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the case of an innovation platform

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Prize formation: the case of an innovation platform[1]

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The necessity to build long term relationships and the use of partnerships are central to (for ?) the strategies of innovative firms in high technology. Yet, since a decade, Internet innovation platforms which connect innovative firms facing research challenges with anonymous researchers throughout the world, have appeared. On these private platforms, each challenge posted by an innovative firm is associated with a monetary award: the prize. In this article we focus on the most famous platform called Innocentive. Relying on socio-economic approaches, we shed light on the dual role of this platform which creates a contest. Firstly, through a specific mode of organizing exchanges, Innocentive allows to overcome classical contractual problems such as information asymmetries, detecting quality and building trust. Secondly, Innocentive influences the prize formation, providing the calculative tools needed to fix the prize in an uncertain environment. The emergence of such platforms illustrates new ways for large firms to consider research and innovation.

Keywords: platform for innovation, Internet intermediation, contest, prize formation, exchange organization, economic sociology

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1. Introduction

Technological innovations often require a wide range of skills from different fields of research which one firm alone may not encompass. Complementarity between skills is essential to the fruition of many innovative products and processes (Owen-Smith and Powell, 2004). The use of partnerships or joint ventures has proved to be indispensable for developing the innovations that will make tomorrow's products, and to secure what Arora et al. (2001) call the "markets for technology". However, new methods of organising research have emerged since the 2000s, exploiting the opportunities offered by the Web 2.0: these are innovation platforms, hosted by private companies, which connect innovative firms facing research problems they cannot solve alone (known as the "seekers") with researchers throughout the world who may be able to provide a solution. The research questions, called "challenges", are posted on the internet platform and supported by prizes defined in advance by the company concerned. These prizes take the form of monetary awards, of varying values, paid to the researchers proposing the best solutions to the challenges that have been posted. Innocentive, created as a spin-off from the pharmaceutical company Eli Lilly in 2000, was a pioneer of these platforms and remains the most popular today.

How can we explain the success of these platforms with innovative companies, when their business models are based on one-off, anonymous transactions? Studying the case of Innocentive, and with the help of a socio-economic analytical framework, we seek to show how the intermediation proposed by Innocentive acts as a counterpart to the one-off and anonymous nature of the transactions. We argue that Innocentive's specific mode of organising economic exchange helps to reduce the asymmetry of information and allows to evaluate the solutions proposed. However, Innocentive's role is not limited to supervision and evaluation; it also plays an earlier, pro-active role. The platform intervenes in the process of defining the research question and influences the level of the prize value offered by the company, through the provision of calculation tools.

Our demonstration draws on two currents of the economic sociology of markets which, in our view, complement each other. The first approach, adopting a Polanyian perspective of "instituted economic process", will allow us to identify and characterise the Innocentive platform's particular mode of organising exchanges (Harvey and Randles, 2010). The second approach, referred to as the "cognitive frame" of markets or "prices from meaning", focuses

on the processes of price formation (Beckert, 2010; Muniesa and Callon, 2003). We use this approach to study the way the level of prize values is determined on the platform. The first section of the paper is devoted to the specificities and properties of knowledge and a presentation of the Innocentive platform. In the second section, we identify the Innocentive platform as a particular mode of organising economic exchange and we describe the principal modes of organisation observed. Following Beckert (2010), we argue in the third section for a *rapprochement*, within the socio-economics of markets, between the organisational (neo-Polanyian) approach to markets and the cognitive approach. The first of these approaches allows us precisely to characterise the modalities of organising exchange on the Innocentive platform, while the second, focused on prices, allows us to bring to light the mechanisms at work in the determination of prizes. Based on interviews with seekers (see Appendix 1), the fourth section addresses the question of the construction of prizes and highlights Innocentive's power over the processes of defining the challenges and fixing the value of the prizes.

2. The knowledge economy and the Innocentive platform: a paradoxical association?

In a context of increasingly complex research (requiring a large degree of interdisciplinarity), growing costs and ever uncertain results, companies must find different ways to exploit their near or more distant environment in the search for knowledge and skills. Joint research ventures, networks with more or less direct partners, licensing agreements or even the buying of patents are all examples of this phenomenon. This is because knowledge, as economists perceive it, is a complex good that can assume different natures: it may be codified and therefore easily transferable, tacit and difficult to transmit, or both at the same time. Moreover, the radical uncertainty that characterises knowledge-based exchanges, the importance of secrecy, and the high specificity of the resources and skills involved all indicate the importance of building and maintaining bonds of trust covering both the credibility and the skills of the partners. Close, enduring ties and mutual trust between partners are necessary to the emergence and/or transfer of knowledge.

Since the 2000s, however, a new possibility has emerged for companies to access new knowledge, via the Web 2.0. This latter has led to the introduction of new practices allowing companies to search for and acquire ideas or innovations. The companies can call on the mass of internet surfers (crowdsourcing) for diverse questions related to innovation, design or ideas, via platforms that act as intermediaries. At first sight, this procedure may seem quite antinomic to the traditional activity of research and the harnessing of knowledge. The

appearance of these new intermediaries on the Web has shattered the idea of the importance of long-term partnerships and prior knowledge of the identity and skills of the other players, since the relations that are formed are often one-off, and the parties involved do not know each other. Innocentive provides a good illustration of this.

Innocentive brings together two categories of players: innovative companies (seekers) facing a research problem (challenge) and scientists throughout the world (solvers), via an Internet platform that serves as meeting place. The challenges are backed by prizes of a value ranging from 5 thousand up to 1 million dollars. Thus, each challenge is associated with an award, determined in advance and offered by the company concerned.

These challenges are visible and freely accessible on the website. They cover a wide range of fields.[3] Some of them are even categorised in a wider classification ("pavilions") including, for example, the search for new molecules, issues concerning developing countries, clean technologies and health, or identifying specific partners like SAP, NASA, Nature, The Economist (and recently the Cleveland Clinic and the U.S. Air Force). The companies that have used Innocentive's services include large, innovative companies such as Solvay, Procter and Gamble, Boeing, DuPont, Novartis, IBM, Johnson&Johnson, Bayer, Syngenta as well as research foundations (Rockefeller Foundation, Prize4Life) (Tapscott and Williams, 2006).

For their part, researchers, engineers, scientists and retired professionals throughout the world (the solvers) can respond to these challenges. If they consider they may possess the solution to a challenge, they register on the platform, sign their agreement to respect a certain number of conditions, (including those relating to intellectual property rights) and thus gain access to a secure private space (the project room) in which they can ask for further details about the challenge and submit their solution within the specified time (usually between 30 and 60 days).

The challenges follow a certain gradation, ranging from a simple idea through to a more complete innovation (see Appendix 2 for some examples of challenges). There are four categories of challenge. (i) Ideation: this is a sort of brainstorming for ideas (see Appendix 3). It may concern a new approach to a problem that has remained unsolved for some time, or new applications for existing products. The solver submits his or her idea in the form of a 2-page document. At this stage, there is no transfer of intellectual property (IP). (ii) Theoretical: this is a more complete document in which the solver proposes a solution (with transfer of IP).

[3] Business & enterpreneurship; chemistry; computer/information technology; engineering/design; food/agriculture; life sciences; math/stats; physical sciences.

The challenge is associated with well-defined criteria of success and deliverables that do not require laboratory work. (iii) Reduction to practice (RTP): here, we are at the level of the prototype, and this stage represents a step further than the previous class, because these challenges mention the need for laboratory work to validate the solution. Again, IP must be transferred if the solution is chosen. (iv) Electronic request for proposal (eRFP): this level allows for greater interaction between seeker and solver. We are at the level of the final product. Here, the company is looking for a partner or supplier for a particular programme.

Recent studies of Innocentive have gathered numerical data on the platform (Brown and Hagel, 2005; Lakhani and Panetta, 2007; Braham, 2007; Morgan and Wang, 2009; Hane, 2011). There are currently 250,000 solvers registered on the site, from 200 different countries. Since the platform was launched, roughly 1200 challenges have been posted by about fifty companies, and nearly 24,000 solutions have been proposed. Between a third and a half of the challenges have been solved. Each problem occupies around 200 solvers, of whom 10 on average submit a solution. On average, it takes two weeks (or 80 hours) to find a solution to the challenges posted on the platform.

At first sight, the idea of companies turning to Innocentive in the domain of knowledge seems paradoxical, and raises a number of questions: to what extent can a question of research involving a one-off transaction with anonymous partners (the solvers) be profitable to the company, despite the importance, as explained above, of building long-term relations of trust? How can a company, whose innovative activities depend largely on secrecy, expose its research problems on an internet platform, accessible to everyone? How can the specific request of a company be matched with the wide range of knowledge of scientists and researchers? How can asymmetries of information and opportunistic behaviour, on the part of both the seekers and the solvers, be avoided or at least reduced?

3. The organisation of economic exchange at Innocentive

To answer the above questions, we must start by characterising the subject of our study: Innocentive. At first sight, it could be defined as a support (the internet platform) for exchanges between two sets of agents: companies and researchers. However, the role of intermediary played by the platform is actually much more complex. Innocentive's intermediation has produced rules that underpin a particular mode of organising economic

exchange in the domain of innovation. To identify the nature of Innocentive, we adopt the analytical framework proposed by Harvey and Randles (2010). These authors consider economic exchange as an "instituted economic process". The term "process" refers both to the act of exchange which is repeated over time and to the idea of reciprocal transfers. The term "economic" refers to the combination of the processes of production, exchange and consumption generally required for the reproduction of resources. Focusing on the term "economic" has two consequences. Firstly, we examine the specificities of economic exchanges compared with other, non-economic exchanges. Secondly, from a Polanyian perspective (Polanyi, 1944, 1957), we affirm that the economic dimension, as a specific, distinct dimension, varies from one society to another and depends on institutions and their histories. What are the advantages of using the term "organised economic exchange" rather than the term "market"? The analysis of economic exchanges involves the study of a huge variety of configurations of exchanges, and it overcomes certain shortcomings related to the concept of market. Using the term "market" implies that one is studying a "pre-defined" market, in which any form of exchange that does not correspond to the rules of the market is excluded. Analysis of the organisation of exchanges, on the other hand, includes both market and non-market forms of exchange within the same analytical framework. The concept of market in the strict sense of the word is not completely banished, but the market becomes a particular form of organisation of exchanges. Moreover, the dynamic view of exchanges also helps us to grasp the technological innovations that characterise exchanges (Harvey and Metcalfe, 2010). Lastly, this analytical framework allows us to move away from the standard criteria of classification and to choose, for example, between "organisation" and "market". In this way, Innocentive can be approached as a particular mode of organising economic exchanges, one that coexists with other modes of organising exchanges in the field of innovation (partnerships, joint ventures, etc.).

Detailed study of Innocentive's mode of organising economic exchange brings to light certain properties of the platform. Exchanges are organised in such a way as to provide solutions to a certain number of problems inherent to the production and transfer of knowledge, such as the asymmetry of information, the weight of uncertainty and how to evaluate the quality of the object of exchange.[4] The organisation of exchanges on this platform results in the completion of transactions between agents of different natures and/or strengths, and who may not have

[4] This question has been largely studied in the literature, notably in the context of licensing agreements between the supplier of a solution (covered by IPR) and the buyer. In particular, see the articles by Beggs (1992), Gallini and Winter (1985), and Gallini and Wright (1990).

the same bargaining capabilities. More precisely, we have identified four main properties of Innocentive's mode of organising exchange that help to overcome, at least partly, the problems mentioned above.

Firstly, the seekers remain anonymous, unless they want to reveal their identity. This anonymity protects them from identification by their competitors.[5] It is strengthened by the very process of formatting the challenges, which appear on the platform's website in the form of very short questions - two or three sentences at most (see Appendix 2 for examples). So a research problem that is deemed to be too large will give rise to several different challenges, each with its own prize. This way of dividing up the research problems has at least two advantages. Firstly, by concentrating on very precise questions, the companies that post challenges are, *ceteris paribus,* "less" identifiable by their competitors. Secondly, researchers from other scientific disciplines can tackle the challenge and try to find a solution. The empirical work conducted by Lakhani and Panetta (2007) and Lakhani and Jeppesen (2010) on the Innocentive platform shows that the winning solvers are often from a different field of expertise to that of the challenge posted. A challenge in chemistry, for example, may be solved by an expert in computing. This partly explains the interest that companies have in such platforms, because via the internet, they can reach researchers in numerous disciplines and throughout the world.

Secondly, the platform provides assistance to the seekers in drafting the challenge. A complete training programme[6] is proposed for firms wishing to use the platform. From the beginning, the seeker is put in contact with one of Innocentive's Key Account Managers, who will act as the company's adviser and accompany them throughout the procedure. The seeker company and the adviser communicate by telephone, e-mail, videoconference and in direct face-to-face meetings. In addition, the intermediation proposed by Innocentive (an expert in its field, let us recall) also consists in helping the seeker to identify their challenge and then express it in the best possible way. The Key Account Manager is expected to co-write the challenge with the seeker, respecting a certain number of pre-established conditions: it must be worded so that one cannot tell which company is behind it, and it must use vocabulary that can be read and understood by a maximum of solvers, to maximise the chances of finding a solution.[7] If

[5] Some of the seekers interviewed even indicated that they had posted "false" research questions in order to throw their competitors off the scent.
[6] The programme is called ONRAMP (Open Innovation Rapid Adoption Methods and Practices).
[7] The study by Lakhani et al. (2007) shows quite surprisingly how the majority of researchers answer challenges in domains far-removed from their own fields of expertise. In their study of 7 chemical companies, Sieg et al. (2010) show that one of the companies studied posted a challenge worded in such a way that it was neither too

necessary, modularity can be improved by dividing the main question into several sub-questions that will each be the subject of a specific challenge, in order to prevent competitors from learning too much about the seeker (Lakhani and Panetta 2007).

Thirdly, Innocentive has established a mechanism to detect the quality of the solutions proposed by the solvers. The members of Innocentive select what they judge to be the best solutions, in relation to the challenge posted, and transmit them to the seeker. This mechanism of quality detection presupposes, implicitly, that the members of Innocentive possess very high levels of scientific expertise, allowing them not only to understand the significance of the challenge but also to determine whether the solutions proposed by the solvers are likely to be satisfactory. When the two or three best solutions have been identified, Innocentive submits them to the seeker, who decides whether to accept one, some, all or none of them (paying a prize for each solution retained). The screening mechanism takes place over several stages. One of the solvers we interviewed (we shall call him CB) gave the example of the challenge he won. When the submission period came to an end, 171 proposals had been made. Innocentive first selected 82 solutions, and then carried out a second screening, after which only 8 proposals remained. At this stage, the platform held interviews by telephone concerning the solvers' abilities to achieve the solution and the results they expected. After the third screening, 4 solvers remained in the running. Further telephone calls were then made, to garner more details about the solvers' past experience, to run over the content of their proposal summaries once again, and to verify the professional situation of the solver (is he or she employed by a company? By a research laboratory? etc.). The next day, CB was designated as the winner, and in the days that followed he had to send Innocentive a deed signed in the presence of a notary, giving up his intellectual property rights over the solution.

Lastly, the question of the management and transfer of intellectual property is also central to understanding how InnocCentive operates. Classically, when IPR are transferred, there is a process of bargaining over a license, involving a buyer and a seller of innovation. This bargaining covers the price and the terms of the license: duration, conditions of use, territoriality. The economic literature has pointed up the problems of uncertainty and information asymmetry inherent to this type of relationship. There is strong uncertainty over the value of the license and the future income that it can be expected to generate. The platform

specific nor written in specialised language, so that a maximum of solvers from other technological domains could respond.

has introduced a completely new contract system to regulate the issues arising from the transfer of IPR (notably patents) and therefore of licensing. Before any commitment or access to a Project Room, Innocentive requires solvers to sign a document called the "Innocentive Solver Agreement", stipulating in particular the clauses of confidentiality and transfer of IPR (notably through clause n° 4). The aim of this type of clause is to settle the problem of licenses very far upstream, for those challenges that require a transfer of IPR (theoretical categories, RTP and eRFP). If the solver's proposal is chosen, the transfer applies to the right to exploit the patent solely in relation to the solution of the challenge.[8] As Lakhani and Panetta (2007) observe: "Most IP transfer clauses grant the seeker rights to internal use and the solver rights to use in applications not required by the seeker". The question of bargaining is dispensed with completely: clause n° 4 appears to function for every type of intellectual property (patent, copyright, etc.). Having accepted the agreement, the solver responds to a challenge for which the value of the prize is known in advance. In the traditional context of licensing, the bargaining between seller and buyer is over the price, but here, the price is imposed *ex ante*. The question of obtaining authorisation from the solver's employer is also stipulated. Innocentive also specifies, in one of the documents for the attention of solvers: "If the seeker selects your solution and the transfer of IP right sis a requirement of the challenge, you must transfer your IP rights to the solution before receiving a financial award. To transfer your IP rights, you must sign a document stating that you own the intellectual property and have the ability to transfer these rights. If you are employed, your employer must sign an agreement to transfer ownership of the intellectual property" (Innocentive, 2009). Lastly, there is a mechanism to ensure that solutions viewed but not acquired by the seeker do not end up in its IP portfolio all the same (Lakhani and Panetta, 2007). In addition to the license contract that must be signed in advance, Innocentive implements a whole series of measures to ensure *ex post* that the rights can be transferred to the seeker. Once the solution has been selected and the solver designated, Innocentive verifies, firstly by telephone and then by signed documents, that the transfer can be completed: by means of a deed signed by the solver in the presence of a notary, Innocentive protects itself against litigation. The seekers (companies) find this system advantageous, and prefer to pay the administrative costs of using

[8] One of the clauses is the following: "Upon acceptance of your proposal by a seeker and payment of an Award to you, you hereby assign and convey to Innocentive all rights, title, and interests in and to the proposal and any work product that are related to the Innocentive challenge, and you retain no rights to the proposal or the work product insofar as they are related to the Innocentive challenge. In the event that the work product cannot be assigned and conveyed under statutory law, you herewith grant to Innocentive a worldwide, unlimited, irrevocable, and exclusive license to use, make, have made, market, copy, modify, lease, sell, distribute, and create derivative works of the work product, including the right to assign the foregoing license to seekers".

the platform rather than face the risk of possible future lawsuits and litigation *ex post*. For their part, the solvers consider the system as a relatively fast way to exploit knowledge they possess[9].

The table 1 below summarises the main features of the organisation of exchanges on the Innocentive platform.

[Insert table 1 here]

In this section we hope to have shown how the organisation of exchanges implemented by Innocentive alleviates the uncertainty inherent to the innovation process, by reducing information asymmetry, detecting the quality and forestalling possible problems linked to the transfer of IPR. However, Innocentive's role is not limited to the reduction of asymmetries and the detection of quality; it also influences the determination of the prize value.

4. Prize formation seen through interviews

A researcher designated as the winner of a challenge on the Innocentive platform wins a prize in the form of a payment whose value is defined in advance, when the challenge is posted, and is visible to all the participants. In an innovation contest, the innovator's efforts are rewarded by a prize, usually of a monetary nature, depending on the results originally hoped for. Scotchmer and Gallini (2002, p.53) define a research incentive prize as "a payment funded out of general revenue that is made to a researcher conditional on delivering a specified invention". In general, a sponsor (public and/or private) launches a contest in which a number of individual inventors or teams embark on the search for solutions to the question posed. The winner (or winners) of the contest receive the prize. Historically, innovation contests and incentive prizes have played a driving role in many technological breakthroughs in our society (Master, 2008; Brunt et al., 2008). In the 18th century, for example, the British Longitude Prize led to a dramatic improvement in navigation in the United Kingdom. In the field of aviation, the most famous prize is the one awarded to Charles Lindbergh for the first solo non-stop transatlantic flight in 1927.

The system of prizes as incentives for innovation has several advantages (Kalil, 2006; Morgan, 2008). First, it stimulates innovation by encouraging competition between teams, so that the sum total of investments made by the different teams often exceeds the value of the

[9] In the context of the proliferation and the extension of Intellectual Property (see for instance Coriat and Weinstein (2012) for the evolution of IPR in the USA), patents and prizes are often opposed, yet in the case of Innocentive these two incentive mechanisms are combined.

prize: “Prize programs can create incentives for nongovernmental organizations and individuals to invest financial resources in support of the activities of prize contestants, and these investments may exceed the value of the prize purse to be awarded to the winner” (National Research Council, 2007, p. 13). Second, by exposing the problem to a contest, the prize system can lead to the solution of complex challenges, requiring interdisciplinarity and collaboration between experts from different domains. At the beginning of the 18th century, it was Harrison’s chronometer that won the Longitude Prize, while the other competitors were concentrated on methods involving the calculation of lunar distance. Thus, the prize mechanism can lead teams and innovators to transcend the limitations of the time and propose a new solution (e.g., the GoldCorp Challenge, to find new gold reserves in a mine). From another perspective, the system makes up for under-investment by the public authorities in certain domains (for example the space industry in the USA). Lastly, the researchers’ interest in participating is also related to the publicity and reputation they can earn for themselves by winning (Maurer and Scotchmer, 2004; Kalil, 2006). However, although the prize system presents unquestionable advantages as an incentive mechanism, it also faces obstacles like the problem of the duplication of efforts, the potential tension between prizes and patents or the difficulties relating to the intrinsic evaluation of prizes and performances. The organisational design of the Innocentive platform reduces the tensions inherent to this type of contest, and satisfies, to all appearances, both the solvers and the seekers.

The particularity of the innovation contests proposed by Innocentive, compared with famous contests of the past, is that they are not organised by a public and/or private sponsor (governments, innovative companies, associations, etc.) but by a private intermediary: the Innocentive platform. But whatever the mode of organisation of the contest, the question of the determination of the prize remains central, because the incentive depends largely on the prize. In the case of Innocentive, it is the seeker company that decides on the value of the prize: if it is too low, it will not attract solvers; if it is too high, it will no longer be profitable to the company. The determination of the prize-value raises a number of questions, because of the nature of the object of exchange: a service relating to the production of knowledge that may give rise to innovations. The prize value is defined within a context of strong uncertainty in the sense of Knight (1921). This uncertainty is complex because it assumes several different dimensions: uncertainty about the transformation of knowledge into innovation, about market access, about the financing required and about the future profitability of

projects.[10] For example, one seeker we interviewed explained that when the company has acquired the solution to its challenge through the Innocentive platform, it must then develop it in order to bring new services or products onto the market. This second stage (exploitation of the solution) often proves to be much more costly than the prize awarded to the solvers, and is again characterised by strong uncertainty. Alongside the highly uncertain context, the process of determining the prize value faces a problem of coordination: how can the value of a prize be determined so that it corresponds to the requirements of the seekers and at the same time attracts the interest of the solvers? To answer these questions, we conducted interviews and questionnaires among the seekers (see Appendix 1 for the methodology). These interviews focused on the main determinants of the value of the prize, and they bring to light the following facts.

i) ***The potential market linked to the innovation is a very important criterion in determining the value of the prize.*** 10,000 dollars, for instance, may seem derisory for a multinational corporation, whereas it may be considered a stimulating amount of money for a researcher, depending on the amount of time required to solve the problem. Consequently, the higher the expected profitability, the higher the prize should be, *ceteris paribus*.

ii) ***The prize value is also positively related to the urgency felt by the company posting the challenge.***[11] This scenario can emerge in the context of an innovation race between rivals, of the "winner-takes-all" type.

iii) ***Competitive pressure exerts a powerful leverage effect***. If the company posting a challenge thinks that its main rivals may be relatively close to obtaining a new product or process, it may raise the value of the prize in order to increase its chances of success. The fiercer the competition, the higher the pressure on the company posting the challenge. However, if the company's objective is simply to go fishing for ideas (challenge category: ideation), to boost its repertory of knowledge, then it can envisage a prize of relatively low value.

iv) **The expected ex-post operating costs of a solution can also affect ex-ante the value of the prize.** Companies are aware that the implementation and operation of certain solutions can be very expensive. If they forecast high costs, they may offer a prize of relatively low value.

[10] See Dubocage (2003) on venture capital.

[11] In 2010, BP posted an urgent challenge (n° 9561385 in the database) to recover oil leaked from the Deepwater Horizon oil well in the Gulf of Mexico, driven by the emergency of the catastrophe.

v) Lastly, **other, complementary criteria are also used**, such as the estimated number of hours per researcher needed to solve the problem. This criterion is used by most of the other platforms (like Presans, for example), who reason in terms of man-months.

The companies replies to the questionnaires and interviews tend to show that there is no pre-established formula for determining the prize value, but numerous criteria, the relevance of which varies according to the nature of the challenge and the context. The determination of the prize value appears as a highly contextual phenomenon, related to competitive pressure and involving the joint consideration of several diverse factors, both quantitative and qualitative. How can one determine the unique price of the research prize on the basis of such heterogeneous criteria (the market, competition, degree of urgency, estimated research time required)?[12] And how can one reconcile the interests of companies facing an insoluble research problem and solvers who may have both monetary and non-monetary motives? Even if it is of low value, a prize may still be attractive to a solver who sees it as a way to attribute market value to some hitherto unexploited knowledge of his. One of the solvers we interviewed recounted how he answered a challenge in the field of marketing (the seeker was looking for an idea) and won a prize of 1000 dollars. The solver had been motivated to reply by the short time needed to submit a solution (so the time to prize-money ratio was very positive for him).

5. Organisation of exchange and price formation: towards a unified socio-economic approach

[12] The question of the determination of the prize is comparable to the evaluation of offer prices for start-ups when they are floated on the stock market (see Dubocage and Revest, 2010).

In the first part of this paper, we have considered Innocentive as a particular mode of organising economic exchanges, of which we have endeavoured described the principal mechanisms. The intention has been to explain how the organisation of exchanges implemented by Innocentive helps to reduce the asymmetries of information and problems related to the management of intellectual property. However, Innocentive's role is not limited to setting up suitable procedures to reduce information asymmetries and reveal quality; it also advises the seekers during the process of deciding the value of the prize. To illustrate Innocentive's role, we must examine the particular question of price formation. Now, this question is somewhat neglected by "instituted economic process" (IEP) approaches, which tend to focus more on the formation of different sets of agents, asymmetrical power relations or the interdependencies between different sets of agents and between market and non-market mechanisms. Harvey and Randles (2010), in their IEP approach, study the way that markets represent distinct forms of exchange in our societies from a more anthropological perspective. They propose a dynamic analysis of market and non-market processes: "By limiting analysis to specifically economic instituted characteristics, the intention is to both broaden the economic sociology of market and to situate the instituted organisation of exchange processes in a much broader field than market exchanges" (p. 19). However, when one focuses on one particular dimension (price formation), modern economic sociological approaches address this type of phenomenon with perception and relevance. Cognitive approaches, concerning pricing technologies (Callon, 1998; Callon and Muniesa, 2003; Preda, 2006), help to better understand the processes underlying the production of prices. We do not believe that there is any contradiction between the first approach, IEP, and an approach in terms of "cognitive frameworks" when it comes to explaining price formation. The latter is encompassed in the former dimension, because it relates to a particular mechanism: the production of prices in a given mode of organising economic exchanges. In reality, there is a strong link between the mode of organising exchanges and the formation of prices, with the former playing a role in frame-making and cognitive formatting.[13] Beckert's proposal (2010, 2011) to build a socio-economic approach to price formation that would simultaneously take into account the three major forces in market dynamics: social networks, institutions and cognitive frames, goes in the same direction. The aim is to obtain a more global view of the emergence, functioning and transformations of markets: "While it might be useful to distinguish the three structural forces analytically, any approach that does not take into account all the forces influencing action

[13] The sociologists Beunza and Garud (2007) compared the evaluation of Amazon on the Nasdaq by financial analysts at the end of the 1990s to a process of frame making.

remains necessarily incomplete in its analysis and is in danger of drawing a distorted picture of the embeddedness of economic action and the dynamics of market fields" (ibid., 2010, p. 606). For Beckert, the notion of field brings together these three dimensions (social networks, institutions and frameworking) within the same analytical space (Di Maggio and Powell, 1991; Bourdieu, 2005; Fligstein, 2001a, 2001b). Here, the concept of field is borrowed from Fligstein (2001b, p. 108), for whom it refers to a social order or arena where "actors gather and frame their actions vis-à-vis one another". Our position differs slightly, in that we attach central importance to the institutional dynamics. According to Beckert, institutions represent one of the three structuring forces that are indispensable for understanding markets and their dynamics. But in our analytical framework, these three dimensions do not occupy the same space. Institutions represent the primary constitutive force, the essence of the market being located in the very concept of "exchange". Networks and cognitive mechanisms of price determination result from the existence of exchange, and are embedded in this larger dimension represented by institutions.

To determine a price, it is necessary to estimate the value of the good or service proposed (Beckert, 2011). In the case of Innocentive, we have chosen to draw on the cognitive approaches that consider markets as calculative tools[14] (Callon, 1998; Callon and Muniesa, 2003, 2005). Markets are perceived as "organised collective devices" that allow to calculate the value of goods through a series of operations and mechanisms (Callon and Muniesa, 2003). The operations through which goods become calculable combine human and non-human factors. Thus, on each market, one can observe agents involved in calculative operations (distributive calculative agencies[15]) and material devices. The calculations - and more precisely the price discovery – are the result of particular algorithmic configurations, i.e., "particular modes of organisation and calculation of the connection between singular supplies and demands" (ibid., p. 220).[16] These configurations refer to the different stages and rules that lead to the completion of exchanges and fully integrating the material devices involved. The financial markets have been a particularly fruitful field of study for this type of approach.[17] Muniesa (2003, 2007) examined the introduction of a new algorithmic configuration on the Paris Bourse: the closing call auction.[18] Generally, the configurations

[14] Even if we consider Innocentive, not as a market, but as a particular mode of organising economic exchange, the logic of price formation applies equally well in this case.
[15] See Callon, 1998.
[16] As a result, there is a wide variety of concrete markets or of forms of organisation of exchanges.
[17] See the works of Knorr Cetina and Bruegger (2002) on trading screens and Preda (2003) on the ticker.
[18] In finance, the question of the modes of organising exchanges on financial markets has been addressed through studies of their microstructure (O'Hara, 1995; Madhavan, 2002). The concept of microstructure associated with

chosen are based both on material, technical and organisational devices and on embedded skills. The choice of certain configurations rather than others (like the closing call auction in the above case) depends on the relative power of the different groups of agents.

Like the financial markets, this socio-economic framework for analysing prices applies particularly well to the case of the Innocentive platform. Firstly, there is not a pre-established formula for calculating the prize value. Secondly, the determination of the prize is characterised by a context of high uncertainty: - the production of knowledge. Lastly, Innocentive illustrates very pertinently the association between the material device (the architecture of the internet platform, crowdsourcing) and the human dimension, through the intervention of members of Innocentive throughout the process (from drawing up the challenge, to screening the solutions, and detecting the quality). We intend to show that in this context, Innocentive plays a crucial role in the production of the algorithmic configurations that influence the decision-making of the seekers. A priori, different categories of agents, with unequal powers, can produce calculative tools, but there is one unique agent, Innocentive, that strongly shapes the price determination process.

The first essential contribution of Innocentive lies in the process of qualification of the service. To make a good or a service calculable, the first step is to qualify it; the process of qualification expressing the fact that the definition of the object of exchange is not self-evident.[19] The good or service is not "given"; it is constructed (see Orléan, 1999, 2011).[20] The process of qualification itself refers to two operations: objectivising and singularizing the goods and services concerned (Callon and Muniesa, 2003).[21] This means defining the objectivised properties of the good or service (transforming it into a "thing"), and directing those properties towards the buyer's world. In the case of Innocentive, we have already seen that writing the challenge takes a long time (weeks or even months). It involves turning a research problem that a company's R&D department cannot solve into a "marketable" question. The collaboration between the members of Innocentive and the seeker leads to the qualification of the good. Here, the skills of Innocentive's members are crucial. The Innocentive team must possess the necessary scientific skills to help the company transform

the material devices is considered equivalent to the concept of algorithmic configuration.

[19] The concept of qualification of products comes from Eymard-Duvernay, 1986.

[20] Numerous works in the economics of conventions and socio-economics have endeavoured to illustrate the process of qualification in different contexts (see for example Cochoy, 2002, or Karpik, 2007, on the economics of singularities).

[21] This approach can be found in the work of the economist Chamberlin (1946) who considered the product as an economic variable allowing adjustment between the desires of the consumers and the supplies of the sellers.

an internal research problem into a marketable question. If the challenge is in the field of chemistry, for example, the Innocentive members who work with the company must be highly qualified in chemistry (PhD level). Finding the right wording for the challenge requires numerous and highly detailed communications between all the parties involved and a shared knowledge base and language. However, the skills of the Innocentive team members are not limited to scientific expertise; they must also be capable of wording the challenge in such a way as to attract other disciplines (see the works of Lakhani). We find all the characteristics of a process of co-production of properties leading to the qualification of the service. And yet, all the work performed jointly by Innocentive and the seeker company consist in translating a research obstacle into a "formatted" question. Once the question has been formatted, it appears on the platform's website with all the other research questions already posted by other companies. When this research question is put in the same space as the others (on the internet) it becomes at the same time different from and comparable to the other questions.

Through a second contribution, Innocentive produces the algorithmic configurations that will influence the determination of the prize. These configurations enable the concrete execution of exchanges, "they not only frame the expression of supply and demand, but also determine the way in which prices are generated" (Callon and Muniesa, 2003, p. 219). Not only does Innocentive decide on the order of the stages in the process of posting a challenge, it also produces a set of tools and benchmarks that influence the fixing of the prize value by the seekers. It is the combination of the order of stages and the tools proposed that constitute the algorithmic configurations of Innocentive. The first stage is formatting the research question into a marketable service. From the beginning, the different categories of challenge proposed as an aid to formatting influence the process of fixing the prize value, which depends, all else being equal, on the category of the challenge. The modularity, i.e., dividing the question into sub-questions "of the same size" as questions already posted, also provides benchmarks for evaluation of the prize. Secondly, a register of the challenges posted and the prizes associated with them can be consulted on the platform and serves as a reference document for the seekers. This record allows firms to proceed by analogy: a company can see what level of prize was offered for a research question similar to their own. Here, the difficulty lies in deciding what "similarity" means in this context. Thirdly, the mention of the degree of urgency associated with the challenge also affects the level of the prize, *ceteris paribus*. We should add that in certain cases, Innocentive may negotiate directly with the company wishing to post a challenge, if they believe the prize value to be too low. Often Innocentive will

encourage the seeker to raise the level of the prize, on which Innocentive's own income depends.

Table 2 presents the five key elements that influence the determination of the prize value by the seekers.

[insert table 2 here]

6. Conclusion:

Innovation is a key word in the discourse of the leaders of the developed countries. It is considered essential for stimulating growth and creating future employment. In this context, the way that research produces innovation arouses great interest. Much of the literature on the economics of innovation has focused on the questions of complementary resources and the shifting frontiers of the firm, but alternative methods of organising research have also emerged: innovation platforms. Innocentive is the leading light of these platforms, through both its history and its current success. Drawing on instituted economic process (IEP) approaches and a cognitive approach to prices, we have shown firstly that Innocentive's particular mode of organising exchanges acts as a substitute for repeated, non-anonymous relations, helping to reduce asymmetries of information, detect quality and generate trust. Secondly, although it is up to the seeker to fix the value of the prize, Innocentive plays an essential role by producing the tools and benchmarks that frame the process of determining the prize. Today, Innocentive simply represents a mode of organising exchanges in the field of innovation, but it raises a number of questions about the development of this type of platforms. Does it herald the emergence of a new model of research organisation that is going to become widespread? Will small and medium companies then find themselves excluded from these new research processes? What are the limitations of this type of platform, especially with regard to the property rights of the solvers? And finally, if Innocentive illustrates an effective mode of incentive for research, can we envisage the emergence of

similar platforms, but where the positive results will not be monopolized by private players (the seekers) but will be of more benefit to society as a whole.

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Tables and Appendix

Table 1: How exchange relations are organised at Innocentive

IP management	*Ex ante* signing of the rights transfer contract; price fixed in advance.
Digital organisation of relations	InnoCentive website to consult the challenges; creating a Project Room to organise more confidential exchanges; hosting a solvers' blog so they can communicate with each other and swop experiences and stories.
Assistance provided to seekers	Training, help in drafting and if need be fragmenting the challenges.
Screening the solutions	Based on the seeker's recommendations: selecting the best solutions through several screenings; telephone contacts to refine the evaluation of the solution, its viability and the possibility of transfer.
Completing the transaction	**2 or 3 best solutions identified**, the seeker decides to acquire one, some all or none of them.
Timing	For the solver: 1 to 2 months between submission and designation of the winner(s). For the seeker: 1 to 3 months to draft the challenge, then 1 to 3 months for the collection and screening of submissions, then the transaction time. **In all: maximum of 6 or 7 months to obtain the solution.**

Source: the authors

Table 2. Modes of organising exchange that influence the determination of the prize value.

- Process of co-production of the qualification - Modularity: dividing the main research question into several sub-questions

- Existence of different categories of challenge

- Mention of the degree of urgency of the solution required

- Record of previous challenges and the prizes associated with them

Source: the authors

Appendix 1: Methodology

We used several different sources to gather more precise details about this case. Direct interviews were conducted by telephone, and semi-structured questionnaires were sent by e-mail. Among the seekers, out of ten companies identified as users of InnoCentive, we carried out interviews with the managers of three that had posted challenges (two in the chemistry sector and one in the seed industry). On the side of the internet surfers, we had five interviews. It must be emphasised that these interviews are not easy to obtain. First, because confidentiality is the rule on this subject, and it is therefore difficult to identify companies that have used InnoCentive. Second, it is very complicated, in these large multinational groups, to find the people in charge of the project with InnoCentive. Information from the specialised press had to be matched with that drawn from the various conferences on the subject, through which we identified the names of R&D managers. In addition, we respect the anonymity requested by our interviewees (the names of companies, managers and solvers). We also communicated with one of the managers of InnoCentive. We made full use of the literature on the subject, in particular the articles by Lakhani et al. (2007). This was complemented by articles in the economic and specialised press. Finally, the InnoCentive website (www.innocentive.com) and the solvers' blog (www.blog.innocentive.com) were very useful for understanding the organisation of the platform, obtaining numerical data and the names of certain solvers and companies, and forming a database of challenges.

Appendix 2 : Examples of Innocentive's challenges

« Increasing the Affordability of Inactivated Poliovirus Vaccine in Low- and Middle-income Countries"

Summary: *The goal of this Challenge is to identify problems or opportunity areas where eventual solutions might significantly reduce the cost of inactivated polio vaccine (IPV) use in low- and middle-income countries*.

Prize : $ 25 000

« Measuring Weight of Live Animals”

Summary*: The Challenge is looking for a portable device capable of a no-contact (“from a distance”) weight measuring of live pigs in the farm setting.*)

Prize: $ 50 000

“Increasing Fat Perception in Low-Fat Food Products”

Summary: T*his Challenge is looking for novel ways to impart full fat characteristics in low fat systems Theoretical-IP transfer*

Prize : $ 40 000

Source : Innocentive Website

Appendix 3 : Challenges categories