

Contributing to Public Goods Inside Organizations: Field Experimental Evidence¹

Andrea Blasco Olivia S. Jung Karim R. Lakhani Michael Menietti

Last updated: 21 March, 2017

¹Blasco: Harvard Institute for Quantitative Social Science, Harvard University, 1737 Cambridge Street, Cambridge, MA 02138 (email: ablasco@fas.harvard.edu). Jung: Harvard Business School, Soldiers Field, Boston, MA 02163 (email: ojung@hbs.edu), Lakhani: Harvard Business School, Soldiers Field, Boston, MA 02163, and National Bureau of Economic Research (email: k@hbs.edu). Menietti: Harvard Institute for Quantitative Social Science, Harvard University, 1737 Cambridge Street, Cambridge, MA 02138 (email: mmenietti@fas.harvard.edu). We gratefully acknowledge the financial support of the MacArthur Foundation (Opening Governance Network), NASA Tournament Lab, and the Harvard Business School Division of Faculty Research and Development. This project would not have been possible without the support of Eric Isselbacher, Julia Jackson, Maulik Majmudar and Perry Band from the Massachusetts General Hospital's Healthcare Transformation Lab.

Abstract

Employees often make choices between working on their assignment and on privately observed opportunities to improve the organization. Inefficient decisions may arise due to an incentive to free-riding on the work of others. An internal competition for prizes may help workers make more efficient choices but it may be detrimental to motivated workers. Using a solicitation of innovation project proposals in a medical center with over 1200 employees, we find that a contest awarding pecuniary prizes for the best contributions generates an 85 percent increase in participation, with no effects on the quality of contributions. The participation effect is the same for men and women, staff with different roles, and appears beyond the value of the prize. We also find that a solicitation appealing to improving the workplace is effective. But emphasizing the patient mission of the organization led to countervailing effects on participation based on gender differences. These results indicate that awarding prizes is a powerful way to foster contributions to organizational public goods, suggesting a complementarity between incentives and underlying motivations associated with the mission of the organization.

JEL Classification: H41; D23; D03.

Keywords: innovation contest; free rider problem; social preferences; altruism; idea generation; organization of work.

Contents

1	Introduction	2
2	Analytical framework and predictions	7
3	Experimental Design	9
3.1	The context	9
3.2	The design	11
4	Data	13
5	Results	13
5.1	Submitting project proposals	13
5.1.1	Interactions	20
5.2	Rating project proposals	21
5.3	The quality of the project proposals	23
5.4	The content of the project proposals	25
5.5	Estimating social preferences	27
6	Discussion	30

1 Introduction

Inside organizations, employees often make choices between working on their regular assignment and privately observed opportunities to improve the workplace. For example, a worker may decide to concentrate solely on production tasks (with pay and promotion tied to performance in these activities) or also devote some time to solve common organizational problems, with no direct compensation for the worker. This situation leads to two issues in the analysis of incentives inside organizations. First, there is a *multitasking* issue (Holmstrom and Milgrom, 1991; Hellmann and Thiele, 2011; Manso, 2011). Because of a limited ability of measuring performance in non-standard tasks, contractual incentives may backfire and result in an inefficient allocation of effort. Second, complications could also arise because of strategic behavior of workers in a *public good* context. Because of the non-rival nature of work in tasks benefiting the organization as a whole, workers may be tempted to avoid these tasks in the hope to free-ride on the efforts of others.

An internal competition for promotions or bonuses can be viewed as a solution to the first problem. A contests awarding pecuniary prizes for the best contributors can stimulate risk taking and participation in less-easily contractible tasks, as discussed by Lazear and Rosen (1981); Green and Stokey (1983); Mary et al. (1984) among others. However, traditional contest theory literature presumes that the contest outcomes will be enjoyed only by the sponsor of the competition (i.e., the manager, entrepreneur) with small gains for the competitors beyond the prizes given to the winners. Thus, it does not take into account the non-rival nature of contributing which constitutes the public good contribution problem. Although realistic in many situations, this assumption becomes questionable when the competition aims at fostering organizational improvements, since everyone can expect gains from the work of others. The use of contests under these circumstances raises important questions. Will prizes be effective in fostering participation and contributions to internal public goods inside organizations? To what extent employees “spontaneously” (without explicit incentives) internalize the need of improvements?

In the present study, we report the results of a natural field experiment to compare two dominant perspectives on the problem. The first perspective borrows from the seminal work of Morgan (2000), who stresses that awarding prizes in lottery-like contests will mitigate, even eliminate, the incentive to free riding. At the margin, employees choose their effort levels so that expected gains and costs are equal. Because these gains include the direct utility from receiving personal rewards and from improving the organization, even small prizes will boost participation beyond what one would expect from the pecuniary value of the prize alone. The other perspective is that workers have prosocial preferences towards the mission of the organization, as discussed by Besley and Ghatak (2005), Prendergast (2007), Delfgaauw and Dur (2008) among others. Probably due to a favorable process of self-selection into jobs, employees are “motivated” in the sense that they will devote time and volunteer effort to perform tasks in the best interest of their organization.¹ Hence, awarding

¹Everyday evidence for this behavior comes from blood donations, charitable giving, social workers. There is also a sizable scientific evidence on this topic that comes from a series of studies in the laboratory based on economic games (see Levitt and List, 2007, for a review) and field studies showing evidence on prosocial preferences at work

small prizes will be ineffective (it will only affect less motivated workers and those with lower opportunity costs to participate), if not detrimental. Competition may indeed evoke mixed feelings in workers with different competitive inclinations, a disposition that is potentially different for men and women (Croson and Gneezy, 2009); it may also inadvertently promote unethical behavior (Lazear, 1989; Charness et al., 2013); weaken intrinsic motivations (Reeve and Deci, 1996; Frey, 1997); and even kill the creativity of innovative work (Erat and Gneezy, 2015).

The study was conducted in collaboration with the Massachusetts General Hospital’s Corri-gan Minehan Heart Center (“Heart Center”), a prominent medical organization in the United States and a teaching hospital of the Harvard Medical School. The health care delivery context is particularly relevant for studying public-good provision problems as the need for organizational improvement and innovation is vastly noted. Also, health care professionals are commonly seen as motivated workers willing to step beyond the boundaries of their contractual duties to offer better care (Delfgaauw, 2005), which makes the comparison of different incentives in a public good context particularly interesting.

The natural field experiment was based on an internal *innovation contest* aimed at improving the operations of the organization, in the spirit of open innovation initiatives as discussed by Terwiesch and Xu (2008), Guinan et al. (2013), and Lakhani et al. (2013), among others. Employees were asked to submit project proposals addressing existing problems or providing improvements. The MGH executives committed to give top proposals proper resources for implementation. Staff could expect more costs and responsibilities from making a winning proposal, such as providing further guidance or a direct involvement in special implementation teams. But these other costs were not matched by any direct financial compensation. The value of winning was relatively small in comparison: top submissions were awarded in-kind prizes of value less than \$250 (Apple iPad mini’s) and there was no clear opportunity for the winners to increase the chances of a promotion or tenure, which are based on wholly different criteria.

The subject pool was the entire population of over 1,200 staff members of the Heart Center including physicians, nurses, and administrative workers. Our main intervention was in altering the content of personalized solicitations to participate in the innovation contest among randomly selected staff members. By doing so, we were able to get causal estimates of the effect of different incentives on two main outcomes: (a) the decision to submit and engage in implementation activities of a project proposal and (b) the quality of the proposal submitted, as measured by over 12,000 ratings made by peers. Using data on profession and gender, we could also characterize the heterogeneity of responses to the treatment, testing the implications of our intervention for the organization.

We designed four treatments related to our research questions. In a first treatment (PRIZE), the solicitation nudged employees to participate in the initiative by announcing a personal reward (an Apple iPad mini) for the top submissions. In a second treatment (FUND), the solicitation nudged employees with the funding opportunity alone and an explicit commitment by Hearsh

(Bandiera et al., 2005; Della Vigna et al., 2016).

Center executives to pay expenses up to \$20,000 in project development. In the remaining two treatments, we “framed” the contest by emphasizing the opportunity to improve the healthcare of the patients (PCARE) or the workplace (WPLACE).

From our empirical results, we find that workers were eager to contribute to improving the organization despite its cost: 196 employees (16 percent) across the entire organization took part in the initiative, with 5 percent of our sample submitting project proposals.² About half of these participating employees were invited by Heart Center executives to follow up with detailed implementation plans, which culminated in two proposals receiving full funding.

Our main finding is that small prizes boosted participation without lowering the quality of the submissions. In fact, simply announcing a personal reward (PRIZE) produced participation rates about 85 percent higher than the average (about 2.5 percentage points increase). This effect appears too large to fit a pure contest environment without public good incentives. The high incomes of our subject pool, the low chance of winning, and the additional costs of being selected for implementation suggest that very few would find it advantageous to participate. We discuss several possible explanations for this observation. We conclude that awarding a prize increased participation by helping motivated employees (i.e., with prosocial preferences) internalize the effects of their active participation for improving the organization, as in Morgan (2000). We then use a simple model to estimate employees’ underlying social preferences, showing that these preferences can account for 25 percent of individual costs of submitting.

The lack of quality effects could indicate there was no crowding-out effect, as the higher propensity of workers in the prize treatment does not seem to be driven by low-quality submissions. We also find little evidence of a difference in content other than peer-evaluated quality, such as the count of projects proposals per proponent, areas of focus and length of the proposals. Overall, these findings suggest no negative trade-off between quantity and quality: treatments that attracted more participants resulted in proposals of comparable quality and content. This also implies that monetary incentives were not counter-productive to creativity compared to voluntary contributions.

Another important finding is that responses were sensitive to the gender of the solicited person. Women’s participation was greater when emphasizing the patient care mission (PCARE) whereas men’s participation was significantly lower, controlling for the profession. At the same time, we do not find gender-based differences with respect to participation in the prize (PRIZE) treatment: women’s participation was slightly higher (but not significant) than men’s. The first finding suggests that female workers may perceive the mission of the organization differently than male workers. Alternatively, women workers were simply more responsive to a call for helping patients probably due to gender-based self-stereotyping. The second evidence indicates relatively small and inconsequential gender difference in preferences such as competitive inclinations or risk

²By comparison, in a purely public good setting such as List and Lucking-Reiley (2002)’s field experiment on individual monetary contributions to charity, the authors find very similar participation rates between 3 and 8 percent. Similarly, in a setting that involves employees of a consulting company making proposals to clients with no clear public good incentive, Gibbs et al. (2015) finds participation rates that are slightly higher (about 10 percent) but over a two-year period versus our four-week competition.

aversion between men and women.

Finally, announcing a funding opportunity alone (FUND), even with a commitment of \$20,000 in project funding, made employees less likely to submit compared to all other treatments, although with no difference in the quality of submissions. This evidence confirms that to being in charge of the project was not perceived as a prize in itself, a task that people would try to avoid unless with the right incentives.

The present study contributes to the literature on the use of relative incentives (prizes) in the workplace, which finds its theoretical foundations in Lazear and Rosen (1981); Green and Stokey (1983); Mary et al. (1984), among others. Our main contribution consists in studying the role of prizes in fostering workers' participation in activities that produce organizational improvements in the field. In particular, the observed increase in participation in the PRIZE treatment is consistent with the results of existing empirical studies (Bull et al., 1987; Knoeber and Thurman, 1994; Eriksson, 1999; Ehrenberg and Bognanno, 1990; Terwiesch and Xu, 2008; Terwiesch and Ulrich, 2009; Boudreau et al., 2011, 2016). However, while most studies focus on tournaments that result in benefits enjoyed exclusively by the sponsor of the competition (increasing sales, production, revenues), we show that this positive result generalizes to situations that generate positive externalities for the contestants (innovation projects to improve the organization). Despite being a common situation,³ this setting has received relatively less attention in past studies.

Our work also contributes to the empirical literature on the use of contest-type lotteries to finance public goods, first studied by Morgan (2000). A number of works have shown a positive effect of prizes on the extent of individual contributions to a public good in the laboratory (Morgan and Sefton, 2000; Dale, 2004; Lange et al., 2007) and in the field (Landry et al., 2006). However, as noted by Vesterlund (2012), the existing evidence on the profitability of contest-type mechanisms for raising money for public goods (e.g., charity donations) is only mixed (Vesterlund, 2012). Our work provides further evidence to this theory as we generalize the results of past studies to an organizational setting, where individual contributions are non-monetary but consists of time and effort in putting forward (and implementing) a proposal whereas the public good consists of the potential improvements for the organization. Under such circumstances, we find evidence indicating that prizes are effective tools for raising the level of participation, compared to voluntary mechanisms, and appear overall very profitable for organizations.

Our results also relate to the literature on social preferences at work. A number of studies have shown that people tend to contribute to public goods, despite strong incentives to free ride. Everyday evidence for this type of behavior comes from blood donations, charitable giving, social workers.⁴ There is also a sizable scientific evidence on this topic that comes from a series of studies based on economic games in the laboratory (see Levitt and List, 2007, for a review) and in the

³Members of the same organization often end up competing on the basis of their ability to solve common issues at the organizational level, such as addressing specific problems, innovating, providing business ideas.

⁴According to the World Health Organization, about 60 percent of blood donations collected globally each year is from voluntary unpaid blood donors. According to List (2011), charitable gifts of money are worth 2 percent of gross domestic product for the United States. Lacetera et al. (2014) further reports that: "27% of Americans volunteer with formal organizations, for a total of about 8 billion hours per year."

field (Bandiera et al., 2005; Della Vigna et al., 2016). Bandiera et al. (2005), for instance, shows that workers internalize preferences of co-workers and may reduce effort under relative incentives. Similarly, Della Vigna et al. (2016) shows a positive effect of mission-oriented preferences, also called “vertical social preferences,”⁵ on the level of effort of freelance workers folding envelopes for a charity. Our work is consistent with a positive effect of vertical social preferences; adding evidence that such social preferences not only increase effort in mandatory pre-specified tasks but also affect voluntary participation to non-mandatory ones.⁶

Another important aspect of the present study is that we focus on incentives to carry out a complex task (writing a project proposal) as opposed to standardized production tasks (Knoeber and Thurman, 1994) or sport (Ehrenberg and Bognanno, 1990). In this attempt, Gibbs et al. (2015) is perhaps the study most closely related to ours. In an ideation task within a consulting firm, Gibbs et al. (2015) finds higher participation rates and quality with standard incentives tied to performance compared to flat wages. In that setting, however, employees are not competing for prizes and managers seek ideas that would “directly benefit the client, as compared to ideas that improve internal processes.” Hence, an employee’s idea is successful only when it is adopted by the client and has no direct impact on the organization. Our study is complementary to Gibbs et al. (2015) as we consider a competition (instead of standard pay-for-performance incentives) directed at improving the organization and its “internal processes.” So, workers have an incentive to free ride not present in Gibbs et al. (2015).⁷ Overall, personal rewards have a positive effect on the participation but we find no (negative) quality effects. We argue this could result from the competition stopping workers from submitting innovation projects below a certain level of quality.

Finally, our work provides support to the incentive effect of a personal satisfaction derived from helping the organization achieving its goals (Akerlof and Kranton, 2005; Besley and Ghatak, 2005; Delfgaauw, 2005; Delfgaauw and Dur, 2008; Prendergast, 2007). This type of altruism is believed to be an important driver of effort for workers in organizations for social public goods, such as hospitals, universities, schools, administrations, and the military. Theoretical models suggest different ways in which managers can exploit these prosocial motivations to raise individual productivity; in the current study, we use “framing” to make particular motivations salient. We find that emphasizing prosocial motivations has countervailing effects on participation; negative for men and positive for women.⁸ While this finding is consistent with altruism being one important driver of effort inside

⁵Social preferences towards peers are instead called “horizontal.”

⁶In Della Vigna et al. (2016), workers can choose how much effort to exert but cannot choose which task to work on (in this sense the task is “mandatory”).

⁷Also, Gibbs et al. (2015) studies teams instead of individual workers. This implies that also in Gibbs et al. (2015) there may be a problem of free-riding within teams. Yet, formal teams are believed to solve internally the free-riding problem through peer pressure, monitoring, reciprocity within the team, etc. Hamilton et al. (2003) finds poor empirical evidence of free-riding in teams. In this sense, by focusing on individual workers, our results center on the problem of free-riding isolated from team dynamics.

⁸Concerning framing, many studies have explored the effects of positive or negative framing on the private provision of public goods in the laboratory (Andreoni, 1995). Inside organizations, Hossain and List (2012) and Hong et al. (2015) are among the first studies to measure the impact of framing interventions on productivity. The current study adds to this literature by showing significant effects associated with a particular type of framing such as appealing to internal motivations towards the mission of the organization.

organizations, it also suggests that people are sensitive to framing and in ways that may be difficult to predict ex-ante.

2 Analytical framework and predictions

In this section, we conceptualize an internal solicitation for innovation project proposals to improve the operations of the organization as a voluntary contribution mechanism for a public good. Successful proposals are viewed as non-excludable because innovation leads to improvements for everyone in the workplace (including customers by increasing the quality and efficiency of the services provided). Submitting a proposal requires costly effort by employees, such as the time to identify a problem, form a proposal, write up a concise description, and the potential for further involvement during proposal implementation.

Consider a linear model of the utility of a typical employee who contributes x and benefits from total contributions of $Y = \sum x$:

$$u(R, Y) = \gamma Y + \delta x + \frac{x}{Y} R - cx. \quad (1)$$

The benefits of contributing derive from three sources. First, there is an altruistic benefit from the improved workplace, γY . The altruistic benefits are the crux of public goods. Only the existence of an improved workplace is desired and the source of contributions is irrelevant. Thus, everyone would prefer to free-ride on others' efforts. Second, participants have some chance of winning the contest and can expect to derive benefits from the prizes, $\frac{x}{Y} R$, where, for simplicity, all efforts have an equal chance of being selected as the winner, as in Morgan (2000). The personal reward R can be thought of as a pecuniary prize, but it could also be an increase in prestige or recognition or any combination of the above. Finally, employees may have an egoistic motivation for contributing "per se," regardless of winning and the effect on others, which is captured by δx . This includes also the case in which workers may derive a personal satisfaction from contributing personally to the organization, often called warm glow preferences for giving (Andreoni, 1995). Since we cannot observe the distinction between altruistic and warm-glow motives in our empirical setup, we are going to impose later that these preferences are such that $\delta = 0$.

Contributors incur some effort cost from developing and submitting a proposal, cx . If there are n employees the public goods dilemma arises when $\gamma + \delta < c < n\gamma + \delta$. Then no individual would contribute without a reward as costs exceed individual benefits, but everyone would be better off if everyone contributes.

Suppose contributing a proposal is a discrete choice by employees. An employee can either contribute a single proposal $x = 1$ and receive utility of

$$u_1 = \gamma \hat{Y} + \delta + \sum_{k=1}^n \Pr(Y = k) \frac{R}{k} - c, \quad (2)$$

where \hat{Y} denotes the expected level of contributions and $\Pr(Y = k)$ is the probability of having

k total contributions. Or they can contribute nothing $x = 0$ and receive utility of

$$u_0 = \gamma(\hat{Y} - 1). \quad (3)$$

If there are n employees, then the unique symmetric mixed-strategy equilibrium is for each employee to contribute a proposal with probability $p > 0$. After using the binomial probability for $\Pr(Y = k)$, the payoff-equating condition to find a mixed-strategy equilibrium is:

$$\frac{1 - (1 - p)^n}{np} = (c - \gamma - \delta)/R. \quad (4)$$

This equation admits one single solution p^* which cannot be expressed explicitly. Using a first order Taylor expansion around p , the equilibrium probability can be approximated as follows:

$$p^* \approx \frac{2(R - c + \gamma + \delta)}{(n - 1)R}. \quad (5)$$

The analysis of the above model is used to derive the following predictions.

- 1) The probability of contributing a proposal to improving the organization is zero when the prize for winning is sufficiently small relative to the individual cost of effort minus the preference for the public good (i.e., $R < c - \gamma + \delta$).
- 2) The probability of contributing a proposal to improve the organization increases with the value of the prize for winning.
- 3) The probability of contributing a proposal to improve the organization increases with the extent of individual preference for the public good ($\gamma + \delta$).

Now suppose that the public good Y constitutes the sum of innovation projects to improve the organization. Imagine that the quality of each project is randomly drawn from a discrete distribution, the same for every contributor (every employee who contributes is assumed to be equally likely to come up with a useful idea). Each proposal can be of high quality with probability ν and of low quality with probability $1 - \nu$. If a proposal is of low quality, then the value for the organization is normalized to zero. The quality of proposals is learned only after the agent paid the cost of effort. Now the equilibrium public good Y is not deterministic but follows a binomial distribution with average $E[Y] = p^{**}\nu n$, where the equilibrium probability p^{**} can be derived as before with the only difference being that it is also an increasing function of the probability ν . This leads to the following prediction.

- 4) If the public good depends on the quality of each contribution and every agent is equally likely to make a proposal of high quality, then the higher the probability of contributing, the higher is the average public good.

This framework can be extended to the case of individuals with heterogeneous costs. In the appendix, we explicitly consider the case of two types of individuals with different marginal costs

of effort that form two groups of equal size. The symmetric mixed-strategy equilibrium is then characterized by the vector of probabilities of contributing with a proposal (p_1^*, p_2^*) . Here, the analysis of the payoff-equating conditions for the mixed-strategy equilibrium shows that the higher the marginal cost of effort minus preference for contributing, the lower the equilibrium probability of individuals (i.e., $p_1^* > p_2^*$ when $c_1 < c_2$, and vice versa). This leads the final prediction.

- 5) If individuals have heterogeneous costs, then the probability of contributing a proposal to improve the organization is higher for agents with lower costs (positive sorting).

3 Experimental Design

3.1 The context

Our natural field experiment was conducted at the Heart Center from July 2014 to November 2014. The Heart Center is a leading academic medical center specializing in clinical cardiac care and research in the United States. Founded more than a hundred years ago, the Heart Center serves thousands of patients every year, occupies more than 35,000 square feet of office space, and employs more than 1,200 people (nurses, physicians, researchers, technicians, and administrative staff) scattered across several buildings on the Massachusetts General Hospital’s main campus in downtown Boston and a few other satellite locations.

The study was in cooperation with the Heart Center’s launch of the Healthcare Transformation Lab (HTL), an initiative aimed at developing innovative health care process improvements to enhance the health care safety and delivery of the hospital.⁹ The launch of the HTL was accompanied by the announcement of an internal “innovation contest,” called the Ether Dome Challenge (the name is taken from a historical place on MGH’s main campus where the first public surgery using anesthetic was demonstrated in 1846) that sought to engage all staff members to participate.

The communication around the innovation contest highlighted the opportunity for staff to help in the selection process of the ideas and a commitment by the Heart Center Management that the leading ideas would be provided appropriate resources so that they could be implemented. The announcement on the contest’s website read:

If you’ve noticed something about patient experience, employee satisfaction, workplace efficiency, or anything that could be improved; if you’ve had an inspiration about a new way to safeguard health; or if you simply have a cost-saving idea, then now is the time to share your idea.

The innovation contest can be divided into three main phases: the submission phase, the peer evaluation phase, and the implementation phase. The timing is shown in Figure 1.

In the four-week submission phase, all staff members were encouraged to identify one or more organizational problems and submit proposals addressing them. Employee participation was voluntary. All project submissions were done online via the website of the contest. There was no limit

⁹See <http://www.healthcaretransformation.org> for more information about the HTL initiative.

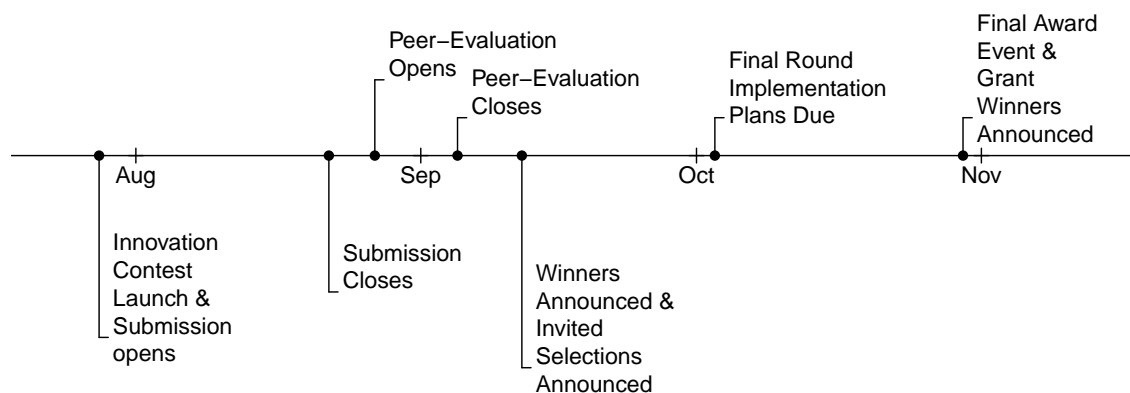


Figure 1: Timeline of the innovation contest

to the project proposals to submit (proposals could cover any issue within the organization, as described above), but each proposal was limited to approximately 300 words to lower the costs of entry and encourage broader participation. To ensure that treatment effects could be isolated, identified, and matched to participants, team submissions were not permitted. Limiting submissions to individual participation allowed us to match each submitter’s characteristics to the randomly assigned treatment. It also lowered incentives to communicate or exchange information with other employees. Also, the website was designed to not provide any information about the status of the contest during the submission period. In this way, decisions could not be easily influenced by the perceived popularity of the contest or previous submissions.

In the two-week peer evaluation phase, all staff members were invited to rate the merit and potential of submitted proposals on a five-point rating scale. All evaluations were done online on the website of the contest. Each signed-up employee was shown a list of anonymized proposals to read and rate. Proposals were presented at random in batches of 10 each. Each proposal was described by a title, a main description of the problem to solve, and the proposal. Voting was then introduced by the following text: “Rate this idea” followed by the rating scale: 1-low; 2; 3; 4; 5-high. Ratings were kept confidential and the website did not provide any feedback or any other kind of additional information that might have influenced individual judgment until the voting phase was over. Evaluators were free to decide how many (and which) proposals to rate. Since these were presented in a random order, every proposal had on average the same exposure to people asked to rate its quality. Evaluators were offered a limited edition T-shirt as a compensation for the effort in voting.

In the final implementation phase, employees having submitted proposals highly rated by peers and judged as particularly promising by the HTL staff were invited to submit a full proposal detailing plans for implementation. Following evaluation by MGH senior leadership, top proposals

were selected to receive support and funding for implementation. This final phase took a few months to complete, essentially the time necessary to select and implement the best projects.

3.2 The design

The main intervention was to alter the content of the communication that announced the innovation contest. The start of the submission phase was indeed announced to all staff members in a series of personalized emails. A direct message was sent to each contact in the list of employees' emails from our subject pool.

The body of this communication with a placeholder for our treatment is reported below (a copy of the exact email is in the Appendix).

Dear Heart Center team member,

[TREATMENT HERE]

The Ether Dome Challenge is your chance to submit ideas on how to improve the MGH Corrigan Minehan Heart Center, patient care and satisfaction, workplace efficiency and cost. All Heart Center Staff are eligible to submit ideas online. We encourage you to submit as many ideas as you have: no ideas are too big or too small!

Submissions will be reviewed and judged in two rounds, first by the Heart Center staff via crowd-voting, and then by an expert panel. Winning ideas will be eligible for project implementation funding in the Fall of 2014!

The first paragraph of the above message was randomized into *four* different solicitation treatments: FUND, PRIZE, PCARE and WPLACE. Thus, creating four treatment groups of equal size (Table 1).

In the first two groups (FUND and PRIZE), the solicitation nudged employees to participate by announcing individual prizes to be won (PRIZE), i.e., an Apple iPad mini, or a \$20,000 budget for developing their project proposals (FUND). In the remaining two groups (PCARE and WPLACE), the solicitation “framed” the contest as an opportunity to improve the healthcare of their patients (PCARE) or the workplace (WPLACE). The exact words are in Table 1. In all groups, employees were not told that they were part of an experiment.

A sample size of more than 300 units for each treatment ensured a sufficiently high statistical power based upon standard power calculations on the difference of proportions (Cohen, 1992). In testing the difference of proportions between any two treatments, the probability of type-I errors was slightly below 0.80 for *small* differences at 5 percent significance level but higher than 0.80 for *medium* and *large* differences at the more stringent 1 percent significance level.¹⁰

¹⁰The definition of small, medium and large differences is given by Cohen (1992); e.g., a difference of 5 percentage points of the pair (0.05, 0.10) is considered a small effect: see Cohen (1992) p. 158.

Table 1: Experimental design

	<i>Employees:</i>		<i>Randomized solicitation:</i>
	Obs.	%	First paragraph
PRIZE	312	25	Submit your ideas to win an Apple iPad mini
FUND	308	25	Submit your ideas to win project funding up to \$20,000 to turn your ideas into actions
PCARE	310	25	Submit your ideas to improve patient care at the Heart Center
WPLACE	307	25	Submit your ideas to improve the workplace at the Heart Center
Total	1237	100	

Also, note the lack of a traditional “control” treatment in this study.¹¹ Indeed, the analysis focused on multiple comparisons of several unordered discrete treatments (e.g., prizes vs funding vs framing).¹²

The website of the innovation contest had supporting information about the available prizes, funding, and timing of the initiative. The website also required an institutional email address to login. Using this feature, we designed the website graphics and layout to reinforce the effect of the announcement: the headings, background images, a short video, and the space just below a “submit your ideas” button were designed to show the exact same first paragraph of the solicitation that the employee received by email (i.e., text in Table 1).

The MGH management and the HTL staff members were blind to group assignment, which prevented potential bias in the communication of the innovation contest that was not under our direct control. We also made an effort to create a “safe” environment for employees submitting proposals by making clear (in the application form) that the identity of the proponents was going to be kept private unless the employee self-identified, so that management could not identify workers without their consent.

Finally, we relied only on official channels for communication to strengthen the effect of the announcement and signal legitimacy of the contest. Each employee received the same exact solicitation email three times: at the launch, eight days from the launch and two days before the end of the submission phase of the challenge. Starting from the second week of the submission

¹¹Since the experiment was run in a workplace, we were constrained to carry out treatments having equal chances of being successful. This prevented us from having a ‘null’ treatment with no personalized incentives messaging as a control group.

¹²Nevertheless, if we were to think of one treatment as the benchmark against which to compare the others, the FUND treatment would be our best candidate because giving information about the size of available funding is the default option for announcing grant programs and was part of the HTL’s initial design before our cooperation in the experiment.

phase, information booths, flyers, and posters were used to encourage everyone to take part in the event and respond to the email solicitation. These flyers and posters were based on a generic, undifferentiated version of the solicitation email without the text of the treatments.

4 Data

Our subject pool was the entire population working at the Heart Center as of the end of 2014, a total of 1,237 individuals. For each individual, we collected administrative data on the gender, the type of profession, and whether they had a fixed office location or not. Additional, complementary data were obtained for a limited group of 378 employees (31 percent). These extra data had self-reported information about employees’ demographics, such as age and years of tenure at the Heart Center, that were obtained from an online survey that was run about two months before the launch of the innovation contest.

Table 2 presents summary statistics showing that the variables in the four treatment groups were statistically balanced.

Notice that the large majority (72 percent) of employees in our sample were women. This is due to the high fraction of workers being nurses (52 percent) and the presence of a gender separation by profession with nurses being predominantly women (92 percent). It is also important to remark that, although we do not have data on income, there were large differences in earnings by profession. According to the United States Bureau of Labor Statistics, the median annual wage of a physician was \$187,200 in 2015, which is about 60 percent higher than the that of a registered nurse (\$67,490) and about 70 percent higher than that of a laboratory technician (\$38,970).

5 Results

5.1 Submitting project proposals

At the end of the four-week submission phase, we collected a total of 118 project proposals made by 60 employees (excluding an additional 20 proposals from 11 employees who were not part of the Heart Center when the experiment was designed). As shown in Table 3 (left panel), the percentage of employees submitting project proposals was highest in the PRIZE treatment, followed by the WPLACE treatment, the PCARE treatment, and the FUND treatment. Table 3 (right panel) also presents statistics for the count of project proposals per person. Based on these data, we find a statistically significant (a Fisher’s Exact Test for Count Data gives a p-value of 0.0263183) association between submission rates and treatments, but no significant difference in the count of proposals (a Kruskal-Wallis rank sum test gives a p-value of 0.786613). Therefore, while we detect treatment effects on participation rates (the “extensive margin”), there is no evidence indicating effects on the intensity of participation as measured by the count of submitted project proposals (the “intensive margin”).

Table 2: Summary statistics by treatment

	<i>Assigned treatments:</i>				<i>All:</i>		
	FUND	PCARE	WPLACE	PRIZE	%	Obs.	P-value
Other	30	30	26	32	29	362	0.844
MD/Fellow	19	18	18	18	18	226	
Nursing	51	52	56	51	52	649	
Female	69	70	75	75	72	890	0.159
Male	31	30	24	26	28	347	
No office	50	46	47	45	47	577	0.556
Office	50	54	52	56	53	660	
18-25 years old*	6	8	8	6	6	24	1.000
26-35 years old*	29	29	31	26	29	107	
36-45 years old*	18	19	24	16	22	81	
>45 years old*	44	46	51	45	42	157	
< 10 years tenure*	40	31	36	37	36	132	0.891
10-20 years tenure*	26	29	38	28	30	111	
20-30 years tenure*	12	19	15	10	14	50	
30-40 years tenure*	10	16	15	12	13	48	
>40 years tenure*	10	4	8	8	8	28	

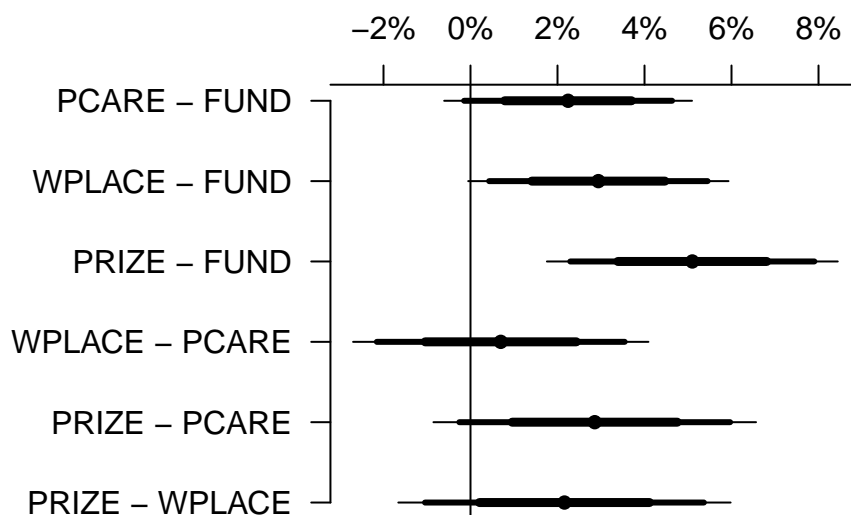
Notes: This table reports the percentage of employees in our sample cross tabulated by the assigned treatment across the gender, profession, whether the employee had a fixed office location, age, and years of tenure at the Heart Center. For each categorical variable, the last column reports the p-value from a Pearson’s Chi-squared test with the assigned treatment and the variable. The asterisk * indicates non-representative self-reported information obtained from an online survey polling 378 employees that was run about two months before the launch of the innovation contest.

Table 3: Outcomes of the submission phase

	<i>Submitting proposals:</i>			<i>Submitted proposals:</i>		
	No	Yes	% yes	Total	Mean	Median
PRIZE	289	23	7.4	40	1.7	1
FUND	301	7	2.3	11	1.6	1
PCARE	296	14	4.5	36	2.6	1
WPLACE	291	16	5.2	31	1.9	1
Total	1177	60	4.9	118	2.0	1

A pairwise comparison of the probability of submitting project proposals (Figure 2) reveals that employees in the PRIZE treatment were significantly more likely (5 percentage points) to submit than those in the FUND treatment. We also find a significant positive difference (about 3 percentage points) between the WPLACE and FUND treatments, although slightly below the 95 confidence level. These results are robust to bootstrap resampling that yields smaller confidence levels (see the Appendix). Also, using the more conservative Holm-Bonferroni correction for multiple comparisons gives essentially the same results (see the Appendix).¹³

Figure 2: Difference in the probability of submitting project proposals



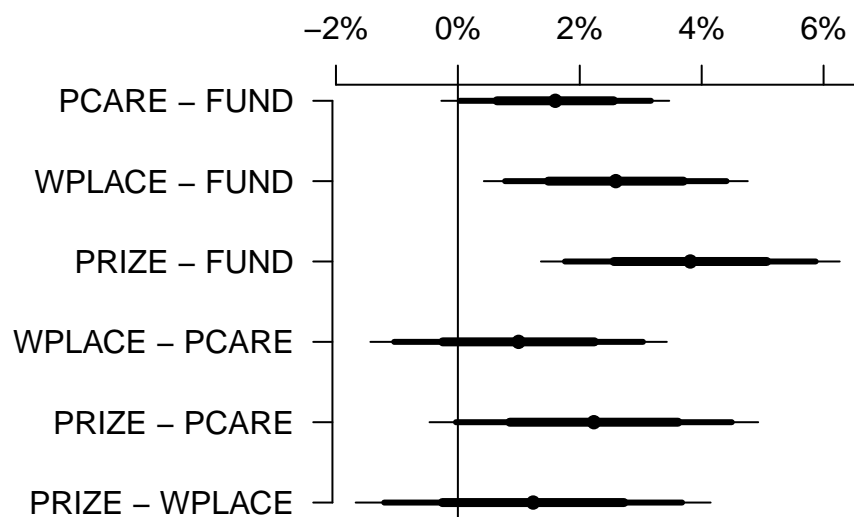
Notes: This figure plots the point estimates of the difference plus ± 1 , ± 1.6 , and ± 2 standard errors. Bootstrap resampling and confidence intervals based on the more conservative Holm-Bonferroni method yields very similar results (see the Appendix).

Results are also robust to restricting attention to staff members that were then selected and invited by the HTL staff to submit implementation plans for their proposals. Of the 29 workers invited to participate in the implementation phase, most were in the PRIZE treatment (13 employees), followed by the WPLACE treatment (9 employees), the PCARE treatment (6 employees), and the FUND treatment (only 1 employee). Also in this case, a pairwise comparison of the probability of submitting proposals and being selected (Figure 3) returns a significant and positive difference in participation between the PRIZE and FUND treatments, as well as between the WPLACE and FUND treatments.

A potential concern with a causal interpretation of the above differences lies in the possibility of *contamination* among experimental units, a topic we will discuss in greater detail in Section

¹³The Holm-Bonferroni procedure is perhaps too conservative in this case, also considered the experimental intervention was fairly small (small effect sizes).

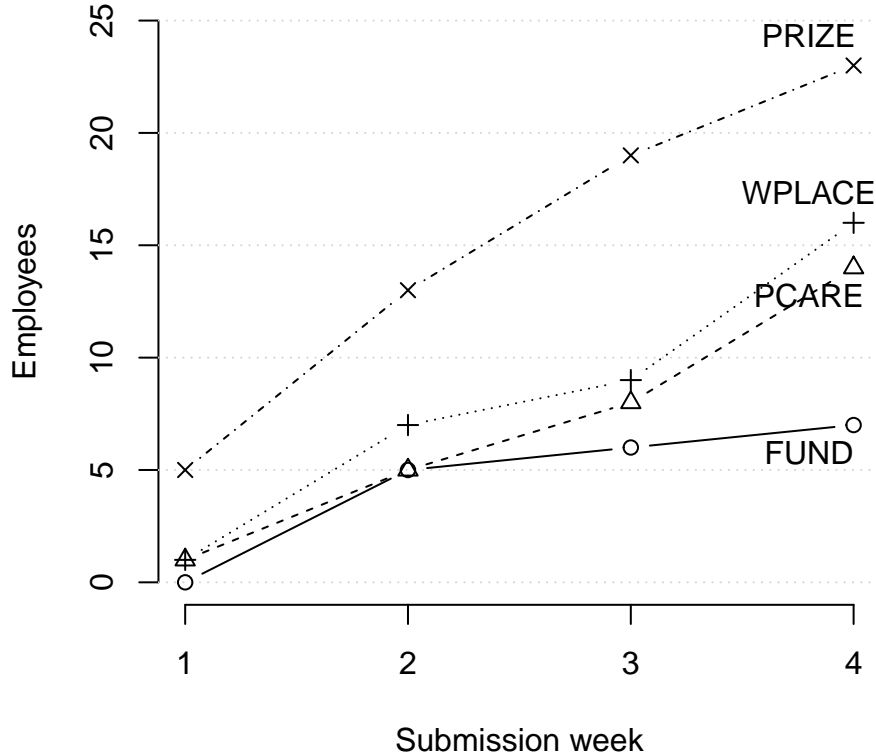
Figure 3: Differences in the probability of submitting finalist project proposals



Notes: This figure plots the point estimates of the difference plus ± 1 , ± 1.6 , and ± 2 standard errors. Estimates have been adjusted for the small counts of finalists (Agresti and Caffo, 2000) resulting in more conservative confidence intervals. Bootstrap resampling and confidence intervals based on the more conservative Holm-Bonferroni method yields very similar results (see the Appendix).

6. For the moment, let us point out that a “contaminated” sample will yield estimates of the difference in participation biased towards zero. Intuitively, if everyone was exposed to the content of each solicitation, participation would be the same in each condition. Therefore, if solicitations were shared through face-to-face communication, one should expect participation rates to quickly converge over time. Contrary to these expectations, an analysis of the submissions over time (Figure 4) does not show signs of a strong convergence. The growth of the number of staff submitting proposals in the PRIZE was higher in all almost weeks. Only in the last week, participation in the WPLACE and PCARE had a little boost. Thus, if anything, contamination occurred at the very end of the competition. And even so, it might only have biased downwards (instead of inflating) the estimated positive effect of prizes on participation. In this sense, our interpretation of a large effect of prizes on participation is robust to contamination.

Figure 4: The dynamic of submissions



Notes: This figure plots the staff submitting proposals over the four weeks of the submission period in each condition.

Although the contest was “unbiased” in the sense that it sought to engage employees at all levels of the organization, one may anticipate participation rates to vary across staff due to differences in individual costs of participation (as our Hypothesis H5 in Section 2). To study this hypothesis, we

model the conditional probability of submitting proposals as

$$\Pr(\text{SUBMIT}_{ij}) = \alpha + \tau_j + \text{JOB}_i + \text{MALE}_i + \text{OFFICE}_i, \quad (6)$$

where the dependent variable SUBMIT_{ij} is 1 if the employee i in treatment j has made a submission, and zero otherwise; the parameter τ_j denotes a change associated with the treatment j controlling for the employee's profession (JOB_i), the gender (MALE_i), and a dummy for office location (OFFICE_i) that indicates whether the employee had a permanent office instead of being assigned to a ward.¹⁴

Table 4 reports the estimation results. To simplify interpretation, coefficients are multiplied by 100 to indicate the percentage point change in the probability of submitting and treatment coefficients must sum to zero to indicate deviations in the average probability.¹⁵ First, note that treatment differences do not change because of the individual controls, which is reassuring given the randomization. Then, by looking at the results of the full model (Column 5), employees in the PRIZE treatment were 2.4 percentage points *more* likely to submit compared to the average, whereas employees in the FUND treatment were 2.4 percentage points *less* likely to do so. Subtracting these two effects gives 4.8 which is the difference in the probability of submitting between PRIZE and FUND treatments. In a similar way, the difference in the probability of submitting between WPLACE and FUND treatment is 2.7 percentage points, which is mildly significant ($p=.083$).

In columns 2 and 5, we examine effects associated with the profession of the employee. One might expect employees to sort by profession because differences in income between hospital employees can be sharp.¹⁶ The coefficient for nurses is indeed positive and negative for physicians, consistent with sorting. However, these effects are not statistically different from the residual category of other workers, as well as from one another.

In columns 3 and 5, we examine possible differential effects on participation between men and women. Although a large literature in economics and psychology (Croson and Gneezy, 2009) has documented a lower propensity of women to become involved in competitive activities (Niederle and Vesterlund, 2007), we do not find evidence of such a difference. In our setting, women are as likely as men to submit proposals.

In columns 4 and 5, we show a positive effect on participation associated with the working having a fixed office location, as opposed to being assigned to a ward. In our context, having a fixed office location is highly correlated with the type of profession. For example, nurses are more likely to being assigned to a ward than physicians or administrative workers, due to the nature of their job. Within each profession, however, having a fixed office location is usually correlated with the hierarchical position inside the organization. Hence, this variable is potentially controlling for

¹⁴Much of the clinical staff might be mobile and only half of the employees (53 percent) had fixed office locations, as they may be on duty in multiple wards. More senior staff tend to have a fixed location. So, within each profession, this measure can be viewed as a proxy for status inside the organization.

¹⁵This is just a normalization; results are not affected by using a different parameterization such as using one treatment as a specific reference category.

¹⁶As mentioned before, the median wage of a physician is about 40 percent higher than the that of a registered nurse.

Table 4: Probability of submitting proposals

	<i>Dependent variable:</i>				
	<i>SUBMIT_{ij} = 1</i>				
	(1)	(2)	(3)	(4)	(5)
PRIZE	2.53** (1.21)	2.53** (1.21)	2.52** (1.21)	2.46** (1.21)	2.45** (1.21)
WPLACE	0.37 (1.09)	0.37 (1.09)	0.35 (1.10)	0.38 (1.09)	0.30 (1.10)
FUND	-2.57*** (0.86)	-2.57*** (0.86)	-2.55*** (0.85)	-2.49*** (0.86)	-2.38*** (0.85)
Job (nursing)		0.14 (0.82)			1.85 (1.23)
Job (MD)		-0.31 (1.03)			-1.14 (1.24)
Male (yes)			-0.54 (1.33)		-0.42 (1.64)
Office (yes)				2.79** (1.20)	4.56*** (1.60)
Constant	4.84*** (0.61)	4.78*** (0.66)	5.00*** (0.73)	3.35*** (0.75)	1.97 (1.25)
Log Likelihood	-5545	-5545	-5545	-5542	-5540
Observations	1,237	1,237	1,237	1,237	1,237

Note: This table reports OLS estimates with heteroskedasticity robust standard errors in parenthesis. All coefficients are multiplied by 100 to indicate the percentage point change in the probability of submitting. Treatment coefficients indicate the percentage point deviation from the overall probability of submitting (there is no specific reference category). The asterisks ***, **, * indicate significance at 1, 5 and 10 percent level, respectively.

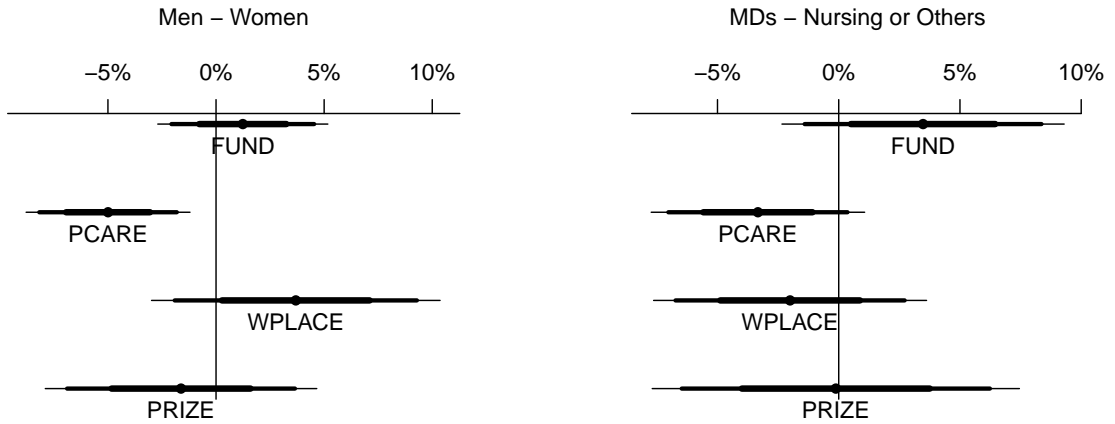
income and hierarchical differences occurring within each profession.

Viewing these results through our theoretical model, it appears that the contribution cost, c , may not change much between different categories of workers. This interpretation makes sense because everyone could have an idea on how to improve the organization, regardless of profession or background skills. Proposals were also required to be short and nontechnical in order to keep individual costs of participation small for everyone. On the other hand, the cost appears systematically lower for those with a fixed office; and one may speculate that these are employees higher up in the hierarchy with more experience of existing organizational problems and the available solutions and therefore lower costs for contributing project proposals.

5.1.1 Interactions

We now turn to examine treatment interactions involving the employee's gender and profession.¹⁷ Following extensive literature on differences in preferences between men and women (Croson and Gneezy, 2009), gender interactions might occur as a result of three main factors: differences in risk taking, social preferences (willingness to contribute to public goods), and competitive inclinations. If women prefer to work on activities that are less risky, more pro-social (e.g., aiming at improving people's health) and where competition is less intense, then we should observe significant treatment interactions. Similarly, one may also expect treatment interactions associated with the employee's profession since the information of a fixed-value prize (i.e., the PRIZE treatment) could be relatively less effective for employees with a higher income, such as doctors, than the others.

Figure 5: Differences in the probability of submitting proposals by gender and profession



Notes: This figure plots the point estimates of the difference between men and women (left panel) and between doctors and other workers (right panel) in each treatment plus ± 1 , ± 1.6 , and ± 2 standard errors.

As shown in Figure 5 (left panel) men were significantly less likely (about 5 percentage points) than women to submit proposals in the PCARE treatment, while there was no gender difference

¹⁷We also look at interactions with office location without finding any significant difference.

in the other treatments. Figure 5 (right panel) also shows that there was no difference associated with the profession: doctors are as likely to submit as any other worker in each treatment.¹⁸

To isolate gender and profession effects, we now employ a version of model (6) with gender-treatment interactions.¹⁹ Estimates are shown in Table 5. After gradually adding profession and office controls, interaction coefficients remain pretty stable across all specifications. The response of men under PCARE is about 3 times the magnitude and in the opposite direction of the women’s response. By subtracting these two coefficients, we find a significant difference between men and women of about 5 percentage points ($p = .018$), which is consistent with our previous analysis. Thus, and overall, we find that men responded less than women in the PCARE treatment. This effect could be due to gender differences in preferences and we will return on this in the discussion of the results.

5.2 Rating project proposals

The project proposals were then rated by 178 employees (14 percent of our sample), with the evaluators rating a median of 65.5 out of 113 project proposals (58 percent) yielding a total of 12,055 evaluator-proposal pairs.²⁰ Unlike the preceding submission phase, the WPLACE treatment had the highest participation (Table 6, left panel), followed by the PCARE, the PRIZE, and the FUND. However, using a Fisher’s Exact Test for Count Data, we find no statistically significant ($p=0.3386304$) relationship between rating proposals and the treatments. Likewise, the differences in the count of rated proposals (Table 6, right panel) were not statistically significant (a Kruskal-Wallis rank sum test gives a p-value of 0.286). Thus, and overall, our data indicate no prolonged effects of the treatments on both the extensive and intensive margin. This result is consistent with the general propensity of the effects from nudging and framing interventions to vanish over time.

One may find counterintuitive that there was less (although not significant) participation in the evaluation phase from employees in the PRIZE treatment than in the other treatments, given the greater participation in the submission phase. In terms of statistical inference, this result is not entirely surprising because only 70 percent of employees who made submissions resolved to rate proposals as well (we detect no difference between the treatments); so, even a difference of 2 percentage points in submitting will shrink to about 1 percentage point in the rating phase. In other words, we were not expecting self-rating to affect evaluation much. Nevertheless, the difference in the probability of staff rating proposals between the PRIZE and the WPLACE or the PCARE treatments being negative might also suggest a slight (although not significant) motivation crowding-out effect.

¹⁸ As before, bootstrap resampling and the Holm-Bonferroni correction yields very similar results (see the Appendix).

¹⁹ We also run a model with profession-treatment interactions and results are similar to those shown in Figure 5.

²⁰ The projects were 118 in total but, due to a technical problem in uploading the proposals on the website for evaluation, five proposals ended up with no ratings. This problem was independent of the treatment. A Fisher’s exact test rejects any association between the missed proposals and the treatment of its proponent ($p = .7$).

Table 5: Probability of submitting proposals

	<i>Dependent variable:</i>		
	<i>SUBMIT_{ij} = 1</i>		
	(1)	(2)	(3)
PRIZE×female	2.99* (1.68)	2.95* (1.79)	2.84 (1.78)
PCARE×female	1.25 (1.57)	1.21 (1.61)	1.08 (1.61)
FUND×female	−2.91*** (1.06)	−2.95** (1.20)	−2.79** (1.19)
WPLACE×female	−0.49 (1.35)	−0.52 (1.44)	−0.62 (1.43)
PRIZE×male	1.37 (2.44)	1.42 (2.51)	1.40 (2.50)
PCARE×male	−3.75*** (1.15)	−3.72*** (1.16)	−3.64*** (1.16)
FUND×male	−1.67 (1.70)	−1.65 (1.65)	−1.48 (1.66)
Constant	4.80*** (0.69)	4.79*** (0.70)	1.87* (1.10)
Job	no	yes	yes
Office	no	no	yes
Log Likelihood	-5542	-5542	-5538
Observations	1,237	1,237	1,237

Note: This table reports OLS estimates with heteroskedasticity robust standard errors in parenthesis. All coefficients are multiplied by 100 to indicate the percentage point change in the probability of submitting. Treatment coefficients indicate the percentage point deviation from the overall probability of submitting (there is no specific reference category). The asterisks ***, **, * indicate significance at 1, 5 and 10 percent level, respectively.

Table 6: Outcomes of the peer evaluation phase

	<i>Rating proposals:</i>			<i>Rated proposals:</i>		
	No	Yes	% yes	Total	Mean	Median
PRIZE	269	43	13.8	2457	57.1	43
FUND	272	36	11.7	2484	69.0	68
PCARE	261	49	15.8	3413	69.7	73
WPLACE	257	50	16.3	3701	74.0	82
Total	1059	178	14.4	12055	67.7	66

5.3 The quality of the project proposals

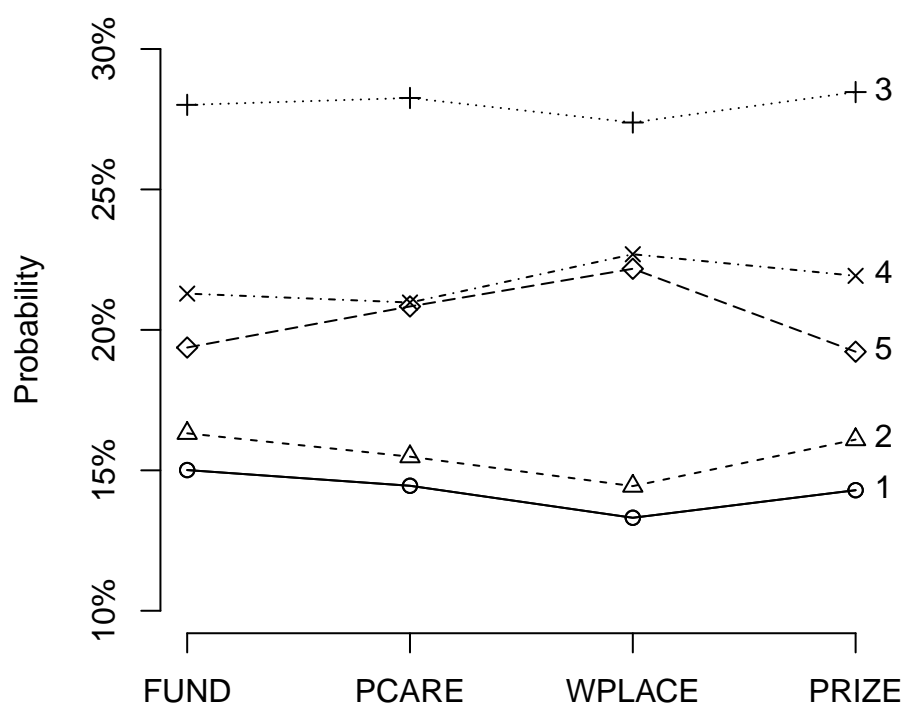
The treatment interventions may not have only impacted the propensity to make a submission, but the quality of the submission as well. Of particular interest is any indication of a quantity versus quality trade-off. For example, if the FUND treatment which generated the fewest submissions also produced the highest quality submissions. A quality versus quantity trade-off would increase the complexity of choosing optimal incentives for employees.

The ratings collected in the peer evaluation phase of the challenge provide our main measure of quality. Figure 6 shows the distribution of the ratings received by a proposal conditional on treatment of its proponent. In each treatment, a proposal was given a rating of 3, the “neutral” point, on a five-point scale about 30 percent of the times with employees being more likely to give high (4-5) rather than low (1-2) ratings.

Figure 6 reveals that the probability of a proposal receiving a given rating was about the same in each treatment. And indeed, by aggregating the mean rating for each proposal, we do not identify any significant treatment effect (a Kruskal-Wallis rank sum test gives a p-value of 0.4155919). Similarly, a linear regression of mean ratings on treatment dummies does not reveal any relationship between ratings and treatments. The treatment coefficients are not significant, with the linear model not significantly different from a constant model (an overall F-test gives a p-value of 0.6114055).

The above analysis on the aggregate ratings does not hold in general. It crucially relies on the assumption that an increment in a proposal’s quality as measured by an increase in ratings from v to $v + 1$ is the same for any value v . So, we also examine the distribution of ratings as generated by treatments with no aggregation. We have over 12,000 ratings, providing a very sensitive test for differences across treatments. Using a Pearson’s Chi-squared test we find that the hypothesis of dependence between the distribution of ratings and the treatments is *not* quite significant at the 10 percent level (p-value of 0.103089). Driving the p-value is a less than 2 percent difference between the proportion of 5’s in the WPLACE treatment versus the other distributions (Figure 6), which is probably due to outliers (the winning proposal was in the WPLACE treatment). Taken together with the fact that our sample is large, we have strong evidence suggesting that there are

Figure 6: Probability of a project proposal receiving a given rating in each treatment



Notes: This figure plots the distribution of the ratings given to a proposal conditional on the treatment of its proponent. Each curve presents point estimates of the probability of a project proposal receiving a given rating on a five-point scale (1=Low and 5=High). Flat, non-intersecting curves indicate that there were small differences across treatments for each rating.

no (economically meaningful) differences in the quality of project proposals across treatments and in particular no evidence of a quantity versus quality trade-off up to the resolution of the five-point scale.²¹

One potential limit of assessing quality only on the basis of peer ratings is that the employees might have a different view of a proposal's quality than executives (due, for instance, to a misalignment of incentives). And indeed, to ensure alignment between managerial goals and the peer assessment, all project proposals were further vetted by the HTL staff before being considered for implementation funding. So, we now focus on the outcomes of this vetting process to investigate more broadly the presence of treatment effects on the quality of project proposals.

The vetting process conducted by the HTL staff resulted in 93 proposals being scored (from 1 to 100 points) with the best 29 proposals invited to submit implementation plans. The remaining 20 proposals were excluded (and received a score of zero) either because flagged as inappropriate for funding or because the proponent manifested intention to not participate in the implementation phase (a Fisher's Exact Test for Count Data finds no association between proposals excluded and treatments with a p-value of 0.6519832).

The Spearman's rank correlation coefficient between the scores given by the HTL staff and the average peer ratings was relatively high (0.1983171), indicating good agreement between our two measures of quality. Indeed, as before, we find no treatment effects on quality using the scores (a Kruskal-Wallis rank sum test gives a p-value of 0.4370005). We also find no treatment differences in the percentage of submitters being selected and invited by HTL staff to present additional implementation plans (a Fisher's Exact Test for Count Data gives a p-value of 0.6519832). Although not significant, employees who made project proposals in the FUND treatment were less likely to be selected as finalist than the others (only 1 out of 7 in the FUND treatment were selected and invited by the HTL staff), providing additional evidence of a no quantity versus quality trade-off, as discussed before.

5.4 The content of the project proposals

The goal of the challenge was to improve Heart Center operations by identifying problem areas and potential solutions. The proposed projects broadly conformed to the stated goals of the contest, aligning with improving the work processes within the organization or providing high-quality patient care. For example, one project proposal that received high peer ratings was to create a platform for patients to electronically review and update their med list in the office prior to seeing the physician. Another was to develop a smartphone application that allows the patient to see the itinerary for the day providing a guide from one test or appointment to another. Nevertheless, other contest organizers may have varying goals and be concerned about different aspects of the

²¹One may worry that such binning is a fairly coarse measure of quality. In particular, effects concentrated in the upper tail of the distribution may not be detected. For example, compare the ratings of proposals A, B, C and D with hypothetical true qualities of 3, 4, 5, and 10 stars respectively. Under a five-point scale rating system, proposals A and B can be distinguished, but C and D cannot be distinguished. Hence, one needs to be very cautious in interpreting these results as evidence against quality effects in general.

submissions. In order to examine additional dimensions of submission content, we now study the area of focus of the submissions. Of particular interest is understanding whether the framing intervention induced employees to concentrate on different categories. For example, while staff in the WPLACE treatment focused on improvements for the workplace, those in the PCARE treatment concentrated on interventions directly targeting the patients.

Table 7: Project proposals by area of focus

	FUND	PCARE	WPLACE	PRIZE	Total
Information and access	0	4	8	11	23
Patient support	2	8	7	6	23
Care Coordination	1	9	3	7	20
Staff workflow	4	5	4	5	18
Workplace	3	6	3	5	17
Quality and safety	0	0	5	5	10
Surgical tools and support to research	1	1	0	0	2
Total	11	33	30	39	113

Notes: The areas of focus were manually identified by the HTL staff at the end of the competition. Due to a technical problem five proposals ended up with no classification.

Members of the HTL categorized each project proposal into one of seven “areas of focus” (Table 7): three categories (“Care coordination”, “Staff workflow”, “Workplace”) identified improvements for the workplace, other three (“Information and access”, “Patient care”, and “Quality and Safety”) focused on improvements centered around patients, and another one (“Surgical tools and support to research”) categorized projects developing tools to support scientific research.

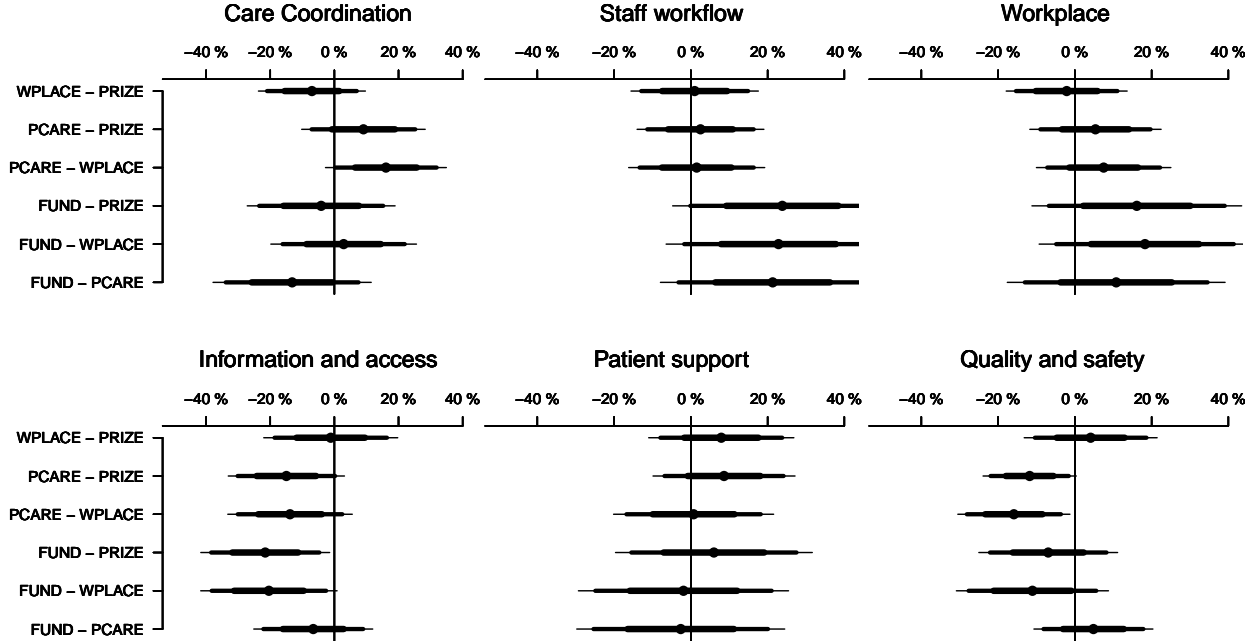
Using a Fisher’s Exact Test for Count Data with simulated p-value (based on 50000 replicates), we find a mildly significant ($p=0.0893382$) association between these categories and the treatments.²² The analysis of pairwise differences between treatments (Figure 7) reveals that this result is driven by differences in the “Quality and Safety” and “Information and access” categories. Project proposals in the PCARE treatment were less likely to fall in the “Quality and Safety” category. Similarly, project proposals in the FUND treatment were less likely to fall in the “Information and access” category.

It is difficult to interpret these effects because our model does not provide any prediction on the content of proposals. One possibility is that framing induced participants to concentrate on different areas of interventions but our data do not appear consistent with this story.

Another possibility is that of differences in the underlying complexity of the project proposal that were not captured by our measure of quality. To address this issue, we now turn to examine differences in the length of a proposal as measured by the word count of a submission. Submissions were below 200 words in most cases with little differences between the treatments. Indeed, testing

²²Simulations are used to reduce the computational burden.

Figure 7: Differences in the probability of proposals being in a given area of focus in each treatment



Notes: This figure plots the point estimates of the difference plus ± 1 , ± 1.6 , and ± 2 standard errors. Estimates have been adjusted for the small counts of the data (Agresti and Caffo, 2000) resulting in more conservative confidence intervals.

for a significant linear regression relationship between the length of submissions and treatment dummies returned an overall insignificant result ($p=.43$, F-test).

As a result, based on the analysis of the areas of focus and the length of the submissions, we do find only little evidence of differences in submission content across treatments. However, submission content is not a well-defined concept and could be characterized in many dimensions. While content does not vary in the dimensions we selected, we have not exhausted all possible dimensions.

5.5 Estimating social preferences

In this section, we calibrate the theoretical model developed in Section 2 with the experimental data to get a sense of the magnitude of underlying preferences for contributing to the organization. Following, the mixed-strategy equilibrium of the model, the theoretical probability of contributing must be proportional to the expected value of winning, R , the underlying preferences towards the public good, γ , the marginal costs of contributing, c , and the number of agents, n .

We assume the cost of making a submission c is the same in each treatment,²³ and the individual preferences are constant, being predetermined to our intervention. Then we derive a structural relationship between the observed difference in the probability of contributing Δp and the difference

²³This seems a reasonable assumption, given everyone is asked to perform the same task (identical submission procedure, same word limit, etc.).

in the expected rewards from winning ΔR between the treatments. That is,²⁴

$$\Delta p \approx \frac{\Delta R}{n(c - \gamma)}. \quad (7)$$

(Throughout this section we will consider $\delta = 0$ ignoring the distinction between impure and pure altruism.) By solving for γ , we get

$$\gamma \approx c - \Delta R / (n\Delta p). \quad (8)$$

This implies that the parameter capturing individual preference for the public good (that is consistent with our data) must be proportional to the ratio between the difference in rewards and the difference in the probability of submitting. Although we do not observe the levels of R in each treatment, we approximate the difference of rewards between the PRIZE and the other conditions by the pecuniary value of the reward, which has its upper bound in the highest price that can be paid for an iPad mini (\$350).²⁵ We further calibrate the cost of submitting a proposal c to \$40 which is the median income per hour of a Nurse Practitioner according to the Bureau of Labor Statistics; we assume the number of competitors n to be 30 percent of the entire sample to take into account rational expectations about the actual number of participants in the contest.²⁶ Finally, by substituting these calibrated values into equation (8) along with the empirical difference in participation rates between the PRIZE and the other treatments ($\Delta p = 0.037$), we get an estimate of the magnitude of the social preferences towards the organization which is $\hat{\gamma} = \$12$. As shown in Figure 8, this value is equivalent to about 30 percent reduction in the cost of contributing. Hence, increasing the prize by \$100 is expected to raise the probability of submitting by 1 percentage points. This increase can be compared to the corresponding increase of 0.7 that one will obtain by assuming no social preferences $\gamma = 0$ at all.

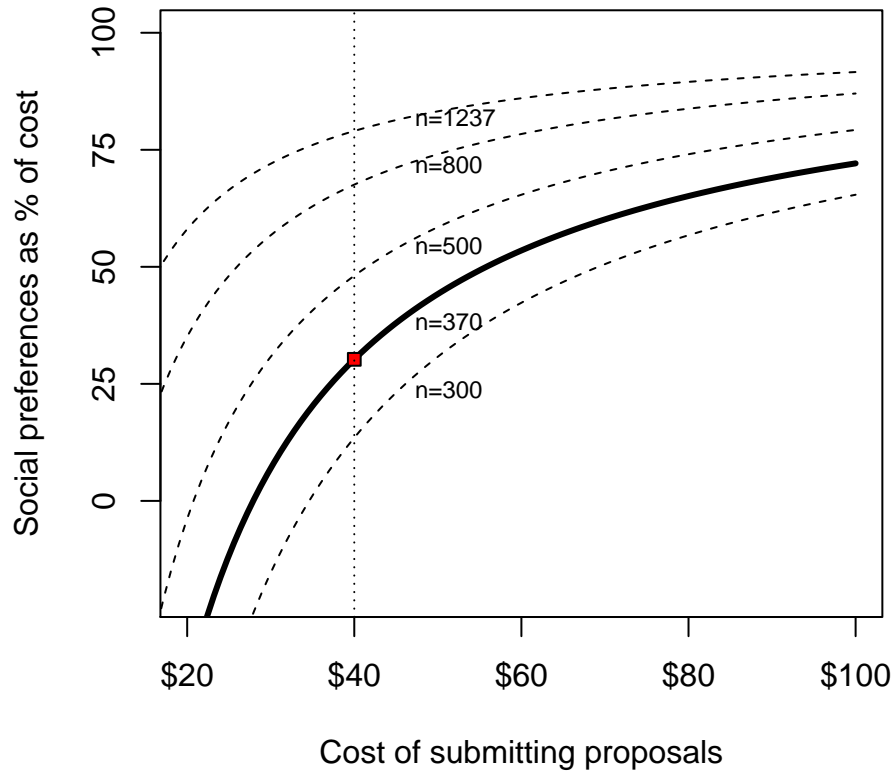
A few remarks are in order here. To get confidence around these estimates one need to consider several sources of uncertainty. First, there is the uncertainty of estimating the probability of submitting in our sample (standard errors can be computed directly from the data). Another source of uncertainty is due to the calibration of the marginal cost or the number of competitors. As shown in Figure 8, the fraction of costs explained by social preferences increases monotonically in the number of competitors (going up to 80 percent of costs if employees expected to compete against every Heart Center staff member); and decreases monotonically in the calibrated cost of making a submission. Finally, another important source of uncertainty is regarding the main behavioral

²⁴This equation can be obtained by following these steps. First, we approximate the profit equating condition (4) to a linear function by noticing that the $1/(1 - (1 - p)^n)$ approximates one for n large enough and p sufficiently small. Second, we solve for p and we simplify using the definitions of Δp and ΔR .

²⁵The price paid by the Heart Center was \$239 at the end of 2014 (including shipping cost). Other popular models (those with cellular data and large storage) could cost as high as \$350. Agents, however, were not aware of the specific model used for the competition and of the price paid. So, the value of \$350 is very conservative.

²⁶This choice is our best guess of the number of active staff members at the Heart Center and is based on the number of employees who voluntarily took a survey before the experiment (378 people). Assuming greater participation would lead to artificially increasing the estimates of underlying incentives. In fact, staff members may have rational expectations about the actual number of potential participants, which may be less than the entire population.

Figure 8: Estimated value of social preferences ($\hat{\gamma}$)



Notes: This figure plots the theoretical relationship between the cost of participation and the the social preferences parameter γ (in percentage of the costs) which is consistent with our experimental data. Different curves represents different assumptions on the number of competitors.

assumptions of the model, as we discuss in the next section.

6 Discussion

In this article, we report the results of a natural field experiment conducted during an innovation contest held at the cardiology unit of the MGH. Different incentives for participation were announced by manipulating the personal messaging to employees. Messaging emphasized either available prizes (iPad mini's) for top submissions, motives for improving patient care and improving the workplace, or a funding opportunity alone. Our data show that announcing a (small) prize for top submissions boosted employee participation by 85 percent, without affecting the quality of the submissions. The effect was the same for men and women, workers with high and low income levels, and appears too large to fit a pure contest environment without public good incentives. Our interpretation is that participation was driven by a complementarity between prizes and prosocial preferences towards improving the organization. Using a simple model, we estimate that these preferences can explain about 25 percent of the magnitude of the effect.

One objection to this interpretation is that employees could have had other motivations to take part in the innovation contest. Common factors are the prospect of promotion and career advancement (Baker et al., 1994; Gibbs, 1995) or prestige and peer recognition (Kosfeld and Neckermann, 2011; Blanes i Vidal and Nossol, 2011). While these other factors are important and could have influenced overall participation levels, these can not explain the significant differences in participation between the treatments. Even assuming that winning the contest was a high chance for a promotion, we designed the experiment so that our interventions were minimal and would not affect the ex-ante probability of being promoted in each condition. Likewise, after the competition, peer recognition was the same in all treatments as publicity was the same regardless of the winner's treatment (the HTL announced the winners online and awarded the prizes during a public event at MGH). Hence, even if employees had a baseline utility from winning (other than prize money), this value was not different across treatments and, therefore, can not explain significant differences between treatments.

Another concern is with *contamination* or *interference* between experimental units (Rosenbaum, 2007). This situation is problematic as it violates the SUTVA for causal inference (Rubin, 1974). With contamination, for instance, decisions of one staff member depend on its treatment and on the treatments of others, such as its neighbors. This may lead to a bias that depends on the level of interference (how intense is the communication among subjects) but also on the association between individual and neighborhood treatments (how dense is the network of social interactions). However, one should not be too much worried about contamination in our setting. First, the resulting bias would be toward a null effect and, therefore, would have worked against our finding significant differences between treatments. In intuitive terms, if everyone had the same information about the contest, participation would have been the same in each condition. Second, internal communication during the submission phase was likely small: staff members competing against one another had

only weak incentives for information sharing. In addition, one may expect participation rates to converge over time, as staff members share information. Contrary to this expectation, we find little evidence of converge when we examine the dynamic of submission. Another reason to not be too concerned with contamination is that the bias disappears with a growing sample size and with a sparse network (Forastiere et al., 2016). In our setting, the sample size was large being of over 1200 units; and the network of interactions was sparse given the limited number of participants and the diversity of tasks and roles inside the organization (doctors, nurses, administrative workers, technicians, researchers, etc.). Hence, and overall, even if there was a bias due to contamination, one should expect such bias to be small.

One might also worry that employees had a poor understanding of the costs from winning the contest which may explain the participation effects. An empirical regularity in laboratory experiments on contests (see Dechenaux et al., 2014) is that people are likely to make mistakes, which may lead to higher effort levels than predicted. Here, a serious concern is that employees in the PRIZE treatment underestimated the costs of taking part in the implementation phase. Announcing prizes may have made more salient the immediate rewards (the iPad’s) inducing employees to pay less attention to the costs of being involved in implementing their own project. If so, some of those who submitted proposals in the PRIZE treatment would reconsider their choice as the competition moved to the implementation phase. Instead, we find that only a negligible fraction of employees submitting proposals were not responsive to the invitation or declined participation in the implementation phase; a behavior that was not different across treatments. Hence, although employees might have had incorrect beliefs or systematic biases that lowered expected costs from winning, these are unlikely to explain the observed significant differences.

Another finding that deserves further comment is that responses were sensitive to the gender of the solicited person. Indeed, women’s participation was greater than men’s when emphasizing the patient care mission, controlling for the profession. This result echoes Delfgaauw et al. (2013) showing gender differences in a sales contest associated with the way a competition is announced or “framed.” This finding is open to various interpretations. One possibility is that female workers may be more altruistic or perceive the mission of the organization differently than male workers. However, the existing literature in economics (Croson and Gneezy, 2009) is not unanimous on this point. Another possibility is that workers were affected in their submission decisions by self-stereotypes associated with the framing condition. Gender-based stereotypes are indeed pervasive in healthcare organizations (Evans, 2002). So one may speculate that men’s propensity to participate was lower in activities perceived as female-typed. In this sense, our study is related to Coffman (2014) who finds evidence in the laboratory that women are less likely to contribute ideas to groups when the topic falls in male-typed domains, e.g., sports, and vice versa.

An interesting (non-)finding is the lack of gender-based differences with respect to participation in the prize (PRIZE) treatment where women’s participation was equal to men’s. An extensive literature in economics has shown significant gender differences in preferences women concerning risk-aversion (Borghans et al., 2009) and women’s distaste for competition compared to men

(Niederle and Vesterlund, 2007). So, one may be concerned that using a contest incentive structure to encourage the private provision of a public good would discourage participation by women. In our experiment, by contrast, women participated most in the treatment emphasizing the contest prize suggesting that this type of contest is robust to these effects. This result could be driven by some unique characteristics of our subject pool (healthcare professional workers), the exploration of which is beyond the scope of the present study.

Finally, one key concern when combining a pecuniary incentive with contributions to a public good is the interaction of incentives with the motive to contribute. A *negative interaction* occurs when incentives crowd-out the motive to contribute. Crowding out effects have been seen in other experiments in the context of blood donations (Lacetera et al., 2013, 2014), or the crowding in effects seen with public “bads” in daycare pick-ups (Gneezy and Rustichini, 2000). We do not observe evidence of a crowding-out in our environment, but differences in context make comparisons difficult. Pecuniary incentives may not have the same effect if in-kind gifts are used in place of currency (e.g., Kube et al., 2012), or if the setting already involves an employer-employee relationship (e.g., Fehr et al., 1998).

In conclusion, the results presented here have implications that go beyond the specific organization under study. Using a competition for prizes appears a profitable way for firms to encourage contributions among workers in situations resembling a private provision of public goods. In many settings, this approach can be more effective than what is acknowledged in the traditional tournament theory literature. The reason being that the incentive effect of prizes interacts with prosocial motivations of workers to exert effort. The management can appeal to internal motivations towards the mission of the organization to raise the level of voluntary contributions. However, this may be tricky in practice due to the heterogeneity of motivated agents. In particular, the evidence on gender differences in response to framing suggests female workers may perceive the goals of the organization differently from male workers. Investigating the causes of these gender-based differences is left as an avenue for future research.

References

- Agresti, Alan and Brian Caffo**, “Simple and effective confidence intervals for proportions and differences of proportions result from adding two successes and two failures,” *The American Statistician*, 2000, *54* (4), 280–288.
- Akerlof, George A and Rachel E Kranton**, “Identity and the Economics of Organizations,” *Journal of Economic Perspectives*, 2005, *19* (1), 9–32.
- Andreoni, James**, “Warm-Glow versus Cold-Prickle: The Effects of Positive and Negative Framing on Cooperation in Experiments,” *The Quarterly Journal of Economics*, 1995, *110* (1), 1–21.

- Baker, George, Michael Gibbs, and Bengt Holmstrom**, “The Internal Economics of the Firm: Evidence from Personnel Data,” *The Quarterly Journal of Economics*, 1994, 109 (4), 881–919.
- Bandiera, Oriana, Iwan Barankay, and Imran Rasul**, “Social Preferences and the Response to Incentives: Evidence from Personnel Data,” *The Quarterly Journal of Economics*, 2005, 120 (3), 917–962.
- Besley, Timothy and Maitreesh Ghatak**, “Competition and Incentives with Motivated Agents,” *The American Economic Review*, 2005, 95 (3), 616–636.
- Borghans, Lex, James J Heckman, Bart HH Golsteyn, and Huub Meijers**, “Gender differences in risk aversion and ambiguity aversion,” *Journal of the European Economic Association*, 2009, 7 (2-3), 649–658.
- Boudreau, Kevin J, Karim R Lakhani, and Michael Menietti**, “Performance responses to competition across skill levels in rank-order tournaments: field evidence and implications for tournament design,” *The RAND Journal of Economics*, 2016, 47 (1), 140–165.
- , **Nicola Lacetera, and Karim R Lakhani**, “Incentives and problem uncertainty in innovation contests: An empirical analysis,” *Management Science*, 2011, 57 (5), 843–863.
- Bull, Clive, Andrew Schotter, and Keith Weigelt**, “Tournaments and Piece Rates: An Experimental Study,” *Journal of Political Economy*, 1987, 95 (1), 1–33.
- Charness, Gary, David Masclet, and Marie Claire Villeval**, “The dark side of competition for status,” *Management Science*, 2013, 60 (1), 38–55.
- Coffman, Katherine Baldiga**, “Evidence on Self-Stereotyping and the Contribution of Ideas,” *The Quarterly Journal of Economics*, 2014, 129 (4), 1625–1660.
- Cohen, Jacob**, “A power primer,” *Psychological bulletin*, 1992, 112 (1), 155.
- Croson, Rachel and Uri Gneezy**, “Gender Differences in Preferences,” *Journal of Economic Literature*, 2009, 47 (2), 448–474.
- Dale, Donald J**, “Charitable lottery structure and fund raising: Theory and evidence,” *Experimental Economics*, 2004, 7 (3), 217–234.
- Dechenaux, Emmanuel, Dan Kovenock, and Roman M Sheremeta**, “A survey of experimental research on contests, all-pay auctions and tournaments,” *Experimental Economics*, 2014, pp. 1–61.
- Delfgaauw, Josse**, “Dedicated Doctors: Public and Private Provision of Health Care with Altruistic Physicians,” *New England Journal of Medicine*, 2005, 353 (15).

- **and Robert Dur**, “Incentives and Workers’ Motivation in the Public Sector*,” *The Economic Journal*, 2008, *118* (525), 171–191.
- , – , **Joeri Sol**, and **Willem Verbeke**, “Tournament incentives in the field: Gender differences in the workplace,” *Journal of Labor Economics*, 2013, *31* (2), 305–326.
- Ehrenberg, Ronald G and Michael L Bognanno**, “Do Tournaments Have Incentive Effects?,” *The Journal of Political Economy*, 1990, *98* (6), 1307–1324.
- Erat, Sanjiv and Uri Gneezy**, “Incentives for creativity,” *Experimental Economics*, 2015, pp. 1–12.
- Eriksson, Tor**, “Executive Compensation and Tournament Theory: Empirical Tests on Danish Data,” *Journal of Labor Economics*, 1999, *17* (2), 262–280.
- Evans, Joan A**, “Cautious caregivers: gender stereotypes and the sexualization of men nurses’ touch,” *Journal of advanced nursing*, 2002, *40* (4), 441–448.
- Fehr, Ernst, Georg Kirchsteiger, and Arno Riedl**, “Gift exchange and reciprocity in competitive experimental markets,” *European Economic Review*, 1998, *42* (1), 1–34.
- Forastiere, Laura, Edoardo M Airoidi, and Fabrizia Mealli**, “Identification and estimation of treatment and interference effects in observational studies on networks,” *arXiv preprint arXiv:1609.06245*, 2016.
- Frey, Bruno S**, “Not just for the money: An Economic Theory of Personal Motivation,” *Books*, 1997.
- Gibbs, Michael**, “Incentive compensation in a corporate hierarchy,” *Journal of Accounting and Economics*, 1995, *19* (2), 247–277.
- , **Susanne Neckermann, and Christoph Siemroth**, “A field experiment in motivating employee ideas,” *Review of Economics and Statistics, Forthcoming*, 2015.
- Gneezy, Uri and Aldo Rustichini**, “A fine is a price,” *Journal of Legal Studies*, 2000, *29*, 1.
- Green, Jerry R and Nancy L Stokey**, “A Comparison of Tournaments and Contracts,” *The Journal of Political Economy*, 1983, *91* (3), 349–364.
- Guinan, Eva, Kevin J Boudreau, and Karim R Lakhani**, “Experiments in open innovation at Harvard Medical School,” *MIT Sloan Management Review*, 2013, *54* (3), 45.
- Hamilton, Barton H, Jack A Nickerson, and Hideo Owan**, “Team incentives and worker heterogeneity: An empirical analysis of the impact of teams on productivity and participation,” *Journal of political Economy*, 2003, *111* (3), 465–497.

- Hellmann, Thomas and Veikko Thiele**, “Incentives and innovation: A multitasking approach,” *American Economic Journal: Microeconomics*, 2011, 3 (1), 78–128.
- Holmstrom, Bengt and Paul Milgrom**, “Multitask Principal-Agent Analyses: Incentive Contracts, Asset Ownership, and Job Design,” *Journal of Law, Economics and Organization*, 1991, 7, 24–52.
- Hong, Fuhai, Tanjim Hossain, and John A List**, “Framing manipulations in contests: a natural field experiment,” *Journal of Economic Behavior & Organization*, 2015.
- Hossain, Tanjim and John A List**, “The behavioralist visits the factory: Increasing productivity using simple framing manipulations,” *Management Science*, 2012, 58 (12), 2151–2167.
- i Vidal, Jordi Blanes and Mareike Nossol**, “Tournaments without prizes: Evidence from personnel records,” *Management Science*, 2011, 57 (10), 1721–1736.
- Kandel, Eugene and Edward P Lazear**, “Peer pressure and partnerships,” *Journal of political Economy*, 1992, 100 (4), 801–817.
- Knoeber, Charles R and Walter N Thurman**, “Testing the Theory of Tournaments: An Empirical Analysis of Broiler Production,” *Journal of Labor Economics*, 1994, 12 (2), 155–79.
- Kosfeld, Michael and Susanne Neckermann**, “Getting More Work for Nothing? Symbolic Awards and Worker Performance,” *American Economic Journal: Microeconomics*, 2011, 3 (3), 86–99.
- Kube, Sebastian, Michel André Maréchal, and Clemens Puppe**, “The Currency of Reciprocity: Gift Exchange in the Workplace,” *The American Economic Review*, 2012, 102 (4), 1644–1662.
- Lacetera, Nicola, Mario Macis, and Robert Slonim**, “Economic rewards to motivate blood donations,” *Science*, 2013, 340 (6135), 927–928.
- , —, and —, “Rewarding volunteers: a field experiment,” *Management Science*, 2014, 60 (5), 1107–1129.
- Lakhani, Karim R, Kevin J Boudreau, Po-Ru Loh, Lars Backstrom, Carliss Baldwin, Eric Lonstein, Mike Lydon, Alan MacCormack, Ramy A Arnaout, and Eva C Guinan**, “Prize-based contests can provide solutions to computational biology problems,” *Nature biotechnology*, 2013, 31 (2), 108–111.
- Landry, Craig E, Andreas Lange, John A List, Michael K Price, and Nicholas G Rupp**, “Toward an Understanding of the Economics of Charity: Evidence from a Field Experiment*,” *The Quarterly journal of economics*, 2006, 121 (2), 747–782.

- Lange, Andreas, John A List, and Michael K Price**, “Using lotteries to finance public goods: Theory and experimental evidence*,” *International Economic Review*, 2007, 48 (3), 901–927.
- Lazear, Edward P**, “Pay Equality and Industrial Politics,” *Journal of Political Economy*, 1989, 97 (3), 561–80.
- **and Sherwin Rosen**, “Rank-Order Tournaments as Optimum Labor Contracts,” *The Journal of Political Economy*, 1981, 89 (5), 841–864.
- Levitt, Steven D and John A List**, “What Do Laboratory Experiments Measuring Social Preferences Reveal About the Real World?,” *The Journal of Economic Perspectives*, 2007, 21 (2), 153–174.
- List, John A**, “The Market for Charitable Giving,” *The Journal of Economic Perspectives*, 2011, 25 (2), 157.
- **and David Lucking-Reiley**, “The effects of seed money and refunds on charitable giving: Experimental evidence from a university capital campaign,” *Journal of Political Economy*, 2002, 110 (1), 215–233.
- Manso, Gustavo**, “Motivating innovation,” *The Journal of Finance*, 2011, 66 (5), 1823–1860.
- Mary, O’Keeffe, W Kip Viscusi, and Richard J Zeckhauser**, “Economic Contests: Comparative Reward Schemes,” *Journal of Labor Economics*, 1984, 2 (1), 27–56.
- Morgan, John**, “Financing public goods by means of lotteries,” *The Review of Economic Studies*, 2000, 67 (4), 761–784.
- **and Martin Sefton**, “Funding public goods with lotteries: experimental evidence,” *The Review of Economic Studies*, 2000, 67 (4), 785–810.
- Niederle, Muriel and Lise Vesterlund**, “Do Women Shy Away From Competition? Do Men Compete Too Much?,” *The Quarterly Journal of Economics*, 2007, 122 (3), 1067–1101.
- Prendergast, Canice**, “The Motivation and Bias of Bureaucrats,” *The American Economic Review*, 2007, 97 (1), 180–196.
- Reeve, Johnmarshall and Edward L Deci**, “Elements of the competitive situation that affect intrinsic motivation,” *Personality and Social Psychology Bulletin*, 1996, 22, 24–33.
- Rosenbaum, Paul R**, “Interference between units in randomized experiments,” *Journal of the American Statistical Association*, 2007, 102 (477).
- Rubin, Donald B**, “Estimating causal effects of treatments in randomized and nonrandomized studies.,” *Journal of educational Psychology*, 1974, 66 (5), 688.

Terwiesch, Christian and Karl T Ulrich, *Innovation tournaments: Creating and selecting exceptional opportunities*, Harvard Business Press, 2009.

— **and Yi Xu**, “Innovation contests, open innovation, and multiagent problem solving,” *Management science*, 2008, *54* (9), 1529–1543.

Vesterlund, Lise, “Voluntary giving to public goods: moving beyond the linear VCM,” in John H Kagel and Alvin E Roth, eds., *The Handbook of Experimental Economics*, Vol. 2, in preparation, Princeton University Press, 2012.

Vigna, Stefano Della, John A List, Ulrike Malmendier, and Gautam Rao, “Estimating Social Preferences and Gift Exchange at Work,” Technical Report, National Bureau of Economic Research 2016.