests.

The results discussed in this chapter can offer important contributions to previous literature and provide managerial implications to seeker companies designing crowdsourcing for innovation contests. The thesis discusses these contributions and implications in the next chapter.

Chapter 7
CONCLUSION

7.1 Introduction

This final chapter aims at drawing together findings and discussion derived from the investigation of the three explored crowdsourcing issues. The main contributions and the managerial implications are here critically reviewed and potential limitations of the thesis are highlighted.

The organization of the chapter is divided into five sections. This chapter begins with the summary and conclusions of the present thesis. Hence, the main theoretical contributions to crowdsourcing for innovation literature offered by this thesis are presented in section three, while section four highlights the managerial implications. Finally, the limitations and suggestions for further research are outlined at the end of this chapter.

7.2 Summary and conclusion

The main purpose of this thesis was to provide an answer to the under-investigated question: *how seekers can design appropriate contests in order to capture value from crowdsourcing for innovation?* Particularly, to address this question the thesis focused on the seekers' point of view and investigated some important decisions that seekers have to make when designing a crowdsourcing for innovation contest. As such, this doctoral thesis gathered the seekers' decisions investigated in the three research articles on which this thesis is based and it addressed three unexplored issues related to the design of crowdsourcing for innovation contests. The first issue concerns the management of the Intellectual Property Rights (IPR) of the winning solution and it is related to the seekers' choice to acquire or licensing-in the IPR from the crowd. The second issue addresses the governance structures and it is linked to the seekers' decision between establishing unilateral or bilateral relationships with the winning solvers at the end of the contest. The third issue concerns the fairness and it is related to the seekers' decision about how to design fair crowdsourcing for innovation contests.

Therefore, to investigate these three unexplored issues, the purpose of this thesis was further broken down into three research questions:

1) What guides seekers in choosing a level of ownership of IPR arrangements when acquiring intellectual property from the crowd? How this decision, in turn, influences the performance of crowdsourcing for innovation contests?
2) What influences seekers in deciding the governance structure of the working relationship they will establish with the winning solver?
3) How seekers can boost the self-selection of a large pool of solution providers and spread the participation of highly skilled solvers by designing fair crowdsourcing for innovation contests?

The theoretical approaches utilized to answer these research questions have been presented in Chapter 3. This chapter has examined the several perspectives describing how each of them can support the investigation of the three unexplored research questions. Then, in Chapter 4, which is based on the research article titled "'To Own or Not to Own?' A study on the Determinants and Consequences of Alternative Intellectual Property Right Arrangements in Crowdsourcing for Innovation Contests", the role of IPR in crowdsourcing for innovation contest has been investigated. In this chapter, a research framework was conceptualized leveraging on both PRT and problem-solving perspective to answer the first research question outlined (Mazzola et al., 2018). Moreover, the chapter has empirically assessed the research framework through secondary data collected from the InnoCentive crowdsourcing platform. Then, it has validated the hypotheses and suggested seekers decide between alternative IPR arrangements considering the attributes of the problem broadcasted and this choice, in turn, affect the solvers' self-selection. Moreover, the results of this chapter have highlighted that the IPR arrangement plays a mediating role between the attributes of the contests and its performances.

Chapter 5, which is based on the research article titled "Considerations on seeker and solver relationship in innovation contests", has investigated the governance structures regulating the seeker-solver working relationship. This chapter has conceptualized a research framework leveraging on both KBV and problem-solving perspective to answer the second aforementioned research question (Piazza et al., 2018). Hence, the chapter has empirically assessed the research framework gathering secondary data from the NineSigma crowdsourcing platform. The chapter, then, has validated the hypotheses and suggested that seekers decide between unilateral and bilateral governance structures considering the attributes of the problem broadcasted.

Finally, leveraging on the research article titled "Treating the Crowd Fairly: Increasing the attractiveness of crowdsourcing challenge", Chapter 6 has addressed the fairness leverages a seeker can use to design fair crowdsourcing for innovation contests. This chapter has conceptualized a research framework to answer the third research question outlined by leveraging on Fairness theory and netnography analysis conducted on the 99designs crowdsourcing platform (Mazzola et al., in review). Then, the chapter has empirically assessed the research framework gathering secondary data from the 99designs crowdsourcing platform. The chapter, then, has validated the hypotheses and suggested seekers can attract a large pool of solvers in crowdsourcing contests using appropriate distributive and procedural fairness leverages.

The set of findings discussed in Chapter 4, 5 and 5 have the potential to offer several contributions to previous literature and important implications to seekers designing crowdsourcing for innovation contests. Such potential contributions and implications are discussed in following.

7.3 Theoretical contributions to crowdsourcing for innovation literature

This thesis offers several important contributions to the crowdsourcing for innovation literature. Specifically, this thesis provides theoretical contributions with reference to the three crowdsourcing issues investigated, i.e. the Intellectual Property Right, the governance structure of the seeker-solver relationship and the fairness issues. Moreover, gathering together the contributions of each investigated issue this thesis also advances some overall theoretical contributions to the crowdsourcing for innovation literature.

7.3.1 Contributions from the Intellectual Property Right issue

This thesis broadens the understanding of IPR issues in the crowdsourcing for innovation context by highlighting the role played by the IPR arrangement. Specifically, three main contributions are offered by this thesis from the investigation on the IPR issue.

First, results from this thesis extend previous research on the legal aspects of crowdsourcing contests (de Beer et al., 2017) by addressing the antecedents a seeker firm focuses on when deciding the degree of ownership to use in order access intellectual assets from the crowd. In fact, except for de Beer et al. (2017) who have focused on the legal issues a seeker faces when acquiring IPR from the crowd, previous research has disregarded to investigate the antecedents that determine whether seekers are more likely to acquire or license-in IPR from winning solvers. While previous researchers have mainly focused on the most effective IPR arrangements for a specific type of partner in collaborative innovation, the arguments developed in this thesis focus on how the attributes of the technical problem dictate the degree of ownership (acquire or license-in the IPR to the winning solution) of the IPR arrangement in innovation contests. Specifically, by adopting the problem solving perspective (Nickerson et al., 2017; Nickerson and Zenger, 2004) and leveraging on PRT (Alchian and Demsetz, 1972; Grossman and Hart, 1986; Hart and Moore, 1990), this thesis demonstrates that the seekers' choice between alternative IPR arrangements depends on two attributes of the problem broadcasted. The first attribute is related to the external field of knowledge capabilities (e.g. software engineering, chemistry, business) required to solve the innovation problem (Mayer et al., 2012). The second attribute concerns the stage of development of the problem, that is when collaboration with solvers takes place considering the innovation process (Manzini and Lazzarotti, 2016; Veer et al., 2016). As such, this thesis suggests the decision about the degree of ownership may rely on the knowledge required to solve the technical problem and its development stage; for example, acquiring knowledge may be essential for long-term, strategic complex problems at the development stage, instead of the ideation stage.

Second, this thesis contributes to the literature that focuses on crowdsourcing performance by demonstrating how alternative IPR arrangements differently influence the solvers' self-selection process. Previous crowdsourcing scholars, recognizing the self-selection of the crowd as crucial to increase the performance of the contest, have deeply explored intrinsic and extrinsic motivations that increase the solvers' willingness to participate, such as the prize award and the attributes of the technical problem (e.g. Boudreau et al., 2011; Jeppesen and Lakhani, 2010; Terwiesch and Xu, 2008; Ye and Kankanhalli, 2017; Zheng et al., 2011). In this context, Franke, et al. (2013) also highlighted that transparency about the terms and conditions regarding the ownership of the IP affect the solvers' willingness to participate. However, so far, there were no studies considering how IPR arrangements with alternative ownership levels influence the solvers' decision to engage in a crowdsourcing for innovation competition. Thus, this work extends the research on the performance of crowdsourcing contests (e.g. Boudreau et al., 2011; Jeppesen and Lakhani, 2010; Terwiesch and Xu, 2008; Ye and Kankanhalli, 2017; Zheng et al., 2011) by providing empirical evidence that the IPR arrangement is a key driver of the performance of the contest. Moreover, suggesting the IPR arrangement plays a mediating role between the attributes of the problem and the performance of the contest, this thesis also adds to the crowdsourcing literature in that the attributes of crowdsourcing contests affect the performance of the contest both directly and indirectly through the IPR arrangements.

Finally, since crowdsourcing for innovation contests are open innovation activities to access external knowledge, this thesis adds to the open innovation debate about the role of appropriation mechanisms by highlighting the relevant role played by IPR arrangements for seekers aiming to capture value from the crowd. So far, the OI literature has scarcely investigated the role of IPR (Hagedoorn and Zobel, 2015). Furthermore, this literature shows an interesting debate that divides OI scholars between authors that advocate the advantages of IPR protection for firms active in OI activities (e.g. Chesbrough and Chen, 2013; Pisano and Teece, 2007), and scholars that, on the contrary, stress the tension between IPR and OI (e.g. Pénin, 2011; (von Hippel and von Krogh, 2003). In particular, the first group of authors suggests that in the OI context, IPR arrangements can ensure firms the possibility to capture value from their innovative activities since the protection offered by IPR facilitates exchanges of intellectual assets between parties. The second group of authors stresses that no firm should be allowed to appropriate any intellectual asset by using an IPR mechanism. According to them, the protection offered by IPR mechanisms might threaten OI, limiting access to intellectual assets and transferring control to a single owner. The results offered by this thesis support the first group of scholars who highlight the need for firms to use IPR mechanisms, such as IPR arrangements, when engaging in OI activities (e.g. Chesbrough and Chen, 2013; Pisano and Teece, 2007), in opposition to those contributors who emphasize IPR mechanisms are not appropriate in this context (e.g. Pénin, 2011; Von Hippel and von Krogh 2003). This thesis, then, adds to OI literature suggesting that firms engaging in crowdsourcing activities prefer to adopt specific acquisition mechanisms as value capture mechanisms in order to benefit from the innovation developed by the crowd. Specifically, by examining two types of IPR arrangements (high vs. low level of ownership) this thesis shows that seeker companies may prefer to adopt different acquisition mechanisms in crowdsourcing for innovation contests according to their innovation needs.

7.3.2 Contributions from the governance issue

Examining the seekers' decision between alternative unilateral and bilateral governance structure to manage the working relationships with winning solvers, this thesis contributes to the crowdsourcing literature offering two interesting insights.

First, this thesis provides evidence that seekers develop preferences toward specific governance structures for managing the working relationship with the winning solver when they launch the contests. Although growing scholarly attention has been paid towards crowdsourcing governance implications, these scholars have mainly investigated the governance decision whether or not to crowdsource (Afuah and Tucci, 2012; Malhotra and Majchrzak, 2014; Pénin and Burger-Helmchen, 2011; Poetz and Schreier, 2012) neglecting to investigate the governance structure that manages the seeker-solver working relationship at the end of a contest. Adopting the problem-solving perspective (Nickerson and Zenger, 2004; Nickerson et al., 2017) and leveraging on the KBV perspective (Grant, 1996; Kogut and Zander, 1992), this thesis demonstrates that the seekers' choice between alternative governance structures depends on the attributes of the problem they are attempting to solve. Specifically, results suggest two attributes of the problem broadcasted guide seekers in taking this decision: the possibility to describe the innovation problem in details and the distance between the knowledge required to solve the innovation problem and the solver's existing knowledge capabilities.

Second, providing evidence that governance structure decisions vary with knowledge requirements, defined as the key problem attributes, this thesis highlights the complementary potential of problem-solving and KBV perspectives in investigating knowledge-governance considerations in the crowdsourcing context (Nickerson and Zenger, 2004). However, even if the complementarity of the problem-solving perspective and the knowledge-based view has great potential in investigating governance issues, these two perspectives are not sufficient to explain the complex process of knowledge transfer between seekers and solvers in the crowdsourcing for innovation context. In fact, to explain the unexpected and counterintuitive result related to the relationship between the search space of the problem and the governance structure preferred by the seeker, Real Options theory (Folta, 1998) has been invoked. Different from the Knowledge-Based View and the problem-solving perspective, the Real Options approach emphasizes the role played by uncertainty in affecting governance structure decisions (Leiblein, 2003). When transferring distant and unfamiliar knowledge, seekers may lack the capabilities to absorb the new knowledge from the crowd and may be unable to integrate it leveraging on their existing capabilities (Cohen and Levinthal, 1990). In such a case, seekers are uncertain about to the value they are able to capture from establishing a relationship with the winning solvers. Considering this uncertainty in their decision processes about the working relationship, seekers may prefer a unilateral governance structure as an initial investment to experiment with the distant knowledge of the winning solution while evaluating the possibility of following up on this investment with a more committed relationship with a bilateral governance structure. Thus, the Knowledge-Based View and the problem-solving perspective offer better predictions for the preferred governance structure when considering the tacit knowledge related to the problem broadcast, while the Real Options theory provides better support when considering the risks a seeker company faces when engaging in distant knowledge searches. In conclusion, governance considerations in the crowdsourcing context need to be investigated under several theoretical approaches to take on board all the complex facets that characterize the knowledge transfer in a crowdsourcing relationship.

7.3.3 Contributions from the fairness issue

By exploring the fairness leverages that influence the solvers' self-selection in crowdsourcing for innovation contests and affect the attractiveness of the contest to high-skilled solvers, this thesis provides two important contributes to the literature.

First, analyzing qualitative and quantitative contests' data this thesis provides evidence of a link between solvers' perception of fairness and three contests' attributes, i.e. the award, the award guaranteed and non-blind contest. This thesis suggests seekers need to take into consideration the potential reactions of community members to perceptions of fair crowdsourcing outcomes and processes. Only Franke et al. (2013), in their experimental study, have previously highlighted the importance of 'fairness' in the crowdsourcing for innovation context. In addition to intrinsic and extrinsic motivations, solvers consider the distribution of resources (distributive fairness) and the process of selecting the winning solution (procedural fairness). This is the first study, however, that adopts a seeker's perspective in investigations of the role of fairness and specifically explores fairness leverages that seekers can use when designing crowdsourcing contests not only to attract more solvers but specifically to attract those more skilled and competent.

Moreover, this thesis offers also valuable contributions to better understanding the relationships between seekers and solvers in crowdsourcing for innovation context. In fact, fairness considerations are critical for understanding the degree to which the agency problem may exist in a seeker-solver relationship. Specifically, under the lens of behavioral agency theory (Pepper and Gore, 2015; Wiseman and Gomez-mejia, 2016), the success of a crowdsourcing contest originates from principals (seekers) attracting the agents (solvers) to which delegate innovation problems in order to find solutions (Afuah and Tucci, 2012). Principals and agents may have not aligned goals, priorities and risks, and these dissimilarities, described as the agency problem, may lead to setbacks in their working relationship. Particularly, behavioral agency theory places the solvers' performance and their motivations at the center of the agency model, arguing that seekers and solvers interests are most likely to be aligned if solvers are motivated to solve the delegated innovation problems. According to the lens of behavioral agency theory, the main source of conflict in the seeker-solver relationship is the lack of fairness (Gefen et al., 2016; Gomez-Mejia et al., 2005; Pepper and Gore, 2015). Considering the perceived sense of fairness in both distributing incentives to solvers and organizing fair procedures and rules that regulate the contest, this thesis suggests that increasing the fairness perception of solvers, seekers may enlarge the number of self-selected competitors in their contest. Thus, in line with the behavioral agency theory (Pepper and Gore, 2015; Wiseman and Gomez-Mejia, 1998), fairness leverages fulfilling the sense of justice of 'inequity averse' solvers lead solvers to trust the seeker and so self-select for participating in that crowdsourcing for innovation contests (Fehr and Schmidt, 1999; Feller et al., 2012).

7.3.4 Theoretical contributions from the investigation of the contests' design

The findings from the empirical investigations of the three investigated crowdsourcing for innovation issues related to the design of contests lead up to several overall theoretical contributions to this strand of literature.

First, by analyzing unexplored issues related to the design of crowdsourcing for innovation contests this thesis adds to previous literature theoretical explanations about how seekers can effectively rely on crowdsourcing for innovation and capture value from the crowd by designing appropriate contests (Schenk et al., 2017; Tucci et al., 2018). Specifically, this thesis provides theoretical enlightenment on how alternative IPR arrangements allow seeker companies to effectively leverage on crowdsourcing contests balancing their need to capture value from the crowd and the solvers' concerns about sharing or ceding their IPR. Moreover, this thesis offers theoretical argumentations on how different governance structures support the knowledge transfer in the relationships between seekers and winning solvers. Finally, additional reasoning that theoretically highlights the critical role played by fairness in crowdsourcing for innovation contests and explains how seeker can leverage on distributive and procedural tools for designing fair crowdsourcing contests for increasing the solvers' self-selection and attracting the most competent one is suggested by this thesis.

Second, findings demonstrate that even it is possible to identify an overarching theory to investigate the design of crowdsourcing for innovation contests and even if each other theoretical approach that together with the overarching Problem-solving perspective has been useful to explain the different issues of crowdsourcing for innovation, this is not sufficient to explain the whole crowdsourcing for innovation phenomenon. This means that none of the theoretical rationales presented in this thesis are holistic. They each explain crowdsourcing for innovation from a narrowed point of view that is insufficient to capture the complexity of the phenomenon. As such, this thesis indicates that crowdsourcing for innovation needs to be investigated under several theoretical approaches in order to take on board all the diverse and complex facets characterizing, in general, this phenomenon and, more in particular, the design of crowdsourcing contests, i.e. the management of IPR, the knowledge transfer in crowdsourcing relationships and the importance of fairness perceptions.

Additionally, existing literature suggests it is very difficult to conduct research collecting secondary data from real crowdsourcing platforms because confidentiality issues are particularly relevant in this field and because crowdsourcing platforms do not build databases including extensive information (Natalicchio et al., 2017). In fact, very few studies dealt with highly granular data (e.g. Boudreau et al., 2011; Jeppesen and Lakhani, 2010), while the great majority used simulation methodology (e.g. Franke et al., 2013; Natalicchio et al., 2017; Terwiesch and Xu, 2008). Thus, this thesis adds to the previous literature by providing evidence retrieved from analyzing real-world data collected from three different crowdsourcing for innovation platforms. Different from prior crowdsourcing studies (e.g. Franke et al., 2013; Terwiesch and Xu, 2008), archival data are not subjective and are not prey to experimenter-imposed bias. The external validity of previous results was thus enhanced by the use of data on actual behaviors (analysis of solvers' postings and contests data) instead of simulated actions.

7.4 Managerial implications of the study

This thesis offers managers and contest organizers that decide to source new knowledge and innovative ideas from the crowd specific guidance on how to design crowdsourcing for innovation contests. With reference to the three crowdsourcing issues investigated, this thesis provides managerial implications on the decision concerning alternative IPR arrangements, the choice of appropriate governance structures for managing the relationships with solvers and the design of fair crowdsourcing for innovation contests that increase solver' self-selection and attract the most competent ones.

More in detail, considering the IPR issue companies' managers have to align their decisions about acquiring or licensing the IPR to the winning solution with the attributes of the problem they are attempting to solve. Managers have to consider two main attributes of the problem, i.e. the stage of development of the problem when it is broadcasted and the nature of knowledge required for solving it. Since it is possible to capture a higher value from RTP contests than from an ideation or a theoretical one, companies' managers should acquire the IPR to the winning solution when broadcasting RTP contests. In turn, managers should choose to license-in the IPR of problems' solutions involving a greater number of different knowledge domains, since they may not be able to assess the quality of the solution proposals. Further, it could be unproductive to choose an IPR arrangement without considering the effects that the IPR arrangement has on the performance of the contest. Particularly, seeker companies have to be aware that by choosing to acquire the IPR related to the winning solution, solvers may be discouraged from participating in that contest. Thus, because IPR arrangements that call for the acquisition of the IPR to the winning solution can jeopardize the performance of the contest, seekers have to balance the allocation of value by offering higher monetary and non-monetary rewards to solvers that have to fully transfer their IPR.

Moreover, contest organizers of the crowdsourcing platform have to consider the mediating role played by the IPR arrangement in a crowdsourcing for innovation contest. When supporting firms in the delineation of the problem to be solved, platform managers have to suggest their clients consider the stage of development of the problem and the nature of the knowledge required to solve it as critical attributes of the problem. In particular, they have to advise seeker firms to align their appropriation strategies with such problem attributes. Also, the crowdsourcing platform may have to advise their clients about the effect of different IPR arrangements on the performance of the contest, and they have to be aware that the allocation of the contest's value is organized in such a way as to ensure solvers are not discouraged from participating. In fact, hosting contests that motivate solvers to participate and, at the same time, safeguard a fair distribution of value among seeker firms and solvers is vital for the crowdsourcing platform, since its success and reputation rely on the capacity to attract both parties and match their needs through crowdsourcing for innovation contests.

Focusing on the governance issue, managers have to match their decisions about the governance structure to manage the crowdsourcing relationship with the attributes of the problem broadcasted. In particular, companies' managers should prefer bilateral governance structures (e.g., a joint development contract) when they cannot provide the crowd with a detailed formulation of the problem at the moment it is broadcast. In such a circumstance, in fact, more interaction and face-to-face personal contact between seekers and solvers are required to share knowledge that is not possible to codify through writing or drawing. Further, seeker managers should govern the crowdsourcing relationship through unilateral structures when pursuing the objective of insourcing knowledge that is located far away from their existing knowledge competencies. In such a case, since seekers may not be able to assess the true value of the solution and absorb the related knowledge, it could be preferable to engage firstly in a less committed relationship to start exploring unfamiliar knowledge and then evaluate more costly and tighter relationships. Finally, seekers should not be concerned about the decomposability of the problem when evaluating the governance structure of crowdsourcing relationships. Specifically, seekers have to be aware of the role of the crowdsourcing platform in helping them to evaluate solution proposals involving interrelated components of knowledge and to develop a common language to share knowledge with the winning solver.

Moreover, managers from crowdsourcing platforms have to suggest their seeker clients to consider the formulation of the problem there are attempting to solve and the extent of familiarity they have with the knowledge required to solve it, as two critical attributes of the problem. In particular, they have to advise seeker firms to choose appropriate governance structures to manage the crowdsourcing relationships that well match with such problem attributes.

Finally, considering the fairness issue, managers should design fair innovation contests to increase solvers self-selection and attract high-skilled ones. That is, managers need to be aware of the perception of fairness that solvers have about the contests. Specifically, to attract a large pool of solvers and draw the most competent ones, managers might design an appropriate reward that creates a sense of equity for solvers about the amount of effort they put into developing their solution proposals and the money they will receive for winning the contests. Moreover, managers should also design specific reward mechanisms to increase the solvers' level of trust in the seeker companies. For example, by being committed and assuring that they will pay out the award at the end of the contest, a seeker can attract a larger number of solvers and increase the participation of the high-skilled ones. Moreover, the promise of a clear, straightforward and transparent crowdsourcing process increases participation in a contest. This assurance can be attained by including non-blind clauses when designing a contest. In fact, when solvers can see the solutions proposed by other solvers they obtain information, feedback and suggestions made by the seeker regarding those submissions that increase the transparency about the system of judgment adopted by the seeker in selecting the winning proposal. However, to increase the participation of high-skilled solvers, seekers have to also be aware of the phenomena of copying between solvers and consider implementing detecting systems that assure high-skilled solvers the protection of their intellectual properties.

In this regard, contest organizers of the crowdsourcing platform have to advise seekers about the critical role played by the fairness in a crowdsourcing for innovation contest. When supporting firms in the design of contests, platform managers have to suggest their clients to fairly set the amount of money the winning solver will receive and to guarantee they will pay out the award in order to increase the attractiveness of contests. Moreover, they have to warn seeker companies about the dual effect that non-blind contests have, in general, on the self-selection of solvers and, in particular, on the self-selection of the high-skilled ones.

In sum, gathering together the managerial implications of each investigated issue this doctoral thesis highlights the importance for managers to design appropriate crowdsourcing for innovation contests in order to capture value from crowdsourcing as a mechanism to source new knowledge and technology beyond their boundaries.

7.5 Limitations on the study and directions for future research

The results of this study should be appraised considering its limitations that could lead to future research directions. First, the analyses are based on three ad-hoc datasets gathering secondary data. The major limitation related to these kinds of data is that the data already exists, and so new constructs of interest cannot be added to it. Secondary data analysis lacks a confirmatory empirical analysis that can effectively demonstrate that the interpretation of data is appropriate. Moreover, some of the measures built through such secondary data could be subject to some limitation due to the lack of secondary data information. For example, considering the crowdsourcing performance, this variable could also be measured by considering the quality of the solution proposed by solvers, the extent to which seekers are satisfied with the solutions or how well the winning solution fulfills predefined criteria. Focusing on seeker-solver working relationships, seekers are often flexible with regard to the specific governance structure and may be willing to accept a variety of forms of collaboration. Thus, different measures capturing the governance structure preferences of seekers could be better refined to reflect the varying degrees of collaboration that seekers are willing to establish. In addition, since it is very difficult to gather data about seekers from real crowdsourcing platforms because of confidentiality issues (Natalicchio et al., 2017), the datasets do not take into account such information. However, the seeker firms' industries and strategies, the importance of solving the problem broadcasted and the necessity to quickly fix it and their abilities may affect the seekers' reasoning about their decisions and preferences. For example, the IPR arrangement decision may be influenced by the experience seekers have accumulated over their previous open innovation activities. Using real data from primary data sources (e.g. conducting a survey) in future researches may be valuable in including additional control variables about seeker companies, in deriving more refined measures, in conducting a better-grounded analysis and in deepening the understanding about the relationships investigated in the research frameworks.

Second, it may also be valuable to consider the seekers' preferences and decisions toward, for example, alternative IPR arrangements or different governance structures, in the different phases of the innovation projects they are pursuing. In crowdsourcing for innovation contests, in fact, seeker companies may need to decompose their innovation problems into smaller tasks in order to make it easier for the crowd to resolve it (Sieg et al., 2010; Afuah and Tucci, 2012). However, this thesis does not consider how the problems broadcasted in the contests are related to the whole innovation projects of the seeker companies. Thus, future research may overcome this limitation by collecting real longitudinal data about the innovation projects of the companies in order to consider the task they are broadcasting along with such innovation projects.

Third, this thesis analyzes how seeker companies can design appropriate crowdsourcing for innovation contests to increase the solvers' self-selection and so to receive a large number of solution proposals, disregarding the possible drawbacks of such phenomenon known in the literature as *crowding* (Piezunka and Dahlander, 2015). In fact, since seeker organizations have a limited attention span, when they receive a large number of solution proposals they can attend to only a subset of proposals. This circumstance can jeopardize the success of crowdsourcing contests since when the crowding narrows the attention of seekers, it is more likely that seekers will pay attention to those proposals more familiar to their existing knowledge and capabilities instead of those more distant and innovative. Thus, future research may investigate how seekers can design appropriate crowdsourcing contests to balance the need to increase the self-selection of solvers and the need to avoid crowding concerns.

Fourth, it may also be noteworthy for future research to consider the differences between crowd, communities and virtual networks when addressing the IPR issue and the considerations about governance and fairness. Crowds, communities and virtual networks differ in the motivations to contribute to online activities and in the sense of belonging of their individuals (Budhathoki and Haythornthwaite, 2013). Thus, future research may investigate, for example, how alternative IPR arrangements differently mediate the relationships between the attributes of the task crowds, communities and virtual network have to perform and their commitment to perform it.

Fifth, future research may also pay further attention to new mediators and moderators and investigate possible interaction effects between the constructs built in the three research frameworks. For example, one possibility would be to examine a causal association concerning procedural fairness and distributive fairness in the crowdsourcing context (Brockner and Wiesenfeld, 1996; Greenberg, 1987; Leventhal, 1980). In fact, Leventhal proposed that perceived procedural fairness consequently affected perceptions of distributive fairness. As he stated, *"[…] such evaluations affect the perceived fairness of the final distribution of reward. If the procedures are seen as fair, then the final distribution is likely to be accepted as fair even though it may be disadvantageous"* (Leventhal, 1980, p. 36).

Moreover, this thesis focuses on three different crowdsourcing for innovation platforms that have been considered as the most appropriate platforms in line with the research direction to investigate the three objectives proposed in the thesis. However, this thesis has disregarded to investigate how the design of crowdsourcing for innovation contest, with reference to the explored seekers' decisions about IPR arrangement, governance and the fairness, differs in the three selected platforms. In fact, although each platform is surely the most appropriate research context for the issue under investigation, it would be unwise to broadly generalize the findings to every crowdsourcing platforms. Future research may leverage on communities of practices and networks of practices literature (e.g. Lave and Wenger 1991; Wenger, 1998; Wasko and Faraj, 2005) to conduct, for example, a comparative study that analyzes the differences in the design of contests between those broadcasted in crowdsourcing for innovation platforms focused on technology-related problems (e.g. InnoCentive and NineSigma) and those focused on design-related problems (e.g. 99designs).

Finally, future studies may investigate the three seekers' decisions related to the IPR arrangements, the governance structures and the fairness leverages in a unique research framework. This thesis explores the seekers' decisions in crowdsourcing platforms characterized by business models that strongly differ between each other. Considering, for example, the governance issue, it would have been not possible to investigate this topic leveraging on contests broadcasted in the InnoCentive platform instead of the NineSigma one. In fact, InnoCentive platform does not envisage that the winning solver engages in a working relationship with the seeker, instead, it considers that the solver licenses-out or sells the IP outright in exchange of a monetary award. Thus, future research could try to integrate the three research frameworks in a whole framework and investigate the design of crowdsourcing for innovation contests considering the three issues related to the IPR, the governance of the seeker-solver working relationship and the fairness in a unique research context, for example, by using primary data and conducting a survey interviewing both seekers and solvers.

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