O.A. ACAR

Crowdsourcing for Innovation

Unpacking Motivational, Knowledge and Relational Mechanisms of Innovative Behavior in Crowdsourcing Platforms

CROWDSOURCING FOR INNOVATION:

UNPACKING MOTIVATIONAL, KNOWLEDGE AND RELATIONAL MECHANISMS OF INNOVATIVE BEHAVIOR IN CROWDSOURCING PLATFORMS

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Crowdsourcing voor innovatie: Motivationele, kennisgerelateerde en relationele mechanismen van innovatie-gedrag op platforms voor crowdsourcing.

Thesis

To obtain the degree of Doctor from the
Erasmus Universiteit Rotterdam by
command of the
rector magnificus

Prof.dr. H.A.P. Pols

and in accordance with the decision of the Doctorate Board.

The public defence shall be held on
25 September 2014, at 13:30 hrs

by

Oguz Ali ACAR

born in **Konya, Turkey**

ERASMUS UNIVERSITY ROTTERDAM

Doctoral Committee

Promotor:	Prof.dr. J.C.M. van den Ende
Committee members:	Prof.dr. G.H. van Bruggen
	Prof.dr. H.W.G.M. van Heck
	Dr. O. Baumann

Erasmus Research Institute of Management – ERIM
The joint research institute of the Rotterdam School of Management (RSM)
and the Erasmus School of Economics (ESE) at the Erasmus University Rotterdam
Internet: http://www.erim.eur.nl

ERIM Electronic Series Portal: http://hdl.handle.net/1765/1

ERIM PhD Series in Research in Management, 321
ERIM reference number: EPS-2014-321-LIS
ISBN 978-90-5892-368-4

Design: B&T Ontwerp en advies www.b-en-t.nl

This publication (cover and interior) is printed by haveka.nl on recycled paper, Revive®.
The ink used is produced from renewable resources and alcohol free fountain solution.
Certifications for the paper and the printing production process: Recycle, EU Flower, FSC, ISO14001.
More info: http://www.haveka.nl/greening

To my parents – Ahmet and Yaşar Acar.

ACKNOWLEDGEMENTS

In the last couple of years, I was looking forward to this very moment: being at the stage of writing the final piece of my PhD dissertation… While I am delighted to see that my hard work over the years has come to fruition and am very excited for the new beginning ahead, my feelings are somewhat bittersweet because of ending the PhD chapter of my life which has involved some really challenging times and many unforgettable memories. I was very fortunate to have many wonderful people with me in overcoming those challenges and in making those unforgettable memories; my PhD journey would have been entirely different without them.

I would like to start by expressing my deep gratitude to my promoter, Jan van den Ende, for being such a great supervisor and for supporting and guiding me throughout my PhD. Thanks a lot for being accessible and supportive when I neededyou, for providing me with the academic freedom and room to grow as an independent researcher, and for being patient with my occasional stubbornness. I will particularly miss your jokes and the fun we had in our meetings.

I owe a special debt of gratitude to Melissa Schilling for inviting me to Stern to work together on one of the chapters of this dissertation and for generously helping me in my job-searching process. I also would like to thank my committee members, Gerrit van Bruggen, Eric van Heck, Oliver Baumann, Michael Jensen and Daan Stam, for the time and energy they devoted to reviewing my dissertation. I am honored that my efforts have been evaluated by such high-caliber scholars. In addition, I want to thank Jim Berry for his insightful suggestions and support in data collection for one of the studies in this dissertation, and Markus Baer and Fiona Murray for their valuable feedback on the earlier versions of the two studies that are reported in this thesis.

The insights provided in this dissertation largely depend on the data that I collected from InnoCentive. I am very grateful to them – in particular to Dwayne Spradlin, Michael Albarelli, Marilyn Toomey and Lyndsey Stadtmueller – for showing great interest in my research, being very open to a close collaboration and generously supporting my data collection. I also want to thank the members of the InnoCentive community who participated in my interviews and survey. In addition, I would like to thank Jasper Michiel van Hemert from TomTom for providing expert ratings for the new product ideation experiments presented in this thesis.

I was blessed to be in some very stimulating environments during my PhD. First, I want to thank all the colleagues from my department, and particularly the faculty of the Innovation group – Jan van den Ende, Daan Stam, Murat Tarakci, Dirk Deichmann and Serge Rijsdijk – our department head, Jan Dul, and the mother of our department, Carmen Meesters-Mirasol, for providing continuous support and input in my academic journey and for making the 10th floor a *second home* for me. I also want to thank the members of our neighboring Marketing Department for pleasant conversations and exchange of ideas in the coffee room and the corridors of our floor, and specifically my thanks go to Christoph Fuchs, Stefano Puntoni, Nailya Ordabayeva and Bram van den Bergh for their help in my job search. Our dean, Steef van de Velde, was also incredibly generous with his support during my job search. I would also like to thank the people in Erasmus Research Institute of Management (ERIM) Office – especially to Tineke, Miho, Natalija and Kim – for making PhD life as easy as it can get. In addition, I want to thank the entire faculty of the Management and Organizations Department at NYU Stern – in particular Melissa Schilling, JP Eggers, Zur Shapira, Gino Cattani, Elizabeth Morrison and Batia Wiesenfeld – and fellow PhD students at NYU, especially Elad Green, Daniel Keum and Joost Rietveld, who were very warm to me during my visit and helped a lot to make my time in New York fabulous both from an academic and personal standpoint. I also want to thank the members of MIT Collective Intelligence Center – particularly Robert Laubacher and Eric Duhaime – for having me as a visiting scholar in their center and for sharing their exciting projects with me. I also want to thank all the scholars who attended my presentations at numerous conferences and seminars for their valuable comments and questions. I would also like to take this opportunity to gratefully acknowledge the financial support of ERIM and my department for these research visits, data collection efforts and participation in academic conferences.

I feel privileged to have had around me many amazing people who contributed greatly to the making of many memorable moments during my PhD journey. Special thanks go to my great friends and paranymphs, Adnan and Nilhan, for loads of drinks, talks, gossips and laughter; to Murat and Dirk for being my usual *smitse-mate* and always providing insightful suggestions to my various academic (and non-academic) problems; to Barış, Zeynep, Melek, Nüfer, and Ezgi for the hours of fun we had together all over Rotterdam; to my colleagues who became good friends over time, particularly Philip, Sandra, Lameez, Stefanie, Başak, Amir, Nima, Aybars, Merlijn, Maartje, Ruben and many others for making social part of my PhD a very entertaining one; to Hakkı for joining me in unforgettable weekend and summer trips; to my other friends from Eindhoven, especially Merih and Levent, for great memories and fun activities at weekends; and to my old friends from Turkey, specifically Gökhan, Barış, Halil, Buket and Uğur, for making me feel that you are with me here even though we cannot get in touch as much as we want to. I also owe special gratitude to Ayla who had a major impact in changing the course of my academic career (and life) towards the end of my PhD.

Last, but certainly not least, I owe my most heartfelt gratitude to the people who made me the person I am today: my beloved family, I am blessed to have you in my life and to have your support during my PhD. My dear mom, Yaşar Acar, without your overwhelming, endless and unconditional love, I would not have been strong enough to cope with the challenges that (PhD) life brings. Ahmet Acar, dad, if I had not been fortunate enough to have an intellectual and insightful father like you, I would probably never have understood the real value of education and have considered a PhD in the first place. Thank you for helping me with your calmness and guidance to remain on track, especially at the times when I felt hopeless and demotivated, and for inspiring me to be the best person I can be. My beautiful sisters, Melahat and Hayriye, I know you hated the idea of me being far away from you, but thank you very much for believing in me and for cheering me up along the way with your unstinting patience and love. My brothers-in-law, Mehmet and Süleyman, I would like to thank you for being proud of me as your older brother. Also, a cute little princess, my lovely niece Zeynep, deserves a special thank you for giving me a real energy boost towards the end of my PhD. And finally, my sweet brother Mete, *the Pasha*, you have been the best surprise of my life and a continuous source of joy and inspiration for me throughout my PhD. Sevgili ailem, bugün bulunduğum noktayı desteğiniz ve sevginize borçluyum. Sizin gibi bir ailem olduğu için kendimi çok şanslı hissediyorum. İyi ki varsınız!

For all other family, colleagues and friends – who have read up to this point to find their name – thank you very much for supporting me in one way or other during my PhD adventure.

With love, gratitude and pride,

Oğuz

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Chapter 1

INTRODUCTION

Innovation has long been considered an important capability for the survival, success and growth of companies. The traditional approach for organizations to build innovation capabilities has been to develop internal innovation capability by means of investment in R&D capabilities since these capabilities are regardad as a strategic asset for competitive advantage (Baldwin & von Hippel, 2011; Chesbrough, 2003). Social and economic changes, market structure and technological advances have put pressure on organizations to move towards a more open model of innovation while providing immense opportunities (Chesbrough, 2003; Dahlander & Gann, 2010). The benefits of openness have been extensively highlighted by researchers, and the importance of external sources for organizational innovativeness has also been widely recognized. Scholars have found that using ideas 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., Brown & Eisenhardt, 1995; Laursen & Salter, 2006; Powell, Koput, & Smith-Doerr, 1996; Rosenkopf & Nerkar, 2001; Shan, Walker, & Kogut, 1994). Research has also focused on the role of different external sources, including customers (e.g. Von Hippel, 1976), suppliers (e.g. Brown and Eisenhardt, 1995), competitors (e.g. Allen, 1983), universities (e.g. Broström and Lööf, 2008) and other institutions (e.g. Laursen and Salter, 2006).

An emerging external channel for open innovation which offers great potential is crowdsourcing. The Internet and advance of communication technologies have brought unprecedented opportunities for organizations to tap into diverse ideas, knowledge and creative potential all over the world. Many organizations typically use either tournament-based crowdsourcing (where members of the crowd compete with each other in a contest) or collaboration-based crowdsourcing (where members of the crowd collaborate with each other) to harness the innovative potential of the crowd (Afuah & Tucci, 2012; Bayus, 2013). Two well-known examples of tournament-based crowdsourcing are InnoCentive and TopCoder. They act as an intermediary between the organizations and the crowd, post the innovation problems in their online platform and organize contests aimed at solving them. Among others, organizations such as Toyota, Procter & Gamble and NASA are actively using these platforms. Another well-known example of tournament-based crowdsourcing was Netflix's 1 million dollar contest for an algorithm to improve its existing recommendation system by at least 10 percent where the company used an open call to the world to encourage crowd participation. In collaboration-based crowdsourcing, a large community typically generates, discusses and evaluates ideas repeatedly over time (Bayus, 2013). For example, Dell and Starbucks have their own dedicated online platforms for crowdsourcing. They have received hundreds of thousands of ideas since starting these platforms and have already implemented more than a thousand of those ideas.

POTENTIAL OF CROWDSOURCING FOR INNOVATION

Crowdsourcing is highly important for innovation for several reasons. First, it enables organizations to access a pool of knowledge that is larger and more diversified than any single organization, no matter how large, would have on its own. A knowledge pool of this kind is highly important for innovation as it allows an organization to tap into multiple sources of diverse knowledge; this, in turn, is likely to stimulate innovativeness as innovation is often cumulative and generated by recombining existing knowledge (Fleming, 2001; Murray & O'Mahony, 2007). There is substantial empirical evidence to highlight the benefits of new, diverse and distant knowledge for developing new capabilities (e.g. Gavetti & Levinthal, 2000; March, 1991), producing path-breaking innovations (e.g. Fleming, 2001; Nerkar & Roberts, 2004), and shaping the evolution of an industry (e.g. Owen-Smith & Powell, 2004; Rothaermel & Deeds, 2004).

Second, crowdsourcing increases the likelihood of reaching extreme outcomes (Boudreau, Lacetera, & Lakhani, 2011; Terwiesch & Ulrich, 2009) as it typically attracts a large number of ideas and solutions (Afuah & Tucci, 2012) and therefore increases the chances of achieving at least one outstanding outcome. Because innovation is all about extremes, rather than overall averages, such outstanding outcomes are fundamental for innovation (Dahan & Mendelson, 2001; Girotra, Terwiesch, & Ulrich, 2010).

Third, innovation is a complex and uncertain process which involves trial and error, experimentation and false steps (Loch, Terwiesch, & Thomke, 2001; Sommer & Loch, 2004). As several ideas are generated, developed and tested concurrently in crowdsourcing (particularly when solving technical problems), this parallel processing helps to reveal in advance potential failures or false steps. This is not only more cost-effective compared to internal development, as payments are made only for the successful ideas, solutions and experiments, but it also has great potential for shortening the innovation process (i.e., improving cycle times) as some of the problems that might prevent or slow down the innovation process can then be foreseen.

OVERVIEW OF THE DISSERTATION

Although using crowdsourcing as an innovation source for exploring creative ideas and solutions is becoming more common for organizations and has immense potential to improve innovativeness, research has lagged behind these recent developments. Scholars have recently started to highlight the importance of integrating different theories in order to understand the dynamics of crowdsourcing platforms (Boudreau et al., 2011; Lampel, Jha, & Bhalla, 2012; Terwiesch & Ulrich, 2009). The main purpose of my thesis is to expand our understanding on the dynamics of crowdsourcing for innovation. That is, I aim to shed light on the behavioral, social, and contextual factors behind the generation and sharing of innovative ideas in crowdsourcing platforms. I addressed these questions by using a broad theoretical lens and integrating multidisciplinary perspectives from management literature on innovation, social psychology literature on creativity, and economics literature on knowledge disclosure and creation.

This thesis explicitly addresses the use of crowdsourcing practices to improve innovation processes. To elaborate, it examines crowdsourcing of ideas and solutions that are developed for the front end of new product development processes and for overcoming problems that arise in new product development processes. In addition, I focus specifically on tournament-based crowdsourcing – contests in which organizations disclose details of their innovation-related problem to an undefined and typically large group of individuals, invite voluntary participation by anyone who considers himself/herself qualified to solve the problem, and make an award for the solution they decide to be the best (Afuah & Tucci, 2012; Howe, 2006; Jeppesen & Lakhani, 2010; Terwiesch & Xu, 2008). Some studies refer to this phenomenon by names such as innovation contests (Boudreau et al., 2011; Terwiesch & Xu, 2008), innovation tournaments (Terwiesch & Ulrich, 2009), design competitions (Lampel et al., 2012) or broadcast search (Jeppesen & Lakhani, 2010).

I collaborated closely with InnoCentive – one of the largest tournament-based crowdsourcing platforms in the world and the global leader in crowdsourcing innovation problems. Our collaboration included company visits, collecting archival data on problems broadcast in the InnoCentive platform, undertaking a large field survey with the InnoCentive solver community, conducting qualitative interviews with solvers and employees and extracting textual data from the Internet. In addition to this rich field data, in collaboration with TomTom I conducted new product idea-generation experiments.

This thesis takes a behavioral perspective and focused on the factors relating to innovative outcomes (i.e., ideas and solutions) devised by the members of the crowd. This was because I believe that having a deep understanding of individuals that make up the crowd is one of the central steps in giving us a better understanding of crowdsourcing and enabling us to use its immense potential. Put differently, it is crucial to understand the heterogeneity of the crowd in terms of motivations, attitudes, abilities, and perceptions, and how that heterogeneity influences the behavior of the crowd. To elaborate, this thesis sheds light on how the crowd's innovative behavior and performance (i.e., creative engagement and problem-solving performance) in a specific contest is influenced by contest-specific factors (e.g., reward size), individual factors (e.g., motivations, expertise) and the interplay between these factors. It also addresses how crowd members differ in their attitudes toward the parties on the other side of the exchange (i.e., those who receive the ideas and those who organize the contests), looking at issues which are critical for the disclosure of innovative outcomes, such as participants' trust in the contest organizers and their fears that the knowledge they disclose might be used opportunistically by others. As a whole, by understanding behavioral, motivational and ability-related differences in various crowdsourcing contests and the effects they can have on the innovative outcomes produced, and by recognizing individual differences in attitudes to sharing outcomes, I aim to explain how crowdsourcing platforms can be better designed.

In the first study, I and my coauthor examined the motivational mechanisms of creativity in a crowdsourcing platform. To that end, we investigated how the interplay between monetary rewards – one of the most extensively used ways of motivating people to a particular outcome and a key element of the design of crowdsourcing contests – and the motivation of crowd members influence the creativity of the ideas generated. Creativity is extremely important for organizational innovativeness because the success of innovation and new product development very often depends on the creativity of the ideas underlying them. By drawing on recent research on the psychological consequences of money, we identified prosocial motivation as a contingency that determines the form and strength of the relationship between rewards and creativity. More specifically, we suggest that rewards would have a positive effect on creativity for people with low prosocial motivation; however, this effect would be diminished with increased levels of prosocial motivation. In addition, we argue that rewards would affect creativity through the primary avenue of creative self-efficacy. We triangulated empirical evidence for these hypotheses from a large field survey in a crowdsourcing platform and an idea-generation experiment in a laboratory. The primary contribution of this study is that it sheds light on the controversy about the relationship between rewards and creativity, and extends our understanding of the motivational mechanisms of creativity in crowdsourcing platforms. This study is presented in several academic conferences and seminars including Academy of Management Annual Meeting (2013) and Organization Science Winter Conference (2012), and currently being prepared for submission to a management journal. I am the first author of this paper and the promoter of this dissertation, Jan van den Ende, is a co-author.

In the second study, we addressed knowledge mechanisms of problem solving in crowdsourcing platforms. Specifically, we investigated how problem-solving performance is influenced by the interplay between the crowd member's level of expertise in the problem to which a solution is being sought and the knowledge search that the crowd member conducts. The core idea in this study is that problem-solving performance is the result of individuals' expertise and the specific behaviors they engage in when searching for a solution. By analyzing knowledge-search behavior used to tackle 139 innovation problems, we found that, as predicted, expertise is positively related to problem-solving performance when it is complemented by appropriate knowledge-search behavior. More specifically, expertise was expected to have a positive effect on performance only when a broad knowledge search was used. Although broad search was required for the performance-enhancing effects of expertise, breadth of the search was not enough on its own. For such positive effects, the knowledge search should also be shallow in the problem domain and in domains that are outside the problem domain, but should be deep in domains that are related to the problem domain (i.e., domains that are at the boundaries of the problem domain). By bringing together psychology literature on how expertise affects problem solving and management literature on the link between knowledge search and problem solving, this study sheds light on previously rather equivocal findings on how expertise and problem-solving performance are related. It also explains the knowledge mechanisms behind problem solving in crowdsourcing platforms – of great importance as problem-solving effectiveness is essential for organizational innovativeness and performance (Atuahene-Gima & Wei, 2011; Nickerson & Zenger, 2004). From a practical standpoint, organizers of crowdsourcing contests can benefit from our findings by encouraging specific knowledge-search behavior. This study is presented in Copenhagen Conference on Innovation and Entrepreneurship, and currently being prepared for submission to a management journal. I am the first author of this paper and the promoter of this dissertation is a co-author. This paper also benefited highly from feedback of Melissa Schilling.

In the third study, we focused on relational mechanisms of knowledge disclosure in crowdsourcing platforms. To that end, we examined individual differences in the main relational risk in crowdsourcing platforms and one of the most critical factors in solvers' knowledge-sharing behavior: fear of opportunism (Arrow, 1962; Szulanski, 1996). By conducting qualitative interviews and surveys with people who disclose knowledge in a crowdsourcing platform, we found that there are individual differences in the degree to which they fear opportunism, and that women and older participants have significantly less fear of disclosing their knowledge. We explain this relationship in terms of the better emotional regulation and stronger orientation towards altruism that aging may bring and gender differences in perceptions of the sincerity and good intentions of others. Also, trust in the intermediary organization is crucial in mitigating such fears. This study has important implications for micro-level knowledge theory and helps to clarify the relational relational mechanisms of knowledge disclosure in crowdsourcing platforms. This study is presented in Academy of Management Annual Meeting 2013 and Organization Science Winter Conference 2013, and currently invited for *revise and resubmit* at an interdisciplinary journal. I am the first author of this paper and the promoter of this dissertation is a co-author.

In the final chapter, I summarize and integrate the findings of the three studies and provide an overview of motivational, knowledge and relational underpinnings of idea generation and sharing in crowdsourcing platforms. I then discuss the general theoretical implications of this thesis for the management, psychology and economics literatures, together with its practical implications for better management of crowdsourcing platforms. Finally, I highlight some potentially fruitful avenues for future research that could help to give us a more comprehensive understanding of how to harness the power of the crowd for the purposes of innovation.

Chapter 2

CAN'T BUY ME CREATIVITY? THE ROLE OF PROSOCIAL MOTIVATION AND CREATIVE SELF-EFFICACY IN THE REWARD-CREATIVITY LINK

INTRODUCTION

Organizations are continuously in need of, and on the look-out for, creative ideas to improve their processes, develop new products or find the next big breakthrough in their industry. Quite often, they use monetary rewards to encourage their employees, customers or others to engage in creative activities for them (Baer, Oldham, & Cummings, 2003; Boudreau & Lakhani, 2013). For example, KPN, the largest telecommunication company in the Netherlands, pays employees for their creative ideas, with amounts ranging from about 20 to 10,000 Euros (van Dijk & van den Ende, 2002). Many other companies spend millions of dollars to utilize the creative potential of the people on the Internet; for instance, the total rewards given for ideas and solutions in InnoCentive, one of the largest online platforms for creative idea generation, exceeds 40 million dollars.

Despite the extensive use of monetary rewards to encourage engagement in creative activities, most of the creativity literature advises against using rewards to stimulate creativity (George, 2007; Hennessey & Amabile, 2010). This argument stems from self-determination theory which postulates that external factors (including rewards) will diminish the perceptions of self-determination (i.e., feelings of being the originator of one's own behavior) and, in turn, intrinsic motivation and creativity (Amabile, 1996; Gagne & Deci, 2005). The self-determination perspective is accepted very broadly in the creativity literature (Shalley, Zhou, & Oldham, 2004; Zhou & Shalley, 2003); however, another group of scholars argue that monetary rewards will increase creativity as long as those rewards are tied to a creativity goal (Eisenberger & Armeli, 1997; Eisenberger & Rhoades, 2001). This stream of research embraces a goal-setting perspective: that is, rewards are valuable in clarifying the goal of the activity and in encouraging goal-directed behavior. Proponents of both opposing perspectives on the reward-creativity link have provided considerable empirical evidence for their arguments, and debate over the direction of the effects of rewards on creativity has continued throughout the past decade (Hennessey & Amabile, 2010). In their review of the creativity literature, Zhou and Shalley (2003: 204) termed this controversy over the relationship between rewards and creativity "the paradox of rewards".

In this paper, we take a step towards resolving this paradox by introducing prosocial motivation as a moderator of the reward-creativity link. Prosocial motivation refers to the desire to expend effort to help other people (Grant, 2007, 2008). Drawing on recent literature on the psychological consequences of money (Vohs, Mead, & Goode, 2006, 2008), we theorize that people with low prosocial motivation will respond positively to increased monetary rewards, as predicted by goal-setting theory; however, this positive effect will be diminished at higher levels of prosocial motivation, in line with the rationale of self-determination theory. Although recent research found that the reward-creativity relationship might change depending on the reward characteristics (e.g., reward contingency, choice of reward) or task characteristics (e.g., task complexity) (Baer et al., 2003; Byron & Khazanchi, 2012), there has been little research to address the possibility that the effects of rewards may not be uniform across all individuals (for an exception, see Baer et al. [2003]). Our study demonstrates how different individuals respond to the same reward differently, and introduces an internal psychological process (i.e., prosocial motivation) that might be an important factor in explaining why rewards stimulate or inhibit creativity. In so doing, the paper provides a conceptual framework to reconcile the two opposing theoretical views on the reward-creativity link.

We shed further light on 'the paradox of rewards' by identifying a psychological mechanism that underlies the interaction effect of monetary rewards and prosocial motivation on creativity. Building on the theories of self-efficacy development (Gist & Mitchell, 1992), we introduce creative self-efficacy – defined as the individual's belief that he or she has the ability to generate creative outcomes (Tierney & Farmer, 2002) – as a key mediating mechanism in the reward-creativity link. We argue that increased monetary rewards will have different efficacy cues (i.e., information cues relating to the formation of self-efficacy) for individuals with different levels of prosocial motivation, which will in turn influence creative self-efficacy judgments and subsequent creativity. Although prior research has focused almost exclusively on intrinsic motivation as the main underlying mechanism between contextual factors (including rewards) and creativity, only a few studies have tested empirically whether intrinsic motivation actually mediates the link between the context and creativity (Shalley et al., 2004; Zhou & Shalley, 2003). Moreover, these studies have shown inconsistent results (e.g., Shalley & Perry-Smith, 2001; Shin & Zhou, 2003). This is why George (2007: 445), in her review of the creativity literature, suggested that "rather than assume that intrinsic motivation underlies creativity, researchers need to tackle this theorized linkage more directly and in more depth". By including both intrinsic motivation and creative self-efficacy in our model, we follow this suggestion and go beyond the widely held assumption in the creativity literature that *singular* mediating process of intrinsic motivation explains the internal processes of the reward-creativity link (Hennessey & Amabile, 2010; Shalley et al., 2004).

We tested our hypotheses in a field study, and subsequently in a lab experiment which supports both the internal and external validity of our results. Our field study is in the context of a crowdsourcing platform: InnoCentive. Crowdsourcing is a recent approach that is increasingly being used to harness the creative potential of people on a global scale; organizations broadcast their innovation problems via an online platform and thereby attempt to reach individuals throughout the whole world in order to generate ideas for solving those problems (Afuah & Tucci, 2012; Boudreau & Lakhani, 2013). By examining creativity in a crowdsourcing platform, we contribute to a greater understanding of the emerging phenomenon of crowdsourcing, which has remarkable potential for improving organizational innovativeness (Jeppesen & Lakhani, 2010; Lampel et al., 2012; Nishikawa, Schreier, & Ogawa, 2013). We started our analysis by conducting interviews and content analyses to explore perceptions of monetary rewards and the role of prosocial motivation in InnoCentive. We then conducted a large-scale survey with community members from the InnoCentive platform. In the laboratory experiment, using different operationalizations of creative self-efficacy and creativity, we constructively replicated the findings of the field study in a controlled environment.

Our research makes three main theoretical contributions to the creativity and motivation literature. First, by theorizing on how and why rewards impact creativity in different ways according to an individual's prosocial motivation, our study takes the first steps towards developing a theoretical rationale for reconciling the opposing perspectives of goal-setting and self-determination theories on the reward-creativity link. Second, we introduce and provide important first empirical evidence for a new mediating mechanism on the reward-creativity link, as we demonstrate that the interaction effect of prosocial motivation and rewards influences creativity primarily by increasing feelings of self-efficacy in relation to the creative task. Third, we extend recent research that focuses on motivational interactions to explain creativity. This line of research has demonstrated that intrinsic and prosocial motivations have synergistic effects on creativity (Grant & Berry, 2011); however, other potential motivational interactions remain unknown. Our study therefore adds to motivation and creativity literature by identifying an unexplored motivational interaction that has an influence on creativity, namely between an extrinsic source of motivation (i.e., monetary rewards) and prosocial motivation. As a whole, our study contributes to a deeper understanding of the complex motivational processes involved in creativity by providing a comprehensive theoretical framework, which integrates goal-setting and self-determination theories, self-interested and other-oriented motivations, and internal psychological mechanisms of creativity.

THEORETICAL BACKGROUND AND HYPOTHESES

Rewards and Creativity

The emphasis of this paper is on building a better understanding of how rewards influence creativity. In the prior literature, creativity is often defined from an outcome perspective – creativity refers to development of novel *and* useful ideas (Amabile, 1996; George, 2007). Less research has been focused on creativity from a process perspective, that is, where creativity refers to engagement in creative activities independent of the qualities of the outcome (Drazin, Glynn, & Kazanjian, 1999; Shalley et al., 2004). In this paper, we incorporate both perspectives in our theoretical model, and use *creativity* as an umbrella term encompassing both the outcome and process perspectives of creativity. We use the term *creative engagement* to denote the process view of creativity and use *creative performance* to specify the outcome view. Our theorizing and focus in this paper will be on the monetary rewards that are offered for creativity (i.e., creativity-contingent rewards) because this reflects the basic logic behind using rewards to enhance creativity (i.e., rewards direct effort and attention to the activity they are given for) and because monetary rewards are one of the most common forms of rewards used by organizations to motivate employees to engage in creative (and non-creative) activities (Baer et al., 2003; Gerhart, Rynes, & Fulmer, 2009; Prendergast, 1999; van Dijk & van den Ende, 2002)

The literature on the relationship between rewards and creativity is divided mainly into two opposing camps (Baer et al., 2003; Shalley et al., 2004; see Byron & Khazanchi, 2012, for a meta-analysis). On the one hand, often drawing on self-determination theory, scholars have postulated that rewards are detrimental to creativity (Amabile, 1996; Hennessey & Amabile, 2010). Empirical evidence for this view mostly comes from experimental studies that involved children and young adults as subjects and from tasks that addressed artistic creativity such as drawing or story-writing (e.g., Amabile, Hennessey, & Grossman, 1986; Kruglanski, Friedman, & Zeevi, 1971). Baer and his colleagues (2003) also provided support for this view in a field study, noting that for complex tasks there is a negative relationship between rewards and creative performance. On the other hand, some scholars have argued that rewards will enhance creativity (e.g., Eisenberger & Armeli, 1997; Eisenberger & Aselage, 2009). This line of research embraces a goal-setting perspective, although often without mentioning this explicitly. Empirical research provides support for this view in both field studies and experiments with children and college students (e.g., Eisenberger & Armeli, 1997; Eisenberger & Rhoades, 2001).

As a whole, the two opposing schools of thought on the reward-creativity link have highlighted two distinct functions of rewards in influencing creativity: informational and controlling (Byron & Khazanchi, 2012; Shalley et al., 2004). Scholars who draw on goal-setting theory highlight the informational aspects of rewards while largely neglecting the possibility that rewards can diminish feelings of autonomy. Scholars who embrace self-determination theory, however, emphasize the controlling aspects of rewards but often disregard the informational function of rewards in terms of directing effort and attention towards being more creative. Moreover, both streams have often predicted that rewards will affect the creativity of different individuals in a fairly uniform way and they have generally overlooked the role of psychological factors in determining how individuals respond to rewards (for an exception, see Baer et al. [2003] who studied the moderating role of cognitive style). We argue that individual differences might be of importance in integrating these contradictory predictions as to the link between reward and creativity because individuals give diverse meaning to, and respond differently to, the same contextual factors (Drazin et al., 1999; Oldham & Cummings, 1996; Woodman, Sawyer, & Griffin, 1993).

Moderating Role of Prosocial Motivation

Our core premise in this paper is that the level of prosocial motivation determines how monetary rewards will be perceived and, in turn, how they will influence creativity – i.e., engagement and performance in creative activities. Prosocial motivation refers to the desire to exert effort in order to help and benefit others (Grant, 2007, 2008). We expect that people with high prosocial motivation for a task might perceive the rewards as more controlling, and therefore respond to increased monetary rewards in line with the predictions of the self-determination theory. This is because increased monetary rewards induce an orientation towards the self and away from others (Vohs et al., 2006, 2008), which conflicts with the internal processes of prosocially motivated people who have a strong orientation towards helping others (Grant, 2008). Perceiving rewards as more controlling has certain negative consequences for feelings of self-determination – the sense of being the originator of one's own behavior (Shalley & Perry-Smith, 2001; Shalley et al., 2004). When individuals feel that the origins of their behavior lie in extrinsic factors (i.e., their behavior is not self-determined), their sense of autonomy and experience of choice will be hampered, and this will be detrimental in terms of the motivational energy and playful engagement required for creative outcomes (Gagne & Deci, 2005; Liu, Chen, & Yao, 2011; Mainemelis & Ronson, 2006).

In contrast, when people have low prosocial motivation, increased reward size will not conflict with their motivational orientation, and therefore will not hamper their sense of self-determination. Instead, those people are likely to perceive rewards as informational and respond to increased monetary rewards in the way that goal-setting theory predicts. This theory suggests that rewards will influence creative performance by affecting the goals set by individuals and their level of commitment to those goals (Locke, Bryan, & Kendall, 1968; Locke, Shaw, Saari, & Latham, 1981). To elaborate, when there are higher monetary rewards, people will set more challenging creativity goals than they would with lower levels of monetary reward (Locke & Latham, 1990), and this will in turn enhance their creative performance (Shalley, 1991, 1995). They will also commit more effort in order to reach those creativity goals (Locke et al., 1968). In the light of the reasoning above, we propose that prosocial motivation is a moderating factor in the reward-creative engagement and the reward-creative performance relationships.

Hypothesis 1: Prosocial motivation moderates the association between size of monetary reward and creative engagement in such a way that the lower the prosocial motivation, the stronger the association between size of monetary reward and creative engagement.

Hypothesis 2: Prosocial motivation moderates the association between size of monetary reward and creative performance in such a way that the lower the prosocial motivation, the stronger the association between size of monetary reward and creative performance.

The Mediating Role of Creative Self-Efficacy

Regardless of the arguments over the direction in which rewards may affect creativity, prior research has focused mainly on the role of intrinsic motivation as the mediating factor in this link (Hennessey & Amabile, 2010; Shalley et al., 2004). While we do not contest the relevance of intrinsic motivation for creativity, we believe that to reach a comprehensive understanding of the internal mechanisms between rewards and creativity it is important to consider alternative mediators. The reasons are twofold. First, empirical research on the mediating role of intrinsic motivation in the rewards-creativity link is scarce and the results have been equivocal. For instance, Eisenberger and Aselage (2009) found evidence for the mediating role of intrinsic motivation in the reward-creativity relationship in one of their studies but failed to do so in another study in the same paper. In fact, the equivocal results about the mediating role of intrinsic motivation are not limited to the literature on the reward-creativity link; inconsistent results are also common in the broader literature on contextual factors and creativity (George, 2007; Shalley et al., 2004). Second, intrinsic motivation is unlikely to explain creative processes that do not involve positive feelings of enjoyment, interest and excitement. To elaborate, creative processes also include processes that are characterized by feelings of desperation, frustration, stress and tedium (Lubart, 2001; Zhou & George, 2003). For example, some biographical accounts point to the struggles, agony and stress that famous artists experience in their creative processes (e.g., Bernstein, 2004). Therefore, we argue that although intrinsic motivation is likely to explain the positive feelings which are essential for creativity, it might fall short in explaining the non-intrinsically motivating parts of the processes which are inherent in creative endeavors.

In this paper, we introduce creative self-efficacy as a mediating mechanism for the interaction effect of prosocial motivation and rewards on creativity. Creative self-efficacy refers to "the belief one has the ability to produce creative outcomes" (Tierney & Farmer, 2002: 1138) and it is a motivational force that differs from intrinsic motivation. Intrinsic motivation concerns a focus on the task itself and is present-focused – having fun while engaging in the task (Grant, 2008; Ryan & Deci, 2000) – whereas creative self-efficacy concerns a focus on the outcome and is future-focused – the expectation of achieving a good performance after engaging in the task (Bandura, 1997; Tierney & Farmer, 2002). In other words, intrinsic motivation is about engaging in a task because it is fun without any concern for the end performance; self-efficacy, by contrast, is about feelings of being competent enough to perform well without any concern for the potential fun aspects of the task.

We focus specifically on creative self-efficacy as a mediating mechanism for two main reasons. First, feelings of self-efficacy in relation to creative performance might be an essential self-regulatory mechanism that would explain why some individuals persist in non-intrinsically motivating processes of creativity. Prior research identified self-efficacy as a vital motivational force which sustains individuals in creative activities that are challenging and risky (Bandura, 1997; Tierney & Farmer, 2002). In addition, self-efficacy might influence cognitive mechanisms that are important for creativity such as broader information search (Cervone, Jiwani, & Wood, 1991). Second, self-efficacy is an important psychological mechanism that can explain the effects of changes in the social-contextual factors on subsequent creativity (Gist & Mitchell, 1992; Tierney & Farmer, 2002). Several recent studies have provided empirical evidence for the mediating role of creative self-efficacy between contextual factors and creativity (e.g., Gong, Huang, & Farh, 2009; Tierney & Farmer, 2011). For example, Gong and colleagues (2009) found that creative self-efficacy is the mediating mechanism between transformational leadership and creativity.

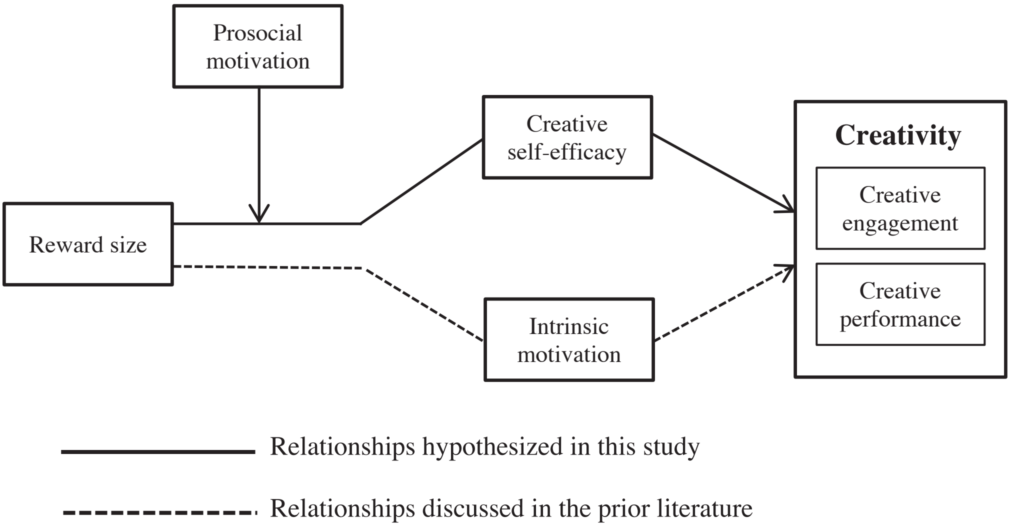
We argue that creative self-efficacy might be a crucial mediating mechanism in the interaction of rewards and prosocial motivation on creativity because increased reward size may have different efficacy cues for people with different levels of prosocial motivation. When increased monetary rewards are perceived as a controlling factor (i.e., when prosocial motivation is high), people will experience a reduced sense of autonomy, and this might communicate certain messages that can diminish their feelings of creative self-efficacy (Gist & Mitchell, 1992). That is, giving someone autonomy in a certain task is an expression of confidence in that person's capabilities to perform well without requiring any control (Grant & Parker, 2009). For example, Frese and his colleagues (2007) found that autonomy at work is significantly correlated with self-efficacy. An indirect empirical support for this argument comes from Parker (1998), who found that autonomy is associated with higher perceived self-efficacy in carrying out work tasks that require proactivity.

When perceived as informational (i.e., when prosocial motivation is low), increased monetary rewards are likely to enhance feelings of self-efficacy in several ways. First, increasing the size of a monetary reward might communicate positive information about competence by indicating that individuals' potential solutions are recognized and highly valued (Eisenberger & Rhoades, 2001; Lawler, 1986); this is likely to enhance creative self-efficacy because social cues that communicate competence enhance feelings of self-efficacy (Gist & Mitchell, 1992). Second, it signals a higher level of expectation on the part of the reward-giver which might persuade people that they are capable of generating creative outcomes and lead to subsequent attributions that promote a sense of self-efficacy (e.g., "I must be competent in creative activities if I am expected to be creative") (Gist & Mitchell, 1992; Tierney & Farmer, 2011). For example, empirical research found that both actual expectations of supervisors and mere perceptions that higher creativity performance is expected serve to increase creative self-efficacy (Tierney & Farmer, 2004, 2011). In the light of the reasoning above, we propose that the interaction effect of prosocial motivation and reward size will influence creative engagement and performance through feelings of creative self-efficacy. Figure 1 depicts our theoretical model. The dashed lines in the figure correspond to the relationships that were discussed in the prior literature whereas the solid lines show the relationships that we hypothesize in this paper.

Hypothesis 3: Creative self-efficacy mediates the moderating effect of prosocial motivation on the relationship between size of monetary reward and creative engagement.

Hypothesis 4: Creative self-efficacy mediates the moderating effect of prosocial motivation on the relationship between size of monetary reward and creative performance.

FIGURE 1
Theoretical Model



Overview of the Present Research

Employing a multi-method approach, we tested these hypotheses in a field study and a laboratory experiment. The field study allowed us to enhance the external validity of our results by testing our predictions in an actual organizational setting and to investigate the effects of naturally occurring variations in monetary rewards and prosocial motivation on creative engagement. In this study, we tested the hypotheses related to creative engagement (i.e., Hypotheses 1 and 3) in a crowdsourcing platform. Before collecting survey data from the members of the crowdsourcing platform to test these hypotheses, we took an exploratory approach (i.e., we conducted in-depth interviews and investigated the publicly available content) in an attempt to gain a deeper understanding of the crowdsourcing context and substantiate our constructs and hypotheses (Eisenhardt & Graebner, 2007). We complemented the field study with a laboratory experiment, which allowed us to draw causal conclusions on the effects of reward size on creativity and to enhance the internal validity of our results by utilizing random assignment procedures (Cook & Campbell, 1979). In the experiment, we tested Hypotheses 1-4, and constructively replicated the results of the field study using different operationalizations of creative self-efficacy and creative engagement (Lykken, 1968).

STUDY 1

Research Setting

We conducted this study in the context of a crowdsourcing platform. Crowdsourcing refers to the act of taking a task once performed internally and opening it up to a large, undefined group of people external to the company in the form of an open call (Bayus, 2013; Howe, 2008). Crowdsourcing offers immense potential for harnessing the creative potential of people on a global scale by providing an unprecedented arena for exploring creative ideas and solutions from both expected and unexpected sources (Afuah & Tucci, 2012; Jeppesen & Lakhani, 2010; Lampel et al., 2012). We collaborated with InnoCentive – one of the largest and earliest crowdsourcing platforms for innovation purposes. It offers an online platform for matching the innovation problems of its clients (i.e. seekers) to its community (i.e., solvers). Seekers share a specific problem (i.e., challenge) with InnoCentive, and InnoCentive then broadcasts this challenge on its online platform. Each challenge requires creative idea generation and problem solving as the problems are ones that typically could not be solved by the internal R&D department of the company. For example, these challenges could be related to new product design (e.g., developing a dual-purpose solar light that would function as a lamp and a flashlight) or novel solutions for the problems in the innovation process (e.g., method for measuring the thickness of thin polymeric films). After a challenge is posted, solvers submit their ideas and solutions by means of a written report. The winning solution is selected by the seeker and rewarded with a prize, typically ranging from 10,000-100,000 U.S. dollars.

As crowdsourcing is an emergent phenomenon, we started our research with an exploratory approach. In the exploratory phase, we employed multiple data sources in order to strengthen our understanding of the context and substantiate our constructs and hypotheses (Eisenhardt & Graebner, 2007). More specifically, we conducted 23 semi-structured in-depth interviews with solvers (10 interviews) and employees of InnoCentive (13 interviews) and examined information publicly available on the Internet. Following the recommendations of Eisenhardt and Graebner (2007) to incorporate diverse views about the questions of interest, we interviewed people in the solver community who had had different levels of success (i.e. multiple winners, single winners and non-winners) and people at different levels in the company hierarchy. In addition, we investigated content in the InnoCentive blog (358 posts), forums (77 posts) and LinkedIn (193 posts) groups that came from more than 80 individual solvers.

In the interviews and analysis of the online content, we sought answers to three questions that are critical for further steps of this study. We first probed whether monetary rewards have a consistent positive effect in this context and whether this effect is the same for all people. A comment by an employee in InnoCentive illustrated the experience of the company in relation to the effects of monetary rewards: *"It is hard to understand solvers' motivation by dollar amounts; some challenges get more popular with a very low amount of money*". Regarding the reaction of solvers, we found evidence that solvers varied in the way they processed information about monetary rewards. For example, one solver explained this process by saying: *"I look at the award money and make deliberate calculations of worth of time, risk and chance of winning",* whereas another solver stated that, *"5,000 or 50,000 is not important to me…… real excitement is in the feeling of having contributed something useful that other people value…*". The second issue we addressed was the relevance of prosocial motivation in this context. We found strong evidence for the importance of prosocial motivation in driving engagement in challenges. For instance, one senior InnoCentive employee explained one of the core motivations of solvers as being that *"they want to work on problems that matter"*. Solvers also quite frequently identified prosocial reasons as one of the drivers of their behavior. For example, one said: "*If you win, it means that you have contributed to decrease entropy on the planet*". The third important point for us was to identify the factors that might influence our study in general and hypotheses in particular. Here we identified the reasons why solvers participate and exert effort in the challenges. In addition, we examined several personal and contextual factors that might influence our study in an attempt to rule out a bias for potentially omitted variables. This process also allowed us to adapt our survey items (from existing scales in the literature) for InnoCentive. Findings from the interviews and content analysis that relate to measurement are discussed in detail in the measures section.

Sample and Procedures

In addition to providing preliminary insights about our hypotheses in the exploratory analysis, we used a web-based survey tool to collect data from the solvers of InnoCentive. Our population was the active solvers – those who participate in challenges. In other words, we were not interested in people who have an InnoCentive account but are not active in the community, only read the challenge descriptions, or never participate in the challenges. Our sample included all submissions by solvers between December 2009 and May 2012 for "Reduction-to-Practice" challenges (i.e., the challenges that require a detailed description of the solution and a prototype that shows the solution will work in practice) and "Theoretical" challenges (i.e., the challenges that require detailed descriptions, specifications and supporting precedents). We selected the latest submission if a solver had made multiple submissions within the specified period.

The entire survey was in English as all the challenges in InnoCentive are posted in English. Participants were from different backgrounds, ranging from experts (academics, consultants) to students. Using contact information retrieved from InnoCentive, a customized e-mail (i.e., addressing the solver and including specific challenge details that we request information for) and an URL survey link, was sent to 3,005 solvers. The e-mail made plain that the researchers were partnering with InnoCentive and that solvers' responses were very important to us. Solvers were also informed by a manager from InnoCentive, via the LinkedIn groups and the InnoCentive blog, that InnoCentive was collaborating with us and that solvers might soon receive an email about the study. A reminder was sent a week later, using a dynamic strategy (i.e., the time, day and text of the initial email was changed) to enhance the response rate (Sauermann & Roach, 2012). We received 744 (24.8 %) responses. Of those, 636 (21.2%) were usable for our analysis[1]. The

[1] We excluded the cases that had two or more incomplete answers in a construct. We kept the cases where only one item in a construct was missing as we thought this item was left blank by mistake. In addition,

average age of our sample was 44.17, 91% of our sample were male and 82.2% of the sample had at least an undergraduate degree. To assess whether non-response bias is an issue in our sample, we first compared the responses of early and late respondents by using a multivariate general linear model test. The assumption in this analysis is that late respondents are closer to the non-responding group than the early respondents (Rogelberg & Stanton, 2007). There were no significant differences in any of the variables measured for early and late respondents. In addition, we compared the level of education of our survey respondents with the whole population (i.e., all InnoCentive solvers), and this also showed no important differences, suggesting that non-response bias is not a major concern for our sample.

Measures

Reward size. This construct is measured by the monetary amount offered for a particular challenge. We extracted this information from the company archives. Because the data was highly skewed we used logarithmic transformation of this variable (e.g., Gong et al., 2009).

Prosocial motivation. We measured *prosocial motivation* with a three-item scale (α = .88) which we adapted from Grant and Sumanth (2009). We modified the items, based on the in-depth interviews with solvers and analysis of the online content, in such a way that they addressed the specific prosocial reasons for participation in the InnoCentive innovation challenges. Respondents rated the extent to which the respective scale items corresponded to the reason for their engagement in the InnoCentive challenge (that was specified in the invitation email). Response scale ranged from 1 "does not correspond at all" to 7 "corresponds exactly". The items are the following: "Opportunity to benefit others through my solution", "Opportunity to work on something that matters", "Opportunity to work on 'real life' problems".

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challenges that have more than one award, video challenges (creating a video for InnoCentive) and grand challenges (i.e., offering one million dollar or more) were excluded from the analysis since they were significantly different from the other challenges (i.e. content, requirement, awarding structure) and since they were exceptionally low in number. Excluding these cases did not change the results of our hypotheses testing.

Creative self-efficacy. We measured *creative self-efficacy* with a three-item scale (α = .85) which we adapted from the creative self-efficacy scale of Tierney and Farmer (2002) based on the in-depth interviews with solvers and analysis of the online content. The items were adapted so that they addressed solvers' beliefs in their ability to be successful in the creative activity of solving innovation problems in InnoCentive. One of the items addressed solvers' perceived level of competence in solving the innovation problem, and the response scale ranged from 1 "not competent at all" to 7 "very competent". The other two items addressed their confidence about generating the best solution to the innovation problem and winning the award, rated on a scale of 1 "no chance at all" to 7 "certain".

Creative engagement. In order to measure *creative engagement*, we used the time spent on developing a creative solution – a commonly used indicator of amount of cognitive resources expended in a task (Yeo & Neal, 2004). We asked solvers to report the total number of hours they spent on two aspects of creative engagement: searching for the solution (thinking, reading, researching and discussing ideas with others) and writing up the solution. These two items address different facets of creative engagement discussed in the prior literature. *Searching for the solution* item taps into the creative acts of information searching and idea generation (Zhang & Bartol, 2010) whereas *writing up the solution* item taps into the creative acts of clarifying the reasoning for the ideas and communicating it to others (Drazin et al., 1999). We used log transformation of these two items due to high skewness. We then created a composite score of creative engagement by averaging these two items (α = .79)[2]. It is also worth noting that this measure excludes non-creative acts because, in our context, solvers are not required to engage in routine tasks as would be the case in traditional organizational settings.

Control variables. From the in-depth interviews, analysis of the online content and prior research, we identified three other motivational orientations for participation in InnoCentive challenges: intrinsic, extrinsic (i.e., recognition and career) and learning motivation (i.e., motivation to learn new things and develop skills). We controlled for these

[2] We tested whether our results are robust to alternative operationalization of creative engagement. To that end, we have re-ran our tests by calculating creative engagement as (1) log transforming sum of the two items (2) log transforming mean of the two items, (3) log transforming items and using as separate dependent variables. None of the operationalization changed the results of our hypothesis testing. The results of these analyses are available from the first author on request.

motivational orientations because they typically influence creativity (Gong et al., 2009; Shalley et al., 2004). Items of intrinsic, extrinsic and learning motivation were adapted from the literature (Baer et al., 2003; Ryan & Connell, 1989; Tierney, Farmer, & Graen, 1999) in the light of the motivations that were revealed in the in-depth interviews and content analysis. The same question and scale anchors of the prosocial motivation scale were used for measuring these motivational orientations. *Intrinsic motivation* was measured with a four item scale (α = .86); a sample item is following: "Enjoyment of solving problems". *Extrinsic motivation* addressed the non-monetary sources of extrinsic motivation (i.e., recognition and career prospects) and was tapped with four items (α = .89), a sample item being: "Recognition I will receive after solving the problem". *Learning motivation* consisted of four items (α = .92); a sample item was: "Learning new things".

We also controlled for the level of complexity as it can influence motivations, the reward-creativity relationship and the time needed to solve a given problem (Baer et al., 2003). We used a dummy variable to control for the *challenge type* (i.e., "Theoretical" or "Reduction-to-Practice") since the requirement for physical evidence in "Reduction-to-Practice" challenges brings more complexity to the creation of final submissions[3]. Moreover, we controlled for *perceived competition* by asking solvers to rate the level of competition because that can influence motivation, engagement and creativity (Boudreau et al., 2011; Shalley & Oldham, 1997). The item was anchored as 1 "very weak competition" to 7 "very intense competition". In addition, our in-depth interviews suggested that constructs relating to prior knowledge can influence motivation, engagement level and perception of rewards. Therefore, to account for the possibility that observed effects may be partly attributable to knowledge-related variables, we controlled for whether someone already knew the solution by using a dummy variable. In addition, we used a seven-point item to assess the distance of the challenge discipline from solvers' field of expertise which was anchored as 1 "inside my field of expertise" and 7 "outside my field of expertise" (Jeppesen & Lakhani, 2010). Moreover, we controlled for solvers' *education level* by asking the highest academic degree earned (six levels ranging from

[3] We also measured perceived complexity by asking solvers to rate the extent of complexity of the challenge on a seven-point scale anchored as 1 "not complex at all" to 7 "very complex". As using this subjective measure of complexity did not affect the results of our hypotheses testing, we preferred to use the objective measure.

"less than a high school degree" to "PhD degree"). Following previous creativity research (e.g., Gong et al., 2009), we also controlled for demographic variables of age and gender. We measured *gender* by using a dummy variable coded as 1 for female and 0 for male. *Age* was measured in years and is reported by the solvers using an open question. We also controlled for *income level* by asking annual income in U.S. dollars (eight levels ranging from "0 to 25,000" to "more than 500,000") because level of income might influence the perceived value of the rewards.

Preliminary Analyses

Means, standard deviations, sample size and correlations are presented in Table 1. In order to see whether the items of creative self-efficacy, prosocial, intrinsic, learning and extrinsic motivation are related to their proposed constructs and whether these constructs are distinct, we first conducted an exploratory factor analysis. We entered all items for measuring motivation into the analysis, with principal axis factoring, varimax rotation and Kaiser normalization. As expected, five factors with eigenvalues greater than 1 emerged. All items showed clear loadings on their respective construct (see appendix Table A2). As a supplementary analysis to assess discriminant validity, we conducted confirmatory factor analysis using LISREL software (see appendix Table A3). The results indicated that the expected 5-factor solution provided an excellent fit with the data (χ^2= 549.12, SRMR = .04, GFI = .91, CFI = .97). In addition, this solution provided a considerably better fit than the alternative nested models (for 4-factor solution where prosocial and learning motivation were loaded on the same factor, χ^2 = 1451.18, SRMR = .08, GFI = .80, CFI = .92; for 3-factor solution where intrinsic, prosocial and learning motivation were loaded on the same factor, χ^2= 2063.84, SRMR= .08, GFI=.73 CFI=.89; for 2-factor solution where all motivational orientations were loaded on the same factor χ^2 = 3398.00, SRMR= .13, GFI=.63 CFI=.81; for single factor solution χ^2 = 4323.20, SRMR = .15 GFI = .57, CFI = .75). Chi-square difference tests also showed that our expected model had a significantly better fit than the alternatives. These results confirmed that intrinsic, prosocial, learning, extrinsic motivation and creative self-efficacy constructs are distinct. In addition, we checked the variance inflation factors to determine whether substantial correlations between motivational orientation constructs are problematic for our analysis. The highest

TABLE 1
Study 1: Means, Standard Deviations and Correlations[a,b]

Variables[b]	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Challenge type	1.16	.37														
2. Education	4.66	1.28	.17													
3. Income	2.50	1.65	.03	.22												
4. Gender	.09	.29	-.01	.04	-.18											
5. Age	44.04	14.35	.04	.14	.35	-.10										
6. Knowing	.16	.37	-.01	-.06	.07	.03	.10									
7. Expertise	3.98	1.91	.09	.11	.01	-.06	.06	-.01								
8. Competition	5.27	1.32	.02	.12	-.09	.13	-.06	-.04	.05							
9. Intrinsic motivation	5.53	1.31	-.04	-.10	-.01	.03	-.11	-.04	-.05	.15						
10. Extrinsic motivation	3.68	1.73	.03	-.04	-.19	.07	-.20	-.10	.05	.15	.38					
11. Learning motivation	4.89	1.69	.02	-.15	-.16	.09	-.09	-.11	-.01	.11	.65	.40				
12. Prosocial motivation	5.43	1.48	-.05	-.11	-.08	.07	-.08	-.03	.04	.16	.57	.33	.57			
13. Reward size	4.38	.23	.49	.19	-.02	.02	.01	.08	.05	.00	-.05	.08	.01	-.03		
14. Creative self-efficacy	4.45	1.45	.02	.07	.00	-.13	.00	.02	.18	.08	.06	.18	.05	.12	.06	
15. Creative engagement	.09	.54	.10	.17	-.09	.02	-.07	-.22	.18	.14	.02	.22	.02	.00	.13	.26

[a] Listwise deletion, N=537, correlations greater than .08 are significant at $p<.05$.
[b] Reward size and creative engagement variables are log transformed.

TABLE 2
Study 1: Results of Hierarchical Regression Analysis[a,b]

	Creative Self-Efficacy						Creative Engagement							
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7	
Variables[b]	*β*	*SE*	*β*	*SE*	*β*	*SE*	*β*	*SE*	*β*	*SE*	*β*	*SE*	*β*	*SE*
Challenge type	-.02	.15	-.03	.17	-.04	.16	.05	.06	.00	.07	-.01	.07	.00	.06
Education	$08^{\dagger}$	.04	$.08^{\dagger}$	.05	$.09^{*}$	.05	$.15^{***}$	.02	$.13^{**}$	.02	$.15^{***}$	.02	$.13^{**}$	.02
Income	.02	.04	.02	.04	.02	.04	-.07	.02	-.07	.02	-.07	.01	-.07	.01
Gender	$-.13^{**}$	.19	$-.13^{**}$	.19	$-.13^{**}$	.19	-.00	.08	-.00	.08	-.01	.08	.02	.08
Age	.06	.00	.06	.00	.06	.00	.00	.00	.01	.00	.01	.00	-.00	.00
Knowing	.06	.15	.05	.15	.05	.15	$-.18^{***}$	.06	$-.19^{***}$	.06	$-.19^{***}$	.06	$-.20^{***}$	.06
Expertise	$.20^{***}$	.03	$.21^{***}$	.03	$.21^{***}$	.03	$.14^{***}$	.01	$.14^{***}$	.01	$. 14^{***}$	.01	$.10^{*}$	.01
Competition	.05	.04	.05	.04	.04	.04	$.08^{\dagger}$	.02	$.08^{*}$	.02	$.08^{\dagger}$	.02	$.07^{\dagger}$	.02
Extrinsic motivation	$.20^{***}$	.03	$.19^{***}$	.04	$.20^{***}$	.03	$.20^{***}$	.01	$.20^{***}$	.01	$.21^{***}$	.01	$.17^{***}$	.01
Learning motivation	-.05	.05	-.06	.05	-.07	.05	-.09	.02	-.07	.02	-.09	.02	-.07	.02
Intrinsic motivation	.08	.06	.07	.06	.09	.06	.00	.02	.02	.02	.04	.02	.02	.02
Prosocial motivation			.04	.05	.04	.05			-.06	.02	-.05	.02	-.06	.02
Reward size			.03	.26	.04	.26			$.09^{*}$	.11	$.11^{*}$	.11	$.10^{*}$	.10
Prosocial x reward size					$-.11^{**}$	.16					$-.13^{**}$	.07	$-.11^{**}$	.07
Creative Self-Efficacy													$.19^{***}$	.02
R^2	.12		.13		.14		.15		.16		.17		.20	
F	6.95		5.95		6.07		8.57		7.72		8.08		9.23	
ΔR^2	$.12^{***}$		.00		$.01^{**}$		$.15^{***}$		$.01^{‡}$		$.02^{**}$		$.03^{***}$	

[a] Values are standardized coefficients.
[b] Reward size and creative engagement variables are log transformed.
† $p < .10$, * $p < .05$, ** $p < .01$, **

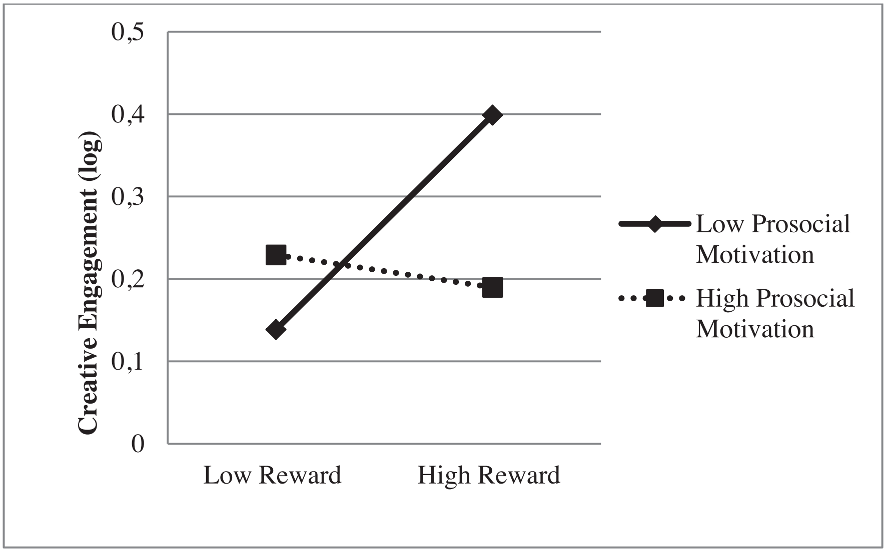
variance inflation factor was 2.29 (well below the recommended threshold of 10), suggesting that multicollinearity was not a problem for our analysis.

Moderation Analyses

We started testing our hypotheses by using hierarchical ordinary least squares regression analyses and followed the recommendations of Aiken and West (1991) for moderated regression analysis. To create an interaction term, we mean-centered prosocial motivation and reward size variables and multiplied them. We entered all control variables in the first step, prosocial motivation and reward size variables in the second step, and the interaction of prosocial motivation and reward variables in the third step. Results are reported in Table 2. With respect to our first hypothesis about the moderating role of prosocial motivation on the reward size-creative engagement link, it is worth noting that reward size was a significant, independent predictor of creative engagement while prosocial motivation was not (see Model 5; β = .09, p < .05; β = -.06, p = .26, respectively). As predicted in Hypothesis 1, the interaction effect of reward size and prosocial motivation on creative engagement was significant (see Model 6; β = -.13, p < .01).

To facilitate the interpretation of this interaction, we plotted simple slopes showing the relationship between reward size and creative engagement at one standard deviation below and above the mean of prosocial motivation (Aiken & West, 1991). Figure 2 depicts the simple slopes. Statistical testing of the simple slopes revealed that when prosocial motivation was low, reward size significantly predicted higher creative engagement (β = .56, p < .001). When prosocial motivation was high, however, the slope was negative but not significant (β = -.09, p = .43). Post-hoc analysis suggested that reward size was significantly associated with lower creative engagement when the level of prosocial motivation was at least 1.42 standard deviations above the mean.

FIGURE 2
Study 1: Simple Slopes for Creative Engagement



Mediation Analyses

To test whether creative self-efficacy mediated the moderating effect of prosocial motivation, we followed the moderated causal steps approach (Muller, Judd, & Yzerbyt, 2005) and bootstrap procedures (Edwards & Lambert, 2007; Hayes, 2013). Muller and his colleagues (2005) suggested that in order for a moderation to be mediated, three conditions should be met. First, the interaction variable should have a significant effect on the mediator and dependent variable; second, the mediator variable should have a significant effect on the dependent variable; and last, bringing the mediator into the equation should reduce the magnitude of direct effect of the interaction variable on the dependent variable. Table 3 demonstrates that the interaction of prosocial motivation with reward size significantly influenced both creative self-efficacy (see Model 3; $\beta = -.11$, $p < .01$) and creative engagement (see Model 6; $\beta = -.13$, $p < .01$). Model 7 in the same table shows that creative self-efficacy also had a significant effect on creative engagement ($\beta = .19$, $p < .001$). Finally, when we entered creative self-efficacy in Model 7, the significant interaction effect of prosocial motivation and reward size reduced in magnitude compared to Model 6 (from $\beta = -.13$ to $\beta = -.11$). Taken together, the three conditions suggested by Muller and his colleagues (2005) were met, confirming Hypothesis 3.

We complemented our mediation analyses by testing the statistical significance of the indirect effects of the reward size and prosocial motivation interaction through creative self-efficacy. We followed bootstrap procedures to construct bias-corrected confidence intervals on the basis of 5,000 random samples with replacement from the full sample (Hayes, 2013; Shrout & Bolger, 2002). Mediation occurs if an indirect effect differs significantly from zero. In support of our Hypothesis 3, the 95 % confidence intervals for the indirect effect of the interaction through creative self-efficacy excluded zero (-0.69, -0.003), which suggested that creative self-efficacy mediated the moderating effect of prosocial motivation on the reward-creative engagement link.

In addition, we tested whether intrinsic motivation also mediated the moderating effect of prosocial motivation by following the same procedures above. We first ran a regression analysis using intrinsic motivation as the dependent variable (not reported here) which showed that the interaction of prosocial motivation with reward size was significant in influencing intrinsic motivation ($\beta = .08$, $p < .05$); however, as shown in Table 3, intrinsic motivation did not have a significant effect on creative engagement (see Model 6; $\beta = .04$, $p = .47$). It also did not affect the magnitude of the interaction effect of prosocial motivation and reward size on creative engagement when entered into the model after the interaction in a separate analysis (not reported here). Moreover, the 95% confidence interval for indirect effects of the interaction term through intrinsic motivation included zero (-0.002, 0.03). Finally, the 95% confidence intervals remained similar when we entered intrinsic motivation and creative self-efficacy simultaneously into the bootstrapping analyses (95% CI for creative self-efficacy [-0.65, -0.003]; 95% CI for intrinsic motivation [-0.003, 0.02]). Taken together, these analyses suggested that intrinsic motivation did not mediate the moderating effect of prosocial motivation in the reward-creative engagement link, but that creative self-efficacy did.

To provide a complete overview of motivational antecedents of creativity, it is worth reporting simple relations between other motivational orientations and creative engagement. The results showed that non-monetary sources of extrinsic motivation (i.e., recognition and career prospects) had a significantly positive effect on creative engagement (See Model 5; β = .20 p < .001) while learning motivation did not have a significant effect on creative engagement (See Model 5; β = -.07, p = .24).

To conclude, these results confirmed that prosocial motivation moderates the relationship between rewards and creative engagement, and creative self-efficacy mediates this interaction effect. However, although in-depth interviews and content analysis minimized potential omitted variable bias by allowing us to control for relevant variables, there was still a possibility of this bias. In addition, our research design was cross-sectional which limited our ability to derive conclusions about causality. We addressed these limitations by conducting a laboratory experiment.

STUDY 2

We complemented our field study with a laboratory experiment for several reasons. First, we aimed to test our mediated moderation hypothesis for creative performance (i.e., Hypotheses 2 and 4). Second, we wanted to strengthen causal inferences, and rule out omitted variable bias and alternative explanations by randomly assigning participants to different prosocial motivation and monetary reward conditions (Cook & Campbell, 1979). Third, to strengthen the validity and generalizability of our results, we wanted to constructively replicate our findings by using different measures of creative self-efficacy, creative engagement and intrinsic motivation (Lykken, 1968).

Sample, Design and Procedures

The participants were 81 full-time undergraduate students at a large university who volunteered to take part in an experiment in exchange for course credits. The average age of participants was 19.9 years and 58 % of them were male. We used a two-by-two (2 x 2) between-participants factorial design (prosocial motivation: control, prosocial by reward size: low, high). Participants who arrived at the laboratory were told that we were interested in seeing how they generated ideas. They were then escorted to separate experimental cubicles. Once they were seated in the cubicle, we assigned each participant randomly to one of the experimental conditions. The cubicles were completely isolated and participants were not able to see or hear each other. Each participant had a computer, a table, and a chair in his or her cubicle.

Experimental task. Participants completed an idea-generation task which is common in experimental studies focusing on creativity (e.g., Baer, Leenders, Oldham, & Vadera, 2010; Grant & Berry, 2011). In an attempt to enhance external validity, the task was adapted from a real challenge in InnoCentive. They were given the following task:

> How can drivers interact with existing devices with minimum distraction from the primary task of driving and focusing on the road? Please submit your idea(s) for drivers to interact with existing devices (cell phones, tablet, music player, GPS etc.) without compromising their ability to drive and pay attention to the road. For example, your ideas could be about new devices, accessories or mobile apps that facilitate interaction with the existing devices. It can also be about novel ways of interaction with these devices.

Prosocial motivation manipulation. In order to manipulate prosocial motivation, we provided information that emphasized the needs of others and potential benefits to others (e.g., Grant & Berry, 2011). Specifically, the information highlighted the importance for other people of safe driving and the suffering that was caused by distracted drivers. By providing some details about the damages and costs to other people, the goal was to create an empathetic concern for others and trigger a motivational state to benefit others. The following text was used to manipulate prosocial motivation:

> Safe driving is a major concern for our society, since road traffic accidents are shown to be one of the top 10 leading causes of death which kills over a million people every year. In addition, every year, 50 million people suffer from car accident injuries, including permanent disabilities. Economic costs of those accidents are estimated to be over 500 billion Euros. A large portion of those accidents is caused by distracted drivers.

Reward manipulation. After participants had been assigned to one of the prosocial motivation conditions, the manipulation of monetary rewards took place. For the low-reward and high-reward conditions, participants were informed that they stood a chance of winning 50 or 500 Euros respectively. We decided on these amounts based on our review of the actual rewards offered in online idea-generation contests for students. For example, NASA Tournament Lab offered prizes ranging from 100 to 500 Euros for an idea-generation contest (finding compelling ways to illustrate and demonstrate the depth and potential of their "Planetary Data System" database) for students while Battle of Concept (a Dutch crowdsourcing platform for students) offers rewards ranging between 50-350 Euros in most of their "brainstorm" contests (e.g., new product/service ideas). Before the experiment, we also interviewed 12 students (from the same university from which the participants were recruited) and confirmed with them that the reward amounts were realistic. Promising a certain amount of monetary reward before the experimental task takes place is a way of manipulating rewards that has commonly been used in previous experimental research (e.g., Amabile et al., 1986; Eisenberger & Rhoades, 2001). We used the following message for the manipulation by changing the amount of reward for the respective group (i.e., 50 for the low-reward and 500 for the high-reward condition):

> There will be a monetary award for the best idea on this idea generation task. If you create the best idea for this problem you will be awarded with 50/500 Euros!

Measures

Creative self-efficacy. We assessed creative self-efficacy with three items adapted from Schmidt and DeShon (2010) which addressed the efficacy feelings about creative performance in the idea generation task. We asked participants to assess their chances of, on a scale from 0% to 100%, "Having the best idea", "Having one of the top 3 best ideas", "Having one of the top 10 best ideas" (α = .94) before they started writing their ideas.

Creative engagement. We measured *creative engagement* with three items adapted from Brown and Leigh (1996) so that they specifically addressed the intensity of the engagement for the idea-generation task. Because the task was a purely creative activity and did not require routine activities, we believe this is an appropriate measure of creative engagement. The scale contained the following items: "I worked at my full capacity while generating ideas during the task", "I tried as hard as I can to generate a good idea", and "I really exerted myself to the fullest for generating a good idea" (α = .90).

Creative performance. We used expert ratings to assess the *creative performance* of participants' ideas in line with the recent experimental studies (e.g., Baer et al., 2010;

Grant & Berry, 2011). In total, we had three experts. One of the raters was a senior user experience researcher at TomTom – an international company that provides navigation and location-based products and services for cars. Another was a project manager who helps companies to incorporate advanced analytics into mobile devices (this manager had extensive experience in the automotive industry). The last was an expert in marketing (with extensive experience of new product and service development). The raters were blind to the identity of the participants, to one another, and to the purpose and conditions of the experiment. The only information that we offered to raters was a spreadsheet of the participants' ideas and the details of the experimental task. Similar to previous studies (e.g., Amabile, 1996), we explicitly defined creative ideas as those that are both novel and useful. We asked the raters to assess the ideas on a scale ranging from 1 "not at all creative" to 7 "very creative" (e.g., Grant & Berry, 2011). We examined the level of agreement across judges by calculating intra-class correlation coefficient (ICC). The three raters achieved good reliability (ICC2 = .67, p < .001) which justifies averaging the individual ratings of experts into a composite score of creativity for each participant's idea (LeBreton & Senter, 2008).

Manipulation checks and intrinsic motivation. In order to ensure that the prosocial motivation manipulation was effective, we asked participants to complete a prosocial motivation scale, adapted from the scale devised by Grant (2008). The four items were adapted in such a way that specifically addressed experimental task: "I care about benefiting others through my idea(s)" "I want to help reducing the traffic accidents" "I want to have a positive impact on road safety" and "It is important to me to do good for others" (α = .80). As for the observable and concrete variables, it is relatively simple to assume manipulations will work as intended (Perdue & Summers, 1986). Therefore, following the prior research that experimentally manipulated reward size via instructions (e.g., Amabile et al., 1986; Eisenberger & Rhoades, 2001), we did not include a self-reported measure for checking reward size manipulation.

We measured *intrinsic motivation* (in order to test whether it mediates the hypothesized interaction effects) with four items adapted from Grant (2008). Participants rated their level of agreement, on a scale of 1 to 7, for the reasons why they were motivated to engage in the idea generation task: "I enjoy the idea generation task", "Idea generation is fun", "I find the idea generation task engaging", "I enjoy generating ideas" ($\alpha = .85$).

Preliminary Analyses

Means and standard deviations by experimental condition are shown in Table 3 (correlations are presented in Table A4). In order to assess whether our prosocial motivation manipulation worked as expected, we conducted an analysis of variance (ANOVA) on the manipulation check measure of prosocial motivation. Only prosocial motivation had a main effect on the self-reported prosocial motivation scale (i.e. participants who received prosocial motivation manipulation reported higher prosocial motivation than those who did not) ($F[1, 77] = 8.53$, $p < .01$). There was no main effect of the amount of monetary reward, ($F[1, 77] = .61$, $p = .44$) nor the interaction ($F[1, 77] = .96$, $p = .33$) on the self-reported prosocial motivation. These results suggested that our manipulation of prosocial motivation was successful.

TABLE 3
Study 2: Means and Standard Deviations by Experimental Conditions[a]

Condition	Creative Self-Efficacy	Creative Engagement	Creative Performance
Control, Low Reward (n=20)	28.82 (21.98)	3.87 (1.22)	2.38 (.62)
Control, High Reward (n=20)	37.67 (30.59)	4.67 (1.23)	2.88 (1.00)
Prosocial, Low Reward (n=20)	54.90 (26.54)	5.25 (.97)	2.82 (1.01)
Prosocial, High Reward (n=21)	31.78 (20.50)	4.83 (1.28)	2.46 (1.02)

[a] Standard deviations are in parentheses.

Moderation Analyses

In order to assess the moderating role of prosocial motivation in the reward-creative engagement and reward-creative performance links, we started our analysis by conducting a multivariate analysis of variance (MANOVA) using creative engagement and creative performance as dependent variables. The effect of prosocial motivation manipulation on creative engagement was significant ($F[1, 77] = 8.60$, $p < .01$) while it was not significant for reward size ($F[1, 77] = .51$, $p = .48$). As predicted in Hypothesis 1, we found a significant interaction effect of prosocial motivation and reward size on creative engagement ($F[1, 77] = 5.42$, $p < .05$). Figure 3 depicts this interaction effect. In order to interpret the interaction better, we examined the simple main effect of reward size on creative engagement in control and prosocial conditions. In the control condition, reward size had a positive effect on creative engagement ($F[1, 77] = 4.57$, $p < .05$). In the prosocial condition, however, reward size had a negative effect on creative engagement but the mean difference was not significant ($F[1, 77] = 1.32$, $p = .25$).

With respect to creative performance, the results of the MANOVA analysis revealed that the effect of prosocial motivation manipulation on creative performance was not significant ($F[1, 77] = .00$, $p = .98$), nor was the effect of reward size ($F[1, 77] = .12$, $p = .73$). The interaction effect of prosocial motivation and reward size on creative performance was significant ($F[1, 77] = 4.29$, $p < .05$) which confirms our Hypothesis 2. To facilitate the interpretation of this interaction, we examined the simple main effect of reward size on creative performance in control and prosocial conditions. Figure 4 shows the graphical representation of this interaction. In the control condition the difference between high and low reward conditions was positive and marginally significant ($F[1, 77] = 2,89$, $p < .10$), whereas this difference was negative, but not significant, in the prosocial condition ($F[1, 77] = 1.51$, $p = .22$). Taken together, these findings suggested that the prosocial motivation level of participants was a moderator of the effects of reward size on creative engagement and creative performance.

FIGURE 3
Study 2: Results for Creative Engagement

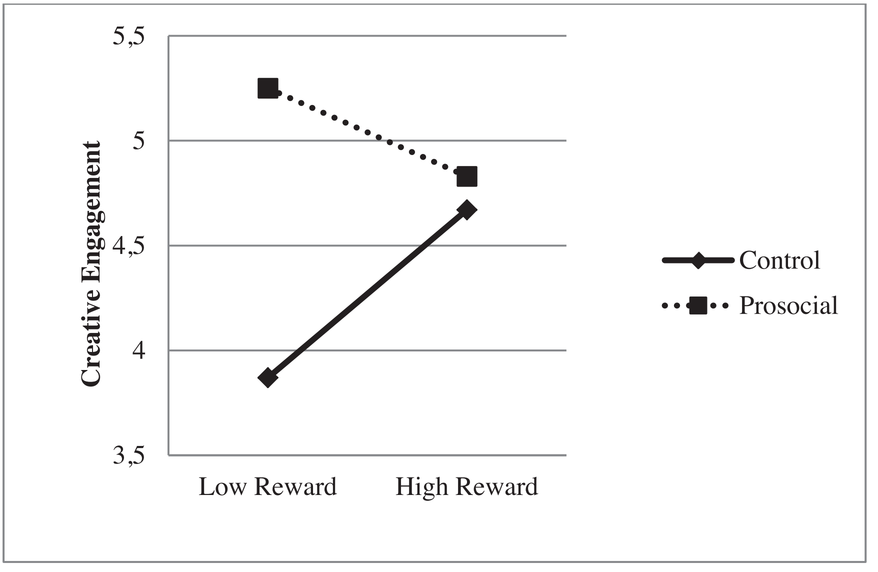
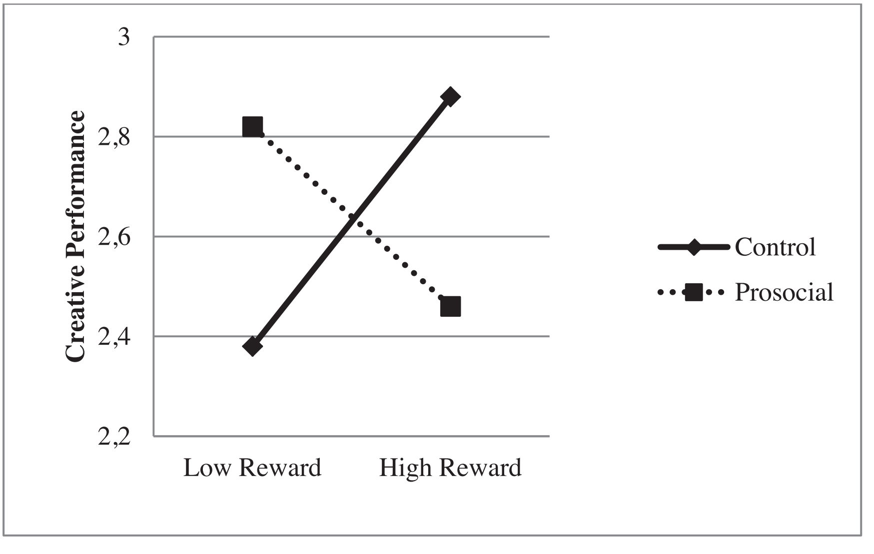


FIGURE 4
Study 2: Results for Creativity



Mediation Analyses

We assessed whether creative self-efficacy mediated the moderating effect of prosocial motivation on creative engagement by following a moderated causal step approach (Muller et al., 2005) and bootstrapping procedures (Edwards & Lambert, 2007; Hayes, 2013), as we did in the field study. We first conducted an ANOVA analysis by using creative self-efficacy as the dependent variable and we found a significant interaction effect of prosocial motivation and reward size on creative self-efficacy ($F[1, 77] = 8.17, p < .01$). To test for the remaining conditions for mediated moderation, we conducted a hierarchical regression analysis (see Table 4). Model 2 in this table shows that interaction effect of prosocial motivation and reward size on creative engagement was significant ($\beta = -.43$, $p < .05$). Model 3 in Table 4 indicates that creative self-efficacy had a significant positive effect on creative engagement ($\beta = .28$, $p < .05$). When we entered creative self-efficacy in the Model 3, however, the interactive effect of the reward size and prosocial motivation manipulations decreased in magnitude (from $\beta = -.43$ to $\beta = -.28$) and to non-significance. Taken together, these results suggested that creative self-efficacy mediated the interaction effect of prosocial motivation and reward size on creative engagement (Muller et al., 2005), supporting Hypothesis 3. To assess the significance of the indirect effects of the interaction on creative engagement through creative self-efficacy, we used bootstrap procedures to construct bias-corrected confidence intervals based on 5,000 random samples with replacement from the full sample (Hayes, 2013; Shrout & Bolger, 2002). In support of Hypothesis 3, we found that the estimate of the confidence interval for indirect effect of the interaction through creative self-efficacy was negative and significant, the interval excluding zero (95% CI [-1.04, -0.06]).

To assess whether creative self-efficacy also mediated the moderating effect of prosocial motivation on creative performance, we followed the same procedures described above. Our results showed that the interaction effect of prosocial motivation and reward size on creative performance was significant (See Model 5 in Table 4; $\beta = -.40$, $p < .05$) and also showed the positive effect of creative self-efficacy on creative performance (See Model 6 in Table 4; $\beta = .24$, $p < .05$). When we entered creative self-efficacy, the interactive effect of the reward size and prosocial motivation manipulations decreased in magnitude (from β = -.40 to β = -.28) and to non-significance. Thus the conditions for mediated moderation were met (Muller et al., 2005). The estimate of the bias-corrected confidence interval for indirect effects of the interaction on creative performance through creative self-efficacy was also negative and significant, not including zero (95% CI [-0.79, -0.03]). These findings suggested that creative self-efficacy also mediated the interaction effect of prosocial motivation and reward size on creative performance, supporting Hypothesis 4.

TABLE 4
Study 2: Results of Mediated Moderation Analysis[a]

	Creative Engagement						Creative Performance					
	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
Variables	β	*SE*	β	*SE*	β	*SE*	β	*SE*	β	*SE*	β	*SE*
Prosocial motivation	.30**	.27	.55***	.37	.41**	.39	.00	.21	.23	.29	.08	.31
Reward size	.07	.27	.32*	.37	.27†	.36	.04	.21	.27†	.29	.18	.29
Reward size x prosocial motivation			-.43*	.53	-.28	.54			-.40*	.41	-.28	.43
Creative self-efficacy					.28*	.01					.24*	.00
R^2	.10		.16		.22		.00		.05		.10	
F	4.24		4.80		5.47		.05		1.47		2.14	
ΔR^2	.10*		.06**		.07*		.00		.05*		.05*	

[a] Values are standardized coefficients.
† $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$.

In addition, we tested whether intrinsic motivation also mediated the interaction effect of prosocial motivation and reward size on creative engagement and performance. To that end, we first assessed whether the interaction of prosocial motivation and reward size had a significant effect on intrinsic motivation by conducting an ANOVA analysis that used intrinsic motivation as the dependent variable. The results for the interaction was not significant (F[1, 77] = .50, p = .48), failing to meet the first condition of a mediated moderation (Muller et al., 2005) The results of the bootstrapping analysis also suggested that intrinsic motivation did not mediate the interaction effect: that is, bias-corrected confidence intervals for indirect effect of the interaction effect on creative engagement and creative performance through intrinsic motivation included zero (95% CI [-0.56, 0.12]; [-0.30, 0.05], respectively). Finally, the results of the regression analyses and bootstrap test remained similar when we entered intrinsic motivation and creative self-efficacy simultaneously into our analysis[4]. Taken together, these analyses suggested that intrinsic motivation was not a mediator of the moderating effect of prosocial motivation in the reward-creative engagement link, but creative self-efficacy was.

As a whole, the results of the experiment were parallel to the field study and provided causal evidence for the moderating role of prosocial motivation in the reward-creative engagement and reward-creative performance relationships. It also demonstrated that creative self-efficacy was a mediating mechanism of these interaction effects on creativity, even after we had controlled for intrinsic motivation.

GENERAL DISCUSSION

Theoretical Contributions

The primary contribution of our study is that it identifies an important boundary condition for the relationship between rewards and creativity. Prior research mainly drew on either goal-setting or self-determination theories to explain the effects of rewards on creativity and provided contradictory recommendations on the reward-creativity link (Hennessey & Amabile, 2010; Shalley et al., 2004). Drawing on recent literature on the psychological consequences of money (Vohs et al., 2006, 2008), we develop a theory that suggests that the size of the reward will have varying effects on people's creativity, depending on their individual level of prosocial motivation. We thereby provide a theoretical framework for reconciling the contradictory perspectives of goal-setting and self-determination theories in relation to the reward-creativity link. More specifically, we demonstrate that increased rewards have a positive effect on creativity for people with low prosocial motivation; however, this effect is diminished when the levels of prosocial

[4] Specifically, both the significance levels and the pattern of the results remained same when we used creative engagement as the dependent variable. With respect to creative performance, the pattern of the results remained similar as well; however, the significance levels relating to the mediating role of creative self-efficacy was reduced. That is, creative self-efficacy still had a positive effect on creative performance when intrinsic motivation was entered into the model where creative self-efficacy was the only mediator (i.e., Model 6 in Table 5), but this effect was marginally significant ($\beta = .21$, $p < .10$). The effect of intrinsic motivation was not significant in this model ($\beta = .09$, $p = .43$). This was also the case for bootstrap analyses. 90% bias corrected confidence intervals for indirect effects of the interaction through excluded zero for creative self-efficacy (-0.63, -0.02) while including zero for intrinsic motivation (-0.24, 0.03); however the 95% confidence intervals for these indirect effects included zero for both variables.

motivation are higher. Studies have recently begun to identify moderators of the reward-creativity relationship that are related to characteristics of the task (e.g., task complexity), the rewards (e.g., reward contingency, choice of which reward to select), or the information accompanying rewards (e.g., performance feedback or creativity training) (Baer et al., 2003; Burroughs, Dahl, Moreau, Chattopadhyay, & Gorn, 2011; Byron & Khazanchi, 2012). However, little research has focused on the personal factors that can drive individuals to respond to the same rewards differently (for an exception, see Baer et al. [2003]).

Our study introduces creative self-efficacy as a mediating mechanism for explaining the interactive effects of rewards and prosocial motivation on creativity. In other words, individuals' different responses to rewards depending on their prosocial motivation level will first affect how efficacious they feel in the creative task, and this will in turn influence how long and how intensively they engage in the creative activities of idea generation. It will also influence how novel and useful the ensuing ideas will be. Prior research has often considered intrinsic motivation to be the main mediating mechanism in the reward-creativity relationship (Amabile, 1996; Hennessey & Amabile, 2010), and has often overlooked the possibility that other motivational processes may explain internal mediating processes of creativity (Shalley et al., 2004; Zhou & Shalley, 2003). Our study thus challenges the common assumption in the creativity literature that rewards will affect creativity only through intrinsic motivation. Including both intrinsic motivation and creative self-efficacy in our empirical model, we demonstrate that creative self-efficacy can mediate the interaction effect of rewards and prosocial motivation on creativity while intrinsic motivation may fail to do so. On a broader level, this finding addresses the call to identify alternative mechanisms (to intrinsic motivation) that mediate between social-contextual factors (including rewards) and creativity because empirical findings on the mediating role of intrinsic motivation are inconsistent and scarce (George, 2007; Shalley et al., 2004). Taking into account recent studies which provide empirical evidence for the mediating role of creative self-efficacy between social-contextual factors and creativity, such as transformational leadership (Gong et al., 2009) or supervisor expectations (Tierney & Farmer, 2011), it is reasonable to expect that creative self-efficacy might also be an essential mediating mechanism in explaining motivational processes between the context and creative outcomes.

We also contribute to the emerging research that focuses on motivational interactions in order to understand the motivational processes of creativity. Prior research showed that prosocial and intrinsic motivation interact in influencing creativity (Grant & Berry, 2011); however, the effects of other motivational interactions remained unexplored (George, 2007). Our study addresses this gap by demonstrating the interactive effect of an extrinsic source of motivation (i.e., monetary rewards) and prosocial motivation in determining creative engagement and performance. The nature of the interaction between extrinsic and prosocial motivation is quite different from the one between intrinsic and prosocial motivation. To elaborate, the prosocial-intrinsic motivation interaction is synergistic: prosocial and intrinsic motivations interact in such a way that they enhance each other's influence on creativity. In contrast, prosocial and extrinsic motivations interact in a substitutive way: an increase in either one of them diminishes the effect of the other on creativity. By demonstrating this unexplored interaction between prosocial and extrinsic motivation, we contribute to a better understanding of motivational mechanisms of creativity and address the calls to investigate how different motivations interact to affect creativity (Amabile, 1996; George, 2007).

Our field study also has several distinct implications for a more comprehensive understanding of motivational antecedents of creativity. First, we found that certain sources of extrinsic motivation (i.e., gaining recognition and career prospects) are associated with greater creative engagement. Although a sizeable stream of literature links extrinsic motivation with lower creativity (Hennessey & Amabile, 2010), this finding demonstrates that some sources of extrinsic motivation can actually stimulate creativity. Second, our findings reveal that learning motivation has no significant effect on creative engagement with the problem at hand. This finding is different from that of a recent temporally-lagged field study by Gong, Huang and Farh (2009) which found a positive effect of learning motivation on creative self-efficacy and creativity. However, our study confirms the findings of an experimental study by Redmond, Mumford and Teach (1993) who documented non-significant effects of learning motivation on creativity. Taken together, this experimental study and our finding imply that learning motivation is not likely to enhance creative self-efficacy and creativity for the task at hand. One explanation is that learning motivation is likely to enhance creative self-efficacy and creativity over time since individuals need time to be able to explore and utilize the knowledge acquired (Gong et al., 2009). In addition, from a methodological standpoint, our field study improves upon prior field studies, which used perceptual measures of rewards, by using an objective measure of reward size.

Finally, an important contribution of this paper is that, in the field study, we address the current innovation practices in organizations that are focused on harnessing the creative potential of people worldwide by means of the Internet – crowdsourcing (Afuah & Tucci, 2012). Crowdsourcing is an emerging channel for open innovation and offers an immense potential for organizational innovativeness and problem-solving effectiveness (Boudreau & Lakhani, 2013)., Scholars have therefore emphasized the importance of understanding the dynamics of crowdsourcing (Lampel et al., 2012). Although prior research expanded our knowledge by examining the role of problem characteristics (e.g., modularity), information technology, competition, prior experience and expertise in crowdsourcing platforms (Afuah & Tucci, 2012; Bayus, 2013; Boudreau et al., 2011; Jeppesen & Lakhani, 2010), research on motivations and rewards in crowdsourcing is limited. We contribute to the innovation literature by identifying the reasons for participating, and exploring the effects of different motivations and reward size on engagement in crowdsourcing platforms. In addition, we challenge the assumption commonly made in the analytical models of crowdsourcing that increased monetary prizes will enhance the efforts made by those who contribute ideas to crowdsourcing platforms (e.g., Terwiesch & Xu, 2008). The results of our field study demonstrate that the effects of monetary rewards are not uniform (i.e., it depends on the level of prosocial motivation) in crowdsourcing platforms and suggest that we need to take a more nuanced perspective when designing such platforms. As a whole, our findings contribute to a better understanding of the dynamics of crowdsourcing.

Limitations and Suggestions for Future Research

These contributions should be interpreted in the light of this study's limitations. First, we did not test directly how increased monetary rewards are perceived (i.e., controlling or informational), depending on the level of prosocial motivation. Future research could conduct such direct tests and look in more detail at how people's perceptions of monetary rewards change with respect to changes in their level of prosocial motivation. Second, we did not have access to creative performance data for the ideas generated in the field study. This is because InnoCentive promises to keep seekers anonymous; we could not therefore contact seeker organizations to rate the creativity of the ideas. As an alternative, we considered using expert ratings of creativity; however, due to intellectual property rights (i.e., either the solver or seeker owns the rights to an idea), InnoCentive was not allowed to share the individual ideas with us. Furthermore, the monetary rewards in our field study and experiment were presented in the form of a tournament (i.e., the most creative idea is rewarded) and involved certain sizes. Although our theoretical reasoning does not rely on the structure or specific amount of the monetary rewards, it will be interesting to see whether this relationship will hold for different reward structures and amounts. For example, to ensure the generalizability of these findings, future research might test how the proposed relationships unfold when rewards are given for exceeding a certain level of creative performance or when different sizes of monetary reward are used. Importantly, several factors, such as who gives the money, why it is given and the way it is given, can also influence the symbolic meanings associated with the money (Mickel & Barron, 2008). Researchers could address how these symbolic meanings might influence the perceptions associated with monetary rewards and the link between rewards and creativity. Finally, it is also of importance to examine whether our findings can be extended to non-monetary sources of rewards such as verbal rewards (e.g., positive feedback), and rewards with different contingencies such as those that are not contingent on the qualities of the creative outcome (e.g., engagement-contingent or completion-contingent rewards).

Practical Implications

Our study offers important practical implications for organizations as it contributes to a better understanding of creativity – a key ingredient of organizational innovation. The core insight provided by this study is that managers should be careful about using monetary rewards to stimulate creativity as it can backfire, or at best be non-effective, for people with high prosocial motivation. Given that prosocial motivation is one of the important motivations for engaging in organizational citizenship behaviors that include creative activities such as idea generation or innovative suggestions (Grant & Ashford, 2008; Unsworth, 2001), managers must carefully assess the nature of the task and people's likely motivation before using monetary rewards. If they do so, they can use monetary resources more effectively to stimulate creativity.

The implications of our study go beyond intra-organizational management of creativity; we provide implications for the management of creativity outside the boundaries of the organization via crowdsourcing. Decisions on the size of monetary rewards are critical in most of the crowdsourcing platforms in driving engagement by the crowd. Our findings, for example, suggest that high monetary rewards should not be used when the prosocial aspects of the innovation problem are highly salient. We also suggest providing opportunities for recognition and career benefits in order to stimulate greater engagement by the crowd. Moreover, our findings imply that providing information cues that will enhance creative self-efficacy judgments of the crowd, such as positive feedback (e.g., Gist & Mitchell, 1992), are important in driving creativity in crowdsourcing platforms. As a whole, our study provides important implications for harnessing the creativity of the crowd – something which offers great potential for solving challenging scientific problems in various disciplines and for improving organizational innovativeness (Boudreau & Lakhani, 2013; Lakhani et al., 2013; Munos, 2009).

Finally, more effective management of prosocial motivation, creativity and money can only benefit our society. Mismanaging such resources would be wasting three valuable assets: human potential to benefit others, creative energies and money. Thus, we encourage managers of both profit and non-profit organizations to evaluate carefully both the context and people before using money as a stimulus for more creative engagement and performance.

Conclusion

By triangulating data from a field study and an experiment, we introduce prosocial motivation as a moderator that determines the effects of rewards on people's creativity. We demonstrate that reward size will enhance creative engagement and performance when individuals have low prosocial motivation; however, this effect is diminished when levels of prosocial motivation are higher. We also show that this interaction effect is mediated by feelings of creative self-efficacy. We hope that these findings will set the stage for further theoretical progress towards a better understanding of the complex motivational processes of creativity.

APPENDIX

TABLE A1
Qualitative Data Sources

Data Source	Interviews	Netnography
InnoCentive Employees	13	
Solver Interviews	10	
InnoCentive Blog Posts		358 posts
InnoCentive Forum Posts		77 posts
LinkedIn Group Posts and Comments		193 posts

TABLE A2
Study 1: Results of Exploratory Factor Analysis[a]

Item	Prosocial Motivation *(α=.88)*	Creative Self-Efficacy *(α=.85)*	Intrinsic Motivation *(α=.86)*	Learning Motivation *(α=.92)*	Extrinsic Motivation *(α=.89)*
Opportunity to benefit others through my solution	.81				
Opportunity to work on something matters	.85				
Opportunity to work on real life problems	.82				
Confidence in having the best solution		.92			
Confidence in winning the reward		.89			
Competence in solving the problem		.80			
Enjoyment of creating new things			.79		
Enjoyment of solving problems			.82		
Enjoyment of working in the field of challenge			.68		
Intellectual curiosity			.74		
Learning new things				.81	
Enhancing my skills				.85	
Sharpening my brain				.82	
Being updated with science				.78	
Improving my resume					.85
Enhancing my career prospects					.87
Recognition of solving the problem					.85
Showing my competences					.79

[a] Exploratory factor analysis with varimax rotation and Kaiser Normalization. All components eigenvalue is over 1 and five factor structures explain 78% of variance. All factor loadings that are greater than .35 are presented in the table.

TABLE A3
Study 1: Results of Confirmatory Factor Analysis of the Main Model and Alternative Models

Models	$\chi 2$	RMSEA	SRMR	GFI	NFI	CFI	IFI
5 factors	549.12	.07	.04	.91	.96	.97	.97
4 factors(cse, Intrinsic, prosocial self combined, extrinsic)	1451.18	.13	.08	.80	.91	.92	.92
3 factors (CSE, Intrinsic, prosocial and self combined vs extrinsic)	2063.84	.15	.08	.73	.89	.89	.89
2 factors (CSE, others combined)	3398.00	.20	.13	.63	.81	.81	.81
Single Factor	4323.20	.22	.15	.57	.74	.75	.75

TABLE A4
Study 2: Correlation Matrix[a]

	1	2	3	4
1. Prosocial motivation				
2. Reward size	.01			
3. Creative self-efficacy	.19	-.14		
4. Creative engagement	.31	.08	.36	
5. Creativity	.00	.04	.27	.29

[a]Correlations equal to or greater than .27 are significant at $p < .05$.

Chapter 3

UNPACKING THE KNOWLEDGE MECHANISMS OF PROBLEM SOLVING IN CROWDSOURCING: THE INTERPLAY OF EXPERTISE AND KNOWLEDGE SEARCH

INTRODUCTION

Capability in solving problems is critical for organizational success and innovativeness since the main function of most innovation projects is problem solving (Nickerson & Zenger, 2004; von Hippel, 1990). Therefore, researchers extensively studied the factors influencing problem solving effectiveness. One of the most important topics, in this respect, is the role of various knowledge related phenomena on problem solving (Argote & Miron-Spektor, 2011; Jeppesen & Lakhani, 2010). Prior research addressed the role of knowledge on problem solving mainly by investigating the effect of expertise on problem solving; however, research in this area has divergent conclusions (Dane, 2010). More specifically, some scholars suggest that expertise is crucial for creative problem solving (e.g., Amabile 1996, Larkin et al. 1980, Weisberg 2006), whereas others claim expertise is associated with inflexibility (e.g., Chi, 2006; Lewandowsky, Little, & Kalish, 2007) and a constraining factor for problem solving (e.g., Jeppesen & Lakhani, 2010; Stacey, Eckert, & Wiley, 2002; Wiley, 1998).

As expertise is characterized by a high level of knowledge on a specific domain (Ericsson, 2006; Schmidt, Hunter, & Outerbridge, 1986), these arguments often hold the assumption that experts merely use the knowledge domain(s) in which they have expertise. This assumption, however, might fall short in explaining complex mechanisms of knowledge usage since experts could differ in their tendency to rely on their expertise and can search for knowledge in different domains outside their area of expertise. In effect, a relatively recent line of research focuses on the effects of knowledge search processes on the innovative performance of individuals (e.g. Fleming, 2001; Schilling & Green, 2011) and organizations (e.g., Katila & Ahuja, 2002; Laursen & Salter, 2006). These studies focused on how knowledge search breadth and depth influence the final innovative performance of individuals and organizations. Although, these studies expanded our understanding on the influence of knowledge on creative performance, the research on knowledge search often merely focused on the effect of knowledge search while neglecting the perspective that expertise and prior knowledge bring for the individual who conducts knowledge search. This is crucial since expertise has certain consequences for individuals in terms of recognition, evaluation and utilization of the information that will be gathered from knowledge search (Cohen & Levinthal, 1990).

The core premise of this paper is that problem solving performance is an outcome of an individual's expertise and specific behaviors he/she engages in when searching a solution. To that end, we integrate psychology literature on the effects of expertise on problem solving and management literature on the knowledge search-innovation link. We start with the acknowledgement that expertise will be required for thoroughly understanding a technical and complex innovation problem but it might lead to cognitive inflexibility that might limit finding creative solutions to the problem. We argue that to the extent the search behavior overcomes the cognitive inflexibilities associated with expertise, it will contribute to a better quality solution for that problem. When experts go outside the domain of their expertise in their knowledge search, by diversifying the knowledge pool for the solution, they will be more likely to perform better in solving complex innovation problems. Nevertheless, diversifying this pool too much will be detrimental for problem solving performance since recombining many different knowledge elements will induce high complexity and uncertainty in problem solving process which might be beyond the cognitive capacities of individuals and distract them from devoting necessary attention and effort required for problem solving.

To capture these effects, in line with earlier literature, we differentiate between breadth and depth of knowledge search (e.g., Laursen & Salter, 2006; Schilling & Green, 2011). We further distinguish depth of search based on relatedness of the domain (Schilling, Vidal, Ployhart, & Marangoni, 2003), namely depth of search in *same*, *related* and *different* knowledge domains compared to the domain of the problem at hand. Analyzing, 139 different innovation problems and 646 solutions developed for those problems, we found support for our hypotheses: expertise is associated with better problem solving performance when it is accompanied with a knowledge search behavior that is (1) high in overall breadth-low in depth for same domain, (2) high in overall breadth-high in depth for related domain and (3) high in overall breadth-low in depth for different domain.

Our study has important theoretical implications for micro level knowledge and problem solving literatures. We shed light on the controversy around the expertise-creativity link by showing this effect depends both on the specific knowledge search behavior conducted for solving a problem. Put differently, we suggest that expertise is an important contingency for the effectiveness of different knowledge search behaviors. Second, by distinguishing between knowledge search breadth and knowledge search depth based on the relatedness of a knowledge domain, we offer a comprehensive framework for the role of knowledge mechanisms for problem solving. Our framework incorporates expertise studies in psychology literature and knowledge search work in management literature which are related streams of research but often remained disparate.

THEORETICAL BACKGROUND AND HYPOTHESES

Expertise and Problem Solving

Our aim in this paper is to shed light on the relationship between expertise and problem solving performance. Earlier research on expertise–problem solving relationship is limited and provides contradictory predictions (Dane, 2010). On the one hand, scholars highlight the positive effects of expertise by pointing to the requirement of deep knowledge on a certain domain for having a significant contribution to a domain (e.g., Amabile, 1983; Weisberg, 1999). On the other hand, scholars emphasize the cognitive inflexibilities in seeing potential alternatives and stabilized cognitive schemas and suggest that expertise would hamper problem solving performance (e.g., Kaplan & Simon, 1990; Luchins, 1942).

Scholars emphasizing the benefits of expertise for problem solving mainly highlighted the advantages of "knowing the territory" and the importance of immersion in to a knowledge domain before contributing to it (Hayes, 1989; Weisberg, 1999). Expertise in a certain domain is highly important to recognize, evaluate and utilize new information in different domains (Cohen & Levinthal, 1990). In addition as experts have automatized habits and efficiency in the skills that knowledge domain requires, they might allocate more effort and attention to novel aspects of problem solving (Dane, 2010; Weisberg, 1999).

Scholars emphasizing restrictiveness of expertise mainly highlighted the cognitive inflexibilities associated with expertise. One of the most widely noted argument is that expertise might cause problem solving fixation- which is the situation that the first idea coming to mind, triggered by expertise in the domain, prevents the alternatives from being considered (Bilalić, McLeod, & Gobet, 2008a, 2008b; Luchins, 1942). Thus when fixation occurs, experts pre-engage in a certain solution and avoid considering alternative solutions. This is limiting for creativity in two ways. First, the idea is mainly triggered by earlier solutions developed in the expertise domain that is unlikely to be a creative solution itself. Second, it further blocks engagement in creative thinking. In addition to fixation, experts typically have stable domain schemas –"structures containing knowledge about a concept or type of stimulus, including its attributes and the relations among those attributes" (Dane, 2010: 581). This stability is associated with resistance to modification, adaptation and cognitive inflexibility which generates an important barrier for problem solving (Dane, 2010; Fiske & Taylor, 1991). In summary, experts are engaged very strongly in a point of view or way of solving problems which inhibits consideration of alternative solutions and therefore diminishes performance in solving an innovation problem (Sternberg, 1996; Koestler, 1964; De Bono)

Interplay of Expertise and Knowledge Search Behavior

Earlier research on expertise and problem solving, most often, either implicitly or explicitly assumed that experts only and extensively use the knowledge they have expertise on. However, the effects of expertise might depend on tendency to rely on their expertise domain. In addition, when solving a problem one is not limited to use his/her knowledge in the area of expertise but can search and accumulate knowledge outside the expertise domain. Individuals have different approaches for searching a solution to a problem: some are more likely to incorporate more knowledge domains than the others (Hong & Page, 2001, 2004; Runco, 1991). Nevertheless, prior studies often addressed the relationship between problem solving performance and expertise separately and neglected the possible differences in proclivity to rely on expertise domain and search behavior. This might explain the inconsistent results in the literature as, for example, inflexibility related problems are more likely to occur when an expert merely uses his/her knowledge in the expertise domain. Therefore, we aim to incorporate expertise and knowledge search behavior in order to have a more comprehensive understanding of knowledge mechanisms of problem solving.

We argue effects of expertise on problem solving performance will depend on the search behavior that experts engage in and whether this behavior helps overcoming inflexibility related problems. To the extent, that the search behavior diversifies the knowledge base to draw on, search behavior will help overcoming cognitive flexibilities. This diversification should positively influence problem solving performance by increasing the conceptual elements for novel recombinations (e.g.,Fleming, Mingo, & Chen, 2007; Schilling & Green, 2011), improving the chances for finding new information (Campbell, 1960; Simonton, 1999a, 1999b), enhancing the chance of seeing unrelated links between different domains and transferring to the problem domain (Hargadon & Sutton, 1997; Schilling, 2005), and stimulating a more creative mindset and thinking style that questions and doubts the current assumptions in the problem domain (e.g. Maitlis & Sonenshein, 2010; Weisberg, 1999). Put differently, diversification is likely to overcome cognitive stability and inflexibility problem that experts encounter by increasing elements for recombination and for challenging the current stabilized cognitive structures and accessing alternative perspectives for analogical transfer.

On the other hand, the benefits of diversification beyond a certain point can be above the cognitive capacity of a certain individual. In such a case diversification would not be beneficial. When the diversification increases too much, interactions between the components become highly complex combined with increased uncertainty associated with the outcomes (Fleming, 2001). Since individuals have limited cognitive capacity, they cannot comprehend and attend to different elements fully and they are unlikely to benefit from the diversification while solving problems. Over diversification is also likely to distract people in problem solving activity since devoted attention and mental energy is required for creativity (Csikszentmihalyi, 1997). In addition, such difficulties might cause stress which might, in turn, be a restraining factor for creative processes when the stress becomes overwhelming (Perry-Smith and Shalley, 2003).

Scholars typically distinguished between breadth and depth of knowledge search both in organizational (e.g., Laursen & Salter, 2006) and individual level (e.g., Schilling & Green, 2011). We extend this by further distinguishing depth of search by separately focusing on different domains. More specifically, we focus on the depth of search in different domains by comparing the domain in question based on its' relatedness to the problem domain and classify domains as *depth of search in same domain*, *depth of search in related domain* and *depth of search in different domain* (compared the domain of the problem at hand). We define *depth of search in same domain* as the intensity of knowledge usage in the problem domain. *Depth of search in related domain* addresses the intensity of knowledge usage the domains that are related to the problem domain (e.g. intensity of using biochemistry knowledge for a problem on organic chemistry). In other words, this construct concerns the intensity of knowledge domain in the boundaries of problem domain. In a similar vein, *depth of search in different domain* is defined as the intensity of knowledge usage in the domains that are different to the problem (e.g. using biology knowledge for solving a problem on organic chemistry). This construct addresses the intensity of search in the truly outside knowledge domains of the problem.

Different combinations of knowledge search depth and breadth would bring different levels of cognitive diversification for experts and therefore, have different impact in terms of overcoming potential cognitive inflexibility related problems. We specifically emphasize knowledge search breadth as it is typically considered as the major driver of diversification (e.g., Simonton, 1995, 1999a) and, thus, critical for cognitive flexibility of experts. Relative to search depth, we expect a broad search over various domains to be more instrumental in solving a problem for experts for two reasons. First, because broad knowledge search enables individuals to use varied knowledge from many different disciplines, it will generate a more diversified knowledge pool for tapping into while solving a problem compared to deeply searching in a certain domain. This is crucial for creative processes of problem solving as it creates the opportunity for generating unusual connections between different knowledge bases which might ultimately lead to fruitful synthesis of them (Simonton, 1995, 1999a, 1999b). Second, breadth of knowledge search would considerably increase the chances of finding an analogous problem and solution in a different domain and applying the solution to the current problem compared to deep search in a certain domain. This is because one would have more chances to be exposed to different kind of problems while searching broadly. This analogous transfer is one of the major mechanisms how insight for a successful and innovative solution occurs (e.g., Gentner, Holyoak, & Kokinov, 2001; Gick & Holyoak, 1980; Hargadon & Sutton, 1997). Therefore, a deep search in a certain knowledge domain, no matter how distant it is to domain of the problem, is likely to generate less cognitive diversification for experts than a broad search over different domains. To clarify, this is not to claim that searching deeply in another problem domain would not allow for diversification for experts but searching broadly would be more instrumental in this respect. Indeed, Schilling and Green (2011) found that although both search depth and breadth significantly increase to chances of creating atypical connections, a major driver of creative solutions, search breadth is much more positively related to create such connections. All in all, we propose that a high level of knowledge search breadth is crucial for problem solving performance of experts.

Combining this high search breadth with different depth of search in abovementioned three categories of knowledge domains (i.e., same, related and different) would have different impacts on diversification and overcoming cognitive flexibilities and, in turn, will determine the subsequent performance in solving an innovation problem. With respect search depth in same domain, we believe minimizing search depth would increase the chances of breaking the boundaries of a certain knowledge domain for experts and overcome fixation effects, which are critical for making a novel contribution to a domain (Bilalić et al., 2008a; Weisberg, 1999), since higher search depth might trigger them to remain in the domain of expertise, act in a habitual and automatized way and limit diversification and novel approaches to the problem (Bilalić et al., 2008a, 2008b). Therefore, we propose the combination high breadth of search with low depth of search in same domain would be more likely to be associated with higher problem solving performance.

Hypothesis 1: Expertise is positively associated with problem solving performance when individuals combine expertise in the problem domain with high breadth of search and low depth of search in the problem domain.

Concerning the knowledge search depth in a different domain, when deeply searching in a very distant domain and searching broadly individuals might feel overwhelmed as such a recombination is likely to be beyond their cognitive capabilities. This is because incorporating the knowledge from a very different domain from the expertise field and broadly searching for solutions in different domains would require intense cognitive effort and attention while generating high uncertainty. Because over diversification causes high complexity and uncertainty in recombining different knowledge elements and distract people from devoting necessary energy on problem solving (Csikszentmihalyi, 1997; Fleming, 2001), we expect a combination of high search breadth with low search depth in a different domain would be optimal for overcoming cognitive flexibilities without restraining creative processes. Therefore we propose:

Hypothesis 2: Expertise is positively associated with problem solving performance when individuals combine expertise in the problem domain with high breadth of search and low depth of search in a different domain from the problem domain.

Regarding the search depth in related knowledge domains, searching deeply for a solution in a related knowledge domain will further contribute to diversification that is brought by high search breadth and, thus, enhance the chances of experts to overcome their inflexibility. Combining both high intensity of related knowledge and high knowledge variation will jointly contribute to positive effects of expertise on problem solving performance. We do not expect searching deeply in a related domain to increase complexity and uncertainty beyond cognitive capacities of experts as it is in the case of deep search in a different domain. The reason behind is that the distance between expertise domain and a related domain is much shorter than the distance between a different domain which would facilitate deeply searching in a related domain for experts. Therefore, we expect deep search in a related domain to further contribute to diversification that broad search brings as opposed to being restrictive in the case of deep search in a different domain. In addition, knowledge search breadth might also benefit related search depth in a way that increases the effectiveness of the decision on what knowledge domain to search deeply. That is, knowledge search breadth might also allow a well-targeted exploration in the appropriate related knowledge domain. Hence, we propose:

Hypothesis 3: Expertise is positively associated with problem solving performance when individuals combine expertise in the problem domain with high breadth of search and high depth of search in a related domain to the problem domain.

METHODS

Research Setting and Data

InnoCentive is an intermediary company and offers a platform for matching innovation problems of its clients (i.e. seekers) with its community (i.e. solvers). Seekers share a specific problem (i.e. challenge) with InnoCentive and InnoCentive broadcasts this problem on its online platform. Almost 300.000 solvers self-select the challenges that they want to participate in and voluntarily submit their solutions by means of an elaborated report. The solutions are then rated by InnoCentive based on their quality and the winning solution is selected and rewarded by the seeker. Typically, the winner receives a monetary reward ranging from 5.000-100.000 USD. As one of the executives in InnoCentive defines, “the challenges here are modules of work characterized by a specific problem statement”. Content wise, they are similar to R&D department work and, in effect, a large number of the challenges originate from R&D groups. Thus, typically, challenges are complex, expertise requiring and demanding tasks.

Our population consists of the all submissions of the active solvers (i.e. solvers who participate in challenges) between Dec 2009 (the date the challenges started to be rated by InnoCentive) and May 2012 in InnoCentive. We have collected data for Reduced to Practice challenges (i.e. the challenges that require detailed description of the solution and physical evidence that proves the solution will work) and Theoretical challenges (i.e. the challenges that require detailed descriptions, specifications and supporting precedents). There were two reasons for focusing on these two types of challenges. First, they were reflecting R&D work better than other challenges and, second, only the submissions to these challenges are rated based on their problem solving performance by InnoCentive. In total, we tested our hypotheses on the solutions to 139 different R&D challenges.

We used a web based survey tool to collect data from the solvers of InnoCentive. The survey was in English. Using contact information from the company, we sent a customized e-mail (i.e. addressed the solver by his/her name and included specific challenge information that we requested information for), along with an URL survey link, to 3005 solvers. The e-mail was clearly demonstrating that we are partnering with the company and that their response was very important for us. In addition to that, InnoCentive informed solvers, in its LinkedIn groups and blog, about our research and collaboration and announced that they might be receiving an email shortly. We sent a reminder a week after the initial contact by adopting a dynamic strategy (i.e. the time, day and text of the initial email was changed) (Sauermann & Roach, 2012). We received 744 (24.8 %) responses. After excluding the cases with incomplete answers, 646 (21.2%) responses were usable for our analysis.

Measures

Expertise. Our expertise measure was derived from the marginality measure of Jeppesen and Lakhani (2010) and measured by the web survey. The item addressed the extent the challenge is in solvers' field of expertise. It was anchored as 1 "inside my field of expertise", 4 "at the boundary of my field of expertise", 7 "outside my field of expertise".

Knowledge search breadth and depth. The knowledge search variables were measured by the web survey. We have developed the items based on the literature and in-depth interviews with solvers and InnoCentive employees. The questions addressed two dimensions of knowledge search: depth of knowledge search in same, related and different domains and breadth of knowledge search for the solution. The questions are presented after elaborate definitions of what we mean with the same, related and different knowledge domains and are accompanied with clear examples explaining the relatedness and breadth in knowledge usage. We provided the following definitions for respondents. For the same domain: "*The knowledge domain you use for solving the challenge and the discipline of the challenge falls into the same domain. An example is using your organic chemistry knowledge for a challenge on organic chemistry*. For related domain: *"The knowledge domain you use for solving the challenge and the discipline of the challenge are related. An example is using your biochemistry knowledge for a challenge on organic chemistry*. For different domain: *"Different domain is the knowledge domain you use for solving the challenge and the discipline of the challenge are different. An example is using your knowledge on biology for a challenge on organic chemistry"*.

Before asking the questions for measuring depth of knowledge search variable, we first provided a text for introducing and reminding that knowledge search depth might vary for individuals: "*Solvers might use different sources of knowledge, in different intensities, while developing their solutions"*. We then asked respondents "to what extent did you use your knowledge in the following domains for solving the challenge". The response scale was seven-point (1 "no use", 4 "moderate use", 7 "intense use"). It comprised three items addressing the intensity of usage for the same, related and different domains. It is similar to the measurement of "depth of knowledge" in the innovation literature (e.g. Laursen & Salter, 2006). For the breadth of knowledge search variable, we first provided an introductory text for pointing that search breadth might differ for individuals: *"Solvers might solve the challenges by intensively using their knowledge on a single knowledge domain or by incorporating their knowledge on various domains."* We then asked "how many knowledge domain(s) did you use for your solution to the challenge?" which was adapted from Zahra and Covin (1993). The response scale was again seven-point (1 "single domain", 4 "moderate variety of domains", 7 "wide variety of domains").

Problem solving performance. Problem solving performance is measured by the rating given for each submission by an "Innovation Program Manager" of InnoCentive. The rating varied from 1 to 5 and an increasing rating refers to a greater success in solving the innovation problem and addressing problem requirements defined by the seeker.

Control variables. We controlled for solvers' engagement in the search by measuring the hours solvers spent for searching solution to the challenge (Yeo & Neal, 2004). Due to high skewness, we used logarithmic transformation of this variable. Additionally, we controlled for four demographic variables that might influence motivations, effort and creativity: *age, gender and education level*. We measured gender as a dichotomous variable coded as 1 for female and 0 for male. Age was measured in years and is reported by the solvers on an open question. The education measure addressed the highest academic degree earned and had 6 levels (ranging from less than high school degree to PhD degree). In order to account for challenge related differences we also controlled for *challenge type* by using a dummy variable (i.e. theoretical challenge vs. reduced to practice challenge) of the challenge. The main difference between these two types of challenges were that physical evidence (e.g. prototype) was required in RTP challenges in addition to the detailed descriptions that are required in theoretical challenges. In addition we collected data from the archives of the company for the *award size* in a challenge Because the data was highly skewed we used logarithmic transformation of this variable. Our in depth interviews revealed that in some cases solvers select the challenges that they already know the answer rather than randomly selecting a challenge and working on it. This could influence both effort and motives; thus we controlled for *knowing the solution* already by a dummy variable.

RESULTS

Means, standard deviations, sample size and correlations are presented in Table 5. We tested our hypotheses by using hierarchical ordinary least squares regression analyses following the recommendations of Aiken and West (1991). In the first step we entered the control variables; in the second step we added the expertise and knowledge search variables. In the last two steps, we entered the two-way and three-way interactions of expertise and knowledge search variables. To create the interaction terms, we standardized expertise and knowledge search variables and multiplied them. In order to address potential multicollinearity issues, we reviewed variance inflation factor values (VIFs) before creating the interaction terms (e.g., Shalley, Gilson, & Blum, 2009). VIF values for expertise and knowledge search variables ranged between 1.05 and 3.36 suggesting that multicollinearity was far from being an issue in our study (Hair, Black, William, Babin, Anderson, & Tatham, 1998).

TABLE 5
Means, Standard Deviations and Correlations[a]

Variables	*M*	*SD*	1	2	3	4	5	6	7	8	9	10	11	12
1. Age	43.5	14.5												
2. Education	3.66	1.26	.14											
3. Female	.09	0.29	-.08	.04										
4. Challenge type	.17	0.38	-.01	.18	-.02									
5. Knowing	.22	0.42	.09	.04	.01	.04								
6. Reward Size	4.39	0.25	.01	.14	.05	.50	.07							
7. Engagement	.65	0.51	-.07	.17	.02	.08	.00	.09						
8. Expertise	3.97	1.89	.03	.10	-.05	.09	.09	.07	.16					
9. Same search depth	4.23	1.78	-.01	.09	.04	.02	.08	.07	.14	.34				
10. Related search depth	4.13	1.50	-.06	.08	-.01	-.05	-.02	.05	.15	.10	.34			
11. Different search depth	3.76	1.73	-.02	-.04	-.08	-.02	-.01	.07	.02	-.09	-.03	.41		
12. Search breadth	7.44	3.30	.05	-.09	-.07	-.05	-.04	.01	.09	-.16	-.02	.32	.52	
13. Performance	2.59	1.12	-.07	.32	-.02	.09	.05	.01	.44	.20	.13	.11	-.08	-.13

[a] Reward size and engagement variables are log transformed. Correlations that are greater than .08 are significant at $p < .05$

The results of the hierarchical regression analyses are displayed in Table 6. As hypothesized, the three-way interactions between expertise, breadth of search and depth of search were all significant. More specifically, the interaction between, expertise, breadth of search and depth of search in the same domain was negative and significant ($\beta = -.17$, $p < .01$). The interaction between, expertise, breadth of search and depth of search in the related domain was positive and significant ($\beta = .23$, $p < .01$). Lastly, the interaction between, expertise breadth of search and depth of search in the different domain was negative and significant (β = -.14, p < .05). This provides initial support for our hypotheses.

TABLE 6
Results of Hierarchical OLS Regression Analyses[a]

	Model 1		Model 2		Model 3		Model 4	
Variables[b]	***β***	***SE***	***β***	***SE***	***β***	***SE***	***β***	***SE***
Age	$-.10^{*}$	.00	$-.09^{*}$	.00	$-.09^{*}$	.00	$-.08^{*}$	.00
Education	$.28^{***}$	.04	$.25^{***}$	.04	$.25^{***}$	.04	$.24^{***}$	.04
Gender	-.03	.16	-.04	.15	-.04	.15	-.04	.16
Challenge type	.05	.13	.05	.13	.05	.13	.04	.13
Knowing the solution	.07	.11	.06	.11	.06	.11	.06	.11
Reward size	-.08	.20	-.07	.20	-.07	.20	-.07	.20
Engagement	$.28^{***}$	.07	$.27^{***}$	.07	$.27^{***}$	.07	$.27^{***}$	.07
Expertise			$.08^{*}$	.05	$.09^{*}$	.05	$.08^{\dagger}$	.05
Same search depth			-.01	.05	-.02	.05	-.04	.06
Related search depth			.07	.05	.08	.05	$.13^{*}$	.06
Different search depth			-.05	.05	-.05	.05	-.05	.06
Search breadth			$-.13^{**}$	.05	$-.12^{**}$	.05	$-.11^{*}$	.06
Expertise x search breadth					.06	.05	.07	.05
Expertise x different search depth					-.01	.05	-.05	.06
Expertise x related search depth					-.03	.05	.10	.06
Expertise x same search depth					-.04	.04	$-.15^{**}$	.06
Search breadth x same search depth					-.09	.05	$-.10^{*}$	.05
Search breadth x related search depth					-.03	.05	-.00	.05
Search breadth x different search depth					.02	.05	.02	.05
Expertise x search breadth x same search depth							$-.17^{**}$	.05
Expertise x search breadth x related search depth							$.23^{**}$	.05
Expertise x search breadth x different search depth							$-.14^{*}$	.05
R^2	.19		.22		.23		.25	
F	17.80		12.48		8.21		7.91	
ΔR^2	$.19^{***}$		$.03^{***}$		.01		$.02^{**}$	

[a] Values are standardized coefficients. Reward size and engagement variables are log transformed.
$^{\dagger}p < .10$, $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$

To facilitate the interpretation of this interaction, we plotted simple slopes depicting the relationship between expertise and creativity at one standard deviation below and above the mean of different breadth of search and depth of search variables. Figure 5-7 depicts these interactions for depth of search in same, related and different domain respectively. In Figure 1 simple slopes suggest that, as expected, expertise is most strongly related to problem solving performance when knowledge search breadth is high and knowledge search depth in the same domain is low. In other combinations of breadth of search and depth in same domain the effect of expertise seems to be slight. Figure 2 shows that, as predicted, expertise is most strongly related to problem solving performance when knowledge search breadth is high and knowledge search depth in the related domain is high. The effect of expertise in all other knowledge search breadth and depth in related domain were small. In Figure 3, slopes suggests that, as hypothesized, expertise is most strongly related to problem solving performance when knowledge search breadth is high and knowledge search depth in the different domain is low. This effect was minor in other search breadth and depth in different domain combinations.

FIGURE 5
Expertise and Problem Solving Performance Relationship in High/Low Breadth of Search and Depth of Search in the Same Domain

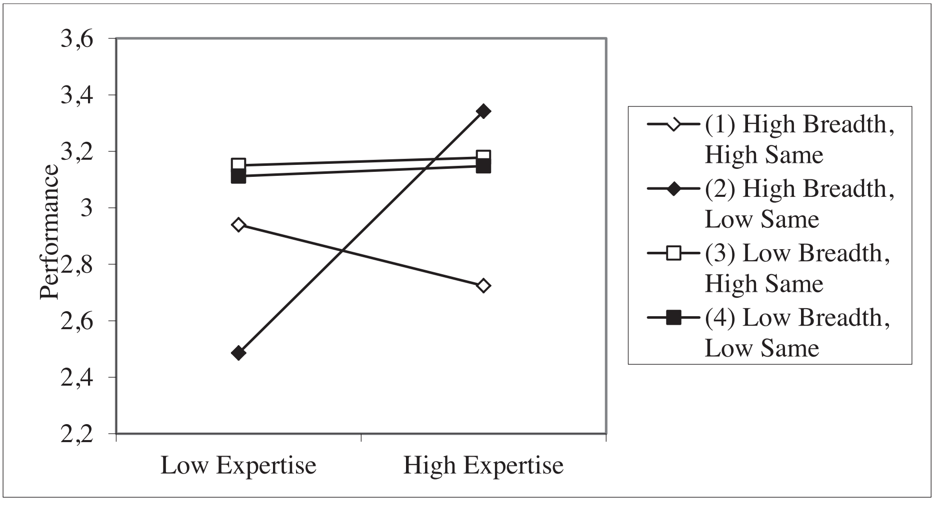


FIGURE 6
Expertise and Problem Solving Performance Relationship in High/Low Breadth of Search and Depth of Search in the Related Domain

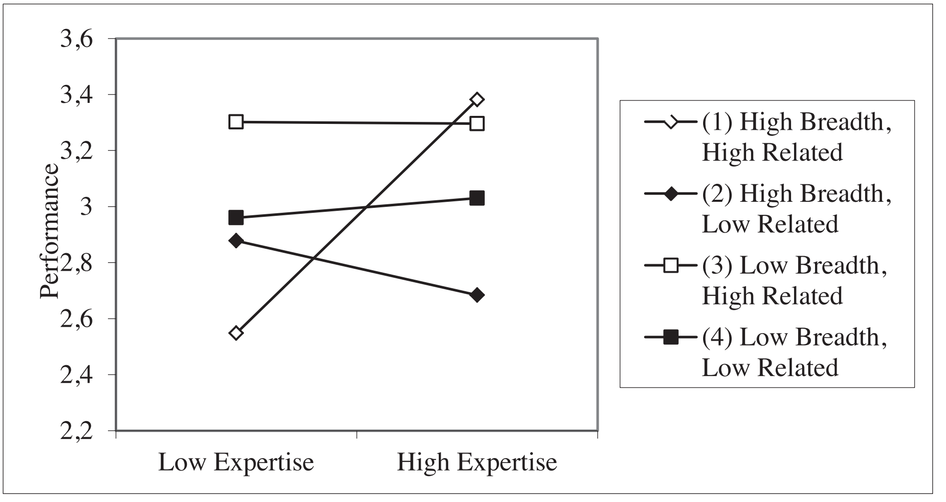
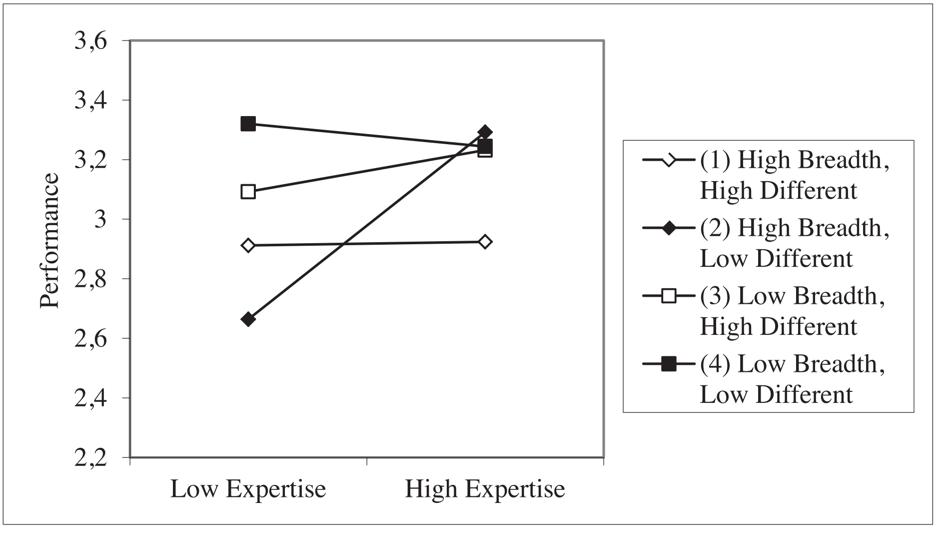


FIGURE 7
Expertise and Problem Solving Performance Relationship in High/Low Breadth of Search and Depth of Search in the Different Domain



To examine this interpretation statistically, we used the Dawson and Richter (2006) slope difference test, which allowed us to examine whether the slopes for the relationship between expertise and problem solving performance was statistically different in certain knowledge search breadth and depth combinations. The results are presented in Table 7.

TABLE 7 Slope Difference Test for Same, Related and Different Search Depth

	Different Depth	Related Depth	Same Depth
Pair of slopes	**t-value for slope difference**	**t-value for slope difference**	**t-value for slope difference**
(1) and (2)	**-1,97***[*]	**2,85**[**]	**-3,28**[**]
(1) and (3)	-0,51	**3,05**[**]	-0,99
(1) and (4)	0,39	**2,78**[**]	-0,86
(2) and (3)	1,47	-0,59	**3,04**[**]
(2) and (4)	**2,51**[*]	-0,98	**3,08**[**]
(3) and (4)	0,89	-0,34	-0,04

[a] (1) High breadth, high depth; (2) High breadth, low depth; (3) Low breadth, high depth; (4) Low breadth, low depth
[*] $p < .05$, [**] $p < .01$

They show that, as hypothesized, the slope for low same usage-high breadth was significantly more positive than each of the other three combinations (i.e., high same depth-low breadth, high same depth-high breadth and low same depth-low breadth) and these three slopes did not differ significantly from each other. Similarly, the slope for high related depth-high breadth was significantly more positive than each of the other three combinations (i.e., high related depth-low breadth, low related depth-high breadth and low related depth-low breadth) and these three slopes did not differ significantly from each other. The slope for low different depth- high breadth was significantly more positive then low different depth-low breadth and high different depth-high breadth but was not significantly different from high different depth-low breadth.

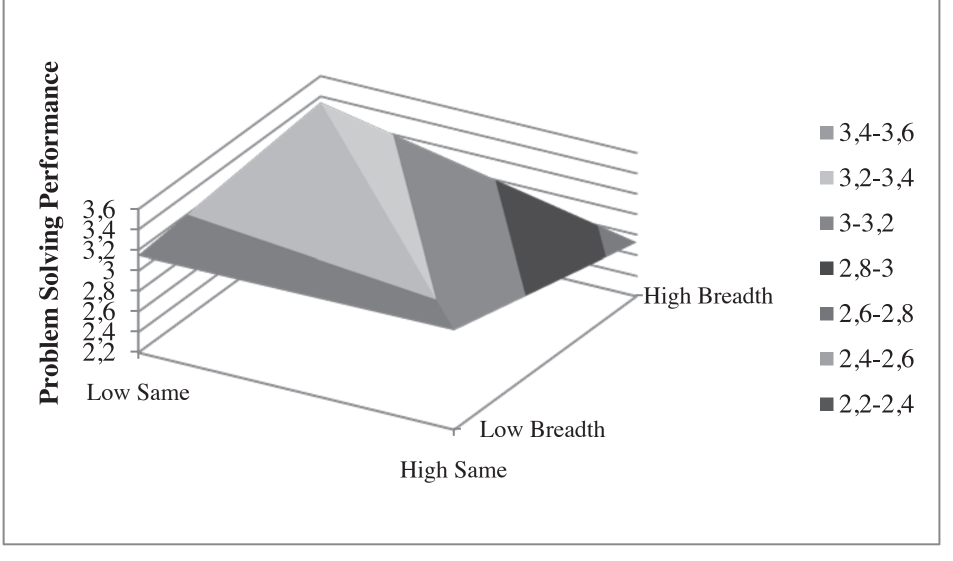
To interpret these slopes further, we compare each of the simple slopes to zero which are shown in Table A4. The table demonstrates that expertise positively and significantly relates to problem solving performance when and search breadth is high and same domain knowledge depth is low ($\beta = 0.43$, $p < .001$), when search breadth is high and related domain knowledge depth is high ($\beta = 0.42$, $p < .001$) and search breadth is high and different domain knowledge depth is low ($\beta = 0.31$, $p < .01$) which confirms our Hypothesis 1, 2 and 3 respectively. None of the other search depth and breadth combinations were significant. All in all, these results provide support for our hypotheses.

Post-hoc Analyses

In an attempt to more clearly describe the optimal knowledge search mechanisms for people with different levels of expertise, we depicted how different combinations of search depth and breadth influence problem solving performance for people with low and high expertise[5] (Figures 8-13). These figures aim to portray how an individual, depending on his/her expertise, should search for solutions in order to maximize his/her problem solving performance.

Figures 8-10 show the optimal search behavior for people with *high expertise*. For these people highest level of problem solving performance was achieved when (1) high level of search breadth was combined with low level of search depth in the same domain, (2) high level of search breadth was combined with high level of search depth in a related domain, and (3) high level of search breadth was combined with low level of search depth in a different domain.

FIGURE 8
Effects of Knowledge Search Breadth and Depth in Same Domain on Problem Solving Performance for People with High Expertise



[5] Solvers who are in *high expertise* group are the people who scored at least one standard deviation above the mean of expertise. Solvers who are in *low expertise* group are the people who scored at least one standard deviation below the mean of expertise.

FIGURE 9
Effects of Knowledge Search Breadth and Depth in Related Domain on Problem Solving Performance for People with High Expertise

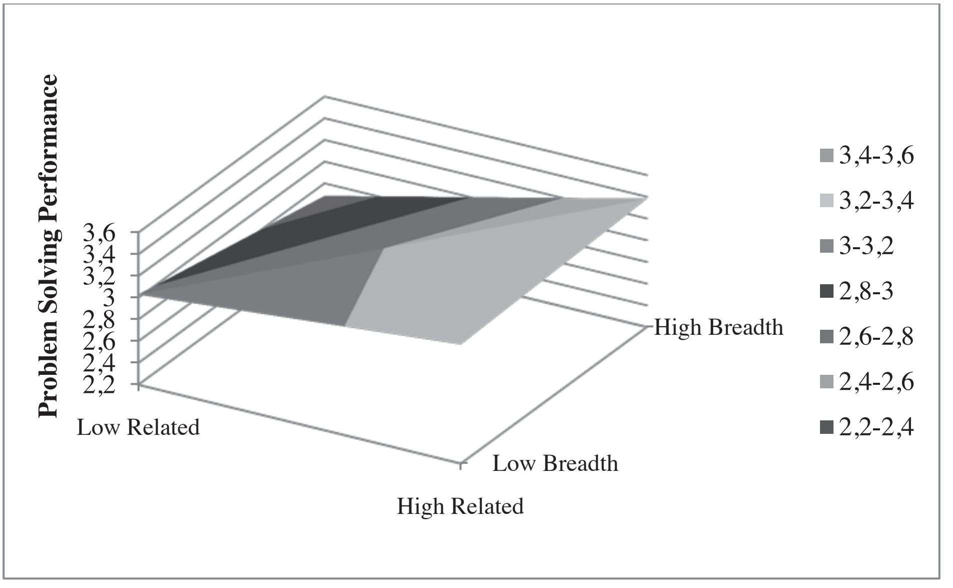
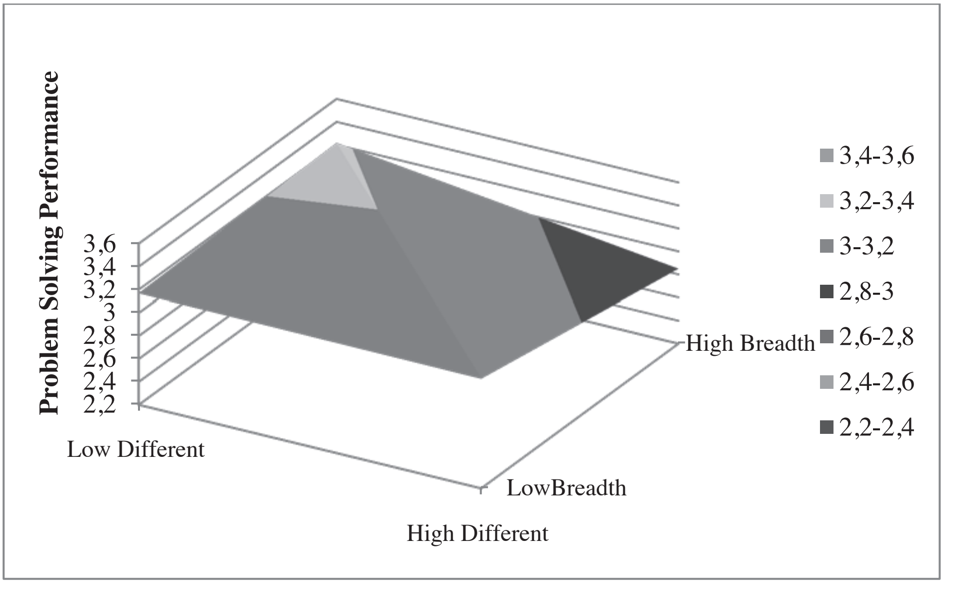


FIGURE 10
Effects of Knowledge Search Breadth and Depth in Different Domain on Problem Solving Performance for People with High Expertise



Figures 11-13 show the optimal search behavior for people with *low expertise*. For these people highest level of problem solving performance was achieved when (1) low level of search breadth was combined with high level of search depth in the same domain, (2) low level of search breadth was combined with high level of search depth in a related domain, and (3) low level of search breadth was combined with low level of search depth in a different domain.

FIGURE 11
Effects of Knowledge Search Breadth and Depth in Same Domain on Problem Solving Performance for People with Low Expertise

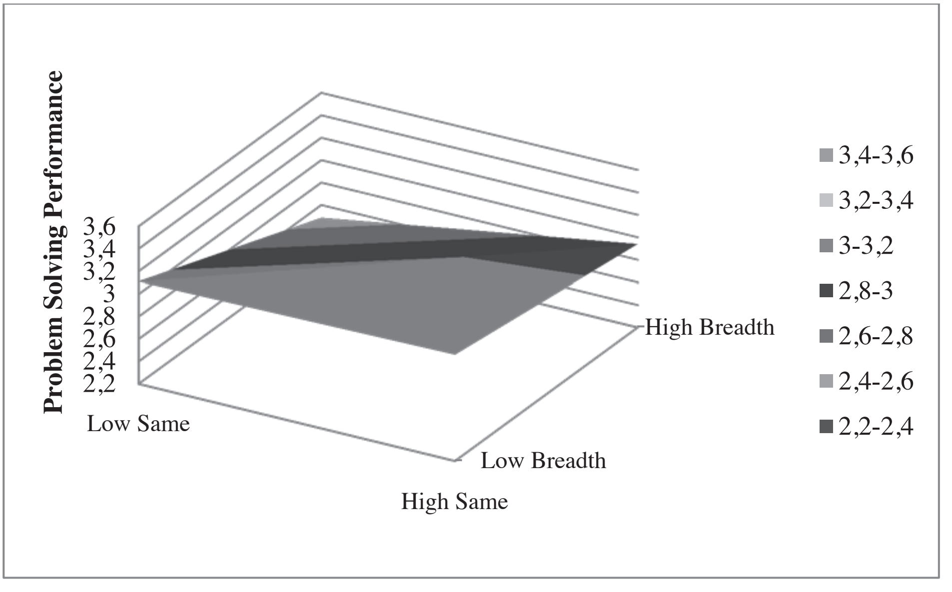


FIGURE 12
Effects of Knowledge Search Breadth and Depth in Related Domain on Problem Solving Performance for People with Low Expertise

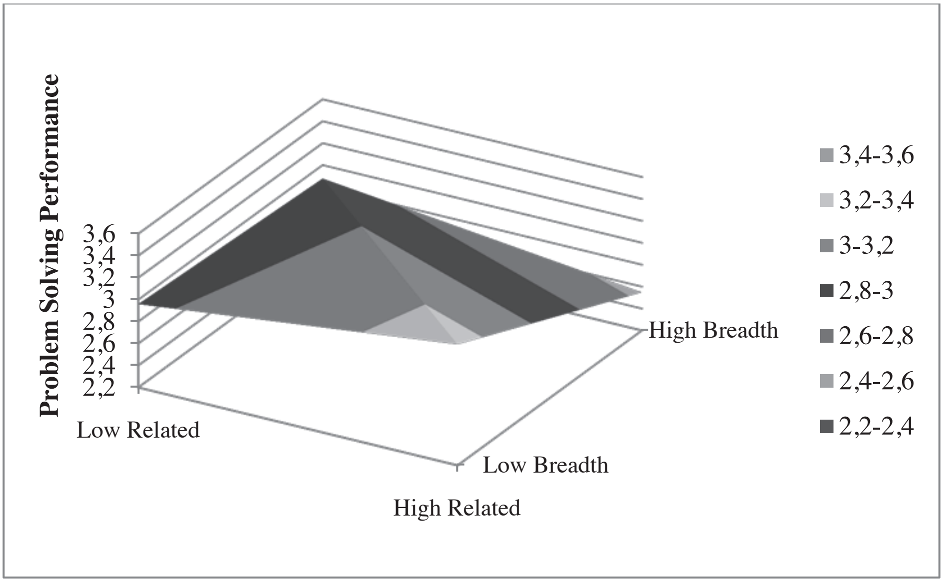
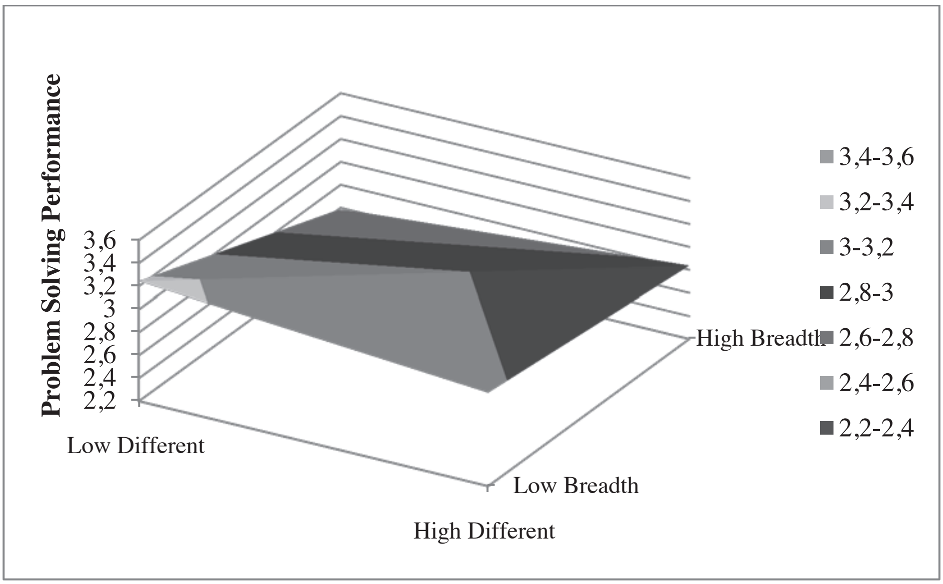


FIGURE 13
Effects of Knowledge Search Breadth and Depth in Different Domain on Problem Solving Performance for People with Low Expertise



GENERAL DISCUSSION

Theoretical Implications

In this study, we examined how the relationship between expertise and problem solving performance unfolds depending on knowledge search behavior. We found that expertise is positively related to problem solving performance: when it is accompanied with a broad search for solutions in other knowledge domains and (1) shallow (i.e., low depth of search) in the domain of problem or (2) shallow search outside the knowledge domain of the problem or (3) deep search in the boundaries of the domain of the problem (i.e., in a related domain). The main contribution of this finding is shedding light on the equivocal findings on the expertise- problem solving performance link as we show when expertise is more likely to contribute performance when combined with certain search behaviors in solving innovation problems. By doing so, we incorporate expertise research in psychology literature and knowledge search research in management literature which often remained separate. This extends understanding of and offers a comprehensive framework for knowledge mechanisms of problem solving.

Another important contribution of our study is that we address the recent shift of locus towards using crowdsourcing practices for organizational problem solving (Afuah & Tucci, 2012; Terwiesch & Xu, 2008): Organizations recently started to tap into the diverse knowledge pool all over the world thanks to the advances in communication technologies and the Internet. This would also contribute to literature on open innovation. Although this literature widely researched the role of external sources, such as customers (e.g., von Hippel, 1976), suppliers (e.g., Brown & Eisenhardt, 1995), competitors (e.g., Allen, 1983) or universities (e.g., Laursen & Salter, 2006), we know little about crowdsourcing platforms for innovation –an emerging channel for open innovation with huge potential (for exceptions see Boudreau et al., 2011; Jeppesen & Lakhani, 2010; Terwiesch & Xu, 2008). We, thus, extend extant open innovation and problem solving literature by showing how expertise and problem solving performance relationship unfolds when the locus of innovation and problem solving is outside the organizational boundaries.

In addition to the main contributions explained above, our study contributes to the discussion about the relation of breadth and depth of solution search. Consistent with the recent views, our results show that search breadth and depth are not necessarily two ends of a continuum but are independent constructs that are often positively correlated (e.g., Katila & Ahuja, 2002; Schilling & Green, 2011). We further contribute to this discussion by distinguishing search depth in different knowledge domains using the problem domain as the reference point. The nature of correlation between these constructs of search depth and breadth was different suggesting that a more fine-grained and detailed analysis of search depth and breadth indeed has merits. To elaborate, only correlations between search breadth and search depth in certain domains, namely different and related knowledge domains, were positive. Also, search depth in a related domain was positively correlated with search depth in both different and same domains but these latter two domains were not correlated with each other. In other words, individuals can search both more deeply and more broadly but these interactions between them are more complex than what the literature found before.

Our results indicated negative main effect of search breadth on problem solving performance. This finding suggests that appropriate combination of search breadth with expertise and search depth is crucial for problem solving. In other words, when a broad search for solutions is not complemented with appropriate search depth and expertise, it would be detrimental in solving innovation problems. One explanation is that when searching very broadly individuals might stray from the problem and knowledge required for solving it unless this search is accompanied with appropriate utilization of prior and new knowledge that are relevant for the problem. In addition, our results show a marginal positive main effect of expertise on problem solving performance. This suggests that prior knowledge in the problem domain and perspective that expertise brings is important in problem solving performance. In this respect, it is also important to recall the nature of the problems in our context: these are not simple problems that merely require creativity but they are knowledge-intensive, complex technical problems. Perhaps, the role of expertise might be less in more simple problems. Also, the results indicate a marginal positive main effect of search depth in related domain on problem solving performance. One explanation to that finding is that search in related domain might bring diversification and novel perspective for the problem domain (compared to search depth in same domain) but do not bring too much difficulties for integrating knowledge to domain of the problem (compared to search depth in different domain).

A clear strength of this study is our unique dataset of innovation problems. This allows a fine-grained analysis of the knowledge mechanisms of problem solving as focusing on the proposed relationships in a certain problem offers certain strengths over focusing on this link in the long-term. First, it offers a certain opportunity by providing clear reference point for the assessment of expertise and knowledge search variables. Second, it allows linking knowledge related constructs directly to real-time evaluations of creative performance in specific problems. This assessment of creative performance also has certain advantages over widely used supervisor ratings of creative performance in the literature. For example, supervisor ratings largely depend on supervisors' capability to observe, evaluate and recall the creative performance of employees in a long period of time and might be overly influenced by recent performances. Moreover, supervisory ratings are prone to biases that are driven by politics, impression management practices of employees, affective cues or halo effects (Grant & Berry, 2011) which is a minor concern for our measurement as the personal relationships between the rater of the creativity and the solvers are very limited. The assessment of knowledge search variables and performance ratings from different sources also allowed us to overcome the concerns of common method bias. We also applied relevant procedural remedies in the questionnaire design (i.e. avoiding common scale anchors in the different constructs and providing definitions and clear examples to avoid item ambiguity) for the self-assessed constructs by following the suggestions of Podsakoff, and his colleagues (2003).

Practical Implications

The main practical implication of this study is that experts can be more effective in solving complex innovation problems experts by searching knowledge beyond their domain of expertise. Therefore, they might proactively expose themselves to various knowledge domains and broaden their search while exploring a solution to a problem. They can also participate in various activities that are not-related to expertise area in order to create diverse pool of knowledge to utilize when solving a problem. Managers can also encourage their employees to take part in various activities such as workshops, seminars or conferences on different knowledge domains. They can also provide free working time where employees can work on projects that are outside their area of expertise and main responsibility. In addition, managers can also provide project teams with specific instructions on how to search for a solution: broaden their search in general, be shallower in using knowledge in same and different domains as well as utilizing the related knowledge domains extensively. In a similar vein, managers of crowdsourcing platforms can also encourage/instruct experts in their platforms to engage in a similar knowledge search behavior. Moreover, organizations that struggle with solving innovation problems, even after encouraging diverse search behaviors, can harness crowdsourcing platforms where experts and non-experts in search for solutions in various ways which increases the chances of finding the right people with right expertise and search behavior for effectively solving innovation problems

Future Research and Limitations

As in all studies this is study is not without limitations. The findings and contributions of this study must be interpreted in the light of these limitations. Using self-assessed expertise and knowledge search measures has its' own advantages and disadvantages. One might question the accurateness of the assessment of expertise and relatedness of domains in the search depth measures as this requires evaluation of the distance between the domain of the problems and solvers' respective fields of expertise and other search domains. Although, this is a fair concern, the high education level of solvers (i.e., 32 % have PhD degree and almost 80% have at least Bachelor's degree) and considerable time and effort spent in solving the problem, this might be a less of an issue (Jeppesen & Lakhani, 2010). Self-assessment of search behavior might also be considered as a limitation, however, it has the benefit of having greater likelihood of tapping into the full spectrum of knowledge reservoir for generating a solution, for instance, compared to studies that use citation measures of knowledge search (Fleming, 2001; Schilling & Green, 2011).

Another point that needs to be taken into account is the process by which these problems are decided to be posted in InnoCentive: Generally firms try to solve these problems internally and spent significant prior effort unsuccessfully before sending it out to InnoCentive. As those employees in the R&D departments are likely to be experts in the problem domain, searching outside the domain might be particularly important for these problems. Also, the problems here are knowledge intensive and complex problems, and generalization of our results to other types of problems must be made with caution. We encourage future research to examine different types of problems in different contexts to assess generalizability of our findings.

APPENDIX

TABLE A5
Test of Simple Slopes for Knowledge Search Combinations

	Slope	t value
High Breadth Low Same Domain Depth	**0,43**	**4,01*** **
High Breadth High Same Domain Depth	-0,11	-0,96
High Breadth Low Related Domain Depth	-0,10	-0,80
High Breadth High Related Domain Depth	**0,42**	**3,81*** **
High Breadth Low Different Domain Depth	**0,31**	**2,55** **
High Breadth High Different Domain Depth	0,01	0,07
Low Breadth Low Same Domain Depth	0,02	0,20
Low Breadth High Same Domain Depth	0,01	0,18
Low Breadth Low Related Domain Depth	0,04	0,43
Low Breadth High Related Domain Depth	0,00	-0,03
Low Breadth Low Different Domain Depth	-0,04	-0,48
Low Breadth High Different Domain Depth	0,07	0,68

Values in bold are relevant to test of hypotheses.
** $p < .01$, *** $p < .001$.

Chapter 4

KNOWLEDGE DISCLOSURE IN CROWDSOURCING: DEMOGRAPHIC DIFFERENCES, TRUST AND FEAR OF OPPORTUNISM

INTRODUCTION

The Internet and advances in communication technologies have provided unprecedented opportunities for accessing and incorporating diverse knowledge all over the world. Researchers have emphasized the importance of creating a global pool of knowledge not only for organizational innovation problems but also for overwhelming challenges humanity faces in the 21st century, such as developing energy sources that do not contribute to climate warming (Boudreau & Lakhani, 2013; Chan, Kirsop, & Arunachalam, 2011; Fedoroff, 2012; Jeppesen & Lakhani, 2010; Malone & Klein, 2007). One effective means of bringing together important knowledge from across the world are online crowdsourcing contests that are global in scope. These contests have remarkable potential in solving challenging problems in various disciplines, such as breakthroughs in the discovery and development of new drugs or ways of dealing with the challenges of big data in the biological sciences (Lakhani et al., 2013; Masum et al., 2013; Munos, 2009).

Knowledge disclosure is a necessary condition for the utilization of knowledge in crowdsourcing contests (Dasgupta & David, 1994; Murray & O'Mahony, 2007). In thisrespect, Nobel laureate economist Kenneth Arrow highlights the paradoxical nature of knowledge disclosure: the value of knowledge can only be determined after one has the knowledge, but then the receiver of the knowledge acquires it without any cost (Arrow, 1962). The purchaser then might act opportunistically and misappropriate the information, which will in turn make the inventor fearful of disclosing knowledge. This fear of opportunism is a major barrier to disclosure of knowledge (Anton & Yao, 2002; Arrow, 1962). However, our understanding of fear of opportunism in crowdsourcing contests is limited. Although prior research has extended our understanding by focusing on the role of expertise, competition and incentives in prize contests (Boudreau et al., 2011; Jeppesen & Lakhani, 2010; Murray, Stern, Campbell, & MacCormack, 2012; Terwiesch & Xu, 2008), to the best of our knowledge, no prior empirical study has focused on participants' fear of opportunism in such contests. A better understanding of, and a specific focus on, the fears of prize contest participants in relation to knowledge disclosure is of great importance because the knowledge created and disclosed by this group of people has great potential in overcoming important scientific challenges and improving organizational innovativeness (e.g., Jeppesen & Lakhani, 2010; Lakhani et al., 2013)

In this project, our main aim is to contribute to a deeper and more fine-grained understanding of the fear of opportunism among the individuals who actively participate in prize contests. More specifically, we question whether the people who generate and disclose solutions in these contests are a specific population of individuals who do not experience fear of opportunism when disclosing their knowledge or whether they disclose their knowledge despite experiencing fear of opportunism. In addition, we explore whether these fears are the same among different individuals and demographic groups. In particular, we focus on gender and age differences since they influence important behaviors and outcomes such as motivation, risk taking and competitive behavior (Costa, Terracciano, & McCrae, 2001; Croson & Gneezy, 2009; Kanfer & Ackerman, 2004; Niederle & Vesterlund, 2011). Age and gender differences in certain personality traits is also well documented in the psychology literature (e.g. Feingold, 1994; Roberts & DelVecchio, 2000). Since such differences involve a variation in perceptions, emotions, motivations, behaviors, personality traits, they have a potential to influence the perceived risks in knowledge sharing. The core premise of our paper is that older people and women will have less fear of opportunism for disclosing knowledge. The underlying reason is that older people have better emotional regulation and would be more concerned with benefiting others rather than satisfying self-interested motives (Carstensen, Pasupathi, Mayr, & Nesselroade, 2000; Kanfer & Ackerman, 2004) and therefore they will experience less fear for disclosing knowledge. Similarly, women will experience less fear of opportunism since they are more inclined to believe in the good intentions of others (Costa et al., 2001; Feingold, 1994).

We aim to further shed light on the gender and age differences on fear of opportunism by investigating *trust to the intermediary organization* as a potential psychological process that might underly the gender and age effects on fear of opportunism. Prior research identified trust as a central factor in alleviating perceptions related to relational risks such as opportunistic behavior (e.g., Gulati, 1995; Woolthuis, 2005) and treated trust and fear of opportunism as distinct constructs (Carson, Madhok, & Wu, 2006; Jap & Anderson, 2003; e.g., Morgan & Hunt, 1994). Trust is a broad concept which refers to "one's expectations, assumptions, or beliefs about the likelihood that another's future actions will be beneficial" (Robinson, 1996: 576), Opportunism, on the other hand, is more specific and refers to "a deceit-oriented violation of implicit or explicit promises about one's appropriate or required role behavior" (John, 1984: 279). As suggested by Jap and Anderson (2003) and in the definitions above, trust is a meta concept which has many facets and levels as opposed to fear of opportunism which is more behavioral and delimited in nature. In addition to this conceptual distinction between trust and fear of opportunism, we further distinguished trust and opportunism by operationalizing them as expectations towards different parties. More specifically, we focused on trust towards the intermediary organization and fear of opportunism from the seeker organization. We argue that trust to the intermediary is more central and relevant than trust to the seeker organization (i.e. the beneficiary of the knowledge) in our context for two main reasons. First, the identity of the seeker organization is typically unknown to solvers whereas solvers typically know the identity of the intermediary and contact regularly with the intermediary. Therefore, developing a trusting relationship with the beneficiaries is unlikely if not impossible. Second, the intermediary organization has a key role in knowledge exchanges as its' ability to mediate the interaction between parties in an unbiased and fair way is crucial. Thus, trust to the intermediary is more relevant in mitigating relational risks in the context of crowdsourcing than trust to the seeker.

Overall, our study contributes to the literature on crowdsourcing and knowledge disclosure in several ways. First, we take the first steps toward understanding the fear of opportunistic behavior in the emerging context of online crowdsourcing contests. Second, we identify demographic differences in how contest participants experience their fear of opportunism. Prior research acknowledged the importance of individual differences that might influence knowledge disclosure and highlighted the importance of abilities, motivational and affective states of people in sharing knowledge (e.g., Gargiulo, Ertug, & Galunic, 2009; Levin, Kurtzberg, Phillips, & Lount, 2010; Reinholt, Pedersen, & Foss, 2011). However, little research has focused on the possibility of demographic differences in factors that might influence knowledge sharing. By identifying gender and age differenence on fear of opportunism, our findings question the previous economics research on knowledge disclosure which has often considered fear of opportunism to be uniform among different individuals. In addition, we shed light on the underlying mechanism through which gender and age differences unfold.

THEORETICAL BACKGROUND AND HYPOTHESES

The emphasis of this paper is on building a better understanding of fear of opportunism in the context of crowdsourcing. Fear of opportunism can be defined as fears for potential opportunistic behavior of the seeker company (i.e., knowledge beneficiary) and it is an essential affective factor for knowledge disclosure because of the paradoxical nature of knowledge sharing (Arrow, 1962). That is, the value of knowledge can only be determined after having the knowledge, but then the purchaser of the knowledge acquires it without any cost. The purchaser, then, can act opportunistically and misappropriate the information, which will, in turn, make the inventor fearful of disclosing knowledge. This fear of opportunism is one of the main barriers of knowledge sharing (Anton & Yao, 2002; Arrow, 1962; Szulanski, 1996, 2003).

Prior research on knowledge sharing most often studied the effects of network characteristics such as network centrality, size or tie strength on knowledge sharing

(Anderson, 2008; Powell & Smith-Doerr, 1994; Tsai, 2001). More recently, scholars addressed knowledge sharing in a more fine-grained way and acknowledged that merely focusing on network position or ties are insufficient in explaining the knowledge sharing behavior. They highlighted the importance of individual factors and demonstrated that individuals may vary in their motivation to share knowledge and their ability to convey and absorb knowledge (Gagne, 2009; Gargiulo et al., 2009; Reinholt et al., 2011). Our study is in line with this recent research direction and examines how an important affective factor for knowledge sharing, fear of opportunism, might differ among different individuals. We specifically study how age and gender is related to the experience of such fears. We also investigate the role of trust as a potential mediating internal process between gender, age and fear of opportunism.

Gender and Age Differences in Fear of Opportunism

In order to have a more comprehensive understanding of fear of opportunism, we examine demographic differences in such fears. Of the potential demographic differences, we specifically focus on gender and age differences because such differences are associated with variation in individuals' emotions and behaviors (e.g., Croson & Gneezy, 2009; Kanfer & Ackerman, 2004).

We argue that age differences will be present in fear of opportunism. More specifically, older people will have less fear about potential opportunistic behaviors of knowledge receivers while disclosing their knowledge for two reasons. First, older people are likely to have better control and regulation of their emotions (Carstensen et al., 2011; Kanfer & Ackerman, 2004) and therefore would experience decreased level of negative emotions compared to younger people (Carstensen et al., 2000). Therefore, older people, by controlling and regulating concerns about opportunistic behavior of the knowledge receiver, would experience less fear of opportunism while sharing knowledge. Second, with aging people become more concerned for others and broader society rather being self-concerned (Kanfer & Ackerman, 2004). As the main cost of opportunistic behavior is not being able to gain monetary and reputational rewards, people with a less motivation toward such self-interested gains would be less worried about opportunistic behavior and would still be satisfied as long as their knowledge benefits others. Therefore, since older people are less self-concerned, they would have less fear of opportunistic behavior. Taken together, we propose:

Hypothesis 1: Older people have less fear of opportunism in knowledge disclosure than younger people.

In addition to age differences, we expect gender differences in fear of opportunism in a way that women would experience less fear for sharing their knowledge. Personality studies investigating gender differences help us explain the reason why we expect gender differences in fear of opportunism. Several studies and meta-analyses examined the link between gender and certain personality traits and consistently found that women are more inclined to believe in the sincerity and good intentions of others (e.g., Costa et al., 2001; Feingold, 1994). Therefore, in a knowledge exchange, women would believe in the good intentions and sincerity of the knowledge receiver more compared to men. As a result of this, expectation of opportunistic behavior from the knowledge receiver would be to a lesser degree for women and, in turn, women will have less concern about their knowledge being used opportunistically. Thus, we propose:

Hypothesis 2: Women have less fear of opportunism in knowledge disclosure than men.

The Mediating Role of Trust

In this paper, we propose trust as a mediating mechanism for the age and gender differences on fear of opportunism. Our proposition is based on the prior research which identified trust as a central mediating mechanism in knowledge and relational exchanges (e.g., Levin & Cross, 2004; Morgan & Hunt, 1994). It is worth clarifying that by trust, we refer to the trust of member of the crowdsourcing platform to the intermediary organization (i.e., owner of the platform). Presence of an intermediary organization is a central difference of the exchange in the tournament-based crowdsourcing context compared to exchanges in traditional contexts. We argue that trust to the seeker is unlikely to be relevant in our context as the identity of the seeker is not known (i.e., you cannot trust a party when identity of that party is completely anonymous). Although the presence of an intermediary organization is not necessary for crowdsourcing platforms, it is particularly common in crowdsourcing practices that are in the form of a tournament (Afuah & Tucci, 2012; Jeppesen & Lakhani, 2010). In such cases, parties of the exchange (i.e., creator and receiver of the knowledge) remain anonymous to each other. Only the intermediary organization has the knowledge about both parties and does not disclose the identity of the parties to each other. Thus, the intermediary has a central role in mediating the knowledge exchange between the parties in a fair and unbiased way which attaches great importance to the intermediary organization. Given this strong role of intermediary in ensuring the fairness of the knowledge exchange and anonymity of the seeker (knowledge receiver), we argue that trust to the intermediary organization might have a vital role in mediating the perceived relational risks that a solver (knowledge creator) experience.

We argue that women might trust more and, in turn, experience a lower level of fear of opportunism than men. This argument is based on extensive research which postulated gender differences in relational orientation. This line of research posited and demonstrated that women are more relationally oriented; that is, women are more inclined to describe themselves in terms of relationships with others and more likely to value being interdependent compared to men (Baumeister & Sommer, 1997; Cross & Madson, 1997; Pratt, Pancer, Hunsberger, & Manchester, 1990). Such a gender difference in relational orientation might also manifest itself in trust towards the other party of the relationship. That is, because women are more relationally oriented they might be more inclined to perceive a relationship more trustworthy compared to men.

In addition gender differences, we argue that older people might also trust more and, in turn, experience a lower level of fear of opportunism than younger people. We base our argument on the recent research highlighting “positivity effect” that aging brings – older individuals have relatively stronger focus on positive information than younger individuals (Carstensen, 2006). We expect older people to focus on the information that will signal trustworthiness and in turn perceive the other party of the exchange more trustworthy. In fact, recent empirical research also found that older people are inclined to trust more than men since they differ in their judgments of trustworthiness (e.g., Castle et al., 2012).

The link between trust and fear of opportunism is well established in the extant literature. The research on the inter-personal and inter-organizational trust consistently highlighted the importance of trust in alleviating perceptions of relational risks in relationships (e.g., Gulati, 1995; Levin & Cross, 2004; McAllister, 1995; Tsai & Ghoshal, 1998; Woolthuis, 2005). As noted earlier, in the context of crowdsourcing contests, one of the most major relational risks related to knowledge disclosure is potential fear of opportunism.

Taken together we propose:

Hypothesis 3: Trust to the intermediary organization mediates the relationship between age and fear of opportunism

Hypothesis 4: Trust to the intermediary organization mediates the relationship between gender and fear of opportunism

METHODS

Research Setting

In an attempt to understand fear of opportunism in crowdsourcing contests, we conducted our research with those contributing solutions on the InnoCentive online platform. InnoCentive applies crowdsourcing principles for solving innovation problems by broadcasting prize-based innovation contests online and awarding financial prizes for the best solutions, typically ranging from 5,000 to 100,000 USD. InnoCentive is one of the best-known examples of how organizations can tap into a global knowledge pool and how people from all over the world and various scientific disciplines can solve challenging innovation problems. Researchers and science writers often highlight the potential of InnoCentive contests to overcome the scientific challenges we encounter and improve organizational innovativeness (Jeppesen & Lakhani, 2010; Munos, 2009; Sansom, 2011; Travis, 2008). Taken together, InnoCentive, with its global community of contributors and wide range of innovation problems, represents an excellent platform for studying fear of opportunism in crowdsourcing contests.

Measures

Fear of opportunism. To measure the latent construct of fear of opportunism, we adapted a validated scale from prior research to our context (Morgan & Hunt, 1994). We modified this scale in such a way that it reflected specific fears of the contest participants in our context. For modifying the scale, we used the information we gathered from 23 in-depth interviews that we conducted with contest participants in InnoCentive and employees of InnoCentive. More specifically, we interviewed contest participants who had won prizes multiple times, had won a prize once and had not won any prizes. Employees that we interviewed had extensive knowledge about contest participants and were from different organizational departments. All interviews were tape recorded. In the scale, we used 7-point scale anchors measuring the extent of agreement which ranged from "totally disagree" to "totally agree". We assessed fear of opportunism with three items. An example item is: "I think seekers will steal my ideas". The internal consistency of the scale was high, with a Cronbach's α value of 0.88. If an item of the scale was not answered, we used remaining answered items to create an average score for fear of opportunism.

Gender and Age. In the survey, we asked participants to fill information on four demographic variables: age, gender, education and income level. We measured age in years, and it was reported in an open-ended question in our survey. Gender was measured by asking respondents to indicate whether they were male or female.

Trust. This construct is measured by seven items using (α = .87) which are developed based on the trust scale of Robinson (1996). An example item is: "I can expect InnoCentive to treat me in a consistent and predictable fashion."

Control variables. We controlled for other demographic variables, namely education and income level. Education level was assessed by the highest academic degree earned and had 6 levels ranging from "less than a high school degree" to "PhD degree". For the income level variable, respondents were asked to report their annual income as within one of 8 ranges. The lowest income level was "0 to 25,000 USD" and the highest one was "more than 500,000 USD".

Sample and Procedures

We used a web-based survey tool to collect data from the solvers of InnoCentive. We focused on active solvers (i.e., solvers who participate in challenges) in InnoCentive. That is, we were not interested in solvers who just signed up or just read the challenge descriptions but never participated in the challenges. We believed that active solvers better represent the solver community in InnoCentive because in-depth interviews with InnoCentive employees revealed that the excluded group of solvers (i.e., solvers who have an account in InnoCentive but do not participate in challenges) includes many solvers who do not even visit the InnoCentive platform. More specifically, we focused on the entire population of solvers who participated in at least one Reduced to Practice (RTP) or Theoretical challenge between Dec 2009 and May 2012. RTP challenges refer to problems that require detailed description of the solution and physical evidence that proves the solution will work. Theoretical challenges refer to problems that require detailed descriptions, specifications and supporting precedents.

Potential participants were invited via an email which described the purpose, procedure and anticipated benefits of the research. The email also explained institutional affiliations of the researchers, anonymity of the responses and that the data will only be used for academic purposes. Participation to the survey was completely voluntary and the respondents did not have any dependencies to the researchers. Survey data were collected only from those who agreed to proceed by clicking the survey link in the email. The entire survey was in English as the contest information in InnoCentive was broadcasted in English. In total, we sent a customized email to 3005 contest participants to invite them to participate in our survey. A reminder was sent a week after the initial contact. We received 744 (24.8 %) responses, of which 630 (21.0%) were usable for further analyses (i.e., had answers for at least one construct of this study). We decided to keep the responses when questions for one or more constructs of our study were answered because we wanted to utilize the data that is usable in pairwise analyses of the constructs. The findings that are reported in the next section remained similar when we excluded the responses that are not entirely complete (i.e., cases that did not answer questions for one or more constructs of this study). To assess whether the non-response bias was an important issue for our study, we compared the answers of early and late respondents. The assumption in this analysis is that late respondents are closer to the non-responding group than the early respondents (Rogelberg & Stanton, 2007). There were no significant differences between early and late respondents in any of the variables measured in this study. In addition, a previous survey conducted with InnoCentive contest participants reported that survey respondents did not have statistically significant differences from nonresponders in demographic characteristics such as gender distribution and ethnicity (Jeppesen & Lakhani, 2010). Taken together, we do not expect non-response bias to be a serious concern for our study.

RESULTS

Means, standard deviations, sample size and correlations are shown in Table 8. In order to assess discriminant validity, we conducted confirmatory factor analysis using LISREL software on our latent variables: trust and fear of opportunism. Table A5 (in appendix) depicts the results of comparison of the fit indices of original theoretical model and alternative models in detail. The results indicated that expected 2 factor solution provided a good fit with the data (χ^2= 158.90, RMSEA = .09, SRMR = .05, CFI = .98, GFI = .95). In addition, this solution provided a better fit than alternative one factor solution χ^2 = 446.71, RMSEA = .16, SRMR = .08, CFI = .93, GFI = .87). Chi square difference tests also showed that our expected model has a significantly better fit than one factor solution. These results suggested that our trust and fear of opportunism constructs are distinct. We also checked for multicollinearity by calculating variance inflation factors (VIF) that measure the severity of multicollinearity in an ordinary least squares regression analysis. VIF values of our variables ranged between 1.00 and 1.21 which indicate a lack of multicollinearity in our results (Hair et al., 1998).

TABLE 8
Descriptive Statistics and Correlations[a]

Variables	***N***	***M***	***SD***	**1**	**2**	**3**	**4**	**6**
1 Gender	624	0.91	0.29					
2 Age	613	44.29	14.80	.10*				
3 Education level	624	4.66	1.28	-.04	.15***			
4 Income level	596	2.50	1.63	.17***	.36***	.21***		
6 Trust	630	5.42	1.08	-.03	.04	.01	-.02	
7 Fear of opportunism	630	3.24	1.56	-.07†	-.14***	-.01	-.04	-.55***

Note: Gender is dummy coded: Female =1, Male = 0. Age was measured in years. Education level variable had 6 levels: 1 indicates “less than a high school degree” while 6 refers to a “PhD degree”. Income level variable had 8 levels: 1 indicates “0 to 25,000 USD” while 6 refers to a “more than 500,000 USD”. Trust and fear of opportunism were self-reported on 7-point scales.
$^{\dagger}p < .10$, $^{*}p < .05$, $^{***}p < .001$

We tested our hypotheses by using hierarchical ordinary least squares regression analyses following the recommendations of Aiken and West (1991). In the first step we entered the control variables (i.e. income level and education level of solvers), in the second step we added age, gender and trust variables. Table 9 shows the results of this regression analysis. The table showed the significant negative effect of age on fear of opportunistic behavior after controlling for education and income level ($\beta = -.14$, $p < .001$) supporting our first hypothesis. With respect to second hypothesis we also found a support that women have less fear of opportunism ($\beta = -.07$, $p < .05$).

TABLE 9
Hierarchical Regression Analysis for Trust and Fear of Opportunism[a]

	Trust		Fear of Opportunism		
Variables	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Education level	-.00 (.04)	-.01 (.04)	-.01 (.05)	.02 (.05)	.01 (.04)
Income level	-.01* (.03)	-.02 (.03)	-.04 (.04)	-.01 (.04)	.00 (.04)
Age		.07 (.00)		-.15*** (.01)	-.12** (.00)
Gender		.03 (.16)		-.09* (.23)	-.07* (.19)
Trust					-.54*** (.05)
R^2	.00	.01	.00	.03	.32
F	.02	.68	.44	3.94	54.56
ΔR^2	.00	.01	.00	.03***	.29***

[a] Values are standardized coefficients, with standard errors in parentheses. Gender is dummy coded, Female = 1 Male = 0
* $p < .05$, *** $p < .001$

To test whether trust mediated the relationship between gender, age and fear of opportunism, we followed causal steps approach (Baron & Kenny, 1986) and bootstrap procedures (Hayes, 2013; Shrout & Bolger, 2002). Baron and Kenny (1986) suggested that in order for a relationship to be mediated, three conditions should be met. First, the independent variable should have a significant effect on the mediator and dependent variable; second, the mediator variable should have a significant effect on the dependent variable; and last, bringing the mediator into the equation should reduce the magnitude of direct effect of the independent variable on the dependent variable. Table 9 demonstrates that the first condition of mediation is not met as the effects of age on trust (see Model 3; $\beta = .07$, $p = .14$) and gender on trust were not significant (see Model 4; $\beta = .03$, $p = .43$). We complemented this mediation analyses by testing the statistical significance of the indirect effects of age and gender on fear of opportunism through trust. To that end, we constructed bias-corrected confidence intervals on the basis of 5,000 random samples with replacement from the full sample (Hayes, 2013; Shrout & Bolger, 2002). Mediation occurs if an indirect effect differs significantly from zero. The 95 % confidence intervals for the indirect effect of gender through trust included zero [-0.32, 0.12] which suggested that trust did not mediate the effect of gender on fear of opportunism. Trust also did not mediate the link between age and fear of opportunism as the 95 % confidence interval included zero ([-.007, 0.002]). These results reject the Hypotheses 3 and 4.

We also conducted two additional regression analyses with different operationalization of education and income level variables. In our original analysis, we treated income and education level variables as continuous variables. Education level scale was treated as a 6-point scale and income level scale was treated as an 8-point scale. In the first post-hoc analysis, we treated education and income level variables as categorical variables; we created 5 and 7 dummy variables to measure education and income level categories, respectively. In the second post-hoc analysis, we excluded the education and income level categories that had less than 50 respondents from the regression analysis. As a whole, these supplemental regression analyses returned parallel results to the results reported in Table 9. This suggested that neither the small sample size in some categories of education and income level variables nor the potential alternative operationalizations of these variables affected our results and conclusions in general[6].

These results showed that trust, age and gender are significant predictors of fear of opportunism. Older people and women have less fear about their knowledge and ideas to be used opportunistically by others. In addition, people who trust more to the intermediary company in crowdsourcing platforms have less concern about the potential opportunistic behavior of the organizations that post their innovation problems in these platforms.

GENERAL DISCUSSION

Theoretical Implications

Our research highlights the significance of age and gender differences in fear of opportunism and identifies trust as an important determinant of such fears in crowdsourcing platforms. By doing so, we provide important theoretical implications. First, we take the first steps toward explaining gender and age differences in fear of

[6] Age was negatively and significantly related to fear of opportunism in both first and second post-hoc analysis (β= -.15, p < .01; β= -.11, p < .05, respectively). The pattern of the results for gender differences was also similar; women had significantly less fear of opportunism in both first and second post-hoc analysis (β= -.09, p < .05; β= -.09, p < .05, respectively).

opportunism. As fear of opportunism is the main barrier for knowledge sharing (e.g., Arrow, 1962), a better understanding of these fears has direct implications for knowledge sharing behavior. This study extends the line of knowledge sharing research that recently started to highlight individual differences in knowledge sharing but neglected demographic differences so far. In addition, our findings question the common assumption in the prior economics literature that fear of opportunism is the same among individuals as we identify a context where this common assumption does not hold. By showing demographic differences in the experience of fear of opportunism, our findings imply that knowledge disclosure paradox might not be equally influential for everyone. We suggest that this paradox is more of a concern for men, younger people and for situations where a trustworthy relationship between the parties does not exist. Although we cannot generalize our findings to other contexts with our data, this paper takes the first steps to imply that a more nuanced perspective needs to be taken to comprehensively understand fear of opportunism. Moreover, we extend the psychology literature which extensively studied demographic differences in various psychological factors (e.g., Costa et al., 2001; Feingold, 1994; Roberts & DelVecchio, 2000) by showing gender and age differences in an important affective factor: fear of opportunistic behavior in knowledge sharing.

In addition to highlighting the importance of demographic differences on fear of opportunism, our study extends the knowledge management literature by addressing the recent developments in organizational knowledge management practices. We examine an emerging medium of knowledge transfer for organizations, i.e. crowdsourcing practices (Afuah & Tucci, 2012). More specifically, we investigate knowledge disclosure in a crowdsourcing platform where organizations post the problems that they want to gain knowledge about and people all over the world try to create relevant knowledge to solve those specific problems. So far, research mostly focused on knowledge sharing within the organization or knowledge transfer between different organizations while neglecting knowledge exchanges between organizations and crowdsourcing platforms. Our findings, thus, by examining the members' fears of disclosing knowledge to an organization in a crowdsourcing platform, addresses the recent developments in organizations toward incorporating knowledge of people on a global scale by utilizing crowdsourcing. As these platforms are an emerging channel of open innovation and problem solving (e.g., Lampel et al., 2012; Terwiesch & Xu, 2008), our study also offers implications for innovation literature.

To our surprise, trust did not mediate the age and gender differences in fear of opportunism. Although, in line with the extant research, trust had a strong and significant negative effect on fear of opportunism, there were no significant gender and age differences in the experience of trust. One explanation to these non-significant differences could be the overall high level of trust towards the intermediary organization; solvers, as a whole, experience quite a high level of trust to InnoCentive. This overall high level of trust might be a consequence of InnoCentive's proactivity and motivation in developing trustworthy relationships with their community members – a point that was widely noted in the in-depth interviews with InnoCentive employees. The speculation we have is that when individuals have a high level of trust and when the other party put intensive effort to develop trustworthy relationships, expected gender and age differences in trust might become dwindled. It could be the case that in a platform where the intermediary organization is not as proactive, gender and age differences in trust might become more salient.

Although we did not find evidence for the mediation role of trust in the link between gender, age and fear of opportunism, our findings suggest a strong association between trust and fear of opportunism. This finding has implications for the literature on trust and knowledge sharing. To elaborate, we focused on the role of trust in knowledge exchanges where parties of the exchange do not know each other and an intermediary organization mediates this exchange. This context attaches a great importance to the intermediary organization in safeguarding the fairness of the exchanges. Therefore, we focused on the role of trust to the intermediary organization in mitigating fears associated with sharing knowledge with another organization. This contributes to trust literature as earlier studies typically showed the importance of trust in knowledge exchange relationships in traditional organizational settings when both parties know each other and in the absence of an intermediary organization (e.g. Nooteboom, Berger, & Noorderhaven, 1997; Woolthuis, 2005). Therefore, by investigating trust and fear of opportunism link in the presence of an intermediary organization, we extend the earlier research on trust and knowledge sharing.

An indirect implication of our findings on how gender influence fear of opportunism in disclosing knowledge would for the study of Ding, Murray and Stuart (2006). They found that women academics patent at about 40% of the rate of men and suggested that lack of exposure to commercial market and higher concern about a potential hindering effect on university careers might be the possible reasons for this. As an alternative or additional explanation, since patents mainly serve to provide a protection of property rights (Arrow, 1962; Huang & Murray, 2009), it might also be the case that women have less concerns for their knowledge to be stolen by other parties and have tendency to share her knowledge than the men.

Limitations and Suggestions for Future Research

The contributions discussed above must be qualified in the lights of the limitations of this study. First, we employ a cross-sectional design in our data collection. Although this is unlikely to cause a problem between the demographic variables and fear of opportunism, the causality of the relationship between trust and fear of opportunism should be interpreted with caution. More specifically, trust influence a solver's fear of opportunism as theorized in our model. Yet at the same time, a solver's fear of opportunism might also influence his or her trust level to the organization. We strongly suggest future studies to use longitudinal designs for exploring the relationship between trust and fear of opportunism.

Second, data on the constructs of interest are self-reported which raises the possibility of common method bias. Nevertheless, as trust and fear of opportunism constructs address emotional states of people and as they are latent constructs, we believe that collecting the data from participants themselves is the appropriate way. For the demographic variables, self-reported measure was the reasonable option since identity information of people in the Internet typically recorded based on self-reports of them. In addition, in order to minimize common method bias, we followed the remedies of Podsakoff and colleagues (2003) in designing the survey, and separated questions used in this study from each other, protecting respondent confidentiality and reducing item ambiguity by developing the questionnaire based on in-depth interviews and ethnographic investigation of online content.

Another limitation of our study is that we do not directly test the mechanisms that we proposed as the underlying reasons of the effect of age and gender on fear of opportunism. We believe that direct tests of the mechanisms we propose here would be beneficial to extend our understanding on age, gender and fear interplay in knowledge sharing. For instance, future research might directly measure emotional regulation or general perceptions toward the sincerity of others to shed light on the mechanisms how age and gender influence fear of opportunism in disclosing knowledge. Lastly, we conducted this study in a single crowdsourcing platform limiting external validity although it allowed us to control for platform level confounding variables. Future research could extend the generalizability of these findings by testing these propositions in different platforms and contexts.

Practical Implications

Our findings provide several important practical implicaitons with respect to designing crowdsourcing contests. Taking fear of opportunism and the demographic differences in such fears into account in the design of crowdsourcing contests (e.g., intellectual property protection and compensation structure) and in communication with the participants (e.g., informing them how opportunistic behavior will be avoided) might be important factors in accumulating a large and diversified knowledge pool via crowdsourcing contests. Our findings on gender and age differences suggest that plans and policies to mitigate the fears of male and younger participants in these contests are particularly important. Contest organizers therefore might consider taking a proactive approach to inform male and younger participants regarding how the opportunistic behavior will be avoided. Contest organizers can also assess the level of fear of opportunism among contest participants with the scale of this study and, if participants experience high levels of fear of opportunism, they might consider modifying the intellectual property structure or making it more transparent to mitigate such fears. In addition, we highlight the importance of gaining trust of the community members for having a large knowledge pool in crowdsourcing platforms.

We found that trust to the intermediary organization (i.e. the organization that owns the crowdsourcing platform) is a significant determinant of fears of opportunism in sharing knowledge. Investments and activities for developing trustworthy relationships with the members of the community are, therefore, very important for the flow of knowledge in crowdsourcing platforms.

More indirectly, this study also points to an alternative channel, crowdsourcing platforms, for involving women and older people in scientific activities. Given the underrepresentation of women in science (Ding et al., 2006; Handelsman, Cantor, Carnes, & Denton, 2005), the aging of the population and increased life expectancy (Lutz, Sanderson, & Scherbov, 2008; Vaupel & Loichinger, 2006), using different means to involve women and elders in science is crucial.

APPENDIX

TABLE A6
Qualitative Data Sources

Data Source	Interviews	Netnography
InnoCentive Employees	13	
Solver Interviews	10	
InnoCentive Blog Posts		358 posts
InnoCentive Forum Posts		77 posts
LinkedIn Group Posts and Comments		193 posts

TABLE A7
Scale Items for Trust and Fear of Opportunism Constructs

Trust to InnoCentive *(adapted from Robinson (1996), α = 0.87)*
I believe InnoCentive has high integrity.
I can expect InnoCentive to treat me in a consistent and predictable fashion.
InnoCentive is not always honest and truthful.
In general, I believe InnoCentive's motives and intentions are good.
I don't think InnoCentive treats me fairly.
InnoCentive is open and upfront with me.
I am not sure if I fully trust InnoCentive.
Fear of Opportunism *(adapted from John (1984) and Morgan and Hunt (1994), α = 0.88)*
I think seekers will steal my ideas.
I think seekers will use my solution without paying me.
I think seekers will change the facts in order not to pay me the award I deserve.

Chapter 5

GENERAL DISCUSSION

Idea generation and problem solving for innovation used to be an exclusive domain for employees and believed to be best kept entirely within the organizational boundaries. In recent years, however, the source of innovation shifted toward more open innovation models (Chesbrough, 2003). Research on these models extensively showed that utilizing external sources of innovation can deliver results that are superior to internally generated innovations thanks to increased product diversity and better match of products and consumer preferences (Almirall & Casadesus-Masanell, 2010; Chesbrough, 2003; Laursen & Salter, 2006; Poetz & Schreier, 2012). The Internet and advance of communication technologies allowed organizations to extend their openness immensely by allowing them to reach and attract more individuals and share information effectively (Lampel et al., 2012). An emerging and potentially groundbreaking way to harness the expertise, skills and creativity of individuals worldwide is opening up innovation processes for the input from the crowd.

In this dissertation, we aimed to extend our understanding on the use of crowdsourcing for innovation purposes by focusing on motivational, knowledge and relational underpinnings for idea generation and sharing in crowdsourcing platforms. The reason why we focus on these three areas (i.e., motivational, knowledge-related and relational factors) is that we consider them as the core behavioral factors that are likely to influence knowledge sharing and creation. In doing so, we strive to provide a comprehensive understanding of the mechanisms behind crowd's behavior and contributions. In addressing motivational mechanisms, we focused on the role of monetary rewards and different motivational orientations in stimulating creative engagement and creativity. With regards to knowledge mechanisms, we shed light on how expertise and knowledge search behavior influence problem solving performance in crowdsourcing platforms. Finally, we aimed to shed light on the relational mechanisms by examining the individual differences and the role of trust in fear of opportunism –the main relational risk in sharing knowledge in crowdsourcing platforms.

OVERVIEW OF THE MAIN FINDINGS: TOWARDS A BETTER UNDERSTANDING OF CROWDSOURCING

Motivational Mechanisms in Crowdsourcing

One of the goals of this dissertation was understanding the role of monetary rewards as it is one of the most extensively used tools to motivate people for a desired outcome and central in the design of crowdsourcing contests. We found that the effect of reward size on solver engagement is contingent on prosocial motivation of individuals. To elaborate, reward size has a significant positive effect on creative engagement of people with low prosocial motivation; however, this effect diminishes with the increased level of prosocial motivation. We replicated this study in a laboratory experiment and found that this interaction effect also holds for creative performance.

Another goal of this dissertation was identifying motivations of solvers in crowdsourcing platforms. We identified four broad groups of motives that drive people to engage in challenges in crowdsourcing platforms: intrinsic, prosocial, self-improvement and extrinsic motivation.

- ***Intrinsic motivation:*** Intrinsic motivation refers to fun and intellectual challenge feelings experienced while solving a problem.
- ***Prosocial motivation:*** Prosocial motivation refers to the desire to exert effort for benefiting and positively impacting others.
- ***Self-improvement motivation:*** Solvers with self-improvement motivation engage in challenges to learn new things and develop their skills.
- ***Extrinsic motivation:*** Extrinsic motivation refers to the desire to gain money,

recognition and future career opportunities.

The effects of these four groups of motives on creative engagement were different. The results revealed that extrinsic motivation is positively associated with the creative engagement in a challenge. Self-improvement motivation, however, has a negative effect on creative engagement. The main effects of intrinsic and prosocial motivation on engagement are not statistically significant while the interaction between them has a significant effect on engagement in solving the problem.

Knowledge Mechanisms in Crowdsourcing

Second focus of this thesis was to understand on knowledge mechanisms of problem solving in crowdsourcing platforms. To that end, we focused on how expertise of solvers and their knowledge search behavior concurrently influence problem solving performance. We distinguished knowledge search behavior between knowledge search depth and breadth. In an attempt to have a fine-grained analysis, we further distinguished between knowledge search depths as depth in same, related and different domain compared the domain of the problem. The results showed a significant main effect of expertise on problem solving performance and a negative main effect of knowledge search breadth on the performance. More interestingly, we found significant three-way interactions between expertise, knowledge search depth and breadth. Expertise is positively related to problem solving performance: when it is accompanied with a (1) high knowledge search breadth and low search depth in the domain of problem (i.e., same domain) or (2) high knowledge search breadth and low search depth outside the knowledge domain of the problem (i.e., different domain) or (3) high knowledge search breadth and high search depth in the boundaries of the domain of the problem (i.e., in a related domain).

Relational Mechanisms in Crowdsourcing

The goal of this chapter was to contribute to a better understanding of fear of opportunism which is the main relational risk in crowdsourcing platforms and critical factor in solvers' knowledge sharing behavior. To that end, first, we investigated whether solvers have demographic differences in the experience of fear of opportunism. Our findings provide strong evidence for gender and age differences in a way that women and older people have significantly less fears. Education and income level, on the other hand, had no influence on experienced fears. Second, we examined the role of trust in affecting fear of opportunism. We found that trust in the owner of the crowdsourcing platform plays a major role in mitigating fears of opportunism.

THEORETICAL IMPLICATIONS

This thesis, as a whole, contributes to a more comprehensive understanding of the dynamics of crowdsourcing practices for innovation purposes. This is of great importance for innovation literature since using crowd as an innovation partner has enormous potential in enhancing organizational innovativeness by allowing access to a diverse source of new product ideas and creative solutions for vexing problems that arise in the new product development processes (Bayus, 2013; Boudreau & Lakhani, 2013; Jeppesen & Lakhani, 2010). Addressing the call for integrating insights from different disciplines to create an understanding of how crowdsourcing work (Lampel et al., 2012), we examined motivational, knowledge and relational mechanisms of crowdsourcing by drawing on insights from social psychology of creativity, economics of knowledge creation and disclosure and strategy literature on knowledge search and problem solving. In doing so, this thesis has several distinct theoretical contributions.

First, we contribute to creativity literature by examining the effects of motives and rewards on creative engagement and creativity in our first study. By introducing prosocial motivation as a moderator in the reward-creativity link, we shed light on a widely-noted controversy in the literature regarding the effects of rewards on creativity (e.g., Baer et al., 2003; Shalley et al., 2004). In addition, we emphasized the mediating role of creative engagement in the relationship between rewards and creativity. Creative engagement was implicitly assumed as a mediating mechanism in this link but this role was not empirically tested (Eisenberger & Armeli, 1997; Gagne & Deci, 2005). To the best of my knowledge, this thesis is the first study to provide evidence for the mediating role of creative engagement in the reward-creativity link. Moreover, we extend the recent research focusing on the role of motivational interactions on creativity. Although researchers found that intrinsic and prosocial motivation constructively interact in influencing creativity (Grant & Berry, 2011), interactive effects of prosocial motivation and extrinsic motivation remain unexplored. Also, we show that different motives have distinct effects on creative engagement which contributes to a more comprehensive understanding of motivational antecedents of creativity. As a whole, these findings extend our understanding of the complex motivational processes of creativity.

Second, this thesis offers implications for economics literature on prize contests. Economists often assumed that individual and total level of efforts will be increased with larger prizes (Kreps, 1997; Prendergast, 1999). The findings of this thesis, however, offer a boundary condition for innovation contests for the reinforcing effect of prize size: Prizes will only encourage more effort for people with low prosocial motivation. In addition, although economists often merely focused on prizes as the main incentive in innovation contests, our findings, in line with recent research (Murray et al., 2012), suggest a more nuanced perspective in this respect. More specifically, incentives in contests are multiple which includes intrinsic, prosocial and self-improvement motives. As a whole, these findings contribute to the recent perspective that calls for going beyond the traditional economic perspectives and creating an integrated theory for understanding incentives which considers both economic and psychological factors (Larkin, Pierce, & Gino, 2012).

Third, this thesis has implications for micro-level knowledge creation and problem solving theory by examining the individual level effect of expertise and knowledge search behavior on problem solving performance. More specifically, we theorized and found that expertise will interact with the knowledge search behavior (i.e., search depth and breadth) in influencing problem solving performance. The main contribution of this finding is shedding light on the equivocal findings on the expertise-problem solving performance link as we show when expertise is more likely to contribute performance depending on certain search behaviors in solving innovation problems. Also, this thesis takes a step toward bridging theories from expertise research in psychology literature and knowledge search research in management literature which often remained isolated. In doing so, we offer a fine-grained framework for knowledge mechanisms of problem solving.

Fourth, this thesis has implications for micro level knowledge disclosure theory. We took a relational perspective and focused on the main relational risk for disclosing knowledge in crowdsourcing platforms: opportunistic behavior. Opportunistic behavior is central to transaction cost theory as its' main behavioral assumption (Nickerson & Zenger, 2004) and it is the main barrier for disclosure of valuable knowledge (Anton & Yao, 2002; Arrow, 1962). Prior research often considered a uniform effect of fear of opportunism on all individuals. This thesis, by showing gender and age differences in the experience of fear of opportunism, extends transaction cost theory and economics of knowledge disclosure literature. In addition, we emphasize the role of trust in mitigating such fears. Although, earlier research widely shown that trust is important in reducing perceptions of relational risks (Nooteboom et al., 1997; Woolthuis, 2005), we extend this literature by going beyond the traditional contexts (e.g., traditional inter and intra organizational trust) by studying the role of trust in a previously unexplored context.

Fifth, having a better understanding of crowdsourcing also has implications for knowledge based theory of the firm (KBT). This view emphasize problem solving and suggests that creating valuable new knowledge by solving problems is the primary knowledge-based objective of managers (Nickerson, Yen, & Mahoney, 2011; e.g., Nickerson & Zenger, 2004). Given that crowdsourcing is highly important as it can improve problem-solving effectiveness immensely (Afuah & Tucci, 2012; Jeppesen & Lakhani, 2010), a better understanding of crowdsourcing is important in knowledge based view. There is a fundamental difference in how search for solutions is conducted in a crowdsourcing platform than local or traditional external search. That is, traditionally organizations that search for solutions in advance identify relevant knowledge domains for a given problem (Nickerson & Zenger, 2004) whereas in crowdsourcing search is open to any knowledge domain that deems themselves qualified to generate a solution (Jeppesen & Lakhani, 2010; Terwiesch & Xu, 2008). This difference might have important consequences for problem solving effectiveness since large and diverse knowledge pool that crowdsourcing creates offers a unique opportunity for analogical transfer between seemingly unrelated fields (Schilling et al., 2003) and for recombining different knowledge (Fleming & Sorenson, 2001; Henderson & Clark, 1990). Thus, a better understanding of crowdsourcing phenomenon will extend the knowledge based theory of firm. This thesis, as a whole, contributes to that understanding.

PRACTICAL IMPLICATIONS FOR MANAGEMENT OF CROWDSOURCING PLATFORMS

This thesis provides clear guidelines on how to better manage crowdsourcing platforms. First set of imlplications are about motives and the role of rewards in crowdsourcing platforms. Managers that want to harness the power of the crowd should start with recognizing the diversity of motives individuals have. Crowds might engage in idea generation and problem solving because they love solving problems, want to learn new things, want to contribute something that matters and are willing to gain extrinsic outcomes such as money or reputation. It is of great importance to know what motivates crowd because different motives do not have the same effect on crowd's level of engagement in generating creative ideas. The results encourage managers to highlight non-monetary extrinsic benefits –recognition and career benefits. Another important implication of this thesis for managers is that effects of different motivation are not independent from each other. Some motives work synergistically while others destruct each others effect. Managers should provide and communitcate intrinsic and prosocial reasons (e.g., fun and helping aspects respectively) together, as they enhance each others' effect on engagement. On the other hand, monetary rewards and prosocial motivation diminish each others' effect. Managers should not use monetary rewards for the challenges that have salient prosocial aspects or for the individuals that are likely to be prosocially motivated. Put differently, when monetary rewards are used managers would benefit from being subtle about communicating prosocial aspects.

Another set of managerial implicatios for managing crowdsourcing is regarding knowledge mechanisms. This thesis encourages managers to provide tools for experts to search knowledge beyond their domain of expertise: Experts are most successful in solving problems when they broadly search for solutions in different knowledge domains, shallowly use knowledge in same (i.e., problem domain) and different domains (i.e., outside the problem domain) while utilizing related knowledge (i.e., in the boundaries of the problem domain) deeply. Managers can encourage experts to engage in a search for solutions that will increase the chances of solving the problem by providing creative training or using specific instructions.

Lastly, this thesis has implications for how to mitigate the fears about the main relational risk (i.e., opportunistic behavior) in crowdsourcing platforms which is highly important for continuous disclosure of solutions. The findings suggest managers to develop plans for building trust for helping solvers to overcome such fears. Managers can, for instance, communicate proactively what they do about ensuring fairness of the exchange between crowd and firms, be transparent about how solutions are assessed and address any concerns that crowd might have. In addition, we suggest managers to have a specific focus on the plans and actions to mitigate the fears of men and younger people as they experience relatively higher levels of fears.

WHERE DO WE GO FROM HERE? SOME AVENUES FOR FUTURE RESEARCH

I hope this thesis set the stage for further improvement of our understanding of crowdsourcing platforms. Our study focused on having a comprehensive understanding of motivational, affective and cognitive factors that influence contributions received in one of the most prevalent crowdsourcing platform for innovation: InnoCentive. The form of the involvement of the crowd was in a tournament structure, also called as tournament-based crowdsourcing, innovation contests, design competitions or innovation tournaments (Afuah & Tucci, 2012; Lampel et al., 2012; Terwiesch & Ulrich, 2009; Terwiesch & Xu, 2008). This form of crowdsourcing is one of the most common ways of involving crowd and very effective in solving complex innovation problems and gathering breakthrough ideas (Boudreau & Lakhani, 2013). Nevertheless, organizations can also involve crowd in a more collaborative manner, instead of a competitive structure (Bayus, 2013). Among others, for instance, BMW, Dell and Starbucks harness the potential of the crowd by creating communities for their users to proactively generate ideas and collaborate with each other in improving those ideas. Addressing the dynamics of crowd involvement in a collaboration-based structure would be a natural extension to my research and enhance our understanding of crowdsourcing. In this respect, I believe one of the promising research directions is to examine role of collaboration in such communities by taking a network perspective. For example, future research might examine how the interactions with other community members, position in the network or strength of the ties with other members influence qualities of the ideas generated in these crowdsourcing platforms.

A promising research direction is the effects of past experience in crowdsourcing platforms. Different experiences in the platform might have different consequences for crowd's subsequent behavior and outcomes. For example, disaggregating past experiences into success and failure experiences and examining how these experiences impact further engagement and success in the subsequent idea might extend our understanding. Bayus (2013) took first steps in this respect by showing past success make individuals more incremental and less diverse in their subsequent ideas in Dell IdeaStorm platform. Researchers could also investigate several moderating factors that impact the link between past experiences, learning and success. Some examples for moderator variables include feedback from the company and complexity levels of the idea generation and problem solving tasks. Addressing these factors might have important implications for sustaining supply of quality ideas over time.

A valuable extension to my research would be investigating the dynamics of crowd involvement in different stages of new product development processes. In this dissertation, my focus was on involvement of crowd for idea generation for the front end of innovation and problem solving to improve innovation processes. It will be very interesting to see how crowd will contribute to other stages of new product development processes since crowdsourcing has important potential to improve other stages as well. For example, researchers could focus on the role and effectiveness of crowd in the selection of products or concept testing. Future research could also focus on crowdsourcing platforms as an outlet for communication and channel for customer feedback before, during and after the commercialization stage of product development.

Future research could also focus on different consequences of innovation crowdsourcing practices. An interesting research direction, in this respect, is focusing on psychological consequences of using crowdsourcing on customers' emotions and perceptions about the company and product. For example, recent research found that customer co-creation enhances customers' perceptions of firms' innovative ability and customer orientation (Fuchs & Schreier, 2011; Schreier, Fuchs, & Dahl, 2012). Researchers could examine whether involving crowdsourcing communities has other psychological consequences such as perceived reliability or conformance of the product. In addition, future research could investigate whether these psychological consequences unfold differently in different industries or product groups. For instance, customers' perceptions regarding innovativeness of a crowdsourced product might be different (and perhaps negative) for a high-tech product where innovativeness might be more associated with deep technical knowledge.

Another fruitful research direction to pursue is formulation of the problem in crowdsourcing platforms. Appropriate formulation of innovation problems is critical for subsequent performance in problem solving (Spradlin, 2012) as noted several decades ago by Einstein and Infeld "formulation of a problem is often more essential than the solution" (1938: 92). Formulation of the problem has certain consequences in terms of diversity of crowd that engage in the problem and qualities of the solutions they generate. For instance, describing an innovation problem very specifically and setting too many constraints will restrict diverse group of people to participate in the problem and the search scope for solution and, in turn, likely to limit the novelty of the solutions. On the other hand, keeping the problem too broad and vague might limit feasibility and usefulness of solutions although it might trigger out of the box thinking.

I also see promising directions for future research on understanding how the ideas generated by crowdsourcing communities are received by the employees of the organizations. As harnessing benefits of crowdsourcing is very much contingent on how these ideas are used in the innovation processes, focus on assessment of these ideas is of great merit in expanding our understanding of innovation crowdsourcing. Researchers could focus on affective factors (e.g., "not-invented-here" syndrome) or cognitive factors (e.g., decision making biases) in evaluation of crowdsourced ideas. Answering these questions has certain implications for improving new product processes as these evaluations affect important decisions such as which ideas will be implemented and how much resources will be allocated for those, both of which would greatly influence new product success. For example, if an employee has negative prejudgments about the credibility and value of the ideas that come from crowdsourcing communities, he is more likely to reject those ideas or commit less to it no matter how great the idea is.

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Summary

The Internet and the advance of communication technologies have brought unprecedented opportunities for harnessing the creative potential of people all over the world. In an attempt to utilize this potential to explore breakthrough new product ideas and find solutions to challenging innovation problems, companies make extensive use of crowdsourcing practices. However, despite its promise, our knowledge of crowdsourcing is limited.

The main purpose of this dissertation is to contribute to a greater understanding of the dynamics of crowdsourcing by providing a comprehensive investigation of the behavioral factors that influence innovative behavior and the performance of the crowd. In particular, we examine motivational, knowledge and relational mechanisms of crowd engagement, creativity and knowledge-sharing behavior. We demonstrate that crowd members engage in new product ideation and innovative problem solving for different reasons (i.e., intrinsic, extrinsic, prosocial and learning motivation), and monetary rewards impact creativity in different ways, according to individuals' prosocial motivation. In addition, we find that a crowd member's performance in solving innovation problems is a consequence of the interplay between his/her expertise and how broadly and deeply he/she searches for solutions. Finally, we show that fear of opportunism by others – the main relational risk attached to disclosing knowledge in crowdsourcing platforms – is not uniform among crowd members, and trust in the owner of the crowdsourcing platform is central in assuaging such fears. As a whole, the studies in this dissertation provide important insights into how crowdsourcing platforms can be better designed and how the immense creative potential of the crowd can be used more effectively.

Samenvatting (Summary in Dutch)

Het Internet en de opmars van communicatietechnologieën hebben ongekende mogelijkheden voor organisaties geschapen om het creatieve potentieel van mensen wereldwijd aan te boren. In een poging dit potentieel voor baanbrekende producten en oplossingen voor uitdagende innovatieproblemen te benutten maken bedrijven veel gebruik van *crowdsourcing*. Er is echter, ondanks de hoge verwachtingen, slechts zeer beperkte wetenschappelijke kennis over *crowdsourcing*.

Het belangrijkste doel van deze dissertatie is om bij te dragen tot een beter begrip van de dynamiek van *crowdsourcing* door middel van een grondig onderzoek naar de gedragsmatige factoren die invloed hebben op gedrag en prestaties van contribuanten aan innovatie door middel van *crowdsourcing*. In het bijzonder onderzoeken wij motivationele, kennisgerelateerde en relationele mechanismen die van invloed zijn op betrokkenheid, creativiteit en kennisoverdracht van contribuanten. We tonen aan dat contribuanten om verschillende redenen meewerken aan het ontwikkelen van nieuwe producten en innovatieve oplossingen (i.e. intrinsieke, extrinsieke, pro-sociale en zelfontwikkelingsmotivatie) en dat de impact van financiële beloningen op creativiteit afhankelijk is van de pro-sociale motivatie van de persoon. Daarnaast laten we zien dat de prestaties van een individu bij het oplossen van innovatie-problemen het resultaat zijn van het samenspel van zijn/haar expertise en van de breedte en diepte waarmee hij of zij naar oplossingen zoekt. Ten slotte tonen we aan dat het ervaren van zorgen over opportunistisch gedrag (het belangrijkste relationele risico bij het delen van kennis in platformen van *crowdsourcing*) niet uniform verdeeld is over de menigte en dat vertrouwen in de eigenaar van het *crowdsourcing*-platform cruciaal is om dergelijke zorgen te verminderen. Als geheel bieden de onderzoeken in deze dissertatie belangrijke inzichten om het ontwerp van *crowdsourcing*-platformen te verbeteren en effectiever gebruik te maken van het immense creatieve potentieel van de buitenwereld bij innovatie.

Özet (Summary in Turkish)

İnternet ve iletişim teknolojilerindeki gelişmeler dünyanın herhangi bir yerindeki yaratıcılık potansiyeline ulaşma noktasında eşi görülmemiş fırsatlar getirdi. Firmalar, crowdsourcing (kitle kaynak) uygulamalarıyla bu potansiyeli radikal yeni ürünler geliştirmek ve zorlu inovasyon problemlerini çözmek için yoğun bir şekilde kullanmaktalar. Ancak bu yüksek potansiyeline rağmen crowdsourcing ile ilgili akademik bilgimiz cok kısıtlı.

Biz bu tezde bireylerin crowdsourcing platformlarındaki davranışlarını inceledik ve böylelikle crowdsourcingin inovasyon için kullanımındaki dinamiklere ışık tutmaya çalıştık. Özellikle, bu platformlardaki insanların motivasyonlarının, bilgi düzeylerinin ve problem çözme yöntemlerinin onların inovatif davranışlarını ve performansını nasıl etkilediğini gösterdik. Buna ek olarak, bu platformlardaki bireylerin ekonomik olarak oldukça değerli olan fikir ve çözümlerini paylaşmasını etkileyebilecek faktörleri inceledik ve bu konudaki farklılıkların kaynağini araştırdık. Bir bütün olarak, bu tezin bulguları crowdsourcing platformlarınının daha iyi dizayn edilebilmesi ve daha efektif kullanılabilmesi için önemli tavsiyeler sunmaktadir.

About the Author

Oguz Ali Acar was born in Konya, Turkey. He obtained his Bachelor's and Master's degrees (with honors) in Management Engineering from Istanbul Technical University, Turkey. He spent a year in Eindhoven University of Technology as a visiting graduate student. Prior to his PhD at Rotterdam School of Management, he gained industry experience in brand management and business development in Turkey. While completing his PhD, he was a visiting scholar at Massachusetts Institute of Technology (2012) and NYU Stern School of Business (2013).

Oguz is fascinated by the transformative power and creative potential of the Internet, and is seeking to understand more about how this potential can be better utilized by organizations and society. In particular, his research focuses on the role of behavioral, social and contextual factors that influence new product ideation and innovative problem solving in crowdsourcing platforms. He has presented his research at more than a dozen international academic conferences, and his papers are currently under review in top-tier academic journals. In addition to his research, he is actively involved in teaching and supervising students at Master's and Bachelor's level on topics relating to innovation management and marketing.

Following his PhD, Oguz will be joining the Management Department of King's College London as a tenure-track Lecturer (Assistant Professor) in Marketing.

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Design & layout: B&T Ontwerp en advies (www.b-en-t.nl) Print: Haveka (www.haveka.nl)

CROWDSOURCING FOR INNOVATION

UNPACKING MOTIVATIONAL, KNOWLEDGE AND RELATIONAL MECHANISMS OF INNOVATIVE BEHAVIOR IN CROWDSOURCING PLATFORMS

The Internet and the advance of communication technologies have brought unprecedented opportunities for harnessing the creative potential of people all over the world. In an attempt to utilize this potential to explore breakthrough new product ideas and find solutions to challenging innovation problems, companies make extensive use of crowdsourcing practices. However, despite its promise, our knowledge of crowdsourcing is limited.

In this dissertation, we contribute to a greater understanding of the dynamics of crowdsourcing by providing a comprehensive investigation of the behavioral factors that influence innovative behavior and the performance of the crowd. Specifically, we examine motivational, knowledge and relational mechanisms of crowd engagement, creativity and knowledge-sharing behavior. We demonstrate that crowd members engage in new product ideation and innovative problem solving for different reasons (i.e., intrinsic, extrinsic, prosocial and learning motivation), and monetary rewards impact creativity in different ways, according to individuals' prosocial motivation. In addition, we find that a crowd member's performance in solving innovation problems is a consequence of the interplay between his/her expertise and how broadly and deeply he/she searches for solutions. Finally, we show that fear of opportunism by others – the main relational risk attached to disclosing knowledge in crowdsourcing platforms – is not uniform among crowd members, and trust in the owner of the crowdsourcing platform is central in assuaging such fears. As a whole, the studies in this dissertation provide important insights into how crowdsourcing platforms can be better designed and how the immense creative potential of the crowd can be used more effectively.

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