Don't Wait! How Timing Affects Coordination of Crowdfunding Donations

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ABSTRACT
Crowdfunding sites often impose deadlines for projects to receive their requested funds. This deadline structure creates a difficult decision for potential donors. Donors can donate early to a project to help it reach its goal and to signal to other donors that the project is worthwhile. But donors may also want to wait for a similar signal from others.

We conduct an experimental simulation of a crowdfunding website to explore how potential donors to projects make this decision. We find evidence for both strategies in our experiment; some donate early while others wait till the last second. However, we also find that making an early donation is usually a better strategy for donors because the amount of donations made early in a project's campaign is often the only difference between that project being funded or not. This finding suggests that crowdfunding sites need to develop designs, policies and incentives that encourage people to make immediate donations so that the site can most efficiently fund projects.

Author Keywords
Crowdfunding

ACM Classification Keywords
H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

General Terms
Human Factors; Design; Measurement.

INTRODUCTION
Crowdfunding sites are a type of online community where large groups of people come together in order to realize a new idea or project that requires financing. Crowdfunding is a form of collective action that requires the participation of people in varying user roles, such as project creators, donors, or site administrators. Success in crowdfunding is achieved when the individual actions of users are well coordinated so that everyone's effort is put to use, not duplicated by other users, or not withheld from the group. Crowdfunding sites have many features that enable this coordination, either by affording direct communication between users, by providing information about users and their collective behavior, or by providing rules and structure that assist users in their decision making.

One feature in many sites that assists in coordination is the setting of a deadline for projects to collect the required funds. This deadline typically accompanies an "All-or-nothing" style of crowdfunding where refunds are given to donors if a project does not meet a specified goal before the deadline [20]. Often in this style of crowdfunding, the site is designed to provide real-time status information about the progress of a project towards its goal. Kickstarter, for example, displays for each project the up-to-date total for how much the project has received, how many people have donated, and how long until the deadline (see Figure 1).

This combination of design features presents an interesting choice for anyone who might consider contributing to a crowdfunding project. *When* should one make a donation? Should donors immediately donate, or wait some period of time before donating? There are good reasons for either choice. It may make sense to wait to see whether other people donate, because the donations of others may be sufficient and a donor could free-ride and reap the benefits of the project without contributing. It might also make sense to donate immediately, because a donation may be used as a signal to others that the project has quality and encourage them to donate.

Both choices are relevant to coordination. Signals sent to other users of a site through donation (or lack of) will influence the way groups coordinate to fund projects, and likely the degree to which they are successful at this collective effort.

We explore this decision from the perspective of crowdfunding donors by conducting an experimental simulation of a crowdfunding site. This study seeks to understand how the decision of when to donate affects coordination on crowdfunding sites. We primarily explore how the degree of interest or preference that donors have for projects (both as individuals and collectively as a cohort of potential contributors) affects their decisions, and how this subsequently affects coordination and crowdfunding outcomes. We show that making an immediate donation is generally a better strategy for potential donors, particularly if they are strongly motivated to see a project completed. Later, we will discuss the implications of this finding for the design of crowdfunding sites.

CROWDFUNDING, COORDINATION AND TIMING

Figure 1. An example Kickstarter project

Recent years have seen the rise of a wide variety of crowdfunding websites [8], including Kickstarter (which funds creative projects), IndieGoGo (which funds a wide variety of ideas and new businesses), Spot.Us (which funds investigative journalism), and Donors Choose (which funds K–12 classroom projects). These websites have enabled people with ideas to raise large amounts of money to support their projects. Kickstarter has raised over $1 billion in funding for a variety of projects from over 6 million people[1]. Donors Choose has raised over $240 million for over 450,000 projects in K-12 classrooms[2].

Projects on crowdfunding websites offer two forms of value to donors. Many projects offer a *public good* – a valuable good that everyone can benefit from, even if they don't back the project. For example, projects on Donors Choose benefit public education, raising education levels particularly among low-income students. Many Kickstarter projects cannot exist without the support they receive from their donors; recently Kickstarter was used to raise money to create a new Veronica Mars movie that we all can now watch. Additionally, many crowdfunded projects offer specific value to individual donors, usually in the form of project-related rewards, product pre-orders, or equity in what is produced. Crowdfunding is rarely used solely as a sales mechanism; almost all crowdfunded projects include some public goods component. Belleflamme et al.[6] argue 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."

Crowdfunding is an effective method of raising funds for projects. Many crowdfunding websites have funding rates higher than 40%: 43%–49% of projects on Kickstarter are fully funded [15, 12]; 43.5% of projects on Spotus are fully funded [11], and almost 70% of projects on Donors Choose are fully funded [19]. Mollick [15] observes that projects that ask for less money have higher funding rates than larger projects.

Crowdfunding Needs Coordination

Crowdfunding enables a large number of people to collaborate through the creation of and donations to projects to produce a public good. Crowdfunding works because people donate to crowdfunding projects irrespective of geography [1]. However, this creates a coordination problem for the people involved: with scarce resources, how can donors and creators decide which projects to put their effort and money behind?

Crowdfunding requires several forms of coordination. Much of the CSCW research on crowdfunding has looked at coordination between project creators and donors or potential donors. Gerber and Hui [7] found that establishing long-term connections with backers and building awareness are important motivations for project creators to use crowdfunding. In other work [10] they show that building a community around one's project and engaging with that community is important for the success of crowdfunded projects. Likewise, Xu et al. [21] showed that effective project updates during the course of a Kickstarter campaign keep backers engaged and positively influence the chance of success for a project. Mitra and Gilbert [14] describe how the language used in project descriptions signals the quality of projects to potential donors.

Another form of coordination on crowdfunding sites is coordination and collaboration between project creators. Hui et al. [10] found that a number of communities have formed around crowdfunding, where creators discuss and critique ideas. Project creators may learn not only from other creators, but also from their own repeated experiences as project creators [9, 16].

Wash and Solomon [20] demonstrated that the discrete nature of many crowdfunding projects creates complementarities in donors' preferences, which means that coordination is required in order for all donors to get what they desire out of crowdfunding. They showed that in some cases, such as when a crowdfunding site uses an "all-or-nothing" mechanism and refunds donations to incomplete projects, getting more in donations may not lead to more projects being funded if the donations are not well coordinated.

Crowdfunding donors face a coordination challenge in that, while donors typically know how much they value a project, they don't necessarily know how others value it. This may be inferred from the amount of backing a project has received previously, but if people are free-riding, this inference could be incorrect and a project may not receive some donations simply because it does not appear to donors that others will also contribute.

Theory of Donation Timing in Charitable Giving

Crowdfunding projects collect donations over an extended period of time. The choices donors make about when to donate may have significant effects on the outcomes of crowdfunding projects. Agrawal et al. [2] argue that crowdfunding prompts "rational herding" where people are more likely to donate to projects when they have already received some donations from others, and that as a project nears its deadline the rate of donations accelerates. This finding has similarly been shown in the context of micro lending [22], which is distinct but conceptually similar to crowdfunding. Kuppaswamy and Bayus [13] found that projects on Kickstarter tend to experience a "bathtub" pattern of donations over time: projects typically get many donations immediately after being posted, go through a period where few donations are made, and then

[1] `https://www.kickstarter.com/help/stats`, retrieved on June 4, 2014

[2] `http://www.donorschoose.org/about/impact.html`, retrieved on June 4, 2014

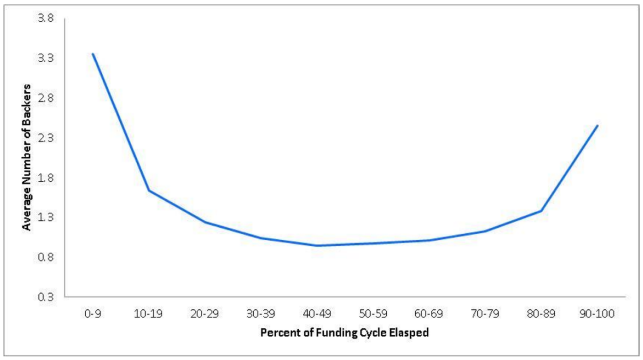

Figure 2. The timing of donations made to Kickstarter.com, as reported by [13]

as the deadline approached, receive a last-minute surge of donations. Figure 2 illustrates their finding.

Public goods are often funded through philanthropy: charitable giving by wealthy (and sometimes not-so-wealthy) donors. Economists have identified a number of rational strategies for choosing when to give to a public good. First, many people choose to free-ride. That is, they choose to not donate to the public good, allow others to fund the good, and then reap the benefits once it is funded. This is a very common and rational strategy. However, if everyone chooses this strategy, then no public good would ever be funded.

A second strategy is to wait until asked to donate, and then contributing to whichever charity asked. Dubbed "the Power of the Ask", this strategy is a minimal-effort strategy that allows people to make charitable donations without the effort of deciding where to donate [4]. Together, these first two strategies represent a *lack of coordination*. Anyone using these donation strategies is explicitly forgoing coordinating with other donors about which projects or charities to fund.

Many donors often intentionally choose a wait-and-see approach to charitable donation. Because there is risk associated with donating, it is rational for a potential donor to wait and see how many other people are donating. This allows the potential donor to assess the likelihood that the project will be completely funded, or to assess the quality of a project based on the assessment of the crowd [3]. By waiting, donors may also benefit if the project is able to be completed without their donation at all.

Because many potential donors take a wait-and-see approach, another strategy is to make a large donation early during a fundraising campaign. Charities often solicit a "leadership donation" – a large donation from a well-known donor for 25%-50% of the total funds needed. Andreoni argues that leadership donations provide a credible signal that a charity or project is high quality and also that the project is likely to receive the funds it needs [5]. It also reduces the remaining funds needed, making the fundraising goal easier to achieve. Thus, by giving early, leadership donors can influence which projects are funded both directly through their donation and indirectly by inducing others to donate.

Timing Donations on Crowdfunding Websites

These donation timing strategies present an interesting coordination dilemma for donors on a crowdfunding site. Typically, no single donor can fund a crowdfunding project, so it is important that donors coordinate their donations to ensure that the project of their choice receives the funds it needs. However, each person might prefer a different project be funded, and therefore must coordinate with others to decide which projects will be funded with the scarce resources available in the crowd.

Wash [19] found evidence of a "completion bias" in crowdfunding projects on Donors Choose: the last person to make a donation to a completed project typically donates far more than an average amount. This could be a selection-and-timing effect, where people who want to make large donations intentionally wait until they are certain that their donation will go to a successful project – the wait-and-see approach identified for charitable giving. Or it could be that donors who hear about a project later experience very little risk, and thus are willing to make an increased donation.

Shin and Jian [17] found evidence of leadership giving in crowdfunding. They observed that most early donations to projects come from friends or family of the project creator (who may be most motivated for the project to succeed). However, leadership giving is risky; if the project never reaches its goal and receives the funds it needs, then the money that was donated is tied up for a period of time, unable to be used more productively.

It is difficult to determine from existing research and data on crowdfunding which of these strategies are being used. It is hard to know, for example, whether those who wait till the end of a campaign are waiting because they are trying to free-ride off the donations of others, or whether they are herding and only see value in a project because enough other people have expressed value through their donations. We do not know with enough precision the motivation or value that a donor has for making the donation. We also can't know whether people who donate early are the ones who really like the project most and want to encourage others, or if they are simply expressing support for the creator because of the personal connection and not as much for the project itself. Similarly, those who wait may be the ones who like the project most, and the completion bias found by Wash [19] offers some evidence for this. Without having more specific information about individual donors' motivations and valuations of projects, our understanding of the timing dynamics is incomplete. In this paper, we report on a lab-based study where we control people's preferences and thus are able to better understand the strategies being used.

METHODS

In order to understand timing choices in crowdfunding, we created an experiment that provided people an opportunity to make decisions about when to donate to crowdfunding projects. This experimental approach allows us to completely control the environment: we controlled exactly which projects could receive donations, each person's budget for do-

nating to crowdfunding projects, and the number of other potential donors.

Also, critically, we were able to assign *preferences* to subjects. For each available project, every subject was assigned a payoff – a number of credits that they would receive if that project is fully funded (regardless of whether that subject donated to the project). At the end of the experiment, subjects exchanged the credits that they earned for real money (100 credits = $1 USD). Vernon Smith showed that by assigning preferences and paying based on credits earned, this structure effectively induces the subjects to value the projects as they are assigned to [18]. Once subjects value the projects, they are likely to make decisions about these projects in similar ways as they do about real-world projects that they value. This Induced Value Theory [18] has been the basis of much of experimental economics in the last 30 years.

Assigning preferences to subjects also allows us to control the difficulty of the coordination problem. If we assign high preferences to many people for a given project, then that project is easy to fund. Likewise, if few people value a project, then that project will be more difficult to fund. Thus, we can effectively create a variety of different types of projects simply by varying the distribution of preferences for a given project across subjects.

Simulated Crowdfunding Website

Our experiment followed a similar setup to the crowdfunding game used by Wash and Solomon [20]. We represented crowdfunding projects as threshold public goods. A group of six subjects formed a crowd of visitors to a simulated crowdfunding site. In this setup, subjects were allotted credits that they could donate to the three projects on our simulated crowdfunding site. Projects were available for donations for 60 seconds, and subjects could make donations at any point during the period. The three projects had no descriptions and were labeled only as "Red", "Yellow", or "Blue" projects. Each project had a goal of 100 credits. Figure 3 shows the site as subjects saw it.

Subjects were shown their assigned payout for each project when the time period began. Subjects were instructed that if the project was funded by the end of 60 seconds, they would receive their payout as a bonus payment in credits. Subjects did not need to make a donation themselves to receive this payout, as long as the project received 100 credits from the group collectively, and that if the project did not reach 100 credits, their donations would be returned (all-or-nothing crowdfunding).

Each subject was given a budget of 30 credits per project that could be donated, and this budget could not be transferred to other projects. This feature of the design ensures that projects on the site are not actually in direct competition with each other for donations. Donating to the Red project, for example, does not in any way diminish one's ability to donate to the Blue project. Although they appear on the site simultaneously, there was no economic incentive to withhold donations or make a strategic choice about timing donations from one project because of the status of any other project. This reflects the common view that people make independent donation decisions about crowdfunding projects, rather than comparing projects and deciding which to donate to. This also allows us to treat the projects as independent in our analysis.

Project:	Difficult		Easy		Medium	
Condition:	1	2	1	2	1	2
Subj. 1	0	15	30	30	45	25
Subj. 2	0	15	30	30	45	25
Subj. 3	0	15	30	30	45	25
Subj. 4	15	15	30	30	15	25
Subj. 5	15	15	30	30	15	25
Subj. 6	15	15	30	30	15	25
Total	45	90	180	180	180	150

Table 1. Payoff a subject receives, in credits, when a given project is funded. In condition 1, the medium project has the same total payout as the easy project but unevenly distributed payouts. In condition 2, the medium project has a lower total payout but everyone has identical payouts.

Subjects were free to donate any amount within their budget at any time during the 60 seconds. Subjects were also free to donate as many times to a project as they wished. For this reason, the number of donations that could be made to a project was limited only by the time available. The total amount in credits of donations was only limited by the budget.

A strategy that we expected to see was for subjects to wait until the last possible moment to submit a final donation. Because we wanted to be sure that we captured all such attempts to make a "last-second donation" and not have the results depend on subjects' ability to time their clicks of the mouse button precisely, we configured the interface to treat the final ten seconds of the round as being effectively the final second. To accomplish this, two changes to the site happened when the clock reached ten seconds. First, subjects' screens stopped updating the status. No new information about project status could be obtained in this period. Second, subjects were only allowed to click the submit button one time in this period (although they could submit donations to all three projects simultaneously with one click). Subjects were also instructed before the experiment to treat this period as the last moment and given an explanation of the interface changes.

Groups played three practice rounds of this game in which credits earned did not count towards one's final total. They then played fifteen live rounds. After each round, groups were re-formed to avoid problems that can arise from repeated games [3].

We recruited 120 undergraduate students (54% female, average age of 20 years) by email from our university to play this crowdfunding simulation. Only 33% of subjects indicated that they had ever visited a crowdfunding website previously. Subject earned an average of about $20 for participating in this hour-long study.

Creating Projects and Preferences

Projects varied only in the preferences assigned to the potential donors, as induced by the payouts offered for completion.

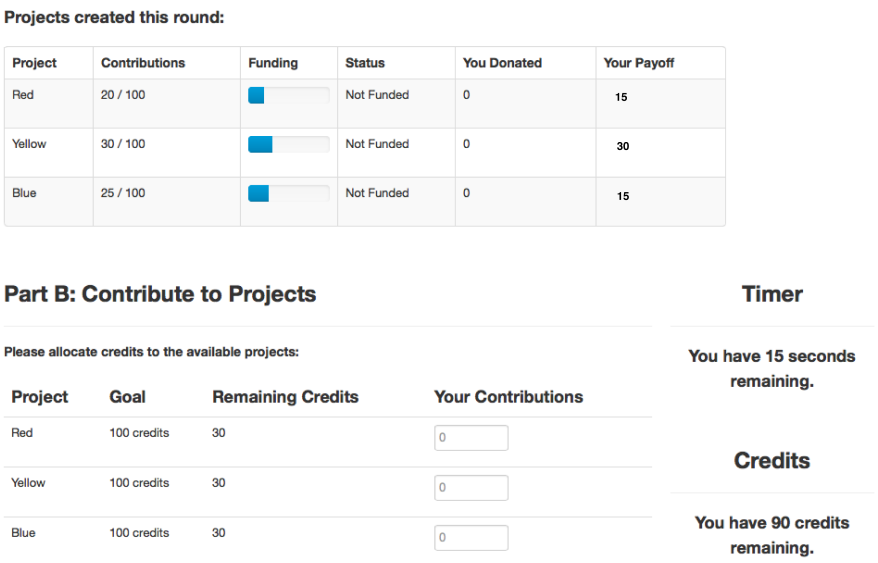

Figure 3. Crowfunding interface used in the experiment

Table 1 lists the payout structure of the experiment. This payout structure created three classes of projects that relate to how much total interest there was in a project (i.e. the sum of all donors' payouts) and the distribution of those payouts (i.e. evenly spread out so all donors receive the same payout, or uneven payouts where some donors receive larger payouts than others).

We have labeled these projects in this description according to their relative difficulty in funding, as determined by the results of the study. Easy projects were funded most frequently, medium projects were funded somewhat rarely, and difficult projects were almost never funded (because funding this project required irrational donating). We anticipated how difficult each type of project would be to fund through pilot testing, and structured the experiment into two conditions that represent two different versions of a crowdfunding site. Each site had three projects, one that was easy, one medium, and one difficult. The primary difference between the two sites was the nature of the medium project. In condition 1, the medium project had a high degree of overall interest, based on the sum of all payouts, but the payouts were unevenly distributed so that some people valued it more than they had budget to donate, and others had only a small preference. This created difficulty because if any one person with a high value decided to free-ride or take a wait and see approach, it became difficult for the rest of the group to rationally fund the project. Likewise in condition 2, the medium project had evenly spread out preferences but they were smaller overall. This similarly reduces the margin of error that users have for coordinating their donations successfully and still earning a payout from the project.

Subjects knew their own payouts for each project, but were not explicitly given any information of others' payouts. Any information they gained about other donors had to be inferred by observing donations to projects over the course of the 60 seconds.

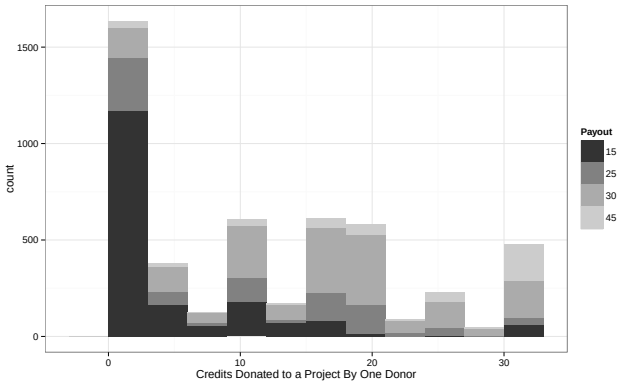

Figure 4. Distribution of donation amounts

RESULTS

Descriptive analysis

How much did people donate?

Of the 30 credit allotment given for each project, subjects donated an average of 10.39 (SD = 10.23) credits to each project on the site. Figure 4 shows the distribution of donations made to a project broken down according to the subject's payout if the project was completed. Subjects largely made rational donations, with only a few instances where subjects donated more than their payout (and the majority of these instances came from a single subject). Subjects on average made 1.3 donations to a given project over the 60 seconds in the round. Figure 5 describes this distribution. Repeated donations from the same donor occurred in less than half of all observations. It was more common to either free-ride or to only make a single donation.

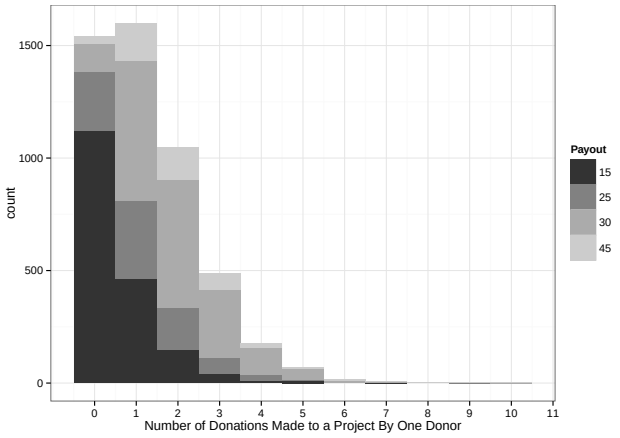

Figure 5. How many times each person donated

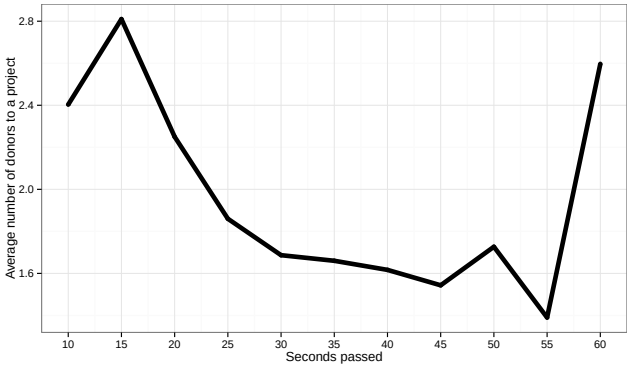

Figure 6. Average number of donations to a project over time

Together, these results illustrate that free-riding – donating zero or a very small amount and letting others contribute most of the needed funds – was a popular strategy among donors. Free-riding was particularly common when subjects had a payoff of 15 credits, which was a low payout amount.

When did people donate?

Figure 6 describes how many donations were made to projects over the course of the 60 second campaign. Donations quickly hit a peak between about 10 and 15 seconds into the 60-second fundraising campaign and then slowly decreased in frequency until another peak right before the end. This pattern is highly similar to what has been observed by other research on live crowdfunding sites (compare Figure 6 to the Kickstarter data shown in Figure 2 above).

When subjects did make donations, there was a general tendency to make larger donations towards the beginning of the round, and smaller donations later on. Figure 7 shows the average size of donations made at each 5-second block within the round (not including donations of 0). This is in contrast to the finding of Wash [19], who found that the last donation of a project was usually much larger than other donations.

How successful were the crowds at funding projects?

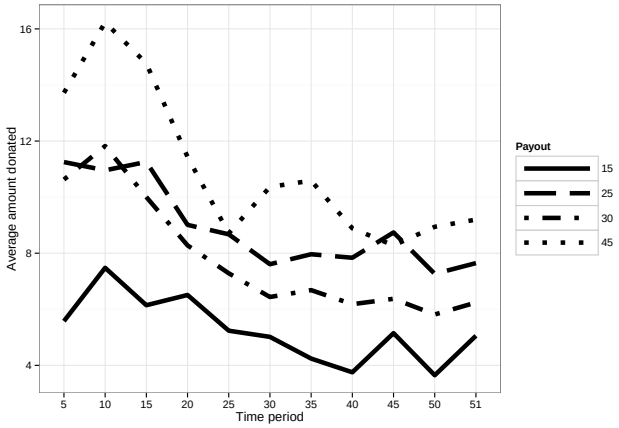

Figure 7. Average donation amount at each time period. These averages exclude non-donations in the period

	Project:	Difficult	Easy	Medium
Cond. 1	Success Rate	0%	54%	35%
	Credits Received	13.7	96.0	85.9
	# of Donations	1.3	11.8	9.5
	Payouts	Uneven	Even	Uneven
Cond. 2	Success Rate	1%	52%	18%
	Credits Received	19.2	94.0	65.3
	# of Donations	1.8	11.5	7.2
	Payouts	Even	Even	Even

Table 2. Donation statistics for each project type, averaged across all projects of that type

The projects varied widely in their likelihood of being funded. The easy project was, unsurprisingly, the most frequently funded project, and the difficult project was only funded once. The medium projects, however, showed an interesting pattern. The medium project with a high total payout but preferences unevenly spread through the crowd was funded 35% of the time. The other medium project, with a lower total payout but an even distribution of preferences, was funded 18% of the time. This difference is statistically significant according to a Chi-square test ($p < .001$). This suggests that it is better to have more total interest in the community than to have everyone like it somewhat. Table 2 describes the outcomes for all types of projects.

The only substantive difference between projects is the payouts that were assigned to subjects. The fact that these projects were funded at different rates, and largely according to patterns in the payouts, suggests that the payouts did successfully induce subjects to value the projects differently even though the projects aren't real.

Identifying Strategies

One of our goals was to identify different strategies that subjects use when making donations. To do this, we used k-mean clustering analysis. The unit of analysis is the amount of donation from an individual at a time period. We cut the entire 60 second session into 3 periods: The first 15 seconds, 16 to 50 second and 51 to 60 seconds. This was based on our initial

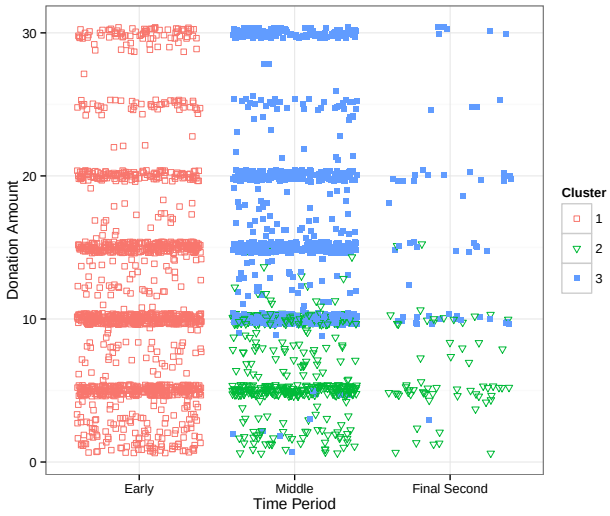

Figure 8. Strategy clusters

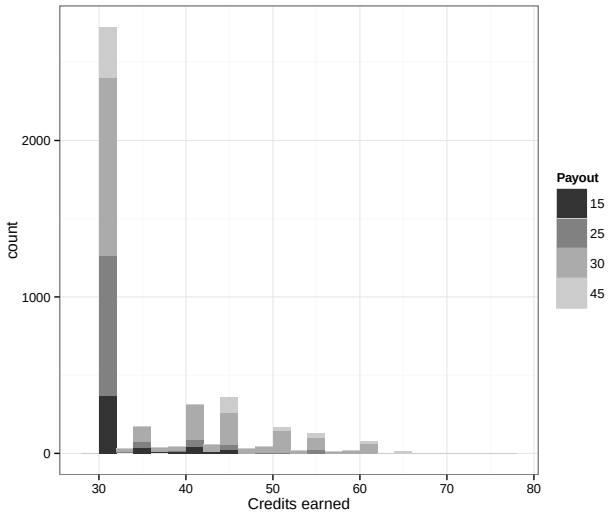

Figure 9. Distribution of the number of credits earned from a project

analysis (Figure 6) where we noted that these three periods had different donation patterns overall. In this analysis, we only examine first-time donations to a project. The first-time donation is the best representation of a donor's strategy, and first time donations are more fairly comparable to each other than subsequent donations. This is because donor's have the choice to make a first-time donation at any point in the round, and they always have an equal amount of budget when making the donation. Subsequent donations are biased towards the end of the round, which makes it difficult to assess the degree to which they act as leadership donations. Additionally, the vast majority of users make only 0 or 1 donation to a project (see Figure 5).

The underlying goal of k-mean is that the algorithm goes through iterations and tries to find a solution that maximizes the distance between clusters and minimizes the distance within clusters. The cluster analysis searched for donations that were similar in terms of the time of the donation, the amount of the donation, the donor's payout for the project, and the amount of donations the project had already received. When using k-means clustering, it is necessary to specify the number of clusters the algorithm should find. After some exploration and trial and error, we settled on three clusters. By finding three clusters, we felt we achieved a satisfactory balance between reducing the the overall error and identifying clusters that could be matched to distinct behavioral strategies.

Figure 8 illustrates the clusters, broken down by the timing and amount of donation made by the observations. Each of the three clusters represents a separate strategy taken by donors. One strategy involved making a donation of any size in the initial 15 second period of the round (cluster 1). Another strategy was to make a larger donation (approximately 10 credits or greater) in either the middle period or the "Last chance" period (cluster 2). The third strategy was to make only a small donation in the middle or final stages of the round (cluster 3).

These clusters only include instances where a subject made any donation in the round. There is a fourth strategy which can clearly be seen in Figure 4 which was to completely free-ride and never make a donation.

We speculated that the size of one's payout would be related to which strategy a donor chose to take. However, removing payouts as one of the factors led to almost no changes in the clusters. We also noted in a visual analysis of donations that the proportion of donations made by each payout level remained constant over the course of the round on average. This means that the size of one's payout did not influence donors' strategies.

These clusters roughly correspond to the strategies identified in the literature review above. Donations in cluster 1 are leadership donations – early donations that signal to others which projects are likely to succeed. Cluster 4 (non-donations) are free-riding. Clusters 2 and 3 appear to be variations on the wait-and-see strategy, though it isn't clear how that strategy is playing out.

Having an Impact

To examine which strategy worked best for donors, we plotted the growth patterns for the three types of fundable projects in Figure 10. Projects that were ultimately funded differ from the unsuccessful projects. A separation in growth appears within the first 15 to 20 seconds for each type of project. For the High Interest projects – the easy project and the medium project with a large payout and uneven spread – this separation does not grow much, if at all, over the rest of the round. For these types of projects, the difference between being funded or not is a direct effect of the donations made early on. In the middle period of the round, the growth rates are equivalent. But the extra donations made early make it more likely that when the final second comes, that someone will donate to complete the project.

For the Medium difficulty project with lower, evenly spread

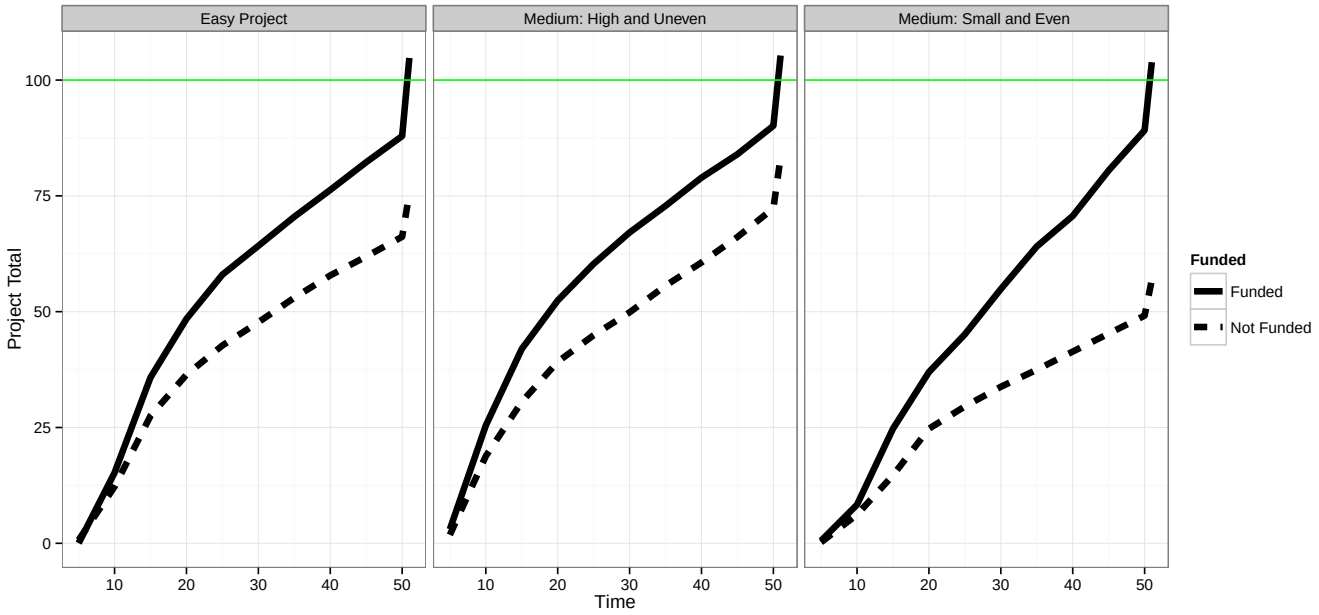

Figure 10. Comparison of growth of funded and un-funded projects

payouts, the early donations are even more important. Unlike the High Interest projects, donations slow down considerably for this kind of project when it does not receive many early donations. When this project was funded, it received a slightly higher rate of initial donations which then was sustained somewhat constantly over the round until it was funded. When these early donations did not happen, donors ignored this project and it received few further donations.

This suggests that as a strategy for personal gain in our crowdfunding simulation, it is generally better for a donor to make an early donation than to wait. To examine this idea in more detail, we ran a set of regression models that estimate the profitability of different donation strategies.

When a project is not funded, the all-or-nothing structure of the site meant that the subject would still earn 30 credits. Since less than 40% of projects were funded, the distribution of earnings was somewhat unusual and heavily inflated with earnings of 30 (see Figure 9). Therefore, we built two models to analyze whether donating early led to better outcomes for donors. The first model estimates the probability that a subject earned any "profit" at all (payout greater than 30) using logistic regression.

When removing projects that were not funded, the remaining distribution is approximately a poisson distribution. Therefore in our second model we estimated the number of credits earned from a funded project based on the timing of the first donation grouped into 15 second intervals. For this model we used a poisson regression – a generalized linear model where the errors are distributed according to a poisson distribution and the natural logarithm as a link function. These models are represented in Table 3. Both models include the subject's payout for the given project and a random effect of the subject (due to the repeated nature of the game). The Intercept in these models represents those who donated in the first 15 seconds. The estimates represent the changes in log odds of earning a profit (Model 1) and the natural logarithm of credits earned above 30 (Model 2) that can be expected from a one unit change in the independent variable.

Model 1 suggests that it is a poor strategy to wait longer than the initial 15 second period to make a donation, though waiting until the last moment is almost as good. Subjects who donated between 15 and 45 seconds were less likely to earn additional credits from the project. Additionally, subjects who never made a donation were very unlikely to earn additional credits. This model describes the probability of earning a profit, but in our study, this is nearly completely synonymous with the probability of a project being funded (since subjects almost always donated less than their payout). Therefore, model 1 can also be interpreted as the effect of the timing of one's donation on the probability of that project being funded.

However, model 2 suggests that if a project was funded, the subjects who waited till the end or did not donate did in fact earn more credits. To get a better overall picture for the value of being an early contributor, we conducted a Wilcoxon Rank Sum test on the total credits earned from a project that compared those who donated early (within the first 15 seconds) and those who did not. The test indicated that those who donate early did earn more credits ($p < .001$), although the difference in means between the two groups was less than 1 credit.

It is worthwhile to note that free-riding was a very poor strategy in this study. Free-riding on average led to much lower earnings than when even small donations were made. This likely speaks to the value of a donation both as an act of funding a creator's idea but also as a coordination signal sent to

	Dependent variable:	
	Profited?	Earnings
	(1)	(2)
Intercept	-0.102	1.462^{***}
	(0.073)	(0.047)
15-30 Seconds	-0.239^{***}	0.033^{*}
	(0.083)	(0.019)
30-45	-0.282^{**}	0.186^{***}
	(0.113)	(0.025)
After 45	-0.091	0.295^{***}
	(0.130)	(0.027)
Never	-1.626^{***}	0.569^{***}
	(0.134)	(0.030)
Amount Donated	-0.019^{***}	-0.022^{***}
	(0.005)	(0.001)
Payout		0.041^{***}
		(0.001)
Note:	*p<0.1; **p<0.05; ***p<0.01	

Table 3. Effect of donation timing on earnings from projects

other potential donors.

DISCUSSION

Donors in the experiment, like real users of crowdfunding sites, face a difficult decision around when to make a donation. Donating early sends a behavioral signal to others that encourages them to donate as well, and improve the chances of the project being successful. However, the project may be successful without one's donation, and by waiting, donors may be able to reap the benefits of a completed project without donating or may only need to make a smaller donation towards the end. This is a potential cost of sending coordination signals to other users.

In our study however, donating early was overall a better strategy for donors. This was particularly true for donors with the most to gain from a project being funded; donating early leads to a higher likelihood of profit. Though, once you know the project will be funded, it is better to donate late because that allows you to partially free-ride using a smaller donation. Conversely, those with only small payouts, equating to those with relatively low preference, may do better by waiting till the end and making a small donation if the project is close to being funded.

This result has some important implications for crowdfunding sites. First of all, it suggests that the rigid all-or-nothing deadline structure of many crowdfunding sites may create some inefficiencies with the way people coordinate to fund projects. Deadlines may create an incentive for people to wait, and if too many people wait then projects that otherwise have enough interest to be completed may not be funded. In our simulation, the collective payouts of most projects was over 100, meaning that it was profitable for the crowd of donors as a whole to fund the project. Since this happened less than 40% of the time for these projects, we argue that there was inefficient coordination among the donors on a site.

A noteworthy result is that the medium project with uneven preferences was funded less frequently than the easy project. Although this was expected, it is noteworthy because the sum total of all payouts to donors was actually the same for both projects. The only difference between them was the difference in how those payouts were distributed. In some subsequent exploration of this result, we noted that the medium project typically almost always failed if one of the three donors with high preference (45 credit payout) decided to wait or to free-ride altogether. When projects have an uneven distribution of preference across the population of potential donors, it is critical that those with with high preference donate early because if they do not, there is not likely to be anyone else who will. When preferences are evenly distributed, there is a greater chance of early donation because if one person free-rides or waits, there is a larger pool of potential replacements for that donation.

Deadlines do have an important role in crowdfunding. Deadlines are necessary for the all-or-nothing style or crowdfunding to be functional. All-or-nothing crowdfunding minimizes the risk for a donor associated with donating [20]. Therefore, it seems logical that this approach would encourage more early donations. Our data do show many early donations, as do real crowdfunding data collected from Kickstarter [13]. But in our study, one or two "missing" donations in the early period was frequently the only difference between funded and un-funded projects. Therefore, it is critical for projects to absolutely maximize their early donations. Even though all-or-nothing may minimize the incentive to wait, it does not eliminate it. People can still estimate for themselves that they may be able to free-ride and still reap the benefits of the project, or at least minimize the size of contribution they need to make. It is also very important to consider that waiting to donate towards the end was a good strategy if the project was funded. That is to say, if a project only needed a small donation at the deadline, the person who waits till the end then makes that small donation ends up with a large profit.

Design Implications

What can crowdfunding sites do get people to donate at the start of a project's campaign? One existing structure likely has a positive influence. Many projects offer potential donors some form of personalized reward or perk in exchange for a donation. Often, projects set limits on how many of these rewards are given out to donors, which gives an incentive to donate immediately. It is a limitation of our study design that we have treated crowdfunding projects as pure public goods, when in fact the rewards offered by projects add some additional complexity.

One potential design for crowdfunding sites that could maintain the all-or-nothing structure, but possibly lead to more early donations, would be to set a mandated pace for donations. Projects might have multiple check-in points during the time period of the campaign, and failure to maintain a pre-specified funding pace at any of these points would result in the project being closed and donations being immediately

refunded. This design may relieve the coordination dilemma that can occur because it encourages people to send signals of interest in a project (by way of donating) immediately, which then gives other potential donors a more accurate estimate of the true interest the crowd has in a project.

Another design might keep the current status or the total funding goal hidden from donors when the project gets close to reaching its goal. In this design, when a project meets its goal, it remains open for some period of time and can collect additional donations, since the status is not communicated. As a project grows beyond its goal, donations would not go to the project but rather to early donors. In our experiment, project status was not updated to donors in the final period and as a result, most projects that were funded received some excess donations. Returning these donations to early donors would offer a new incentive to donate early and express one's preference for a project rather than waiting or free-riding.

Limitations

This study has several limitations that should be considered. In our experiment, we created a simplified replication of a crowdfunding site that is has some clear differences from most real crowdfunding sites, such as the extremely limited amount of time of a campaign and the limited amount of information available about projects. In particular, our experiment was designed such that the only information donors had with which to coordinate was a project's funding total at a given moment in the campaign, whereas much richer information is available to donors making real crowdfunding decisions. Future work should examine how other type of information or communication afforded by crowdfunding platforms might influence timing decisions, or how our results may be moderated in more authentic crowdfunding scenario.

Our study also simulates the decisions of a large number of distinct people by having a smaller number of people make multiple decisions, such as how many times to donate and how many projects to donate to. This is demanded by the complexity of recruiting and coordinating participation in an experiment. Although the study successfully replicated the results of real crowdfunding sites by condensing the "crowd" in this way, it should be noted as a limitation because our simulation may have achieved similar results but for different reasons.

CONCLUSION

Overall, we can conclude that all-or-nothing crowdfunding with a deadline creates an inefficiency because it encourages people to withhold their donation. By withholding donations, people not only withhold funds from a project but also a signal to others about the crowd's interest in a project. Without these signals, donors do not efficiently coordinate and fund projects even when there is sufficient interest. Crowdfunding sites should explore ways to increase early donations so that crowd interest in projects is effectively communicated and donations are coordinated.

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