Crowdfunding and the Return Rule: Reducing Risk but Increasing Spread

RICK WASH, Michigan State University
JACOB SOLOMON, Michigan State University

Crowdfunding websites like Kickstarter, Spot.Us and Donor's Choose are marketplaces that seek to match creators of public goods projects to donors with preferences for seeing those projects completed. The efficiency of these markets is hindered by complementarities in the preferences of both donors and project creators: creators prefer multiple donors to completely fund their project, and donors prefer to contribute to projects that will be completely funded. Some crowdfunding sites employ a *return rule* in which donations to projects that do not reach their self-imposed fundraising goal are returned to the donors. Other sites use a *direct donation* structure where all donations are kept by the project even if the total is insufficient.

We simulated a crowdfunding site using a threshold public goods game in which a set of donors tries to fund multiple projects that vary in riskiness. We find that the return rule has two important effects on a crowdfunding market. First, the return rule leads to improved efficiency over the direct donation model by eliciting more donations from the site's visitors than under the direct donation model. This efficiency, however is offset by market *spread*: donations are spread out across more projects, reducing the likelihood that any individual project is funded. Under direct donation, donors implicitly coordinate on low-risk projects; the return rule removes that coordination, complicating the complementarity problem in crowdfunding.

Categories and Subject Descriptors: J.4 [**Social and Behavioral Sciences**]: Economics

General Terms: Economics

Additional Key Words and Phrases: Crowdfunding

Raising money to do a project is difficult; projects are inherently risky because they might not succeed in achieving their goals. When a project needs money to succeed, convincing people to pay or contribute money to the project is challenging because the potential donors see a lot of risk. Crowdfunding websites attempt to help this by publicizing projects that need money, and allowing many contributors to each make a small contribution toward a larger project. By aggregating many small donations, crowdfunding websites can fund large and interesting projects of all kinds. For example, the movie writer Charlie Kaufman and his associates raised over $400,000 from over 5,000 donors to fund the creation of an animated movie[1]. Kickstarter, Spot.Us, and Donors Choose are all examples of crowdfunding websites targeted at specific types of projects (creative, journalism, and classroom projects respectively). Crowdfunding websites are two-sided matching marketplaces: they seek to match donors with projects that need money. However, crowdfunding websites might actually in-

[1] http://www.kickstarter.com/projects/anomalisa/charlie-kaufmans-anomalisa

This material is based upon work supported by the National Science Foundation under Grant No. CCF-1101266.
Authors Address: Rick Wash and Jacob Solomon, Department of Telecommunication, Information Studies, and Media, Michigan State University.

DOI:http://dx.doi.org/10.1145/0000000.0000000

crease the riskiness of funding projects because they allow people to contribute less money than the amount needed for the project, with no guarantee that the project will ever receive the needed funds.

Many crowdfunding websites use a marketplace-enforced *return rule*: if a project does not receive sufficient funding by a pre-specified deadline, then all donations to that project are returned to the donors. The return rule formalizes a structure already present in preferences: donations to projects are complements. Each donation is itself insufficient to fund a project, and therefore each donor prefers to donate to projects that are receiving donations from others, so that the project receives enough funds to succeed. Other crowdfunding websites use a more traditional *direct donation* rule where all donated funds (minus the marketplace cut) are delivered to the project, regardless of whether they are sufficient to fund the project.

In this paper, we make two contributions. First, we propose that matching marketplaces like crowdfunding websites that include complementarities in preferences have a unique new property that can lead to market failure: *spread*. If donations are spread across too many projects, then each project will have insufficient funds to succeed. Unlike market thinness [Roth and Xing 1994], adding additional projects can actually increase market spread, leading to market failure where few projects receive enough money to meet their goals.

Second, we experimentally show that including a marketplace return rule has two distinct effects. First, it rationally increases the willingness to donate; people contribute more money in a marketplace that uses a return rule. And second, it increases spread by encouraging people to donate to riskier projects. In our experiment, these effects offset, leading to no efficiency gains.

1. BACKGROUND

1.1. Crowdfunding

Crowdfunding is the act of soliciting, via an open call, resources from a wide variety of contributors in order to realize a new idea. Crowdfunding can be done in many ways – via an open call on one's webpage, through posting a notice in a public place, or through an organized online marketplace called a crowdfunding website. It is these online marketplaces that we are concerned with in this article.

A crowdfunding website is an online marketplace where users – who we call project creators – can post ideas for projects (art projects, businesses, bands, classroom exercises, etc.) and other users – donors – can contribute small amounts of money toward funding those projects. By aggregating large numbers of small-amount contributions, these sites enable project creators to raise funding for a wide variety of projects.

Crowdfunding websites are a relatively new phenomenon; Modern Internet technologies enable crowdfunding because they permit low-cost, centralized advertising of project ideas, secure and trustworthy contribution to those projects, and simultaneous solicitation by a large number of projects. Recent years have seen the rise of a wide variety of crowdfunding websites [Greenberg and Gerber 2012], including Kickstarter (which funds creative projects), IndieGoGo (which funds a wide variety of ideas and new businesses), Spot.Us (which funds investigative journalism), Sellaband (which funds musicians) and Donors Choose (which funds K–12 classroom projects).

Project creators sometimes solicit purely altruistic donations, but often creators offer something in exchange for donation. These exchanges fall into three categories: rewards, product pre-orders, and equity. Rewards are usually small tokens of appreciation that are attached to different levels of contribution, such as an acknowledgement at the end of a crowdfunded movie, or thank you letters from students who used crowdfunded supplies in their classroom. Product pre-orders are contributions that effectively ”pre-order” a product, to be delivered at a later date. Product pre-orders are an effective way to raise initial capital to create a new product. Equity is currently relatively rare as a crowdfunding exchange in the US, though the recent JOBS act (H.R. 3606, 2012) explicitly legalized using crowdfunding for equity exchanges. The various crowdfunding websites have differing levels of support for each of the types of exchange.

In addition to the explicit exchange, crowdfunding almost always includes some amount of public good being funded. For product pre-orders, the public good being funded is the ability to purchase a product on the open market, as usually the product won't exist without startup capital. In more altruistic marketplaces like Donors Choose or Spot.Us, the public good is a more traditional public good such as news or education. Indeed, Belleflamme et al. [2012] argues that in the absence of any public good aspect, crowdfunding theoretically ”yields exactly the same outcome as seeking money from a bank or equity investor.” In other words, the primary reason that someone would prefer crowdfunding as a method of raising capital is because of the public good aspects of what is being produced.

Project creators choose to use crowdfunding websites to raise capital for a number of reasons. Gerber et al. [2012] identify six reasons beyond the obvious reason of needing capital: expanding awareness of one's work, maintaining creative control over the outcome, measuring supporter interest in the project, making longer-term connections with customers, gaining approval and confidence in the project, and to learn more about business and fundraising. Belleflamme et al. [2012] finds that, at least when offering product pre-orders via crowdfunding, it is the high-value customers that are most likely to contribute to a crowdfunding project, thus suggesting that the connections made with customers through crowdfunding are likely to be high-value.

Projects posted on crowdfunding websites have a surprisingly high likelihood of being funded. 43–47% of projects on Kickstarter are fully funded [Mollick 2012; Kickstarter 2013]; 43.5% of projects on Spot.Us are fully funded [Jian and Usher 2013], and almost 70% of projects on Donors Choose are fully funded [Wash 2013]. Mollick [2012] uses data from Kickstarter to find that projects are more likely to be successful if they ask for smaller amounts of money, they are created by someone with a large social network, are higher quality projects to start with (as indicated by the presence of a video), and fit in with the culture of the city the creator lives in (such as music projects in Nashville, TN or film projects in Los Angeles, CA).

People donate to crowdfunding projects irrespective of geography [Agrawal et al. 2011], though friends and family are often the initial donors that provide the first contributions [Shin and Jian 2012]. Using qualitative interviews, Gerber et al. [2012] find five motivations for people who contribute to crowdfunding projects: collecting rewards, helping others achieve their goals, supporting like-minded people, being part of a community, and supporting a cause. Confirming this with empirical data, Shin and Jian [2012] find that people who find contributing fun, or who like contributing to friends and family contribute the most money to crowdfunded projects.

1.2. Matching Markets

Crowdfunding websites are an instance of what economists call *matching marketplaces*. In a matching market, two sides of a market need to be matched with members of the other side of the market, and both sides of the market have preferences over the matches [Roth and Sotomayor 1990]. The sub-field of Market Design involves economists working to apply the tools of microeconomics and game theory to design and redesign marketplaces [Roth 2002], with a particular emphasis on matching marketplaces. Market design has been applied to redesign matching marketplace rules to match medical interns to hospitals [Roth and Peranson 1999], children to preferred schools [Abdulkadiroglu et al. 2005; Chen and Sonmez 2006], and kidney donors to transplant patients [Roth et al. 2007].

Gale and Shapley [1962] were among the first to design the rules for matching marketplaces. Their rule is now called the "Deferred Acceptance Algorithm" for matching two sides of a market without prices. They provide two hypothetical examples of matching markets where this algorithm can be used: marriage markets where men are matched with women, with both sides having preferences over the match; and college admissions markets where students are matched with colleges they will attend, and both sides have preferences over the match but each college is matched with multiple students.

In general, the outcomes of matching markets are frequently not *stable* [Roth and Sotomayor 1990]. A stable match (in a marriage market example) is one where there is no man-woman pair who are not matched to each other but would both prefer to be. Stability is an important constraint on matching markets; markets that do not produce stable matches often suffer from unraveling and other problems which lead to the market failing [Roth 2002]. Gale and Shapley [1962] proved that for the marriage market (and any two-sided one-to-one matching market) that a stable match always exists. Furthermore, they prove that their Deferred Acceptance Algorithm always results in a stable match. Roth and Sotomayor [1990] also point out that these two-sided matching mechanisms are robust to a generalization that includes a money amount – that is, a wage associated with each job. For an appropriately modified definition of stable that includes wage preferences, including wage in the matching mechanism doesn't change any of the theoretical properties.

Gale and Shapley made an important and undisclosed assumption in their original paper: they assumed that preferences were entirely over the individuals involved, even when, as is the case with college admissions, groups of students were being matched to each college. They assumed that preferences did not include any complementarity or substitutability across individuals. Roth and Sotomayor [1990] were able to prove that the original algorithm works as long as preferences are *responsive*: any complementarities or substitutability present in preferences doesn't affect an overall ordering of individuals. Kelso and Crawford [1982] was able to generalize this and show that Deferred Acceptance produces stable matches even when individuals are substitutable.

1.3. Complementarities in Crowdfunding Marketplaces

When a matching market doesn't produce stable matches, the market frequently suffers from widespread market failure or market inefficiencies. Much of the followup work in recent years has focused on how to structure real-world matching markets in the presence of different forms of complementarities in preferences. For example, National Resident Matching Program used the Gale-Shapley deferred acceptance algorithm to match medical interns to hospital jobs for many years. But when couples started graduating from medical school together, the algorithm unraveled [Roth and Xing 1994]. Deferred acceptance no longer provided stable matches because couples have complementary preferences. Roth and Peranson [1999] were able to prove that in the presence of couples, there did not always exist a stable match, and therefore, no algorithm could be guaranteed to find it. However, they were able to use computer simulations to show that a revised algorithm would find a stable solution in almost all cases as long as the number of couples in the market was sufficiently small [Roth and Peranson 1999].

Complementarities have continued to challenge market designers. Many matching markets include complementarities that make matching difficult, including those for medical internships [Roth and Xing 1994], law clerks [Avery et al. 2001], PhD Economists [Coles et al. 2010] and schools for schoolchildren [Sonmez and Abdulkadiroglu 2003]. Most of the approaches to these problems have relied on the fact that in these markets, strong complementarities are the exception rather than the norm. These approaches often use a traditional, deferred-acceptance based algorithm that is modified to accommodate a small number of complementary preferences by treating the people with complementary preferences as a single unit.

Crowdfunding is wholly different; almost all preferences involve complementarities, and often those complementarities involve multiple people. Donors may prefer one project over another, but even more strongly they prefer projects to which others will also sufficiently donate so that the project can succeed. This means that traditional approaches to this problem of complementaries won't work when designing a crowdfunding marketplace. However, to a first approximation, the complementarities in crowdfunding marketplaces have a regular structure: donors have preferences over the number of other donors to a project (and the amounts those donors contribute), but not over who specifically contributes. This regular structure allows us to make progress on designing marketplace rules for a crowdfunding marketplace.

1.4. Threshold Public Goods

The complementarities found in crowdfunding projects make them an example of threshold public goods as described by Bagnoli and McKee [1991]. A project requesting contributions gets no benefit from having a single donor if that donor's contribution is insufficient to complete the project. However, if the total donations from all donors exceeds the amount required to complete the project, then anyone who has a preference for seeing a project completed will benefit, making crowdfunding projects non-exclusive. Likewise, donating to a crowdfunding project creates no benefit to the donor unless the project can be completed. Assuming no potential donor values a project enough to contribute the entire requested amount, the benefit of donating is dependent on the donations of others. Thus, having insufficient donations is unacceptable to all parties with a preference for seeing a project completed. In a marketplace with only a single project, crowdfunding is equivalent to a threshold public goods game. In such a game, a group of individuals have preferences for a public good, which can be provided only if the good receives a minimum level of contributions from the group (at which point the good becomes both non-exclusive to any member of the group, as well as non-rival in that players' payoffs for providing the good are independent of each other).

Bagnoli and Lipman [1989] prove that in a threshold public goods game, any outcome where the sum of all contributions is exactly equal to the threshold required for producing the good is both a Nash Equilibrium and a Pareto Efficient outcome of the game, provided that no player is contributing more to the good than their valuation of the good. They also prove that there exist other equilibria in such games which are not efficient. Particularly, there exists a strong free-riding equilibrium in threshold public goods games wherein nobody contributes to the good and therefore the good is not created.

Since both efficient and inefficient equilibria exist in threshold public goods games, it is important to detect the factors that lead to efficient outcomes in which the good is funded. Cadsby and Maynes [1999] conducted a series of threshold public goods games which varied the size of the threshold for the good, the size of the reward for funding the good, the type of contribution allowable (continuous vs. discrete), and whether or not contributions would be refunded if the threshold was not met. In their experiments, higher rewards and allowing continuous contributions led to higher donations and more frequent funding of the public good. They also found that goods with a higher threshold received less contribution. However, they found that offering refunds when the threshold was not met increased the likelihood of reaching the threshold, particularly when the threshold was high.

This refund mechanism is analogous to the return rule in crowdfunding sites, and so we might expect from threshold public goods games that crowdfunding sites which use the return rule will be more successful at generating contributions to projects, particularly projects requesting large amounts of contributions. But crowdfunding sites have an additional property not found in previous threshold public goods games. Crowdfunding sites are markets for multiple public goods which are simultaneously soliciting contributions from a set of potential donors who visit the site. Visitors to a crowdfunding site may like to see several of the projects on the site be completed. The *budget* of a visitor is the maximum amount of money an individual is able and willing to donate to projects on the site. We can infer from empirical research on crowdfunding that, in general, the combined budgets of a site's visitors is less than the combined requests of all projects on the site. As noted above, funding rates on crowdfunding sites do not approach 100%. Analyses of Donors Choose [Wash 2013] and Kickstarter [Mollick 2012] find that overfunding of projects is minimal. If donors are unwilling to overfund projects and also unwilling to fund all projects, their combined budgets must be less than the combined requests of the projects.

Therefore, in addition to the problem of complementary preferences of donors to a single project described above, crowdfunding sites have another matching problem in that projects and donors must be matched in such a way that the maximum number of projects are funded. Visitors to crowdfunding sites may have varying levels of preference for any number of the projects on the site, and the distribution of these preferences across all visitors may influence the efficiency of the crowdfunding market as a whole. This issue of a matching multiple donors to multiple threshold public goods has not been examined in the existing literature, but it is critical to the understanding and design of crowdfunding markets.

2. THEORY

A two-sided matching market is a situation where there are two distinct groups of people, and each person involved has preferences over the outcome. Each person on one side of the market needs to be matched with one or more people on the other side. A match is the outcome of a matching market, and specifies which people on the first side are matched with which people on the second side. In a one-to-one matching market, a match is considered to be stable if there does not exist a pair of people, one from each side, who would both prefer to be matched with each other but are not currently matched. That is, a match is stable if no one could rationally defect from the pairings. Gale and Shapley [1962] proved that all one-to-one matches have at least one stable outcome, and their deferred acceptance algorithm always finds one.

However, crowdfunding markets are not guaranteed to have a stable match. Consider a market with 3 donors A, B, and C, and three projects 1, 2, 3. Each project has the the same preference: It needs donations from any two donors to succeed, but weakly prefers zero donors to having only one contribute. This is a complementary preference; one donor is not valued unless accompanied by another and therefore donors are complements. Now, assume the donors have the following preferences over projects:

A: $1 > 2 > 3$
B: $2 > 3 > 1$
C: $3 > 1 > 2$

Given the preference against having one donor contribute, only one project can be matched to donors. However, no matter which project is matched to the donors, the two donors who don't list that project as their top choice have an incentive to defect. This means that no matter which project is matched to donors, the match is not stable. Thus, there does not necessarily exist a stable matching outcome on a crowdfunding site, and certainly there does not exist a mechanism that always produces a stable matching.

Threshold public goods games have both efficient and inefficient equilibria [Bagnoli and Lipman 1989], and the presence of multiple threshold public goods may create new inefficiencies not seen in previous threshold public goods games. Consider a crowdfunding site which has four projects and six visitors to the site. Each visitor's budget is \$50. Each project is requesting \$100. The combined budget of the site's visitors is \$300 and the combined requests of the projects on the site is \$400. It is not possible for the visitors to fund all four projects, but it is possible to fund three projects. However, if each visitor donated \$25 to two different projects, and the six visitors' preferences were evenly spread out among the projects such that each project received an equal number of donations, then each project would receive \$75 in contributions. This would result in none of the projects being completed, and would be an inefficient outcome.

A more efficient outcome in this scenario would be for one player to only donate \$25 instead of \$50, but to make that donation to a project that also receives another \$75 in donations. One project would be funded, resulting in a more efficient outcome even though the total amount of contributions would be smaller than in the first scenario. The most efficient outcome for this site would be for the six donors to coordinate their donations so that one project receives \$0 and each of the other projects receives \$100. This coordination, however, is in conflict with the given distribution of preferences for projects on this site and would not be a stable match. This conflict is one source of potential inefficiency in a crowdfunding market.

An additional tension and inefficiency can arise in a crowdfunding site from the fact that projects may vary in the amount of *risk* involved in donating. Some projects may be more popular, requesting less, or closer to meeting the threshold and therefore more likely to be funded than others. The likelihood of reaching a funding threshold makes contributing less risky because there is less possibility that the contribution will go unrewarded. This may create a tension among donors with preferences for multiple projects if they have stronger preferences for riskier projects. [Cadsby and Maynes 1999] showed that the use of a refund mechanism increased donations to goods with higher threshold because the availability of refunds mitigates the risk. But how will this refund mechanism influence the coordination of donors on a crowdfunding site where multiple public goods are simultaneously requesting contributions? What will be the effect on the efficiency of the market in matching donors and funding for as many projects as possible? It is possible that the return rule, while eliciting more donations overall, decreases the efficiency of a site by swaying donors to base their contributions more on their preferences than on risk.

3. EXPERIMENT SETUP

To understand how the return rule affects contributions and funding of projects on crowdfunding sites, we simulated a crowdfunding site using a threshold public goods game similar to the games reported by [Bagnoli and McKee 1991] and [Cadsby and Maynes 1999]. The public goods in our game were presented as projects on a crowdfunding site which were each requesting 400 credits. A project could only be completed if contributions to the project equaled or exceeded 400 credits. However, unlike previous threshold public goods games, our game involved multiple projects which simultaneously requested contributions from the public.

The game was designed to simulate three important tensions that can exist in a crowdfunding market. First, it simulates the matching problem of a project preferring

Table I. Details of the four different projects

	Amount Needed	Seed Funding	Probability of Being Funded
Low Risk	400	300	88%
Medium Risk	400	200	72%
High Risk	400	100	13%
Unfundable	400	0	0%

The different seed levels induced different levels of risk. In the experiment, the projects were given uninformative names. The probability of being funded is the frequency that each project was funded in the experiment.

Table II. The payout structure for each participant for each project

Subject	Low Risk	Medium Risk	High Risk	Unfundable
1	200	150	100	50
2	50	200	150	100
3	100	50	200	150
4	150	100	50	200
5	200	100	150	50
6	50	150	100	200

only enough donors to achieve full funding. Second, it simulates the coordination problem faced by the site as a whole that not all projects can be funded, and therefore the distribution of preferences among projects can lead to inefficiency. Third, it simulates the tension among donors who must choose between donating according to their preferences and donating according to the risk involved.

These three tensions are all sources of potential inefficiency in a crowdfunding market. This experiment is designed to evaluate how the return rule on a crowdfunding site interacts with these tensions and the subsequent influence on efficiency of the crowdfunding market.

3.1. Crowdfunding game

The crowdfunding simulation involved six players simultaneously making contributions to four fictional projects. Each player was given an endowment of 150 credits which could be allocated in any way among the four projects. Players could also keep some or all of the credits.

Preferences for projects were induced on the players by offering payouts which would be given to participants whenever a project received at least 400 credits. Table II describes these payouts in detail.

All projects were requesting 400 credits. However, in order to simulate the variability of risk between different crowdfunding projects, we seeded varying amounts into the projects. This created four types of projects; a low-risk project, a medium risk project, a high risk project, and an unfundable project. Table I describes this variation in risk.

The variation in risk between the projects and variation in the distribution of preferences among the donors was designed to create a tension for donors in their decision making. Even though the collective potential payouts for each project are equal (750 credits), some donors strongly prefer high risk projects and must therefore choose between donating according to their preferences at a higher probability of failure and donating according to risk for a lower payout.

3.2. Experimental Conditions

The crowdfunding game is played under two conditions. In the direct contribution condition, all donations to projects are final and participants lose their contribution regardless of whether the project to which it was made reaches the funding threshold. In the return rule condition, any contributions made to a project that does not reach its funding threshold are refunded to participants.

These two conditions result in two different payoff functions of the game. P is the set of all contributions (including contributions of zero) made by a player to each project. F is the set of contributions made by the player to projects which were funded. R is the set of rewards earned by the player from funded projects. ϵ is the initial endowment of 150 credits given to each player. Equation 1 gives the function for the payoff (π) in the direct donation condition, in which donations to all projects are subtracted from the total payout. Equation 2 gives the function under the the return rule, where only contributions to funded projects are subtracted.

$$\pi = \epsilon + \sum_{r \in R} r - \sum_{p \in P} p \tag{1}$$

$$\pi = \epsilon + \sum_{r \in R} r - \sum_{f \in F} f \tag{2}$$

3.3. Participants

We recruited undergraduate students from our university through email to participate in the study.

The email promised $5 for signing up and showing up to the study, and an additional reward based on their performance and the performance of others in the experiment, with an expected average of $20 for participating. 4% of students contacted responded to the email, and a total of 168 participants were scheduled to participate in 14 experimental sessions (8 sessions under the return rule and 6 under direct donation).

Participants were 48% female with a median age of 20. This is equivalent to the demographics of the undergraduate population at our university from which we recruited participants, and so we do not suspect that our recruiting methods were biased.

Only 18% of participants had ever visited a crowdfunding website before, and only one participant had ever created a project on a crowdfunding site before. Because participants were generally unfamiliar with crowdfunding, we do not suspect that previous experience with crowdfunding sites would have influenced participants' behavior in the game.

3.4. Experiment Procedure

Each experimental session involved 12 players playing under a single experimental condition (return rule or direct contribution). Each session consisted of 18 rounds of the game. In each round, the 12 players were randomly divided into two groups of six, and players were never aware of which other players were in their group in a given round. This follows the procedure used by Andreoni [1988] to prevent players from learning their partners' strategies in a public goods game.

In each round, participants were given a different set of preferences (see Table I). Over the 18 rounds, each participant was assigned each of the six unique preferences three times.

Figure 1 shows the interface for the crowdfunding simulation. The interface provided participants with all necessary information and enforced the rules and timing of the game. Since we are not interested in the effects of the timing of donations in a

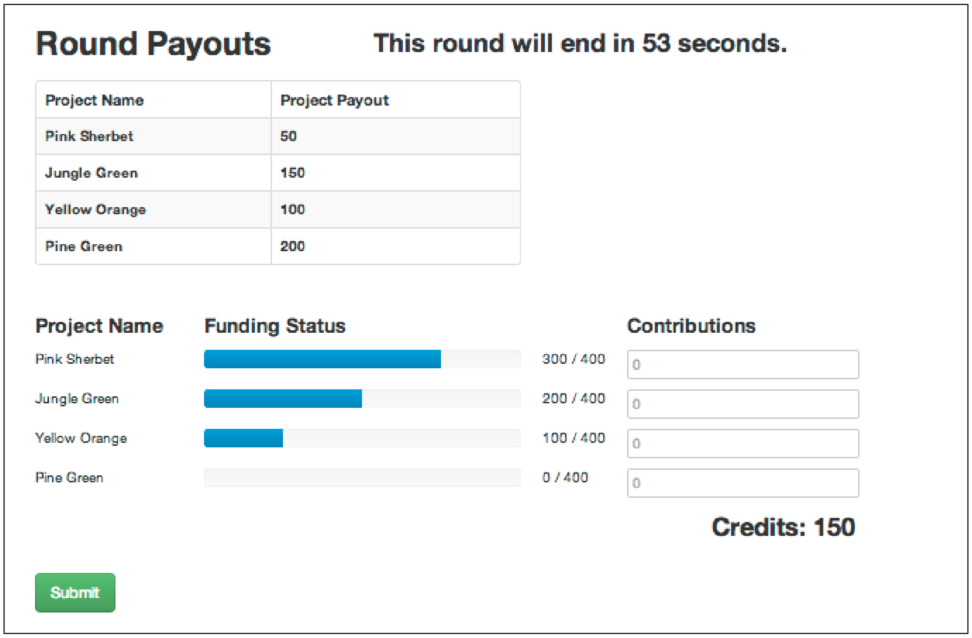

Fig. 1. Crowdfunding simulation donation screen

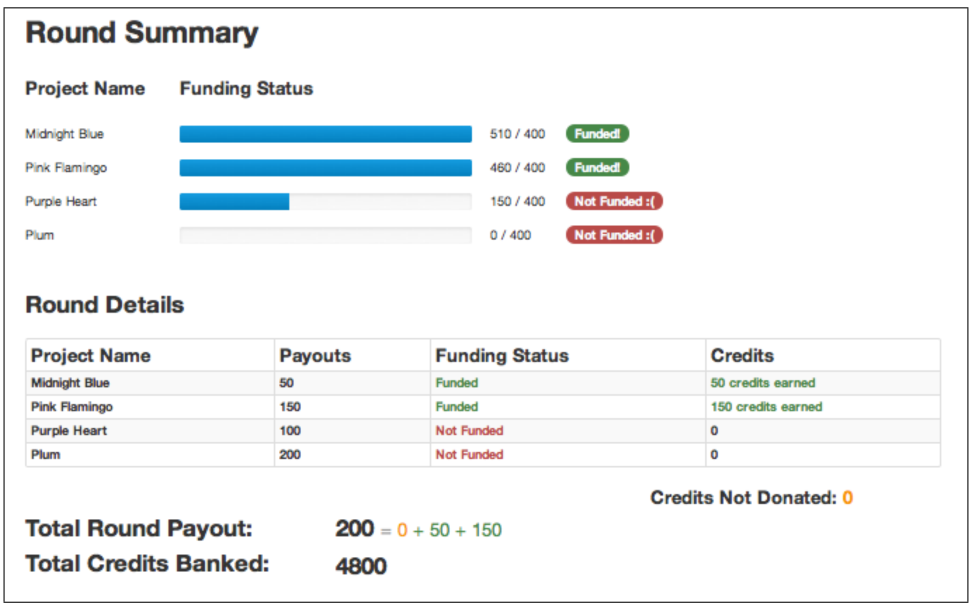

Fig. 2. Crowdfunding simulation round summary screen

crowdfunding site, all contributions were made simultaneously. To help players learn the game, a detailed summary was provided at the end of each round that displayed the outcome of the round and a detailed calculation of the player's payout (see Figure 2).

3.4.1. Manipulation Checks. After the game, we verified participants' understanding of the rules of the game in a short questionnaire.

Table III. Perceptions of risk for each project

	Return Rule		Direct Donation	
Project	Mean	(SD)	Mean	(SD)
Low risk	1.97	(1.36)	1.64	(0.83)
Medium risk	3.43	(1.00)	3.33	(0.80)
High risk	4.82	(1.08)	5.40	(0.80)
Unfundable	5.89	(1.99)	6.82	(0.78)

Table IV. Donations decisions

	Donation Amount	Donated Budget
Direct	91	27%
Return Rule	122	59%

Donation amount is the average number of credits donated in a round by a subject. Donated budget is the proportion of donations decisions where the subject donated all 150 credits they were allocated.

20% of participants gave at least one incorrect answer. 10% did not understand the return rule (or lack of return rule). 12% did not know how many other donors were in their group. 7% of participants did not understand that others had different preferences for projects. Overall, participants appeared to understand the rules of structure of the game at the end, but there was not perfect comprehension of the game and it is possible that some results are skewed as a result.

We further verified in the questionnaire that participants interpreted the variation in seed credits among the four projects as variation in risk as was intended. Participants clearly interpreted projects with fewer seed credits as being more risky in both conditions (see Table III). Thus, we are satisfied that the seed credits created the desired perception of risk for the projects.

4. RESULTS

4.1. The Return Rule Increases Donations to High-Risk Projects

Logically, the return rule should reduce the risk to donors involved in contributing to crowdfunding systems. If a project doesn't receive enough funding, then your money is returned and you are no worse off than if you hadn't donated. Taken to the logical extreme, this argument predicts that subjects will donate all of their 150 credits in the return rule condition.

On average, people donated approximately 30 credits more under the return rule. However, subjects in the return rule condition only donated an average of 121 out of their 150 credit budget, and only 60% of the time did they donate their full budget.

However, even under the return rule, there is some risk; credits donated above what was requested are effectively lost. Also, because the return rule reduces risk, high-risk projects will seem less risky. For these two reasons, we expected more and larger donations to higher-risk projects.

The return rule had very little effect on the low-risk and medium-risk projects. However, it over doubled the total contributions made to the high-risk and unfundable projects, and over doubled the number of people donating to those projects. When people donate, however, they donate similar amounts in both the direct donation and return rule conditions. (See Table V for details.)

Table V. Contributions to Each Project

	Total Contributions			Number Donors			Average Donation		
	Direct Donation		Return Rule	Direct Donation		Return Rule	Direct Donation		Return Rule
Low Risk	166		161	4.07		4.13	41.5		39.5
Medium Risk	245		237	4.39		4.55	56.3	*	52.9
High Risk	102	*	226	1.75	*	3.69	62.7		62.2
Unfundable	33	*	108	0.71	*	1.84	48.1	*	60.3

Statistically significant differences ($p < 0.01$) from a Wilcoxon rank sum test between experimental conditions are marked with a *.

Table VI. Two measures of market *spread*

	Direct Donation	*Return Rule*
# Projects Donated To	1.82	2.37
Gini Coefficient	0.39	0.23

For the Gini coefficient, 0 means equal contributions to all projects, and 1 means all of the money is concentrated on a single project. Both comparisons are statistically significant ($p < 0.01$) from a Wilcoxon rank sum test.

4.2. The Return Rule Increases Spread

The return rule seems to lead people to donate money to higher risk projects. This suggests that this could actually cause the market to have more *spread*. We operationalize spread in two different ways. First, at the individual level, we look at how many different projects a person donates money to at a given time. When a person contributes to more projects, they are spreading their money out over more options. We find that our subjects donated to about 0.5 more projects under the return rule than under direct donation.

Second, we look at the market level. We operationalize spread using the Gini coefficient. The Gini coefficient is normally used to measure income inequality in a population, but here we use it to measure donation inequality across projects. A market is more spread out if the contributions to projects are more equal. We find that Gini coefficient is much smaller (0.16) under the return rule, which is evidence that donations are spread more equally when markets use the return rule.

4.3. The Overall Effect of the Return Rule is Mixed

In theory, the prior two results have opposite effects on market efficiency. Increased donations should increase market efficiency and allow the market to fund more projects. Spread should decrease market efficiency by reducing the amount that goes to each project, reducing the likelihood that it gets funded. Since the return rule has both effects, the theory is unclear which effect will dominate; will efficiency increase or decrease under the return rule?

In our experiment, we found mixed results. Markets using the return rule funded 1.80 projects on average, and markets using direct contribution funded 1.63 (see Table VII). While this difference is statistically significant ($p < 0.02$), it is not nearly as large an increase in efficiency as would be predicted by the increases in funding. Donations went up by 33%, but the number of projects funded only increased by about 10%. We attribute this lackluster increase in performance to the effects of market spread induced by the return rule. Most of the increased donations went to projects that didn't get funded.

Table VII. Market Efficiency

	Direct Donation	*Return Rule*
# Projects Funded	1.63	1.80
Return on Investment	126%	83%

Measured by the number of projects funded by the market and return on investment through production of the project. Both differences are statistically significant ($p < 0.02$) from a Wilcoxon rank sum test.

Similarly, donations made under the return rule yield a smaller return on investment in terms of the value of the public good that has been produced. Under direct donation, donors earned a 126% return on investment for every credit donated to projects. Under the return rule, donors earned only an 83% return for every credit donated, a statistically significant difference ($p < .01$). By spreading donations to higher risk projects, the return rule diminished the efficiency with which the market turned donations into a public good.

There are two distinct effects of the return rule: increased donations and spread to higher risk projects. There is one complication that makes the overall effect difficult to determine with high certainty: First, subjects might be donating anew to higher risk projects, but not changing their low-risk donations. This basically means that the return rule only affects the likelihood of donation, but not the amount of donation. Second, subjects may spread all their money out across more projects, but choose to increase the total donated, offsetting the changes in donation amounts to existing projects. Both effects of the return rule — increased total donation amount and decreased donation amounts due to spread — affect donation amounts. This experiment is not able to distinguish between these two explanations with high certainty.

4.4. Without the Return Rule, People Learn to Only Fund Low Risk Projects

Our experiment asked subjects to play this simulated crowdfunding game repeatedly. This allows us to examine how subjects learned what strategies were effective.

The return rule condition did not exhibit much learning; the number of donors to each project and the average amount contributed to each project remained fairly stable over the course of the 18 rounds. The right sides of Figures 3 and 4 show little trend over time. Subjects did appear to learn to contribute more to the high-risk project, with the average contribution increasing from 25.8 in the first round to 40.6 in the last.

However, the direct donation condition did exhibit noticeable learning. Subjects appear to be learning not to donate to the high risk and unfundable projects. The number of subjects donating to the high risk project averages 3.0 in the first round, and decreases to 1.08 in the last round. Likewise, the number of subjects donating to the unfundable project averages 2 .08in the first round, and decreases to 0.25 in the last round. Average contribution amount shows a similar decrease.

5. DISCUSSION

The main goal of this study was to examine the effect that the all-or-nothing return rule has on a crowdfunding marketplace, relative to a direct donation model. We found that this rule leads to two distinct outcomes, and these outcomes have opposite effects on the efficiency of the market.

First, individual donors are significantly more willing to contribute money to projects, and in particular high-risk projects, leading to an overall increase in donations. Second, the available donations are significantly more spread out over more

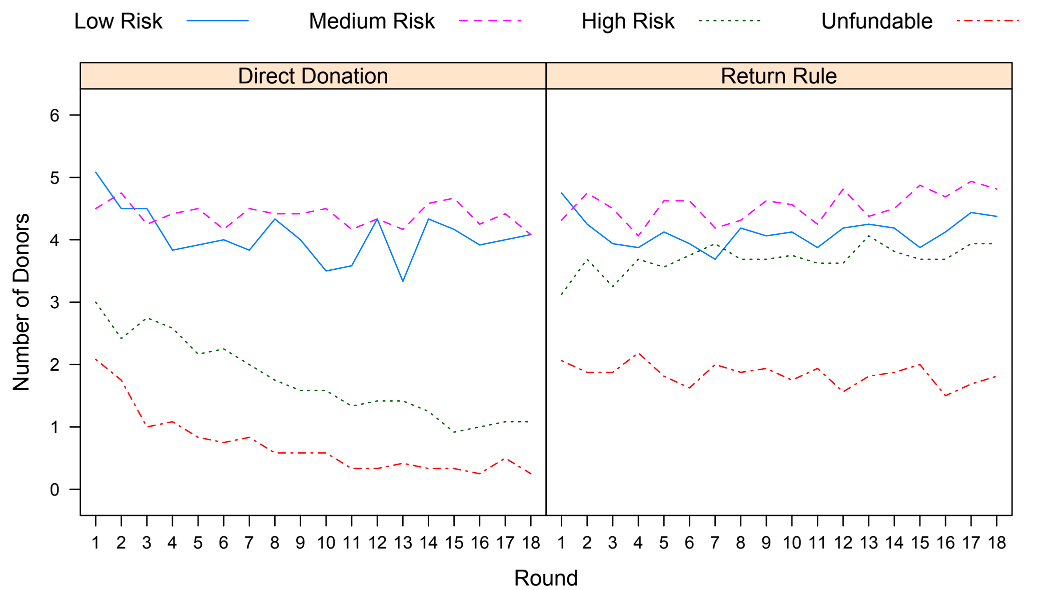

Fig. 3. Number of donors who contribute to each project, by round. The left panel is for the Direct Donation condition. The right panel is for the Return Rule condition.

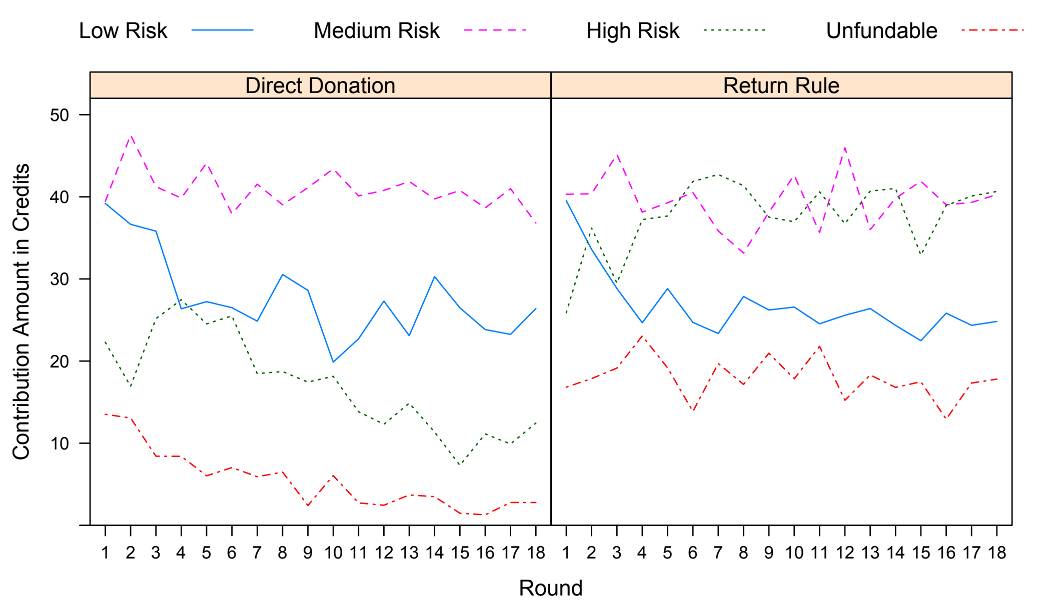

Fig. 4. Average contribution to a project by round.The left panel is for the Direct Donation condition. The right panel is for the Return Rule condition.

projects. Increased spread in the market makes it more difficult for each project to achieve its goal, and can potentially lead to fewer projects being funded. These two effects appear to approximately offset in our experimental setting, leading to a very small efficiency gain when using the return rule.

When donors are using a direct donation system, they seem to learn to coordinate on low-risk projects that are highly likely to be funded. This implicit coordination makes it relatively easy to fund low-risk projects and also leads to a higher return (in terms of the value of the newly produced public good) on each donation. In this experiment, the risk inherent in the projects, largely due to complementarities inherent in projects that need a certain amount of funding to succeed, appears to have served as a coordination device.

On the other hand, in a return rule system, there was much less coordination among donors. Donors seem to feel like it is safe to donate to any project, since they get their money back if the project doesn't achieve its funding goal. The return rule, therefore, eliminated much of the incentive to coordinate with other donors about which projects are being funded. This is why we saw an increased spread in donations; donors were focused more on the projects they preferred and less on solving the complementarity issue.

These findings have implications for market designers working to design better crowdfunding systems. First, they suggest that there isn't a clear answer whether using an all-or-nothing return rule or using a direct donation rule is better. If the marketplace has a large number of projects simultaneously seeking support, the return rule has the risk that donors will spread out their donations, leading to many donations but low funding rates for projects. On the other hand, if projects are largely undifferentiated (so there is nothing to coordinate on) or if many projects are seen as high risk, then the increased donations that result from the return rule might enable the market to fund more projects.

Additionally, if the goal of the marketplace is to fund high-risk high-reward projects, the return rule is more likely to succeed. If the goal of the marketplace is to weed out high-risk projects and focus donor attention on projects with a high likelihood of success, using a direct donation mechanism might work better.

Increasingly we are seeing crowdfunding websites that offer project creators a choice — on the same website, they can either offer their project as a direct donation project or as a return rule project. For example, IndieGoGo recently changed from a direct donation marketplace to one where each project gets to choose. Our results would suggest that higher risk projects should choose to be offered under a return rule. On the other hand, projects that can benefit from coordination and a strong word-of-mouth should probably choose direct donation, as that provides a stronger incentive for donors to coordinate and spread the word.

6. CONCLUSION

Crowdfunding websites like Kickstarter, IndieGoGo, Donors Choose, and Spot.Us pose an interesting challenge for market designers. They are matching marketplaces, matching people with ideas for projects with donors willing to contribute money to those projects. But they have a strong inherent complementarity in the market structure: multiple donors are needed to fund a project, and the project often cannot succeed without full funding. Complementaries such as this cause large theoretical problems for market designers; matching markets with complementarities frequently do not have stable equilibria, and regularly have problems with market failure or market inefficiency.

There are two major strategies that existing crowdfunding websites have used to deal with this problem: allow direct donations to projects (used by IndieGoGo), or use an all-or-nothing return rule that returns donations if a project doesn't achieve its goal (used by Kickstarter). We conducted an experimental study of these two mechanisms to better understand how these strategies enable matching markets with complementaries to function.

We find that each of these two mechanisms has distinct strengths and weaknesses. Direct donations provide an incentive for donors to coordinate to solve the complementarity problem, and are more likely to fully fund projects even when total donations in the marketplace are small. The return rule encourages people to donate to more projects and to higher risk projects, but has the potential of spreading out contributions among too many projects, causing few of them to reach their goal. Both mechanisms appear to be viable means for partially solving the complementarity problem in matching marketplaces.

7. ACKNOWLEDGEMENTS

The authors would like to thank Kyle Safran for his help designing and running this experiment. The authors would also like to thank Jan Boehmer and the whole BITLab Lab Group for feedback.

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