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Does Social Inducement Lead to Higher Open Innovation Investment? An Experimental Study

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Abstract

Open innovation has attracted an avalanche of interests from many practitioners and scholars, and is gradually becoming an acceptable scientific and managerial paradigm over the past few decades. Traditionally, however, innovative activities ought to be confidential within certain groups or individuals before the marketing process, and will be protected strictly by the intellectual property rights laws, for the sake of innovators' economic benefits and encouraging further innovation attempts. This paper aims at addressing the question of how to stimulate firms and managers to invest more resources to open innovation, and focuses on social inducement's effectiveness, in the art of a pre-recorded video, using an experimental approach. We established two open innovation investment models in which investors decide to allocate resources to open and traditional innovation projects. In the first model, we introduce the spillover effect and assume that traditional innovation projects may profit from open innovation investment. We then consider uncertainty to make the investment more realistic in the second model. The effect of social inducement on open innovation provision has been investigated in all the three settings, i.e. *No Video*, *Full Video* and *Half Video*. The striking result is that social inducement increases open innovation investment, but only if both induced subjects and non-induced subjects exist; meanwhile, economic uncertainty also matters.

Keywords

Open Innovation; Social Inducement; Conditional Cooperation; Economic Uncertainty

JEL Classification

C92, H41, O31

1 INTRODUCTION[1]

Traditionally, innovation activities ought to be confidential within certain groups or individuals before the marketing process, and will be protected by intellectual property rights (IPR) laws for the economic benefits of innovators and encouraging further innovation attempts (e.g. Gould and Gruben 1996; Helpman 1993). Currently, however, business and innovation models of open source, such as Apache server developer, Android operation system, Linux operation system and Mozilla Firefox, are broadly applied and well-known worldwide, and have continuously received increased attention for a decade. In this sense, firms can use external ideas for free as they are improving their own technology and market performance. Open source software (OSS, hereafter), which is a core component of open innovation projects, has gained significant public attention mainly because of its attractiveness and the ever-growing market share of open source programs and other software, which are developed on the basis of open innovation models. The OSS development involves developers at many different locations and organizations sharing code to develop and refine programs (Chesbrough 2003, 2006, 2010; von Hippel 2005; Quan and Chesbrough 2010; West et al. 2014; Lerner and Tirole 2002). Therefore, OSS can be defined as a public good, since it is characterized by non-excludability and non-rivalry in consumption. Within the conventional economic wisdom, such engaging behavior of non-paid programmers, commercial enterprises in the OSS program is enigmatic, and the development paradigm of OSS should not have accounted to be successful. However, its development has been strongly contradictory to our intuition. The reason behind the open source movement's success lies in "the creation and nurturing of a community of developers, testers, and users in order to create a set of symbiotic relationships that ensure the contributions of one group are tried, tested, and improved by another within the community" (Niman 2011: 904). Hence, the core of the open source community is how to create a cooperation culture and to maintain the reputation in skills and commitments of agents within a community. Open source can be understood as open collaboration that is defined as "any system of innovation or production that relies on goal-oriented yet loosely coordinated participants, who interact to create a product (or service) of economic value, which they make available to contributors and non-contributors alike" (Levine and Prietula 2014: 1415).

Therefore, open innovation's major challenge is how to encourage firms and individuals to open their own private ideas and innovations, given that the traditional innovation paradigm is dominant. Many factors contribute to achieve this object, for instance, contributors may directly benefit from the software code they developed (Raymond 2001; Garzarelli and Fontanella 2011); self-satisfaction in the developing process also might be relevant (Kollock 1999); and they can establish their own reputation within the community through making high-quality contributions to an open source program (Raymond 2001; Kollock 1999); in addition, this kind of reputation may bring well-being to their careers and enable them to obtain advantages in the job market (Lerner and Tirole 2002); in addition, the contributors also expect others to do so in order to efficiently develop something new more (Kollock 1999). Furthermore, sometimes the entities with specific cultural factors, for example, with self-determination/fulfillment values, can be an important positive element for the supply side of OSS (Engelhardt and Freytag 2013). Among those factors discussed above, open innovation may generate a spillover effect on traditional innovation projects within a firm, which makes the investment in a mixed form

1 We thank Jeannette Brosig-Koch, Timo Heinrich and Torsten Heinrich for helpful comments. Furthermore, we thank Minqi Guan and Jiaxiu Zhang for their excellent research assistance. Financial support from the German Federal Ministry of Education and Research (BMBF) is gratefully acknowledged.

more profitable than only investing in either project (Harhoff et al. 2003). In this paper, we contribute theoretically to this spillover effect model and test its influence on the level of open innovation investment. Above considerations all originated from the contributors' endogenous perspective, that is, without being influenced by external factors, comprising of either some direct executive orders or indirect economic incentives. We would introduce a kind of external force, which might be functional to lead individuals and firms more keen to make their innovation open. Hirschman (1958) mentions that given the strategy of development is to find and exploit "inducement mechanisms" which make for decisions that are "induced" and routine rather than "autonomous" and uncertain. Inducements are especially crucial to technological change (Rosenberg 1969). In our context, as most of the decision makers are well educated with the conventional innovation model, and any individual who tries to transit to open innovation will find this risky and challengeable (Alexy et al. 2013), social inducement might be a proper approach to coordinate their behaviors, and lead to their collective escape from the dilemma. This paper's second contribution is therefore to test social inducement's effect on the level of open innovation provision. We introduce three levels of social inducement in the experiment. Besides *No Video* setting in which subjects do not watch the video, and *Video* setting where all the subjects watch the video, we also include the *Half Video* setting where only half of the subjects in each group watch the video before decision making. Thus, this allows us to differentiate the induced and non-induced agents in different social inducement scenarios, and interestingly find that only the induced ones in the *Half Video* setting are aware of the significance of open innovation and they might "lead" in the group. This design reveals how the agents who have an information advantage act in decision-making processes and how leadership interacts with social inducement.

In the experimental literature, the effect of different types of communication (including face-to-face; chat-room; numerical cheap talk etc.) on the contribution level in a public good game is well investigated and the main conclusion is that communication is a valid mechanism to promote cooperation though different types of communication are effective in different ways (Dawes et al. 1977; Isaac and Walker 1988; Brosig et al. 2003; Bochet et al. 2006). However, social inducement, a one-directional top-down communication, is rarely covered in the experimental studies. Brosig et al. (2003) have a similar setting in one of the experiment series and show subjects a video-lecture given by a lecturer before a standard public good experiment. They find that a lecture as a unidirectional communication technology is rather an ineffective means to enhance cooperation. With regards to leadership, the results are quite mixed. While leadership can have positive effects in some public good experiments (Rivas and Sutter 2011; Cappelen et al. 2015), there are also studies which demonstrate no effect or even a negative effect (Hidreth and Anderson 2016).

Research from the field and social-psychologists' findings also demonstrate the significance of social inducement, which may be conducted in many means, for example, posters, newspapers, television and radio programs. DellaVigna and Kaplan (2007) found that Fox News, of which the political coverage is to the right compared to the other main television news channels, significantly increased the Republican vote share in presidential elections by 0.4 to 0.7 percentage points between 1996 and 2000. This finding implies that Fox News convinced 3 to 28 percent of its audience, of whom some are non-Republican, to vote Republican, although this effect is temporary. A similar insight comes from Yanagizawa-Drott (2014), who discovered that the main radio station broadcasting propaganda during the Rwandan genocide significantly increased participation in violence. Kearney and Levine (2015) reported that the MTV show, *16 and Pregnant*, led to a 4.3 percent reduction in teen births, and concluded that social media could be a powerful driver for social outcomes.

In particular, under an ambiguous situation, social information is likely to more positively in-

fluence subjects (Crutchfield 1955). Shang and Croson (2009) find that the social information provision has stronger persuasion effects on new members than on renewing members in a field donation experiment. Hence, we introduce a model scenario with uncertainty and a model with the spillover effect, in order to investigate the effect of social influence in a more ambiguous situation.

The remainder of this study is structured as follows. We develop theoretical models which are the experiments based on in Section 2. Section 3 describes the experimental design, variation of treatment parameters, and details on the experimental procedures and the recruitment process of subjects. Section 4 shows the results and Section 5 concludes.

2 THEORETICAL MODELS

We assume that there are n decision-making individuals in the market. Each of them can decide to invest their resources into different projects in the present paper to traditional innovation y_i and to open innovation z_i, to maximize their profits under an identical endowment E, $y_i + z_i \leq E$.

2.1 MODEL 1: AN OPEN INNOVATION INVESTMENT WITHOUT UNCERTAINTY

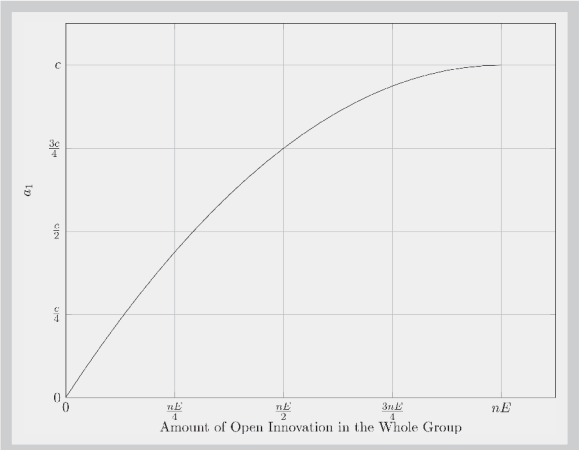
We start with a special situation, where there is no investment uncertainty. Open innovation is a proper example of "private provision of a public good" – individual users and programmers decide whether to invest their own efforts to develop a software enhancement that will be a public good (Johnson 2002). Therefore, as the individual decision maker decides to distribute his or her resources E into different kinds of projects, of which one is open innovation, the so-called public goods pool. Every unit z_i contributed to the open innovation project by any individual will bring b_0 unit to every agent. The parameter b_0 measures the public good's marginal per capita return (MPCR). Consequently, at the end of the investment, the open innovation's payoff will be $(z_i + z_{-i})(1 + b_0)$, where z_{-i} is the amount of open innovation investment from all the others, and b_0 is negative but larger than −1, which reflects the public good property of open innovation.

Aside from the open innovation investment, individual investors could also invest in traditional innovation projects. The rate of return of the traditional innovation investment consists of two parts: one part is a benchmark return, here denoted by a_0, and the other part comes from the spillover from the open innovation investment, denoted by a_1; which means every participating investor can benefit from the open innovation investment regardless of whether he or she has contributed in the open innovation project itself. This assumption is consistent with the finding of Henkel et al. (2014) that it would be beneficial for their business if firms selectively waive IPRs. We assume the spillover effects follow a quadratic function. Hence, we have,

$$a_1 = \frac{-c}{(nE)^2}(z_i + z_{-i})^2 + \frac{2c}{nE}(z_i + z_{-i})$$

where c is the maximally reachable a_1. The relation between a_1 and total open innovation investment $z_i + z_{-i}$ is illustrated in Figure 1.

Figure 1: The Spillover Effect of Open Innovation



Thus, we have the payoff function which individual firms will maximize, subject to the constriction of total initial capital E.

$$\text{Max}_{y_i, z_i} \prod_i = y_i(1 + a_0 + a_1) + (z_i + z_{-i})(1 + b_0)$$

Then, we have the optimal open innovation investment level z_i^*,

$$z_i^* = \frac{4nE + 2E - 4z_{-i} - \sqrt{(4nE + 2E - 4z_{-i})^2 - 12\left(z_{-i}^2 - 2Ez_{-i} - 2nEz_{-i} + 2nE^2 + (b_0 - a_0)\frac{nE^2}{c}\right)}}{6}$$

Furthermore, if we assume symmetry, that $z_i = z$ and $z_{-i} = (n - 1)z$, it means everyone invests the same amount in the open innovation project. We have,

$$z^* = \frac{4E + 2nE - \sqrt{(4E + 2nE)^2 - 4(2+n)\left(2E^2 + (b_0 - a_0)\frac{nE^2}{c}\right)}}{2(2+n)}$$

This is the symmetric Nash equilibrium solution. In addition, if we assume that all group resources are collectively distributed, we will find the social optimal solution. The total investment return level for all investors will be determined by the following profit maximization equation,

$$\text{Max}_{Y,Z} \prod = Y(1 + a_0 + a_1) + nZ(1 + b_0)$$

where $\prod = n\prod_i$ and $Y + Z \leq nE$. Then, we will have the socially efficient open innovation investment level,

$$Z^{\#} = \frac{6nE - \sqrt{(6nE)^2 - 12\left(2(nE)^2 + (n - 1 + nb_0 - a_0)\frac{nE^2}{c}\right)}}{6}$$

Please note that, if $nz^* < Z^{\#}$, there will be an under-investment, which means rational individual investors will invest less than the socially efficient level. This condition is fulfilled with the parameter specification in our experiment.[2]

2.2 MODEL 2: AN OPEN INNOVATION INVESTMENT WITH UNCERTAINTY

Every investment will involve uncertainty, or simply, investors must face the possibilities of economic boom or recession. Here, we distribute the possibility of 50% to both. The expected return rate value is therefore the average level of that under both conditions, that is,

$$a_0 = \frac{a_0^- + a_0^+}{2}\,;\; b_0 = \frac{b_0^- + b_0^+}{2}$$

As the economy is experiencing a boom, say the economic state is good, we have $a_0 = a_0^+$ and $b_0 = b_0^+$, the profit function is given as the following:

$$\prod_i^{*+} = (1 + a_0^+ + a_1) + (z_i + z_{-i})(1 + b_0^+)$$

And as the economy is under recession, say the economic state is bad, we have $a_0 = a_0^-$ and $b_0 = b_0^-$, the profit function is given as the following:

$$\prod_i^{*-} = (1 + a_0^- + a_1) + (z_i + z_{-i})(1 + b_0^-)$$

where the optimal open innovation investment level determines the optimal profit level, which should be the same as in Model 1, if risk neutrality is assumed. Note that the socially efficient solution is also the same as in Model 1.

2 The detailed theoretical solution of Model 2 is provided in Appendix A.

2.3 PARAMETERS

In the experiment series, we give parameters specific values and in particular assume $a_0 = 0.1$; $b_0 = -0.4$; $a_0^+ = 1.2$; $b_0^+ = 0.2$; $a_0^- = -1$, $b_0^- = 1$, $c = 4$; $n = 4$ and $E = 1000$, then we have numerical solutions of the Nash equilibrium and efficient outcomes for each model, which have been summarized in Table 1.

Table 1: Properties of the Models

	Model 1: No Uncertainty	Model 2: Uncertainty
Endowment	1000	1000
Rate of Return on Traditional Innovation	1.1 + [0.4]	Good State: 2.2 + [0.4] Bad State: .0 + [0.4]
Rate of Return on Open Innovation	0.6	Good State: 1.2 Bad State: .0
Symmetric Nash Equilibrium	134	134
Efficient Solution	530.15	530.15

Source: Own Table.
Note: The Nash equilibrium and the efficient solution of Model 2 are the same as of Model 1, if risk neutrality of subjects is assumed.

3 EXPERIMENTAL DESIGN

Our experiment aims at investigating the influence of different levels of social inducement on open innovation decisions under alternating model settings. The experiment is framed as an individual's investment decision, and the individual is running a small company. This company, together with the other three companies, organizes a Research and Development (R&D) network. Consistent with the models described in Section 2, every subject has to decide how much of the given endowment to allocate to their own traditional innovation and how much to the open innovation, which is beneficial to everybody in the network. Individual payoff consists of two payoff types. The first part is from his traditional investment, which is simply the amount invested in traditional investment multiplied by the rate of return on traditional innovation. As discussed in Section 2, we assume a spillover effect of open innovation on traditional innovation; thus, the rate of return on traditional innovation is positively dependent on the total level of open innovation within a group (a R&D network). The second part is from his open innovation investment, which is the amount of open innovation investment in the whole group multiplied by the rate of return on open innovation. Model 2 is only to this extent different to Model 1, in that we extend the setting with *Uncertainty* in Model 2, which hopefully makes the experiment more realistic and more externally valid.

3.1 SOCIAL INDUCEMENT

An additional treatment variable of the design is the level of social inducement, which varies across treatments. The understanding and perception of open innovation may depend on the social inducement level available to the decision makers. We aim to test whether seeing a video about open innovation influences the level of investment to open innovation. For this purpose, we introduce three levels of social inducement to examine potential differences. In *No Video* settings, subjects make investment decisions without any further information other than a standard instruction. In *Video* settings, all the subjects watch the video designed and produced by us before they turn into the game stage. In *Half Video* settings, only half of the subjects in each

group watch the video before decision making, and they are informed that the other two members do not see the video. The video is about six minutes long and contains three main information components.[3]

1 Traditional innovation with property right protection is dominant and has been important in history.

2 Open innovation could be more beneficial.

3 Free riders may exist.

Combining the two described models and three different social inducement levels, we have a 2 × 3 design and a total of 6 treatments, which have been summarized in Table 2.

Table 2: Treatments

Treatment	Model	Social Inducement Level
NoUn_NoV	Model 1: No Uncertainty	No Video
NoUn_V		Video
NoUn_HV		Half Video
Un_NoV	Model 2: Uncertainty	No Video
Un_V		Video
Un_HV		Half Video

Source: Own Table.

3.2 EXPERIMENTAL PROCEDURES

A total of 192 subjects from the University of Nankai and Tianjin University[4] in China participated in the computer-based experiment using z-tree (Fischbacher 2007) in March and April of 2015. All of the sessions were conducted at the Smith Lab for experimental studies at the University of Nankai.

3.2.1 SUBJECT POOL AND RECRUITMENT PROCESS

To recruit students from the University of Nankai and the Tianjin University, we hired one student assistant from each university. With the two assistants, we distributed flyers in different canteens on the two campuses, in order to awaken potential subjects' interests, who had to register in the form of an E-mail or a telephone call, providing their basic demographic and educational information and their available time slots. Registered subjects had been invited three or four days before a particular session via telephone calls or SMS, and subjects who wanted to participate in this particular session had to confirm either in the telephone call directly or reply to the SMS with a positive answer. Confirmed subjects received a reminding mobile message the evening before the session.

3.2.2 SEQUENCE OF EVENTS

All treatments included the same sequence of events, splitting into six subsequent steps shown in Figure 2. Participants first read the instructions while having the opportunity to pose clarifying questions (part 1).[5] To ensure that everybody understands the instructions and the general process, participants are asked to answer four control questions (part 2). Certain subjects, namely those who are in *Video* settings and half of those who are in *Half Video* settings are then shown with the video (part 3).[6] [7] The actual decision part is the core of the experiment (part 4), including different treatment types as summarized in Table 2.

Figure 3 shows a screenshot of the decision part. Before a subject makes the real investment decision, he could use the payoff calculator on the left side of the screen to help him. The economic

3 The translated video manuscripts are provided in Appendix B.

4 Tianjin University is the neighbor of the University of Nankai. The two universities have a similar ranking in China and their students have similar backgrounds. The two universities share a range of teaching and research programs.

5 The experimental instructions are provided in Appendix C.

6 Note that in *Half Video* settings subjects who will watch the video are told in the introduction that only two subjects in the 4er group will watch a video; whereas subjects who will not watch the video have no information about the video at all.

Figure 2: Sequence of Events

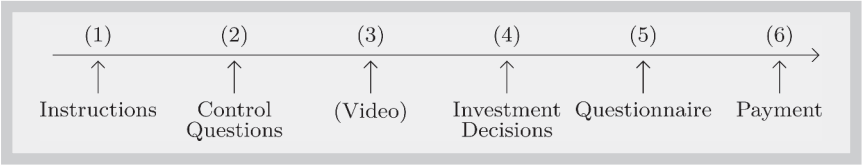
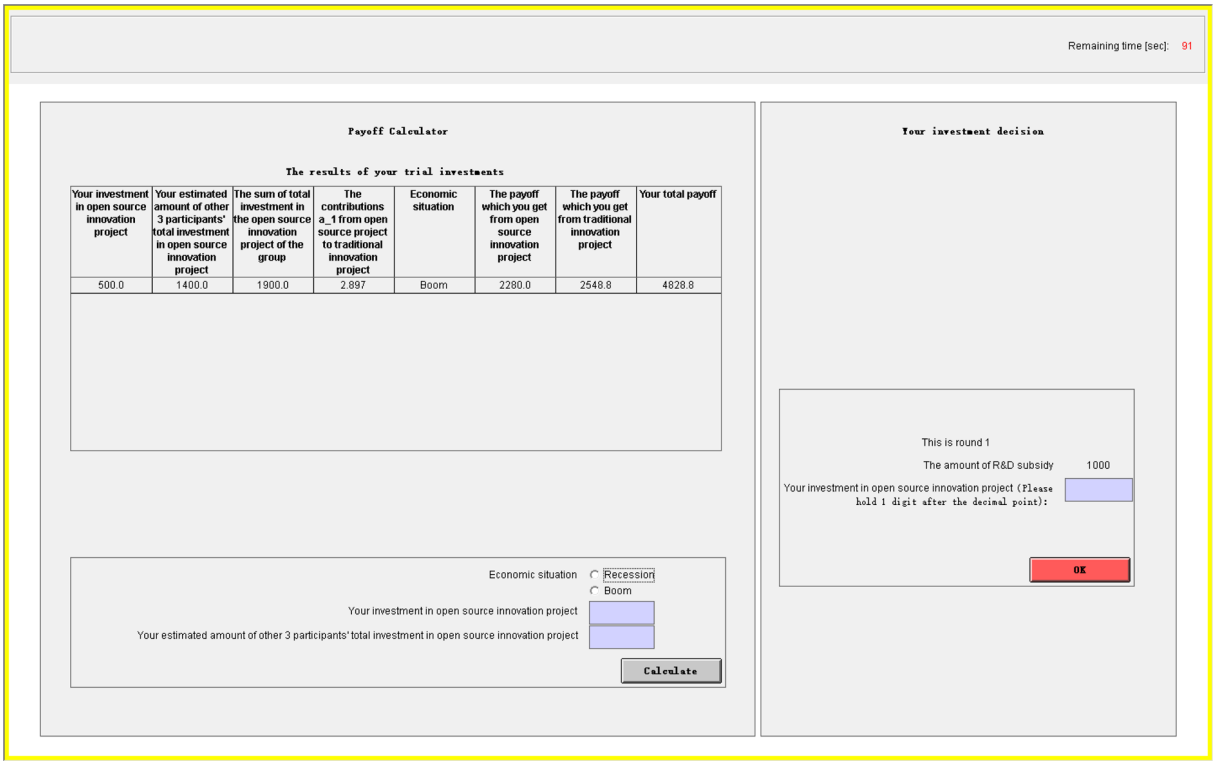


Figure 3: Screenshot of the Decision Screen



situation (economic boom or economic recession) has to be first chosen (only for Model 2), and then he inputs the investment amount in open innovation projects and his estimated amount of the other 3 participants' total investment into open innovation projects and then clicks *Calculate*. The calculator will give the total investment sum in the group's open innovation project, the contributions a_1 from open innovation project to traditional innovation project, the payoff that he receives from the open innovation project, the payoff which he obtains from the traditional innovation project and his total payoff. The calculator could be used multiple times in each round. When he has decided the amount of investment in the open innovation project, he could input it in the decision text-box which is shown on the right side of the screen and then click *OK*. Subjects repeatedly make investment decisions in each round, and there are 10 rounds in total.

After each round, a subject will be informed about:

7 To prevent the non-watchers from occasionally seeing the video during the six minutes and to prevent them from being aware that some subjects are watching a video, curtains are pulled over each cabin during the whole experiment and headsets are used for the video play. Nonetheless, it is possible that they infer some subjects might receive some extra information that they do not have, because otherwise they do not wait for that long time. Another point worth mentioning is that we only provided headsets in those cabins where the headsets would be used for the video, in order that subjects might notice this difference among cabins and through interference they might be provided with different information.

- His investment amount in the open innovation project;
- The total investment amount in his group's open innovation project;
- The average investment amount of his group's open innovation project;
- The contributions a_1 from the open innovation project to the traditional innovation project;
- His investment amount in the traditional innovation project;
- The economic situation (economic boom or economic recession) in the current round (only in Model 2);
- His payoff from the open innovation project;
- His payoff from the traditional innovation project;
- His payoff in the current round;
- His total payoff until the current round.

The investment decision part is followed by a questionnaire on socio-economic questions (Part 5). We collected information about gender, age, the number of siblings, net monthly income, final school grade (National College Entrance Examination, NCEE; in Chinese pinyin, Gaokao), number of semesters studied and field of studies. All subjects were then asked to report their risk attitude (0–10) and their ex-post attitude towards open innovation (0–10). We also asked for the main criterion for the investment decision. The answers are among a) Payoff Maximization, b) Last Round Group Average, c) Random Choice and d) Other. The total subject pool is summarized according to these variables in Table 7 and summarized separately in respect to diverse models in Table 8 (Model 1), and Table 9 (Model 2) in Appendix D.

At the end of the experiment, subjects were privately paid (part 6) with an exchange rate of 500 units of laboratory tokens = 1 RMB (around USD 0.161 at that time). The final payoff consists of the payoffs in all 10 rounds. The experiment took around 60 minutes and the average payoff was 53.6 RMB (around 8.6 USD), ranging between a minimum of 28.4 RMB and a maximum of 84.0 RMB. The expected payoffs are real average hourly wages that intend to reflect opportunity costs. To further ensure a functioning incentive structure, we did not pay a lump-sum amount / show-up fee. Payoffs depended on individual investment decisions only, other group members' investment decisions and economic situations (economic boom or economic recession).

4 RESULTS

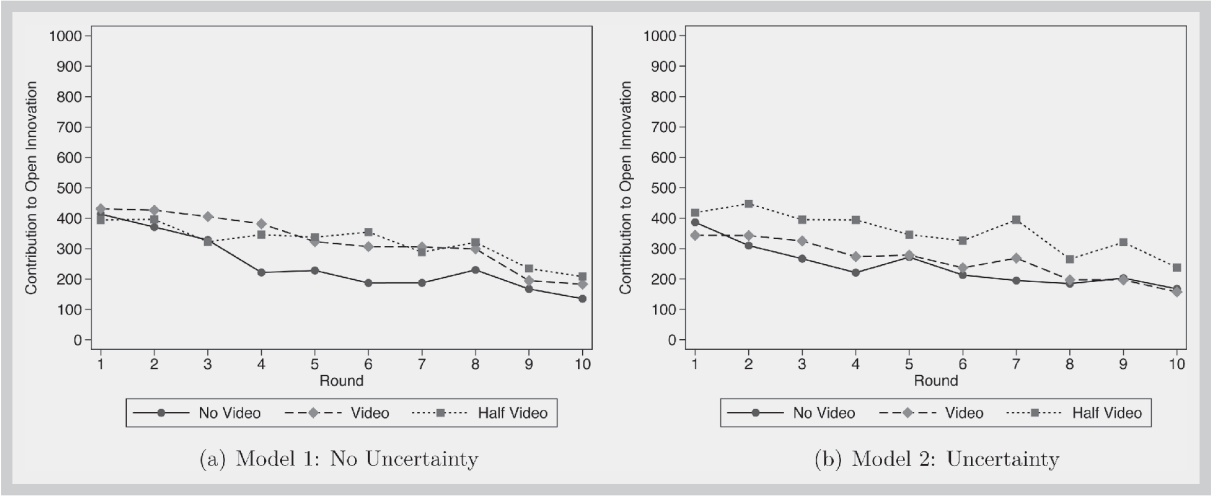
4.1 MAIN FINDINGS

Figure 4 presents the summary results of the overall average contribution in different models across the three social inducement scenarios. We observed that moderate contribution and end round effect exist in all the two models, which is consistent with the other experiments using a public good game (Andreoni 1988; Chaudhuri 2011).

4.1.1 NON-PARAMETRIC TESTS

In order to identify social inducement's impacts and accordingly its differences across the models, we applied non-parametric test approaches. First, we only looked at the first round. Since in the first round other group members' decisions did not influence individual decisions, there were more independent observations, which made the statistical power higher. We compared *No Video* vs. *Video* and *No Video* vs. *Half Video* within both model scenarios and no significant difference has been found, meaning that, in the first round, social inducement had no significant influence on open innovation provision in any form (*Video* or *Half Video*) and in any model environment (*No Uncertainty* or *Uncertainty*). However, if we pairwise compared

Figure 4: Overall Average Contributions in Model 1 and Model 2



Source: Own calculation based on experimental data.

each of the three social inducement levels between the two working models, we found that with the *Video* setting, subjects in Model 2 contributed significantly more than in Model 1 in the first round ($p = 0.06$), indicating that, at least at the very beginning, a secure investment environment may positively contribute to open innovation provision if all of the decision makers are well informed. Then we extended the analysis to all ten rounds and the main finding is that social inducement only generates a statistically significant difference between the treatments of *No Video* and *Half Video* in Model 2; and in other scenarios, there is no significant difference. Again, we pairwise compared each of the three social inducement levels between the two working models, and now even the single significant result with *Video* no longer exists. The results are shown in Table 3.

Table 3: Non-Parametric Tests: Main Results

	Model 1: No Uncertainty			Model 2: Uncertainty		
	No Video	Video	Half Video	No Video	Video	Half Video
			First round			
Mean contribution	413.5	431.1	394.5	386.3	343.4	417.8
N (group)	32	32	32	32	32	32
No Video vs. *Video*		−17.6			42.8	
z-stat. (*p*-value)		−0.36 (0.723)			0.86 (0.391)	
No Video vs. *Half Video*		18.9			−31.5	
z-stat. (*p*-value)		0.55 (0.581)			−0.83 (0.408)	
N (total)		96			96	
			All rounds			
Mean contribution	247.0	325.7	320.3	241.8	261.9	354.4
N (group)	8	8	8	8	8	8
No Video vs. *Video*		−78.7			−20.1	
z-stat. (*p*-value)		−1.58 (0.115)			−0.32 (0.753)	
No Video vs. *Half Video*		−73.3			−112.6	
z-stat. (*p*-value)		−1.16 (0.248)			−2.84 (0.005)	
N (total)		24			24	

Source: Own calculations using experimental data.
Note: Tests are two-sample Wilcoxon rank-sum tests (z-statistic). There are 32 independent observations for Round 1 in each treatment. For all rounds, the number of independent observations in each treatment collapse to 8 due to interactions within groups.

Concerning the uniquely significant difference if at all identified in Model 2, it is immediately apparent that social inducement works better under uncertainty in this open innovation context, which is consistent with the existing literature (Crutchfield 1955). Moreover, the only significant difference in Model 2 is generated between *Half Video* and *No Video*, not between *Video* and *No Video*. Hence, as uncertainty is taken into account, part social inducement as in the *Half Video* setting generates a better performance than full social inducement, in terms of leading more contribution to open innovation.

4.1.2 REGRESSION ANALYSIS

To control for additional influences, a regression has been used in addition to the standard non-parametric tests.

Table 4 demonstrates that in Model 2, *Half Video* generated more open innovation than did *No Video*, which is consistent with the non-parametric test results[8]. In all the two models risk aversion has been found to be correlated with the contribution level, which is consistent with the literature; for example, see Thaler et al. (1997). Other factors including gender, age, the number of sisters and brothers, net monthly income and education including NCEE (Gaokao) grade and numbers of university semesters did not bring any coherent and consistent significance.

4.2 THE IMPACTS OF *HALF VIDEO* SETTING

4.2.1 THE BEHAVIOR OF THE WATCHERS

It has been shown that, at the average level, in Model 2 the subjects in the *Half Video* treatment invested more in open innovation than that in the *No Video* treatment; this effect does not exist in

Table 4: Regression Analysis: Main Results

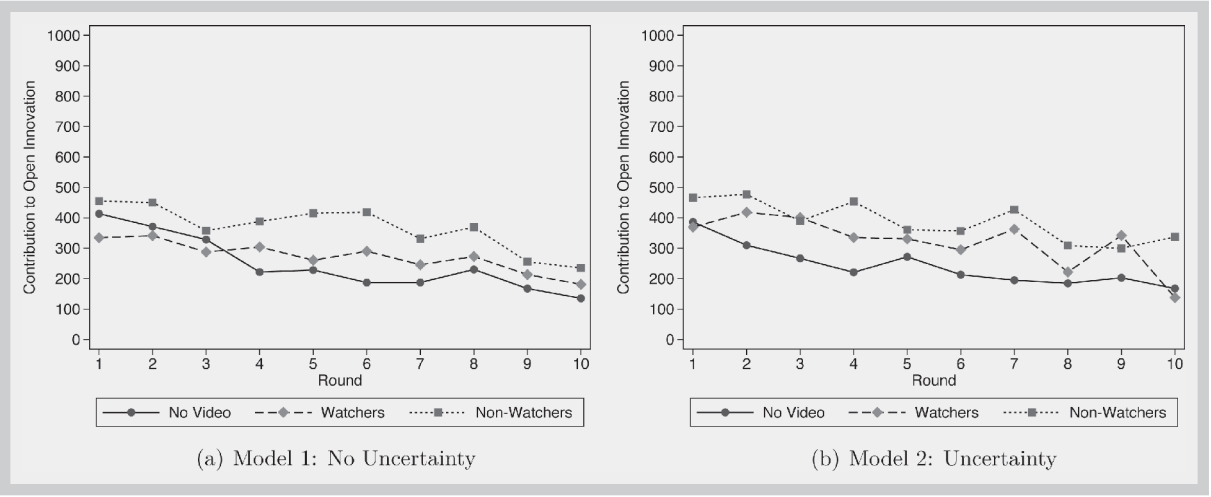
	Model 1		
	(1)	(2)	(3)
Treatment Variable			
Video	78.7**	74.5**	70.7**
Half Video	73.3	68.6	30.1
Stated Risk Preferences (0–10)		16.6	21.0**
Male			–63.7**
Age in Years			3.8
N Siblings			4.8
Net Monthly Income			
0–500 RMB			REF
>500–1000 RMB			–10.0
>1000–2000 RMB			–42.2
>2000–3000 RMB			–169.0*
>3000 RMB			170.2
Grade NEMT (Gaokao)			–0.2
N semesters at university			–4.8
Constant	247.0***	156.0**	261.4
N	96	96	96
	Model 2		
	(1)	(2)	(3)
Treatment Variable			
Video	20.1	3.2	20.8
Half Video	112.6***	97.0***	104.7**
Stated Risk Preferences (0–10)		21.7***	22.7***
Male			–41.9
Age in Years			9.9
N Siblings			10.5
Net Monthly Income			
0–500 RMB			REF
>500–1000 RMB			44.0
>1000–2000 RMB			–5.0
>2000–3000 RMB			2.4
>3000 RMB			–1.7
Grade NEMT (Gaokao)			0.3
N semesters at university			2.5
Constant	241.8***	148.1***	–261.9***
N	96	96	96

Source: Own calculations based on experimental data.
Note: Reported values are coefficients from OLS regressions. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. *Std. Err.* adjusted for 24 clusters, each group of four subjects is one cluster.

Model 1. In this section, we concentrate on the *Half Video* setting and identify the effects of the social inducement on the open innovation decision for various subject groups, the watchers

8 In Model 2, regression suggests a significant effect in *Video* as compared to *No Video*, this contradicts to the more conservative non-parametric test. Since non-parametric tests are standard and more accepted in experimental economics, we ignore this significance in our further analysis.

Figure 5: Model 1 and Model 2: No Video vs. Half Video (Watchers and non-Watchers).



Source: Own calculation based on experimental data.

and the non-watchers (in the *Half Video* setting, we term the two subjects who watch the video as watchers, and non-watchers for those who do not watch the video) in different models; therefore, we will find out whether the watchers or the non-watchers are influenced more effectively by the social inducement and invest significantly more than subjects in the *No Video* treatments, which makes Model 2 different from Model 1. Figure 5 reveals the comparison of open innovation investment between *No Video* subjects, the watchers and the non-watcher subjects.

As Table 5 shows that for both Model 1 and Model 2, video watchers in the *Half Video* setting more significantly invested in open innovation (120.5 and 145.8 respectively) compared with the subjects in the *No Video* treatments, which reflects the significant influence of social inducement on open innovation provision. Furthermore, if we compare watchers in the *Half Video* setting and subjects in the *Video* setting (where all subjects watch the video before their investment decisions), we find that in Model 2 the socially induced subjects who have non-induced group members contribute even significantly more (125.6) than those group members who watch the video.[9] This finding leads us to conclude

9 This comparison shows that social inducement works more effectively with the existence of non induced subjects, which also explains why within Model 2, *Half Video* setting provides a significant treatment effect whereas *Video* setting does not.

Table 5: Non-Parametric Tests: Watchers

	Model 1: No Uncertainty			Model 2: Uncertainty		
	No Video	Video	Half Video Watchers	No Video	Video	Half Video Watchers
Mean contribution	247.0	325.7	367.5	241.8	261.9	387.5
N (group)	8	8	8	8	8	8
No Video vs. *Watchers*		−120.5			−145.8	
z-stat. (*p*-value)		−1.89 (0.059)			−3.15 (0.002)	
Video vs. *Watchers*		−41.9			−125.6	
z-stat. (*p*-value)		−0.21 (0.834)			−2.52 (0.012)	
NN (total)		24			24	

Source: Own calculations using experimental data.
Note: Tests are two-sample Wilcoxon rank-sum tests (z-statistic). *Watchers* relate to subjects who saw the video in the *Half Video* setting.

that, given the existence of uninformed subjects (non-watchers), economic uncertainty makes socially induced subjects (watchers) more motivated to "lead" and to convey the information to the uninformed, in the way that they invest in open innovation of a high level as a signal.

4.2.2 THE BEHAVIOR OF THE NON-WATCHERS

Now we focus on the other type of subjects in the *Half Video* setting, the non-watchers. As Table 6 reveals, non-watchers do not behave differently in the *Half Video* treatments than the subjects in the *No Video* treatments in any of the two models. Yet, if we check the results from the last five rounds, non-watchers do contribute more than the subjects in the *No Video* treatments in Model 2[10]; but we do not find this effect in Model 1.

10 In fact, such a difference is significant even in the last 9 rounds. This difference is also significant with a regression. See Table 10 in Appendix E.

Table 6: Non-Parametric Tests: Non-Watchers

	Model 1: No Uncertainty		Model 2: Uncertainty	
	No Video	Half Video Non-Watchers	No Video	Half Video Non-Watchers
	All rounds			
Mean contribution	247.0	273.1	241.8	321.3
N (group)	8	8	8	8
No Video vs. *Non-Watchers*	−26.1		−79.5	
z-stat. (*p*-value)	0.11 (0.916)		−1.26 (0.208)	
NN (total)	16		16	
	Last five rounds			
Mean contribution	181.4	240.6	192.5	271.8
N (group)	8	8	8	8
No Video vs. *Non-Watchers*	−59.2		−79.2	
z-stat. (*p*-value)	−0.74 (0.462)		−1.68 (0.092)	
N (total)	16		16	

Source: Own calculations using experimental data.
Note: Tests are two-sample Wilcoxon rank-sum tests (z-statistic). *Non-Watchers* relate to subjects who did not see the video in the *Half Video* setting

5 CONCLUSION

In this paper we model investment decision problems in respect of the trade-off self-serving traditional innovation and public-serving open innovation. We then test the effectiveness of social inducement, in the form of a piece of video under two different model environments (with and without uncertainty) and three different levels of social inducement. In our model, the open innovation business model is combined with the conventional business model, as we showed in Model 1 and Model 2, where open innovation is a public good per se, but it also generates a positive spillover effect on traditional innovation. Open innovation means that we make innovation open; it does not mean giving up profits; therefore, a reasonable and practicable business strategy might be combining the open innovation business model with the convention models, which has been observed quite often in the real world (Google as an example discussed above). Our results demonstrate that two elements are crucial for making innovation open with the help of social inducement. First, the existence of non-induced subjects may make social inducement more effective. The asymmetric inducement setting makes the induced agents feel

more responsible to convey the value of open innovation to the non-induced ones by action. This point triggers us to think about how the public (media, authorities, etc.) identifies the critical group to promulgate the open innovation model. Compared with large-scale mass-oriented social inducement, targeting a certain group of the mass is not only cost-efficient, but could also be more effective, even concerning the non-targeted group's reaction of the non-targeted group. Second, economic uncertainty increases the effectiveness of social inducement. Hence, we might argue that during economic periods with higher uncertainty, ideas about open innovation and their related projects would be more easily promoted.

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APPENDIX A: THEORETICAL SOLUTION OF MODEL 1

There are n individual investors on the market. They can decide to invest their resources into different projects in order to maximize their profits. Two parts can contribute to the investment in the traditional innovation investment, one part is a benchmark return, here denoted by a_0, and the other part comes from the spillover from the open innovation investment, denoted by a_1; which means every participating firm can be benefit of the open innovation investment regardless whether it has contributed in the open innovation project. we assume a quadratic function. Hence, we have

$$a_1 = \frac{-c}{(nE)^2}(z_i + z_{-i})^2 + \frac{2c}{nE}(z_i + z_{-i}) \ ,$$

where z_i and z_{-i} are the investment amounts of the investor and the investment amounts of the others in open innovation respectively, and c is the maximally reachable a_1.

The return rate of open innovation is b_0, which is constant. Thus, we have the payoff function and individual investors will maximize it, subject to the constriction of total initial capital E.

$$\mathrm{Max}_{y_i, z_i} \prod_i = y_i(1 + a_0 + a_1) + (z_i + z_{-i})(1 + b_0)$$

$$\Leftrightarrow \ \mathrm{Max}_{z_i} \prod_i = (E - z_i)\Big(1 + a_0 + \Big(\frac{-c}{(nE)^2}(z_i + z_{-i})^2 + \frac{2c}{nE}(z_i + z_{-i})\Big)\Big) + (z_i + z_{-i})(1 + b_0)$$

We differentiate $\prod_i$ with respect to z_i ,

$$\frac{\partial \prod_i}{\partial z_i} = (E - z_i)\Big(\frac{-2c}{(nE)^2}(z_i + z_{-i})^2 + \frac{2c}{nE}\Big) + (-1)\Big(1 + a_0 + \Big(\frac{-c}{(nE)^2}(z_i + z_{-i})^2 + \frac{2c}{nE}(z_i + z_{-i})\Big)\Big) + (1 + b_0) \stackrel{!}{=} 0$$

$$\Leftrightarrow \ 3z_i^2 - (4nE + 2E - 4z_{-i})z_i + z_{-i}^2 - 2Ez_{-i} - 2nEz_{-i} + 2nE^2 + (b_0 - a_0)\frac{(nE)^2}{c} = 0 \ .$$

Thus, z_i could be solved out:

$$z_{i_{1,2}}^* = \frac{4nE + 2E - 4z_{-i} \pm \sqrt{(4nE + 2E - 4z_{-i})^2 - 12\Big(z_{-i}^2 - 2Ez_{-i} - 2nEz_{-i} + 2nE^2 + (b_0 - a_0)\frac{nE^2}{c}\Big)}}{6} \ .$$

Because $4nE + 2E - 4z_{-i} \geq 4nE + 2E - 4(n-1)E = 6E$, we have:

$$\frac{4nE + 2E - 4z_{-i}}{6} \geq E \ ,$$

so,

$$\frac{4nE + 2E - 4z_{-i} \pm \sqrt{(4nE + 2E - 4z_{-i})^2 - 12\Big(z_{-i}^2 - 2Ez_{-i} - 2nEz_{-i} + 2nE^2 + (b_0 - a_0)\frac{nE^2}{c}\Big)}}{6} \geq E$$

which is impossible. Then, we have the optimal open innovation investment level z_i ,

$$z_i^* = \frac{4nE + 2E - 4z_{-i} - \sqrt{(4nE + 2E - 4z_{-i})^2 - 12\Big(z_{-i}^2 - 2Ez_{-i} - 2nEz_{-i} + 2nE^2 + (b_0 - a_0)\frac{nE^2}{c}\Big)}}{6} \ .$$

Furthermore, if we assume symmetry, that $z_i = z$ and $z_{-i} = (n-1)z$, which means everyone invests same amount in the open innovation project. We have,

$$z^* = \frac{4E + 2nE - \sqrt{(4E + 2nE)^2 - 4(2+n)\left(2E^2 + (b_0 - a_0)\frac{nE^2}{c}\right)}}{2(2+n)} \quad .$$

This is the symmetric Nash equilibrium solution. In addition, if we assume that all resources for the group are distributed collectively, we will find the social optimal solution. The total investment return level for all investors will be determined by the following profit maximization equation,

$$\text{Max}_{Y,Z}\prod = Y(1 + a_0 + a_1) + nZ(1 + b_0) \ ,$$

where $\prod = n\prod_i$ and $Y + Z \leq nE$.

$$\Leftrightarrow \ \text{Max}_Z\prod = (nE - z)\left(1 + a_0 + \left(\frac{-c}{(nE)^2}Z^2 + \frac{2c}{nE}Z\right)\right) + nZ(1 + b_0) \quad .$$

We differentiate $\prod$ with respect to Z,

$$\frac{\partial\prod}{\partial Z} = (nE - Z)\left(\frac{-2c}{(nE)^2}Z + \frac{2c}{nE}\right) + (-1)\left(1 + a_0 + \left(\frac{-c}{(nE)^2}Z^2 + \frac{2c}{nE}Z\right)\right) + (1 + b_0) \stackrel{!}{=} 0$$

$$\Leftrightarrow \ 3Z^2 - 6nEZ + 2(nE)^2 + (n - 1 + nb_0 - a_0)\frac{(nE)^2}{c} = 0 \quad .$$

Thus, Z could be solved out:

$$Z_{1,2}{}^{\#} = \frac{6nE \pm \sqrt{(6nE)^2 - 12\left(2(nE)^2 + (n - 1 + nb_0 - a_0)\frac{nE^2}{c}\right)}}{6}$$

Because $\frac{6nE}{6} \geq nE$

so,

$$\frac{6nE \pm \sqrt{(6nE)^2 - 12\left(2(nE)^2 + (n - 1 + nb_0 - a_0)\frac{nE^2}{c}\right)}}{6} \geq nE$$

which is impossible. Then, we will have the socially efficient open innovation investment level,

$$Z^{\#} = \frac{6nE - \sqrt{(6nE)^2 - 12\left(2(nE)^2 + (n - 1 + nb_0 - a_0)\frac{nE^2}{c}\right)}}{6} \quad .$$

Please note that, if $nz^* < Z^{\#}$, there will be an underinvestment, which means, rational individual investors will invest less than socially efficient level.

$$nz^* < Z^{\#}$$

$$\Leftrightarrow \ \frac{n\left(4E + 2nE - \sqrt{(4E + 2nE)^2 - 4(2+n)\left(2E^2 + (b_0 - a_0)\frac{nE^2}{c}\right)}\right)}{2(2+n)}$$

$$< \frac{6nE - \sqrt{(6nE)^2 - 12\left(2(nE)^2 + (n - 1 + nb_0 - a_0)\frac{nE^2}{c}\right)}}{6}$$

$$\Leftrightarrow \ 3n\left(4E + 2nE - \sqrt{(4E + 2nE)^2 - 4(2+n)\left(2E^2 + (b_0 - a_0)\frac{nE^2}{c}\right)}\right)$$

$$< (2+n)\left(6nE - \sqrt{(6nE)^2 - 12\left(2(nE)^2 + (n - 1 + nb_0 - a_0)\frac{nE^2}{c}\right)}\right)$$

Using the parameter specification in our experiment $a_0 = 0.1$; $b_0 = -0.4$; $c = 4$; $n = 4$ and $E = 1000$, the upper condition is fulfilled,

$$\Leftrightarrow\ 3n\left(4E + 2nE - \sqrt{(4E + 2nE)^2 - 4(2+n)\left(2E^2 + (b_0 - a_0)\frac{nE^2}{c}\right)}\right) = 19292.34186$$

$$< (2+n)\left(6nE - \sqrt{(6nE)^2 - 12\left(2(nE)^2 + (n - 1 + nb_0 - a_0)\frac{nE^2}{c}\right)}\right) = 75694.80254\ .$$

The symmetric Nash equilibrium solution z^* is around 134, which is smaller than the socially efficient investment level of open innovation $Z^{\#}/4$ equal to 530.15 .

APPENDIX B: VIDEO MANUSCRIPTS

A traditional Chinese saying hustling for benefit, all come; busting for benefit, all leave. Nowadays, when we got better knowledge about the market economy, this saying becomes easier to be understood and acceptable. There is no free lunch for us in the world, nor do we have the duty to offer a free lunch for the others.

As an individual, one must be diligent, work hard and enhance capability in order to feed him or herself and to realize personal value; as a firm, it must have a good knowledge about the market, seize the opportunity, and better off investment in order to ensure business sustainability. After successfully education, you must firmly believe that all what you have had put efforts on will finally pay back financially one day in the future. Once you have a valuable innovation or project investment, please hand it to the market. Please keep in mind, profit maximization is always the key to survive. Right now, 100 percent for sure, by joining this experiment, you must know that you will be paid at the end, which you deserve to.

This is all about money, profits and benefits, but nothing about ethic. Rather, those cold and impersonal vocabularies, which are we really need, provide the fundamental mechanism for securing and promoting the development of our society and life. It is because of the existing of these market mechanisms and tools that we can see the increasing willingness of people to invest, to bear the risk and to innovate.

The patent institution is no wonder a brilliant idea. Only when there is patent protection, there will be motivation to innovate, there will be ambitious to invest, and there will be guaranteed on profits. In 1450, the Venice government has issued a series of patents to local firms for promoting the development of the domestic glass manufacturing industry. Although the duration of these patent protections was only 10 years, during the following 500 years, the glass manufacturing industry has playing a decisive role in Venice. In the 17th century in the United Kingdom, patent protection became the key to escort the industry revolution and prosperity of the UK. Comparatively, the young United States is also the vivid textbook in patent protection and innovation promotion. However, lacking of patent protection and being filled with numerous copycat products, China does not hold a bright future for technology innovation in people's mind.

Thus, when we talk about innovation and investment, it also must be the topic about patent protection, technology protection, monopoly and profit maximization.

All of these are market principles that we are familiar with, acknowledged and relied on, and they are the rules of the game for us to live and develop. We don't expect a free lunch, nor share free business information leased by others.

However, this is not all of our lives. In fact, you are enjoying the free lunch for every second and

receiving business secrets of others for every day. If without the offering of the free PDF reader by Adobe, then you must still be struggling in choosing the stable and right form to save your document. If without the offering of the free Android system by Google, Apple must monopolize the whole smartphone market now. If without the sharing of free recipes, how you still be faithful to name yourself "chief" in front of your mom. If without the voluntarily contribution on Wikipedia, then you will still be lost in the ocean of the library, only to search for one notion. If without the sharing of free online movies and music, you will must suddenly realize that you have to pay for them.

So, have you ever being thought about to design a free application for others, to update the Wikipedia, to buy a popular movie or music and share with others?

You also should be clear that, the volume of resources increases when more people contributing the resources for download; Wikipedia becomes comprehensive when more people are contributing; everyone can be benefited from the increasing willingness to share each one's achievement. As the traditional Chinese saying, when everybody adds fuel the lames rise high. However, it has to say, to watch out those people who only waiting for the free lunch while have never added any fuel for you.

However and fortunately, even if there is someone who comes to exploit our innovation, most people are still willing to offer free products, sharing their innovation outcomes, and looking for more and more people to join their group. This is the open innovation. The traditional close innovation depends on private investment on research and development, and on launching new products to gain the market share solely. This type of zero-sum competition is so-called the Red Ocean Strategy. On the contrast, open innovation depends on sharing of innovation outcome with each other, to speed up innovation process and sharing the market share. This cooperation is a win-win situation, which is so-called the Blue Ocean Strategy.

As we know, the Windows system is the world leader of private PC. However, recently, its weakening innovation capability has threatened its competitiveness. At the same time, the operation system that running on the supercomputer under the idea of open innovation actually performs impressively well. For example, in 2004, more than 90 % of supercomputers are running with the Linux system. And this achievement is based on the facts of research outcomes sharing and co-innovation.

When Apple comes out with the unique smartphone which draws the attention of the world, while we cannot pay for it, Google stood out and offered free operation system. Thus we can see brands like Samsung, Huawei, Xiaomi and Smartisan that who providing better cost performance smartphones to consumers. On the contrast, Nokia, who was once the global mobile phone giant, now has lost the chance to compete with other companies due to its sticking to traditional close innovation model, and it finally been acquired by Microsoft. By sticking to the open innovation, Android system has now taken over more than eighty percent market share in mobile phone industry. As long as it keeps doing open innovation, we may see the repeated story of Nokia on Apple. Nonetheless, don't worry if you are an Apple fan, because Apple is now following the trend and starting open innovation already.

When you are enjoying a yummy dish, have you ever thought about offering others a free recipe? When you are scornfully deemed to private investment, research and harvest, have you ever thought about giving up the traditional close innovation, but to cooperate with others, to gain faster and more profits? But, here is one kind reminding, there are always people surrounding you who only waiting for the free lunch but without sharing any of their secrets.

APPENDIX C: INSTRUCTIONS

The instructions are translated from the original Chinese instructions. The instructions are provided separately for different models, namely Model 1, Model 2 and Model 3. To reduce the length of the Appendix, all the instructions for the three models include the three social inducement levels: *No Video*, *Video* and *Half Video*: the instructions for *No Video* treatments are the main parts and special paragraphs only for *Video* and for *Half Video* Type 1 are in squared brackets. Please note that instructions for *Half Video* Type 0 are the same as those for *No Video* treatments.

C.1 INSTRUCTIONS: MODEL 1

Welcome to the Experiment!

Preliminary Note

You are participating in a study of decision-making behavior in the context of experimental economics. During the study you and the other participants will be asked to make decisions. You can earn money in this experiment. How much money you earn depends on your decisions. You are provided with detailed instructions about this in the following. All participants are paid in cash directly after the experiment one by one. To assure this, please remain seated after the experiment until your cabin number is called.

Throughout the experiment, no participant will receive information about the other participants' identities. All decisions are therefore made anonymously.

Should you have questions before the start of the experiment, please ask an employee of the laboratory. He will come to your place and help you. **Any communication with the other participants during the experiment is forbidden; breaking this rule will lead to an immediate exclusion from the experiment.**

Description of the Decision

Please read the following instructions completely and thoroughly. Please click the *START* button only **after you have clarified all questions.** As soon as you have clicked the button, we kindly ask you to answer some questions concerning the experiment. Once all participants have correctly answered these questions, the experiment begins.

[Only for *Video*: Before you start to make decisions, please watch a 6 minutes' video.]

You are a member of a group **with 4 participants,** [Only for *Half Video* Type 1: You and another participant will watch a 6 minutes' video, the other two participants **do not watch** the video and they do not know, that you and another participant watch it. The instructions are otherwise the same for every participant.] Each of you is running a small company. Four of you structured a **Research and Development (R&D) network** together. This experiment has **10 rounds** in total. You are going to face with the same situation which needs to be decided in each round.

In each round, you will get a R&D subsidy of **1,000 units of experimental currency** from the government (here's the experimenter). You are going to decide how to allocate this 1,000 units R&D subsidy: how many units to invest into the **traditional innovation project** in your own company and how many units into the **open innovation project** of the R&D network you belong to. All participants who are belong to this R&D network will benefit from the open innovation project equally. Please note that your investment in the open innovation project per round can be any amount between 0 and 1,000 units, and it is **the same rule** for every participant in this group.

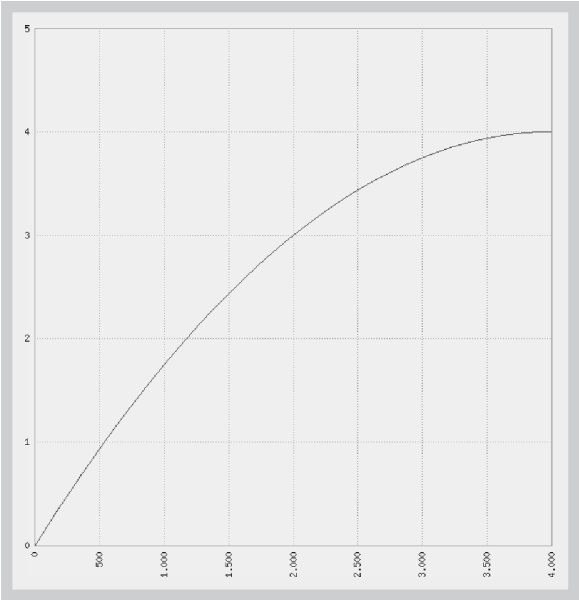
The rate of return in the open innovation project is b_0. In this experiment, it equals 0.6. If you

invest n units in open innovation project, then all participants of this R&D network (including yourself) will get $0.6n$ units as return. For example, when you invest 1 unit in open innovation project, each of you and the other 3 participants will get 0.6 unit as return, that means, the whole R&D network you belong to will get 2.4 (0.6×4) units as return. Based on the same rules, you will also get return from other participants' investment in open innovation project. The part of subsidy which you didn't invest into the open innovation project will keep in your own company for traditional innovation project.

The rate of return in traditional innovation project consists of two parts: a_0 and a_1. If you invest n units into traditional innovation project, you will get $(a_0 + a_1)n$ units as return. a_0 means the basic rate of return in traditional innovation project. Here it equals 1.1. a_1 means the contributions from open innovation project to traditional innovation project, its value is:

$$a_1 = \frac{1}{500}\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right) - \frac{1}{4000000}\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right)^2$$

The relationship between a_1 and the sum of total investment in the open innovation project of the group is shown graphically as follows:



The x-axis represents the sum of total investment in the open innovation project, whereas the y-axis represents a_1. Please note that there is a **positive relation** between x and y, that is, the larger the sum of total investment in the open innovation project of the group (Max.: 4000 units) is, the higher a_1 is. However, when the amount of the sum of total investment in the open innovation project is increasing, the increment of a_1 is reducing. The **maximal achievable a_1 is 4.**

Above all, in each round, your payoff will consist of two parts: one comes from your investment in open innovation project; the other comes from your investment in traditional innovation project.

With summarizing the introduction in one formula, you will get payoff in each round shows as follows:

$$\begin{aligned}&\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right) \times b_0\\ &+\left(\begin{array}{c}\text{Your investment in traditional}\\ \text{innovation project}\end{array}\right) \times (a_0 + a_1)\\ &= \left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right) \times 0.6\\ &+ 1000 - \left(\begin{array}{c}\text{Your investment in open}\\ \text{innovation project}\end{array}\right)\\ &\times \left(1.1 - \frac{1}{4000000}\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right)^2\right.\\ &\left.+ \frac{1}{500}\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right)\right)\end{aligned}$$

Please note that you could find the **Payoff Calculator** which shows on the left side of the screen to help yourself make decisions. Please input the amount of your investment in open innovation project and your estimated amount of other 3 participants' total investment in open innovation project and then click *Calculate*. The sum of total investment in the open innovation project of the group, the contributions a1 from open innovation project to traditional innovation project, the payoff which you get from open innovation project, the payoff which you get from traditional innovation project and your total payoff will be given by the calculator. You could use the

calculator multiple times in each round. When you have decided the amount of your investment in open innovation project, please input it in the **Decision Text-box** which shows on the right side of the screen and then click *OK*.

After each round, you will be informed about:

- The amount of your investment in the open innovation project;
- The total amount of investment in the open innovation project of your group;
- The average amount of investment in the open innovation project of your group;
- The contributions a_1 from open innovation project to traditional innovation project;
- The amount of your investment in the traditional innovation project;
- Your payoff from open innovation project;
- Your payoff from traditional innovation project which equals with your investment in traditional innovation project;
- Your payoff in current round;
- Your total payoff until current round.

All information from above descriptions and previous rounds will be provided in a data table.

Payment

Your payoff for participating this experiment is calculated as:

500 units experimental currency = 1 RMB

After 10 rounds, you will be asked to fill out a questionnaire. Then please keep waiting in your seat until your seat number is called. Please hand in your **participation number** which you have drawn in the beginning of the experiment while getting paid. Please also fill your name and signature in the receipt. After getting paid, please leave the laboratory quietly.

We would like to ask you not to discuss with anyone about the content of this experiment in case other participants would be affected. Thank you for your cooperation!

C.2 INSTRUCTIONS: MODEL 2

Welcome to the Experiment!

Preliminary Note

You are participating in a study of decision-making behavior in the context of experimental economics. During the study you and the other participants will be asked to make decisions. You can earn money in this experiment. How much money you earn depends on your decisions. You are provided with detailed instructions about this in the following. All participants are paid in cash directly after the experiment one by one. To assure this, please remain seated after the experiment until your cabin number is called.

Throughout the experiment, no participant will receive information about the other participants' identities. All decisions are therefore made anonymously.

Should you have questions before the start of the experiment, please ask an employee of the laboratory. He will come to your place and help you. **Any communication with the other participants during the experiment is forbidden; breaking this rule will lead to an immediate exclusion from the experiment.**

Description of the Decision

Please read the following instructions completely and thoroughly. Please click the *START* button only **after you have clarified all questions.** As soon as you have clicked the button, we kindly ask you to answer some questions concerning the experiment. Once all participants have correctly answered these questions, the experiment begins.

[Only for *Video*: Before you start to make decisions, please watch a 6 minutes' video.]

You are a member of a group **with 4 participants** [Only for *Half Video* Type 1: You and another participant will watch a 6 minutes' video, the other two participants **do not watch** the video and they do not know, that you and another par-

ticipant watch it. The instructions are otherwise the same for every participant.] Each of you is running a small company. Four of you structured a **Research and Development (R&D) network** together. This experiment has **10 rounds** in total. You are going to face with the same situation which needs to be decided in each round.

In each round, you will get a R&D subsidy of **1,000 units of experimental currency** from the government (here's the experimenter). You are going to decide how to allocate this 1,000 units R&D subsidy: how many units to invest into the **traditional innovation project** in your own company and how many units into the **open innovation project** of the R&D network you belong to. All participants who are belong to this R&D network will benefit from the open innovation project equally. Please note that your investment in the open innovation project per round can be any amount between 0 and 1,000 units, and it is **the same rule** for every participant in this group.

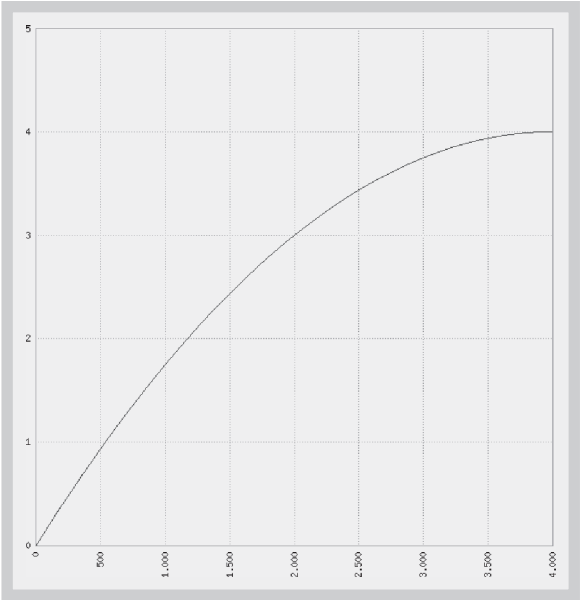
The rate of return in the open innovation project is b_0. In this experiment, there are two possible **economic situations: economic boom or economic recession**. Each of the economic situation occurs **randomly** with 50 % probability. You will be informed whether economic boom or economic recession you were facing with **after you've made investment decision in the end of each round.** Please note that, previous rounds are **irrelevant** to the economic situation in current round.

In a round with economic boom situation, b_0 equals **1.2**; and in a round with economic recession situation, b_0 equals **0**. If you invest n units in open innovation project, then all participants of this R&D network (including yourself) will get b0n units as return. For example, in a round with economic boom situation, when you invest 1 unit in open innovation project, each of you and the other 3 participants will get 1.2 units as return, that means, the whole R&D network you belong to will get 4.8 (1.2 × 4) units as return; and in a round with economic recession situation, when you invest 1 unit in open innovation project, each of you and the other 3 participants will get 0 unit as return, that means, the whole R&D network you belong to will get 0 (0 × 4) units as return. Based on the same rules, you will also get return from other participants' investment in open innovation project. The part of subsidy which you didn't invest into the open innovation project will keep in your own company for traditional innovation project.

The rate of return in traditional innovation project consists of two parts: a_0 and a_1. If you invest n units into traditional innovation project, you will get $(a_0 + a_1)\,n$ units as return. a_0 means the basic rate of return in traditional innovation project. In a round with economic boom situation, it equals 1.1.; and in a round with economic recession situation, it equals 0. a_1 means the contributions from open innovation project to traditional innovation project. The economic situation is irrelevant to it. Its value is:

$$a_1 = \frac{1}{500}\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right) - \frac{1}{4000000}\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right)^2$$

The relationship between a_1 and the sum of total investment in the open innovation project of the group is shown graphically as follows:



The x-axis represents the sum of total investment in the open innovation project, whereas the y-axis represents a_1. Please note that there is a **positive relation** between x and y, that is, the larger the sum of total investment in the open innovation project of the group (Max.: 4000 units) is, the higher a_1 is. However, when the amount of the sum of total investment in the open innovation project is increasing, the increment of a_1 is reducing. The **maximal achievable a_1 is 4.**

Above all, in each round, your payoff will consist of two parts: one comes from your investment in open innovation project; the other comes from your investment in traditional innovation project.

With summarizing the introduction in one formula, you will get payoff in each round shows as follows:

$$\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right) \times b_0$$

$$+\left(\begin{array}{c}\text{Your investment in traditional}\\ \text{innovation project}\end{array}\right) \times (a_0 + a_1)$$

In a round with **economic boom** situation, a_0 equals 2.2, and b_0 equals 1.2, the sum of the payoffs equals:

$$= \left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right) \times 1.2$$

$$+ 1000 - \left(\begin{array}{c}\text{Your investment in open}\\ \text{innovation project}\end{array}\right)$$

$$\times \left(2.2 - \frac{1}{4000000}\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right)^2 + \frac{1}{500}\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right)\right)$$

In a round with **economic recession** situation, a_0 equals 0, and b_0 equals 0, the sum of the payoffs equals:

$$1000 - \left(\begin{array}{c}\text{Your investment in open}\\ \text{innovation project}\end{array}\right)$$

$$\times \left(-\frac{1}{4000000}\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right)^2 + \frac{1}{500}\left(\begin{array}{c}\text{Sum of total investment in the open}\\ \text{innovation project of the group}\end{array}\right)\right)$$

Please note that, you could find the **Payoff Calculator** which shows on the left side of the screen to help yourself make decisions. Please choose the economic situation (economic boom or economic recession) first, and then input the amount of your investment in open innovation project and your estimated amount of other 3 participants' total investment in open innovation project and then click *Calculate*. The sum of total investment in the open innovation project of the group, the contributions a_1 from open innovation project to traditional innovation project, the payoff which you get from open innovation project, the payoff which you get from traditional innovation project and your total payoff will be given by the calculator. You could use the calculator multiple times in each round. When you have decided the amount of your investment in open innovation project, please input it in the **Decision Text-box** which shows on the right side of the screen and then click *OK*.

After each round, you will be informed about:

- The amount of your investment in the open innovation project;
- The total amount of investment in the open innovation project of your group;
- The average amount of investment in the open innovation project of your group;
- The contributions a_1 from open innovation project to traditional innovation project;
- The amount of your investment in the traditional innovation project;
- The economic situation (economic boom or economic recession) in current round;
- Your payoff from open innovation project;
- Your payoff from traditional innovation project which equals with your investment in traditional innovation project;
- Your payoff in current round;
- Your total payoff until current round.

All information from above descriptions and previous rounds will be provided in a data table.

Payment

Your payoff for participating this experiment is calculated as:

500 units experimental currency = 1 RMB

After 10 rounds, you will be asked to fill out a questionnaire. Then please keep waiting in your seat until your seat number is called. Please hand in your **participation number** which you have drawn in the beginning of the experiment while getting paid. Please also fill your name and signature in the receipt. After getting paid, please leave the laboratory quietly.

We would like to ask you not to discuss with anyone about the content of this experiment in case other participants would be affected. Thank you for your cooperation!

APPENDIX D: DESCRIPTIVE STATISTICS

Table 7: Descriptive Statistics: Full Samples

	Full Sample		By Models		
	Mean	Min / Max	Mean Model 1	Mean Model 2	T-stat (p-value)
Dependent variable					
Contribution to open innovation	291.8	0.2 / 1000	297.6	286.0	0.57 (0.572)
Socio-demographic variables					
Male	0.48	0 / 1	0.48	0.48	0.00 (1)
Age	21.2	17 / 29	21.6	20.9	2.53 (0.012)
N Siblings	0.73	0 / 5	0.85	0.61	1.66 (0.099)
Net monthly income					
0–500 RMB	0.04	0 / 1	0.03	0.04	−0.38 (0.702)
>500–1000 RMB	0.22	0 / 1	0.23	0.21	0.35 (0.727)
>1000–2000 RMB	0.66	0 / 1	0.67	0.65	0.30 (0.763)
>2000–3000 RMB	0.06	0 / 1	0.04	0.08	−1.19 (0.235)
>3000 RMB	0.03	0 / 1	0.03	0.02	0.45 (0.653)
Education					
Grade NEMT (Gaokao)	617.0	372 / 738	610.0	624.1	−2.15 (0.033)
N Semesters at university	2.6	1 / 15	2.6	2.7	−0.54 (0.593)
Field of studies					
Economics	0.37	0 / 1	0.43	0.31	1.65 (0.101)
Engineering	0.41	0 / 1	0.29	0.53	−3.46 (0.001)
Natural sciences / Math	0.06	0 / 1	0.08	0.03	1.55 (0.122)
Medicine	0.03	0 / 1	0.03	0.02	0.45 (0.653)
Sociology	0.07	0 / 1	0.06	0.07	−0.29 (0.775)
Humanities	0.03	0 / 1	0.05	0.01	1.66 (0.098)
Other	0.04	0 / 1	0.05	0.02	1.15 (0.250)
Risk, attitude and decision criterion					
Stated risk preferences (0–10)	5.2	1 / 10	5.6	4.8	3.07 (0.003)
Attitude towards open innovation (0–10)	7.0	0 / 10	7.2	6.9	0.89 (0.375)
Decision criterion					
Payoff maximization	0.60	0 / 1	0.53	0.68	−2.08 (0.039)
Last round group average	0.19	0 / 1	0.21	0.17	0.74 (0.462)
Random choice	0.04	0 / 1	0.04	0.03	0.38 (0.702)
Other	0.17	0 / 1	0.22	0.13	1.73 (0.086)
Payoff experiment					
Payoff in RMB	53.6	28.4 / 84.0	55.0	52.1	2.05 (0.041)
N	192		96	96	

Source: Own calculations based on experimental data.

Table 8: Descriptive Statistics: Model 1

	Full Sample		Model 1			
	Mean	Min / Max	No Video	Mean Video	Half Video	F-stat (p-value)
Dependent variable						
Contribution to open innovation	279.6	12 / 1000	247.0	325.67	320.3	3.08 (0.051)
Socio-demographic variables						
Male	0.48	0 / 1	0.47	0.56	0.41	0.78 (0.461)
Age	21.6	18 / 29	21.3	21.8	21.7	0.41 (0.664)
N Siblings	0.85	0 / 5	0.59	0.75	1.22	2.73 (0.070)
Net monthly income						
0–500 RMB	0.03	0 / 1	0.00	0.09	0.00	3.21 (0.045)
>500–1000 RMB	0.23	0 / 1	0.16	0.19	0.34	1.84 (0.164)
>1000–2000 RMB	0.67	0 / 1	0.81	0.66	0.53	2.95 (0.058)
>2000–3000 RMB	0.04	0 / 1	0.03	0.06	0.03	0.25 (0.776)
>3000 RMB	0.03	0 / 1	0.00	0.00	0.09	3.21 (0.045)
Education						
Grade NEMT (Gaokao)	610.0	372 / 684	612.4	602.5	615.2	0.58 (0.564)
N Semesters at university	2.6	1 / 15	3.0	2.4	2.3	1.26 (0.289)
Field of studies						
Economics	0.43	0 / 1	0.50	0.44	0.34	0.80 (0.454)
Engineering	0.29	0 / 1	0.28	0.22	0.38	0.95 (0.392)
Natural sciences / Math	0.08	0 / 1	0.06	0.09	0.09	0.13 (0.876)
Medicine	0.03	0 / 1	0.06	0.03	0.00	1.02 (0.364)
Sociology	0.06	0 / 1	0.06	0.06	0.06	0.00 (1)
Humanities	0.05	0 / 1	0.03	0.13	0.00	2.82 (0.065)
Other	0.05	0 / 1	0.00	0.03	0.13	2.82 (0.065)
Risk, attitude and decision criterion						
Stated risk preferences (0–10)	5.65	2 / 10	5.5	5.7	5.8	0.24 (0.786)
Attitude towards open innovation (0–10)	7.16	1 / 10	6.8	7.9	6.8	3.12 (0.049)
Decision criterion						
Payoff maximization	0.53	0 / 1	0.53	0.63	0.44	1.12 (0.331)
Last round group average	0.21	0 / 1	0.28	0.16	0.19	0.81 (0.448)
Random choice	0.04	0 / 1	0.06	0.03	0.03	0.25 (0.776)
Other	0.22	0 / 1	0.13	0.19	0.34	2.42 (0.094)
Payoff experiment						
Payoff in RMB	55.0	28.4 / 81.7	52.0	57.1	55.8	2.72 (0.071)
N	96		32	32	32	

Source: Own calculations based on experimental data.

Table 9: Descriptive Statistics: Model 2

	Full Sample		Model 2			
	Mean	Min / Max	No Video	Mean Video	Half Video	F-stat (p-value)
Dependent variable						
Contribution to open innovation	286.0	0.15 / 730	241.8	261.9	354.4	6.64 (0.002)
Socio-demographic variables						
Male	0.48	0 / 1	0.50	0.47	0.47	0.04 (0.960)
Age	20.9	17 / 25	22.1	20.1	20.4	20.90 (0.000)
N Siblings	0.60	0 / 4	0.59	0.34	0.90	3.71 (0.028)
Net monthly income						
0–500 RMB	0.04	0 / 1	0.06	0.00	0.06	1.03 (0.360)
>500–1000 RMB	0.21	0 / 1	0.19	0.19	0.25	0.25 (0.782)
>1000–2000 RMB	0.65	0 / 1	0.66	0.63	0.66	0.04 (0.957)
>2000–3000 RMB	0.08	0 / 1	0.06	0.16	0.03	1.78 (0.174)
>3000 RMB	0.02	0 / 1	0.03	0.03	0.00	0.50 (0.608)
Education						
Grade NEMT (Gaokao)	624.1	1 / 14	614.8	634.3	623.0	1.91 (0.154)
N Semesters at university	6	1 / 15	3.3	2.0	2.7	5.91 (0.004)
Field of studies						
Economics	0.31	0 / 1	0.16	0.28	0.50	4.82 (0.010)
Engineering	0.53	0 / 1	0.75	0.53	0.31	6.83 (0.002)
Natural sciences / Math	0.03	0 / 1	0.03	0.03	0.03	0.00 (1)
Medicine	0.02	0 / 1	0.00	0.06	0.00	2.07 (0.132)
Sociology	0.07	0 / 1	0.06	0.06	0.09	0.15 (0.861)
Humanities	0.01	0 / 1	0.00	0.00	0.03	1.00 (0.372)
Other	0.02	0 / 1	0.00	0.03	0.03	0.50 (0.608)
Risk, attitude and decision criterion						
Stated risk preferences (0–10)	4.8	1 / 8	4.3	5.1	5.0	1.53 (0.222)
Attitude towards open innovation (0–10)	6.9	2 / 10	6.8	7.6	6.4	3.02 (0.054)
Decision criterion						
Payoff maximization	0.68	0 / 1	0.69	0.75	0.59	0.89 (0.413)
Last round group average	0.17	0 / 1	0.13	0.16	0.22	0.51 (0.600)
Random choice	0.03	0 / 1	0.03	0.00	0.06	1.02 (0.364)
Other	0.13	0 / 1	0.16	0.09	0.13	0.28 (0.758)
Payoff experiment						
Payoff in RMB	52.1	33.1 / 84.0	52.7	44.4	59.3	27.00 (0.000)
N	96		32	32	32	

Source: Own calculations based on experimental data.

APPENDIX E: DETAILED REGRESSION RESULTS

Table 10: Regression Analysis: Watchers and non-Watchers

	Model 1		
	(1)	(2)	(3)
Treatment Variable			
Non-Watchers	26.1**	26.7	−26.4
Watchers	120.5*	108.9*	104.4**
Stated Risk Preferences (0–10)		19.6	19.2
Male			−84.8**
Age in Years			9.6
N Siblings			3.0
Net Monthly Income			
0–500 RMB			REF
>500–1000 RMB			−239.5
>1000–2000 RMB			−227.2
>2000–3000 RMB			−334.2
>3000 RMB			0 (omitted)
Grade NEMT (Gaokao)			−0.1
N semesters at university			1.0
Constant	247.0***	139.5*	236.6
N	64	64	64
	Model 2		
	(1)	(2)	(3)
Treatment Variable			
Non-Watchers	79.5*	75.3**	103.5**
Watchers	145.8***	118.0***	131.4**
Stated Risk Preferences (0–10)		22.2*	25.8*
Male			−47.6
Age in Years			15.7
N Siblings			12.1
Net Monthly Income			
0–500 RMB			REF
>500–1000 RMB			42.3
>1000–2000 RMB			8.0
>2000–3000 RMB			−43.4
>3000 RMB			64.5
Grade NEMT (Gaokao)			0.1
N semesters at university			8.4
Constant	241.8***	145.9**	−315.4
N	64	64	64

Source: Own calculations based on experimental data.
Note: Reported values are coefficients from OLS regressions. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
Std. Err. adjusted for 16 clusters, each group of four subjects is one cluster.

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