Auctions for Charity: The Curse of the Familiar[*]

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Abstract

Recently there has been considerable interest in the use of raffles and auctions to fund public goods. Economists have developed theories that predict which of the standard mechanisms should do well and they have run a variety of experiments to test the performance of these mechanisms. One aspect that has been largely overlooked, however, is whether new mechanisms can yield even more of the public good. We run fundraising events in the field at the meetings of a well-known service organization across the United States to examine the properties of five mechanisms: one that is common in the literature (first-price all-pay auction), two that are familiar to practitioners in the field (the English/live auction and the raffle), and two that are new (the "bucket" auction and a lottery-auction hybrid). Consistent with theory, we find large differences in performance between the two most familiar formats but these disparities are dwarfed by the differentials achieved using the new and less common formats. Our results demonstrate the continued potential of mechanism design to inform the provision of public goods and fundraising.

Keywords: Public Good, Raffle, Lottery, Auction, Fundraising, Mechanism Design, Field Experiment.
JEL Codes: C93, D44, D64, H41

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1 Introduction

> "[T]he onus is on philanthropists, nonprofit leaders and social entrepreneurs to innovate. But philanthropic innovation is not just about creating something new. It also means applying new thinking to old problems, processes and systems."
>
> Laura Arrillaga-Andreessen, philanthropist

The conversion of donated goods and services into more liquid assets to fund public goods is a familiar exercise to most charities and non-profits. According to the Internal Revenue Service, for the reporting year 2012, almost 50 percent of the nearly 46 million households that itemize deductions claimed non-cash charitable contributions. The estimated fair market value of these contributions was almost 47 million dollars. Indeed, for some organizations, this "transformation problem" is a formidable logistical challenge. Raffles and auctions are common solutions to this problem and, over the last decade or two, a vibrant literature on mechanism choice for non-profits has emerged. Along with the analysis of standard formats, a nascent literature has arisen that has offered new ones, which, in theory, should do better. For both analytical and empirical reasons, however, an ordering of mechanism performance based on expected revenue, not to mention participation and bids, is complicated.

As a theoretical matter, revenue equivalence does not hold, even in the simplest strategic environments wherein non-profits use the revenues to provide a public good. For example, the sealed-bid analysis of Goeree et al. (2005), working within the structure developed in Morgan (2000), was perhaps the first to show that in a world of altruistic, risk neutral bidders with independent private valuations each of whom (also) receives a benefit that is proportional to the total amount raised "all-pay mechanisms," including raffles, should do better.[1] The intuition is straightforward: in "winner-pay mechanisms," a class that includes most, but not all, familiar auction formats, a bidder who "tops" her rivals foregoes the externalities associated with their bids. What remains unclear, however, is the robustness of this result to the addition of new, perhaps dynamic, formats and endogenous participation choices.

It is also hard to assess the relative performance of auction and raffle mechanisms with revenue proportional benefits because the few experiments that have been conducted tend to be modest as a consequence of each auction yielding just one revenue observation. In addition, experiments often compare just a few existing formats and new ones have yet to be tested or compared to the formats that are typically chosen by charities and other

[1] Engers and McManus (2007) confirm many of these predictions while extending the literature by analyzing strategic choices of the auctioneer to set reserve prices or dissolve the auction. Carpenter et al. (2010a) compare the same sealed bid mechanisms but allow participation to be endogenous.

organizations investing in the public good. On top of all this, aside from a few important stylized facts, the experimental results have been inconclusive.[2]

The theory and experiment described in this paper were designed to extend the developing literature on charitable mechanism design in a number of important dimensions. Our first contribution is analytical. In contrast to the benchmark in this literature, Goeree et al. (2005), we compare an expanded set of mechanisms and allow for endogenous participation, all in an independent private values setting. To test our predictions, we report the results of a field experiment conducted on behalf of a national service organization at almost a hundred events across eleven US states. Our purpose is to provide a robust evaluation of five auction mechanisms in a natural setting.

The choice of which mechanisms to include was driven by three considerations. First, to make our results useful to practitioners, we included the two mechanisms used most frequently by charities in the field - the English or "live" auction and the raffle. Not only does including these two formats allow us to test how familiar formats compare to new and less familiar ones, a field comparison of just these two mechanisms is novel and should be of general interest for those organizations that might be reluctant to try something new.

Second, and with a nod to recent theoretical developments, we included two formats that ought to do better than those commonly used in the field. Goeree et al. (2005) show that the all-pay auction, in which the highest bid wins but all bids are forfeited, should yield more revenue than any winner-pay format like the second-price auction or, by extension, its strategic equivalent, the live auction. Further, Orzen (2008) finds that the all-pay also does better than the raffle in a common value environment because the raffle provides weaker incentives to compete due to the randomness of its allocation rule. More recently, Carpenter et al. (2014) show that a "bucket auction" in which bidders take turns making monetary contributions to a "bucket" and the winner is the person who makes the last contribution should do even better than the standard all-pay because it too is all-pay but has the incentives of a war of attrition. Following the related literature, we model the bucket auction as a second-price all-pay auction. While we find, in accordance with previous analyses, that bidders in the bucket bid more aggressively than in the all-pay, we also find, somewhat surprisingly, that both mechanisms generate the same level of participation. As a result, the bucket auction is predicted to perform best in terms of revenue, largely because of the competitive environment it instills.

Third, to examine the field validity of erstwhile empirical results, we were also careful to

[2] To see this, compare the results of Morgan and Sefton (2000), Dale (2004) and Carpenter and Matthews (2015) concerning raffles, Davis et al. (2006), Carpenter et al. (2008), Schram and Onderstal (2009), Corazzini et al. (2010), Onderstal et al. (2013) concerning standard auction formats and Goerg et al. (2015), Orzen (2008), Carpenter et al. (2014) and Damianov and Peeters (2018) on new mechanisms.

consider mechanisms that have previously done well in the lab. Though already included, both the all-pay and bucket auctions have done well in the lab environment (Orzen, 2008; Schram and Onderstal, 2009; Corazzini et al., 2010; Carpenter et al., 2014) but this performance is judged solely on the revenue properties of the mechanisms. Because we are interested in participation and bidding too, we included winner pay formats which, in theory, should attract more bidders. In addition to the live auction, we consider a "hybrid" that combines a lottery for participants financed by entry fees with a live auction for those who choose to enter. Our model predicts that, although this hybrid format should not do particularly well in participation due to the participation fee, it should outperform the commonly used formats (i.e., the live and the raffle) because it collects revenue from two sources.[3]

According to our analysis, the bucket auction is predicted to raise more money than any other mechanism considered, despite it not yielding the highest participation while the raffle is predicted to generate the largest number of participants because it incentivizes less competitive bidding and even the lowest-valued participant has a chance to win. In terms of mechanism design, we also show that the hybrid could be optimized by correctly choosing the entry fee, in which case is should always raise more money than the live auction. Considering our experiment, our title is intended to underscore both our central result and one of the most important lessons of our work: whatever the revenue differential between the two most familiar auctions, both perform much less well than the new mechanisms, a pattern that suggests that behavioral mechanism design has much to contribute.

2 Study Design

When considering where to run our experiment, we sought regional variation to broaden the representativeness of our results but we also required a host that, to a great extent, could provide a controlled environment, one with a common setting and philanthropically minded participants. After a successful local pilot, we decided to conduct our auctions at meetings of various local Rotary International clubs across the United States. Rotary is a service organization with 34,000 chapters and 1.2 million members worldwide. Members believe in the "commitment to service above self" and when they are not volunteering in their communities, members help raise money to support education and job training, provide access to clean water, combat hunger, improve health and sanitation, and eradicate polio.[4] Local Rotary clubs meet weekly over a meal (usually breakfast or lunch) and are accustomed

[3]Ironically, despite the entry fee, the hybrid attracted the highest number of bidders in lab experimental comparison (Carpenter et al. 2010b).

[4]https://www.rotary.org/en/about-rotary.

to hosting speakers and events in addition to the weekly business conducted at the meetings. We "piggybacked" on this structure, which allowed us to control for the meeting environment across different locations, to conduct charity auctions with randomly assigned formats at various chapters across the country.

We chose a prize for each event that would be site-independent and context-free. We decided that the prize should also be familiar, something that would be natural at a fund-raiser and that it should be acquired easily at our different field locations. Our lot consisted of two bottles of relatively high quality wine (both received *Wine Spectator* scores of 90 out of 100). We included one bottle of non-vintage prosecco (that showed a "good blend of baked apple, sour lemon and grapefruit") and one bottle of South American cabernet sauvignon (with "crushed plum, fig and black currant fruit woven with Mauro tobacco and bittersweet cocoa"). The combined retail value of the wine was $35. At each event, we provided the prize and all proceeds from the auction went directly to supplement the fund-raising efforts of the local Rotary chapter that hosted the event.

To conduct the events, we recruited eleven auctioneers from various graduate programs in economics in addition to our two local research assistants. Each auctioneer attended a training session at which we explained the background and goals of the research project, worked through the details of the protocol, and met with the president of the local Rotary chapter to strategize about the best way to gain access to clubs. Shortly after arriving home, each auctioneer received a standard provision of supplies that allowed him or her to conduct events. The auctioneers worked first to get on the meeting schedule for clubs in their local area and were able to use our local president as a reference. Once the schedule was set, we randomly assigned mechanisms to clubs, stratifying on location with the purpose of making sure that each of our auctioneers would run multiple different mechanisms.

Prior to every event, the Rotary chapter contacts let the members know that our research assistant was going to visit to conduct a fundraiser for Rotary and then talk about raising money for charity, more broadly. However, neither the leaders nor the members knew the details of the event in advance. Most importantly, they did not know which mechanism would be used. Once an event started, the auctioneer followed a highly scripted protocol. Club members were given a large manila envelope and told to take out a survey to complete while they ate. Once the surveys (and meals) had been completed, the auctioneer introduced her- or himself and said that (s)he was there to talk about ways of turning donations in-kind into cash but that they would start with an example – our wine auction. The auctioneer then displayed and described the two bottles of wine (but did not reveal the retail price) and stressed that we had donated the wine but all the revenue from the auction would go directly to Rotary. Participants took out printed instructions from the envelope and read along as the auctioneer explained the rules, all of which, including any mechanism-specific language, are provided in the appendix.

Once any questions were clarified (by returning to the appropriate section of the instructions), the auction began. Club members were instructed to first pull out a "registration" card on which they indicated whether or not they would participate. For the sealed bid mechanisms (all-pay, raffle) this card also recorded their bids.

The bidding in each mechanism proceeded as follows. For the live auction, and the live component of the hybrid auction, the auctioneer was told to always start by asking for an opening bid of $25 and to reduce the opening bid by $5 decrements until someone entered. Once the bidding began, the auctioneer was instructed to increase the price by $5 increments until (s)he could no longer and then drop to $1 increments until the final price was determined. In the all-pay, participants wrote their bids on the registration cards and included them with payment in a sealed envelope.[5] In the raffle, participants indicated on the registration card the number of $5 tickets they would like to purchase and the auctioneer collected payments before randomly selecting the winning ticket. In the bucket, each participant was given a common endowment: a clear bag that contained 30 red poker chips, each worth $5. Participants were told that they would only have to pay for the chips that they used and that more chips were available, if needed. They were then sorted by their randomly assigned participant numbers and organized into a circle. The auctioneer presented a small galvanized bucket to the person with the lowest participant number who started the auction. This person could either place a $5 chip into the bucket or withdraw from the auction. The auctioneer then cycled with the bucket around the circle (in order of increasing participant numbers) asking each person to add a chip to the bucket or withdraw. Eventually all but one bidder dropped out and the last remaining bidder was declared the auction winner. In the hybrid, before getting to the live auction, members who wanted to participate had to pay a $5 entry fee for which they received one lottery ticket. After the live auction had finished, the auctioneer drew one of the tickets at random and the ticketholder won half of the entry fees. The remaining half was added to the auction revenue and donated to Rotary (this is known as a 50-50 lottery).

Once winners were determined and payments reconciled, the auctioneer awarded the wine, announced how much money had been raised and publicly gave the chapter president the auction proceeds. After this, there was typically enough time for the auctioneer to do a quick debriefing. Members were given a two-page summary of the project with some previous lab results and the auctioneer answered questions and discussed the problem of

[5] It was common knowledge that payments could be made via credit card, check (made out directly to Rotary) or cash (and that the auctioneer could make change, if needed).

in-kind donations and the virtues of the different charity auction mechanisms.

3 Participation, Bid and Revenue Predictions

To get a sense of the expected fundraising capabilities of the five mechanisms implemented in the field, we study their equilibria and compare their relative performance on both the extensive (participation) and intensive (expected bid) margins as a means to decompose any expected revenue differences. Our model combines two features that have recently been studied in separate strands of the auction theory litrature: bidding in the presence of externalities generated via charitable giving (see e.g. Engelbrecht-Wiggans 1994, Goeree et al. 2005 and Engers and McManus, 2007) and endogenous participation related to entry costs (see, e.g. Samuelson, 1985 and Menezes and Monteiro, 2000). As in most of this work, we consider a model in which $n \geq 2$ potential risk neutral bidders have valuations which are independent draws from a continuously differentiable probability distribution F with support $[\underline{v}, \overline{v}]$ and density f that is positive in the interior of the support. The valuation of bidder $i = 1, 2, \ldots, n$, denoted by v_i, is private information, while the cumulative distribution function F is common knowledge.

As in Goeree et al. (2005), all bidders receive a benefit equal to a proportion, $\alpha < 1/n$, of auction revenues. Further, as in Menezes and Monteiro (2000), bidders incur a participation cost, $c > 0$, which is associated with the time and effort expended to prepare and submit a (sealed) bid or to formulate and execute a bidding strategy. The seller utilizes one the following five mechanisms: all-pay auction (a), bucket auction (b), hybrid auction (h), live auction (l), or raffle (r). In this setting, the live auction is isomorphic to a second-price winner-pay action (see Engers and McManus, 2007, Proposition 1) while the hybrid auction is isomorphic with a second-price winner-pay auction with a participation fee. Further, for the purpose of our equilibrium analysis, we approximate the bucket auction with the second-price all-pay auction. An equilibrium analysis with endogenous participation of the second-price winner-pay (or live) auction and the all-pay auction is developed in Carpenter et al. (2010a). We extend this analysis and discuss the symmetric Bayes-Nash equilibrium behavior for all five formats.

For expositional clarity, and to facilitate the comparison across mechanisms, we analyze separately the all-pay auctions, the winner-pay auctions, and the raffle, which is an all-pay format based on a non-perfectly discriminating contest. The equilibria of all mechanisms are given in cutoff strategies such that bidders participate only if their valuations are equal to or exceed a certain threshold and, conditional on participation, submit a bids which depend on their private values. The following proposition describes bidding in the all-pay formats.

Proposition 1 (**All-pay auctions**). *The threshold participation values for both auctions are equal,* $\underline{v}^a = \underline{v}^b = \underline{v}^{ab}$ *and are given by the equation*

$$F(\underline{v}^{ab})^{n-1}\underline{v}^{ab} = c$$

The symmetric Bayes-Nash equilibrium bid functions $\sigma^j(v)$ *for* $j = a, b$ *and* $v \geq \underline{v}^{ab}$ *are*

$$\sigma^a(v) = (n-1)\int_{\underline{v}^{ab}}^{v} \frac{xf(x)F(x)^{n-2}}{1-\alpha}dx$$

$$\sigma^b(v) = (n-1)\int_{\underline{v}^{ab}}^{v} \frac{xf(x)F(x)^{n-2}}{(1-\alpha)-(1-\alpha n)F(x)^{n-1}-\alpha(n-1)F(x)^{n-2}}dx$$

The corresponding expected revenues are

$$R^a = n(n-1)\int_{\underline{v}^{ab}}^{\overline{v}} \frac{x}{1-\alpha}[F(x)^{n-2}(1-F(x))f(x)]dx$$

$$R^b = n(n-1)\int_{\underline{v}^{ab}}^{\overline{v}} \frac{x(1-F(x)^{n-1})}{(1-\alpha)-(1-\alpha n)F(x)^{n-1}-\alpha(n-1)F(x)^{n-2}}[F(x)^{n-2}(1-F(x))f(x)]dx$$

and the bucket auction revenue dominates the all-pay auction (i.e., $R^b > R^a$*).* See the appendix for a proof of this proposition.

We next present an analysis of the winner pay formats: the live and the hybrid auctions. Recall that the difference between these two formats is that in the hybrid auction bidders are charged an entry fee, half of the entry fees collected are awarded as a prize in the lottery part of the auction and the other half are added to the auction revenue. We denote the effective participation fee, i.e., half of the entry fee charged, as e. Predictions in the live and the hybrid auctions are given as follows.

Proposition 2 (**Winner-pay auctions**). *Participation in the live auction is greater than or equal to participation in the hybrid but the live yields less revenue than an optimally designed hybrid auction, conditional on the optimal hybrid having a positive entry fee. The participation threshold values for the live auction* $\underline{v}^l$ *and the hybrid auction* $\underline{v}^h$ *are given by the equations*

$$F(\underline{v}^l)^{n-1}\underline{v}^l + \alpha(n-1)F(\underline{v}^l)^{n-2}(1-F(\underline{v}^l))\sigma^{ls}(\underline{v}^l) = c$$

$$F(\underline{v}^h)^{n-1}\underline{v}^h + \alpha(n-1)F(\underline{v}^h)^{n-2}(1 - F(\underline{v}^h))\sigma^{ls}(\underline{v}^h) = c + (1-\alpha)e$$

if these equations have a solution in the interval $(\underline{v}, \overline{v})$. *Otherwise, either all bidders participate or none do in the respective mechanism.*

The symmetric Bayes-Nash equilibrium bid functions are the same $\sigma^l(v) = \sigma^h(v) = \sigma^{lh}(v)$ *and are given by*

$$\sigma^{lh}(v) = v + \int_v^{\overline{v}} (\frac{1-F(x)}{1-F(v)})^{\frac{1}{\alpha}} dx$$

and the expected revenues are

$$R^l = n(n-1)\int_{\underline{v}^l}^{\overline{v}} F(x)^{n-2}(1-F(x))f(x)\sigma^{lh}(x)dx$$

$$R^h = n(n-1)\int_{\underline{v}^h}^{\overline{v}} F(x)^{n-2}(1-F(x))f(x)\sigma^{lh}(x)dx + n(1-F(\underline{v}^h))e$$

A noteworthy aspect of these results is that for $n = 2$ and $\underline{v}^l = \underline{v}$ the left hand-side of the first equation equals $\alpha\sigma^{lh}(\underline{v}^l)$ and is positive. This suggests that when c is smaller than the left hand-side of the same equation evaluated at $\underline{v}$, the seller can charge an entry fee equal to the difference $c - F(\underline{v})^{n-1}\underline{v} + \alpha(n-1)F(\underline{v})^{n-2}(1-F(\underline{v}))\sigma^{ls}(\underline{v})$ without causing bidders to exit. Thus, the revenue in the hybrid auction, for an appropriately chosen entry fee, exceeds the revenue in the live auction. This is only a feature of the two bidder case, however, as the participation of one bidder prevents her rival from obtaining the prize without contributing anything. Note that in the case of three or more bidders this effect does not exist and the incentives to enter are weaker. That is, in the case of three or more bidders, in equilibrium bidders will enter with a probability of less than one as long as $c > 0$. In addition, from the equation defining the participation rate in the hybrid auction we observe that charging an entry fee might potentially raise revenue but at the cost of participation. To establish a condition for the revenue-maximizing entry in the hybrid auction, it is convenient to write the entry fee as a function of the threshold value using the equation for the entry in the hybrid auction:

$$e(\underline{v}^h, c) = \frac{1}{1-\alpha}[F(\underline{v}^h)^{n-1}\underline{v}^h + \alpha(n-1)F(\underline{v}^h)^{n-2}(1-F(\underline{v}^h))\sigma^{ls}(\underline{v}^h) - c]$$

With this formulation, the problem of the auctioneer can be stated as one of choosing the optimal $\underline{v}^h$.

A derivation of the symmetric Bayes-Nash equilibrium of the live auction is presented in Carpenter et al. (2010a). As the hybrid auction can be viewed as a live auction augmented with an entry fee, it is straightforward that bidders will follow the same type-dependent strategy in equilibrium, yet, due to the entry fee, the participation threshold value in the hybrid auction will be greater. Bidders with valuations below the threshold, $\underline{v}^h$, given by the first equation in Proposition 2 receive a negative payoff and prefer not to participate while bidders with values equal to or above $\underline{v}^h$ find it worthwhile to make a bid.

Considering biding in the raffle,

Proposition 3 (**Raffle**). *The raffle has a unique Bayes-Nash equilibrium. The participation threshold value for the raffle* $\underline{v}^r$ is determined by the equation

$$v^r \times \int_{\underline{v}}^{\overline{v}} \cdots \int_{\underline{v}}^{\overline{v}} \frac{\sigma_i(\underline{v}^r)}{\sum_{j \neq i} \sigma_j(v_j) + \sigma_i(\underline{v}^r)} dF_{-i}(v_{-i}) = c$$

if this equation has a solution in the interval $(\underline{v}, \overline{v})$*. Otherwise ether all players participate or all players do not participate in the mechanism. For* $v \geq v^r$ *the (symmetric) Bayes-Nash equilibrium function* $\sigma^r(v)$ *satisfies the conditions*

$$v \times \int_{\underline{v}}^{\overline{v}} \cdots \int_{\underline{v}}^{\overline{v}} \frac{\sum_{j \neq i} \sigma_j(v_j)}{[\sum_{j \neq i} \sigma_j(v_j) + \sigma_i(v)]^2} dF_{-i}(v_{-i}) \begin{cases} = 1 & if \quad \sigma_i(v) > 0 \\ \leq 0 & if \quad \sigma_i(v) = 0 \end{cases}$$

where $\sigma_i(v) = \sigma_j(v) = \sigma^r(v)$ *for* $i = 1, 2, \ldots, n$*. Bidders with values* $v < v^r$ *do not participate, i.e. for these values* $\sigma^r(v) = 0$*.*

A proof of the existence and uniqueness of equilibrium in this setting is provided by Ewerhart (2014). The first condition in Proposition 3 requires that the threshold bidder has an expected payoff equal to the entry cost. The second condition is a first order condition that requires that each bidder type submits a bid which maximizes its expected payoff given the equilibrium strategy employed by the other bidders. A similar approach is used by Fey (2008), Ryvkin (2010) and Wasser (2013). As pointed out in these studies, the equilibrium strategy in the raffle cannot be expressed in closed form, yet further progress can be made using numerical methods.

To get a sense of the relative performance of the five mechanisms, we adapted the numerical routines developed in Wasser (2013) to account for endogenous entry choices and report the participation, bids and revenues generated by each of the five mechanisms using parameter values based on our experiment. As part of our post-experiment questionnaire, we asked participants for their private valuations of the lot of wine we used as the auction prize. It turns out that 90% of these values are between \$10 and \$60. We, therefore, assume that values in our simulations are uniformly distributed over the interval $[10, 60]$, with an expectation of \$35, the actual monetary value of the prize. We assume that the cost of participation is low, $c = \$1$ and to examine how the results change as the number of bidders increases, we present calculations for as few as 2 potential bidders and as many as 20. Lastly, the benefit from the public good is set at $\alpha = 0.25$ and the entry fee for the hybrid is \$2.5, half the fee charged in the field (see the appendix for additional details of our numerical methods). The major results are presented in Figure 1 below.

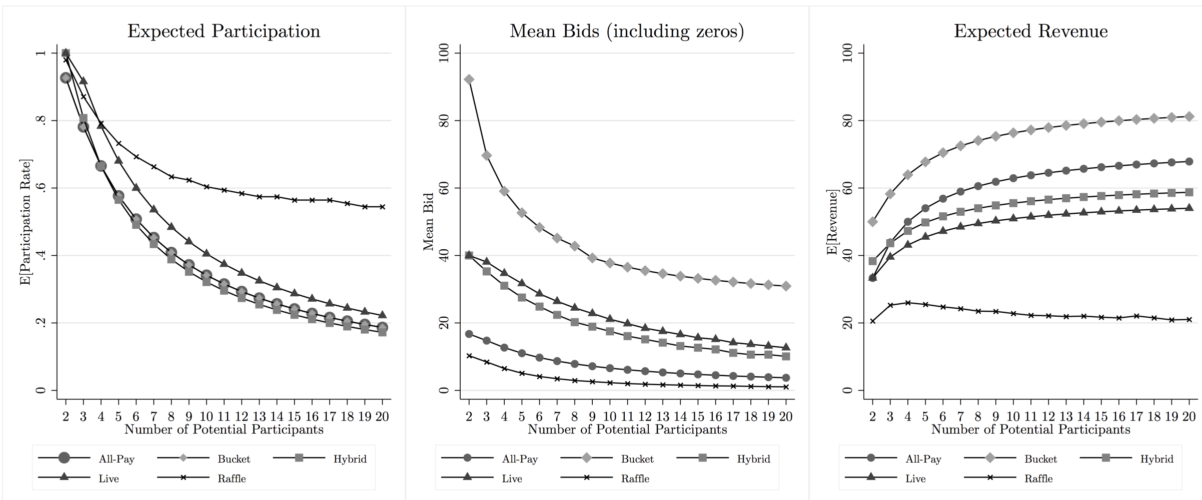

Figure 1: Charity Auction Theoretical Predictions (Note: numerical simulations generate predictions on expected rates of participation (left), mean bids, including zeros for non-participants (middle) and expected revenues conditional on endogenous participation (right)).

The numerical simulations help highlight several aspects of the expected performance of the mechanisms. Starting with the extensive margin, we see that the raffle does particularly well, with expected participation rates often well over 50%. In fact, with thick enough auctions (i.e., $n > 4$) the raffle is predicted to perform best on participation and the gap between it and the live auction only grows with the size of the event. The driving force behind this result is that even the lowest-value participant has a positive chance of winning the prize and the mechanism elicits lower levels of competition due to the non-perfectly discriminating nature of the lottery contest. Placing second in the participation race is the live auction, which is no surprise given bidders have nothing (beyond the same participation cost faced by the others) to lose. In third (and fourth) place in terms of participation, are the all-pay formats, which do just a bit better than the hybrid. Hence, the balance of our numerical simulations suggest that in circumstances like ours in which the number of active bidders is always greater than four, in terms of participation, we should expect: *Raffle* > *Live* > *All-pay* = *Bucket* > *Hybrid*.

Considering predictions on the intensive margin, at the center of Figure 1, we see that the bucket is predicted to garner the highest average bid, regardless of the size of the event. In addition, the predicted difference between it and the second highest performer, the live auction, is large. The predicted average bids in the other four mechanisms are clustered in two groups. Along with the live in the better performing cluster, is the hybrid in third place. The anticipated difference between the live and hybrid auctions is not large, however. As expected, the remaining two all-pay mechanisms perform worst in terms of predicted bids, with the all-pay doing a bit better than the raffle. Putting this all together, our model predicts the following ordering of mean bids: *Bucket* > *Live* > *Hybrid* > *All-pay* > *Raffle*.

On the right of Figure 1, we find that the bucket, which is predicted to incentivize competitive bidding, is expected to yield the most revenue under all conditions and the differential is always sizable. Because, like the bucket, the all-pay collects bids from everyone and doesn't scare away too many bidders, it comes in second place in the revenue race after more than four bidders join. The fact that the hybrid gathers revenue from two sources helps it do better than the live auction. Finally, the predicted inefficiency and reduced competitiveness of the raffle causes it to come in last place in the theoretical revenue competition. Summarizing our revenue predictions, we expect: *Bucket* > *All-pay* > *Hybrid* > *Live* > *Raffle*.[6]

Also of note, though mostly for future work, is that our numerical simulations also demonstrate that the opportunity cost of not designing the hybrid auction optimally is small. Using the results of Proposition 2 to calculate the optimal entry fee for each set of parameter values, we see that, if designed properly, the hybrid would remain in last place in the participation competition because the optimal fee is always larger that the one charged in the field, and despite the larger fee, because it is collected from even fewer participants in many cases, the hybrid never quite "pips" the all-pay for second place in terms of revenue.

4 Results Overview

In total, our research auctioneers conducted 96 events in 11 states with 1706 Rotary club members. The geographic distribution of our auctions is depicted in Figure 2. Starting in the Northeast, 4 sessions were conducted in rural Maine (52 participants), 8 sessions were

[6]One last thing to notice about Figure 1 is that in some cases (mostly when n is low) the mean predicted bid in the bucket is larger than the revenue to be collected. To reconcile these results, recall that the bucket is isomorphic with a second-price all-pay auction in which the highest bid is never collected.

conducted in Vermont (162 participants), 2 were conducted in upstate New York (20 participants) and 30 sessions were conducted near Pittsburgh and Philadelphia in Pennsylvania (490 participants). Among the mid-Atlantic and southern states we conducted 4 sessions in Virginia (48 participants), 15 sessions in the Knoxville area of Tennessee (280 participants), 1 session in Georgia (18 participants) and 2 in Tallahassee, Florida (40 participants). In the Midwest, we visited 5 Rotary chapters in Indiana (94 participants) and 21 chapters in Texas (418 participants). Lastly, on the west coast, 4 sessions were conducted in California (85 participants).

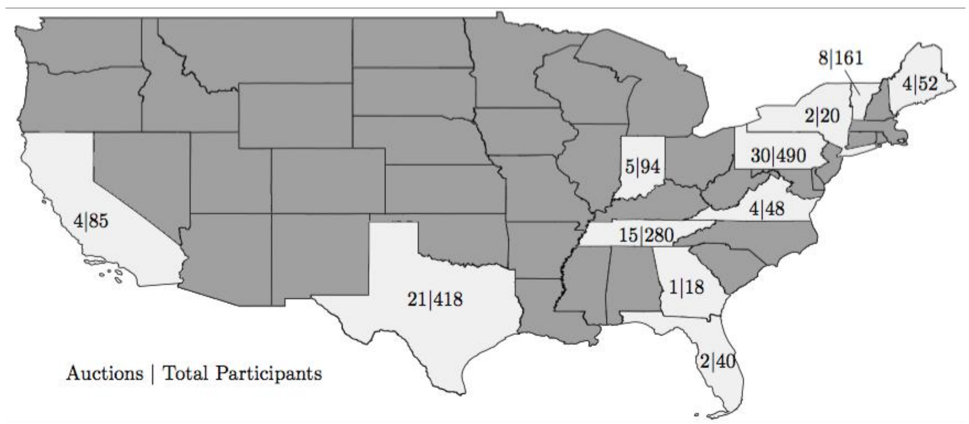

Figure 2: Auction sessions and participation by state.

We were able to collect auction data from 95 of our 96 sessions (in one case the meeting dissolved earlier than planned), which yielded almost 20 observations per mechanism. At the session level, we gathered participation, bid and revenue data from 20 all-pay auctions, 19 bucket auctions, 19 hybrid auctions, 19 live auctions, and 18 raffles. Overall, attendance at our events averaged 17.92 Rotary members (the minimum was 5 and the maximum was 29) and 11.79 of these members, on average, participated. This corresponds to a mean participation rate of close to 70%. The mean bid, excluding those people who chose to not participate but including those participants who opted in but then bid zero, was $24.41. In terms of revenue, our events raised a total of $18,081 for Rotary International. Perhaps more salient is the fact that, on average, we raised $190.32 with just $35 of wine.

Table 1: Treatment Balance

	All-pay	Bucket	Hybrid	Live	Raffle
Age	57.93	58.12	56.80	56.00	56.79
Female	0.26	0.22	0.23	0.25	0.23
White	0.82	0.84	0.87	0.90	0.89
College or More	0.70	0.68	0.69	0.76	0.76
High Income	0.54	0.56	0.50	0.51	0.53

Notes: Participant characteristic means by treatment.

Given the membership of Rotary, our participants were representative. The average age of session attendees was 57.11, 24% were female, and 86% had at least a college education. The median income of the group (measured in intervals) was \$100k-\$124k. For the purposes of our analysis we create an indicator ("High Income") for at least this level of earnings.[7] Considering randomization to auction format based on observables, Table 1 indicates balance was achieved, for the most part.[8]

5 Mechanism Differences

In many cases charities that conduct fundraisers such as ours are as interested in participation as they are in revenue. An event that draws in potential donors because it is interesting, fun or stimulating may raise as much or more money in the long run through the development of a "warm list" (Landry et al. 2010) as one that initially generates a lot of revenue but leaves donors feeling "tapped out". In addition, final auction revenue is determined both by bidding behavior and participation. With this in mind, we analyze our auction data in three steps. We start by testing for differences in participation rates across the five mechanisms, we then repeat the tests to explore any differences in bidding behavior and we conclude the analysis by comparing the revenues generated by each mechanism.

[7] Specifically, there were ten household income brackets participants could choose from (starting with "less than \$25k" and ending with "more than \$225k") and High Income is coded as 1 when a participant chose one of the top five choices (and is coded as 0 otherwise).

[8] Using t-tests, in only 8 of the 50 possible comparisons between mechanisms do we find demographic differences that rise to the 5% level of significance.

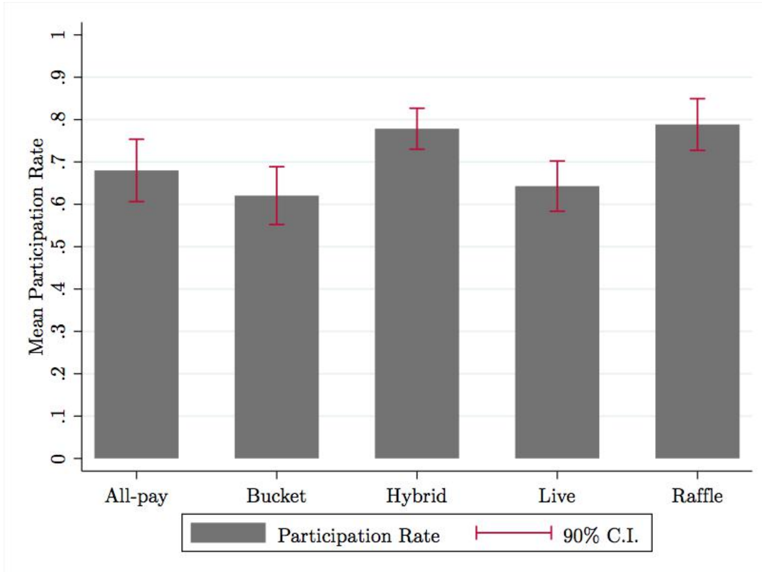

Figure 3: Participation Rates by Mechanism.

In Figure 3, we present mean participation rates by auction format. As mentioned above, the first thing to notice is that participation is relatively high, in general. All mechanisms yield participation rates between 60% and 80%. However, there are some modest differences. Starting with the familiar formats, the raffle attracts the most participants on average (79%), while the live auction does poorly (64%) by comparison. Considering that the other three, less common formats, perform (more or less) somewhere in between the raffle and the live, it is unlikely that mechanism familiarity drives our participation differences.

There are a few other things to note in Figure 3. First, in line with our predictions (see Figure 1), the raffle does well on participation, a finding that is consistent with previous laboratory experiments (Carpenter et al., 2010b). Also in accordance with theory, the all-pay and bucket auctions are in the middle of the pack and the difference between the two formats is small. Compared to previous experiments, the bucket result is similar to the lab results of Carpenter et al. (2014) who show that participation in this format is similar to in other mechanisms, but the all-pay result is novel given it attracted more participation here than it has in previous field trials (e.g., Carpenter et al. 2008 and Onderstal et al. 2013). One interpretation of this difference is that the all-pay seems to do well among people inclined to give (i.e., rotarians). The big surprise, given our theoretical predictions, is the reversal of the live and hybrid auctions in the participation ordering. The model predicted the live auction to do well (because bidders have nothing to lose) and the hybrid to do poorly (because of the entry fee) but we find exactly the opposite. That said, this reversal is consistent with the lab results of Carpenter et al. (2010b) and one possible explanation has to do with the hybrid providing two chances to win instead of just one.

Table 2: Participation Differences

	(1)	(2)	(3)	(4)
All-pay (I)	0.037	0.036	0.024	0.031
	(0.055)	(0.057)	(0.044)	(0.046)
Bucket (I)	-0.022	-0.007	-0.031	-0.013
	(0.053)	(0.059)	(0.044)	(0.053)
Hybrid (I)	0.136***	0.128**	0.139***	0.132***
	(0.044)	(0.054)	(0.035)	(0.045)
Raffle (I)	0.146***	0.156***	0.148***	0.152***
	(0.049)	(0.054)	(0.045)	(0.043)
Intercept	0.643***	0.766***	0.616***	0.566***
	(0.034)	(0.244)	(0.028)	(0.072)
Level of Analysis	Ses.	Ses.	Ind.	Ind.
Experimenter Fixed Effects	No	Yes	No	Yes
Participant Demographics Included	No	Yes	No	Yes
Zip Code Level Controls Included	No	Yes	No	No
Observations	95	95	1690	1583
Adjusted R^2	0.13	0.40	0.02	0.03

Notes: Dependent variable is event participation rate for session-level analysis and a participation indicator for individual analysis; omitted mechanism is the Live auction; OLS; (robust standard errors); * p<0.10, ** p<0.05, *** p<0.01; demographics include mean age, number of female attendees, number of attendees with high income, number of attendees with a college degree or more education; other zip code level controls include averages of adjusted gross income, unemployment insurance, charitable contributions, homeownership rates and travel times to work.

To generate conservative estimates of the participation differences, in Table 2 we regress event-level participation rates on format indicators in the first two columns. The first column replicates the findings presented in Figure 3 – there are two groups of mechanisms separated by a participation differential of slightly more than 10%. In one group, the raffle and the hybrid attract almost 80% of bidders and in the other group the all-pay, the bucket and the live attract closer to 65%. Comparing all combinations of the point estimates, confirms this grouping. In the second column we add experimenter (i.e., auctioneer) fixed effects to make sure that we aren't attributing differences to the mechanisms when they are actually driven by the differential "charm" of our auctioneers. We also add characteristics of the attendees: their average age, the number who are female, the number who earned a college degree or more and the number who have incomes larger than the median of our entire sample. Using IRS and Census data from 2010 we also created controls at the zip code level for household-level averages of adjusted gross income, reported unemployment insurance received, charitable contributions, homeownership, and travel times to work.

Although some of the auctioneers were more charming than others (see the increased adjusted R^2 in column 2), the differences are orthogonal to our mechanism treatments (as stratification ensured). The addition of the other variables (to control for willingness to pay, philanthropic environment, population density, and, perhaps sprawl/stress) contributes little to the explanatory power of the model and has no effect on our participation estimates. In columns (3) and (4) of Table 2 we redo the analysis using the individual-level participation data. Here the point estimates are nearly identical but measured more precisely because of the increased number of observations. In the end, we conclude that the familiar raffle and the not so familiar hybrid attract more bidders than the other three mechanisms, however, while significant, the participation differences are modest.

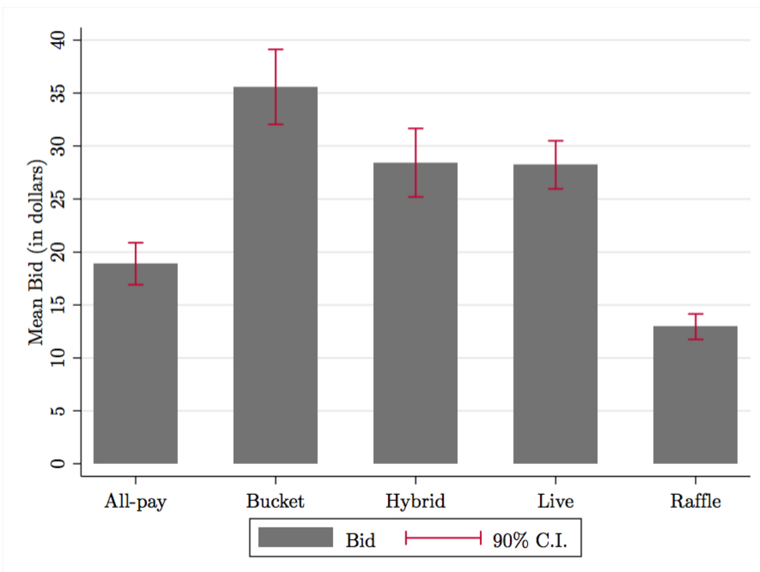

Figure 4: Bids by Mechanism (participants only).

Average bids, including those from people who participated but bid zero (18% of the sample), are summarized by format in Figure 4. Notice first that the mean bids in the live auction and the hybrid are only slightly lower than the retail value of the wine. On average, participants bid \$28.22 in the live and \$28.42 in the hybrid (excluding the \$5 participation fee) which, as predicted in Proposition 2, are statistically indistinguishable in the individual-level data ($t = 0.07$, $p = 0.95$). Also notice that participants in the all-pay and the raffle react as expected to the fact that their bids are always forfeited - they bid less than participants in the winner-pay formats. Again using the individual-level data, the all-pay mean bid is significantly lower than all formats except the raffle ($p < 0.01$ for all comparisons). Bidders in the bucket, do not reduce their bids, however. The mean bid in the bucket is \$35.58, an amount significantly greater than all the other formats ($p \leq 0.05$ or lower) and indistinguishable from the retail values of the prize ($t = 0.20$, $p = 0.84$). Considering our theoretical predictions by returning to Figure 1, we see that mean bids are ordered, more or less, exactly as predicted.

Table 3: Bid Differences

	(1)	(2)	(3)	(4)
All-pay (I)	-9.315***	-8.607**	-8.835***	-9.155***
	(3.066)	(3.848)	(1.975)	(2.283)
Bucket (I)	7.145	6.690	8.103**	6.198*
	(4.710)	(5.360)	(3.540)	(3.674)
Hybrid (I)	1.021	1.723	1.225	-0.665
	(4.936)	(5.126)	(3.107)	(2.884)
Raffle (I)	-13.828***	-13.780***	-14.276***	-14.990***
	(3.182)	(4.593)	(1.810)	(12.541)
Intercept	27.862***	10.165	18.729*	20.421*
	(2.461)	(26.971)	(9.969)	(10.687)
Lambda			18.004	8.517
			(18.697)	(20.090)
Level of Analysis	Ses.	Ses.	Ind.	Ind.
Experimenter Fixed Effects	No	Yes	No	Yes
Participant Demographics Included	No	Yes	No	Yes
Zip Code Level Controls Included	No	Yes	No	No
Observations	95	95	1554	1535
Adjusted R^2 or Rho	0.21	0.27	0.56	0.29

Notes: Dependent variable is mean bid for session-level and bid for individual-level analyses; the omitted mechanism is the Live auction; OLS or Heckman with instruments of having cash on hand and a willingness to participate in a follow-up survey; (robust or bootstrap standard errors); * p<0.10, ** p<0.05, *** p<0.01; demographics include mean age, number of female bidders, bidders with high income and bidders with a college degree or more education; zip code level controls include averages of adjusted gross income, unemployment insurance, charitable contributions, homeownership rates and work travel times.

Table 3 offers guarded bid estimates by first collapsing the data to session averages in columns (1) and (2). Compared to the live, participants in the all-pay and raffle bid considerably less. Conditional on participating, all-pay donors bid approximately \$9 less than live bidders and raffle donors give even less, almost \$14. Both of these differences are highly significant and do not depend on whether demographic or experimenter controls are included. In addition, the hybrid point estimate is never significantly different from zero suggesting there are no synergies between the lottery and auction in this mechanism. Again, auctioneer fixed effects and participant demographics have little effect on these estimates. Lastly, the point estimate on the bucket differential hovers around \$6 which is a significant sum, but there is not enough power in the auction-level data to identify it precisely.

In the second two columns of Table 3, we re-examine bids by taking advantage of the individual level data. Doing so increases the power of the analysis considerably and has the additional benefit of allowing us to instrument for selection. We utilize a standard two-stage Heckman selection model in which the first stage instrument comes from our survey. Although all methods of payment were possible on the day of an event, we expected people to be more likely to participate if they had cash on hand (and that this would be equally true for all the mechanisms). Indeed, having access to cash at the time of the event is a strong predictor in the first-stage regressions: it increases the probability of participating by 8.5 percentage points (and has no significant effect on bids conditional on participation). In addition, the estimated effect of selection (Lambda $\times$ the average mills value) is economically significant: those who choose to participate submit bids that are between \$4.41 and \$9.24 higher. But, despite all this, a Hausman test indicates that the estimated selection effect does not bias the collection of mechanism coefficients significantly. Most importantly, the only noticeable change we see from using the individual-level data is that our estimate of the bucket differential increases and is now significant. While all-pay bidders in the sealed bid auction and raffle reduce bids as expected compared to the live and hybrid auctions, we find that bucket auction bidders donate more than all others.

At this point the careful reader should have a good sense of what the revenue comparisons will look like. Given participation is roughly similar across mechanisms but participants tend to reduce their bids in only two of the three all-pay mechanisms, the one in which they do not reduce their bids must do well. Indeed, in Figure 5 we report average revenues by mechanism and find that the most familiar auction mechanism (the live) tends to double the retail value of our prize while the least familiar (the bucket) increases it by more than an order of magnitude. Compared to the other formats, the live auction appears to underperform, but it actually did rather well for Rotary. On average, the live auction garnered \$63, which is close to double the wine's retail value. The hybrid, with its two components, did a bit better, \$103, on average.[9] And, consistent with theory, the all-pay (\$211 on average) did

[9]However, if we just consider the live auction proceeds (i.e., in the absence of the lottery revenue), the hybrid generates an average of \$71 which is indistinguishable from the live (p=0.50).

slightly better than the raffle ($179) but both do considerably better than either the hybrid or live auctions. All the revenue differences are dwarfed, however, when we consider the bucket, which raised an average of $393. Not only does the bucket come close to doubling the revenues generated in either the all-pay or the raffle, it yields more than six times the revenue raised in the live auction. Considering theory, the observed revenue ordering is as predicted with one exception: while the raffle was predicted to collect the least amount of revenue, in the field it outperformed both the hybrid and live auctions.

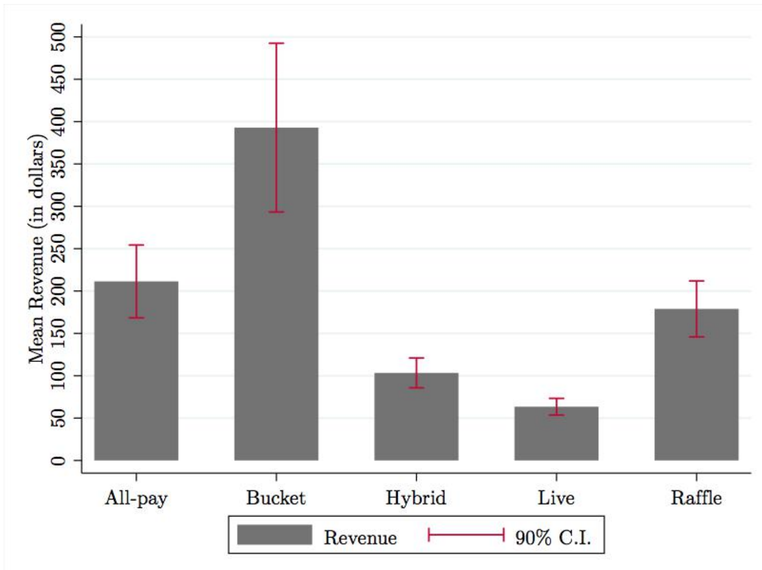

Figure 5: Revenue Raised by Mechanism.

In Table 4 we examine the revenue differences more closely. Again, the live auction is used as the baseline mechanism. Column (1) suggests that all the mechanisms yield significantly more revenue than the live auction. Comparing the point estimates we also confirm that the hybrid raises significantly less money than any mechanism except for the live auction, the all-pay and the raffle raise equal amounts of revenue, and the bucket earns significantly more revenue than any other mechanism. In column (2) we add experimenter fixed effects, bidder characteristics and the zip code level controls to little effect.[10] In column (3) we include the number of active bidders (instrumented using the start time of the event - more active bidders turn out at breakfast meetings) to make sure that the revenue differences are not being driven by differences in participation. Although it is the case that, on average, another bidder increases revenue by slightly less than $12 across mechanisms, controlling for this affects our estimates of mechanism performance only slightly. Like the rest of the

[10]Judging by the small bump in adjusted R^2 between the first two columns of Table 2, the differences among our auctioneers effect participation primarily and not revenue.

analysis, our revenue results are very robust: the hybrid and live auctions perform relatively poorly, the all-pay auction and raffle do relatively well, but the bucket auction raises the most revenue for charity in this field setting.

Table 4: Revenue Differences

	(1)	(2)	(3)
All-pay (I)	147.965***	164.519***	168.854***
	(25.497)	(32.027)	(33.594)
Bucket (I)	329.474***	333.863***	345.748***
	(59.345)	(76.732)	(82.726)
Hybrid (I)	39.895***	57.518**	55.608*
	(11.622)	(26.787)	(30.928)
Raffle (I)	115.468***	130.436***	104.415***
	(19.757)	(34.481)	(38.610)
Active Bidders (#)$^{\alpha}$			11.943
			(14.385)
Intercept	63.421***	4.902	-90.018
	(5.676)	(329.920)	(382.508)
Experimenter Fixed Effects	No	Yes	Yes
Participant Demographics Included	No	Yes	Yes
Zip Code Level Controls Included	No	Yes	Yes
Observations	95	95	95
Adjusted R^2	0.41	0.45	0.48

Notes: Dependent variable is auction revenue; the omitted mechanism is the Live auction; OLS; (robust standard errors); $^{\alpha}$event start time is used as an instrument for the number of active bidders; * p<0.10, ** p<0.05, *** p<0.01; demographics include mean age, number of female bidders, number of bidders with high income, number of bidders with a college degree or more education; other zip code level controls include averages of adjusted gross income, unemployment insurance, charitable contributions, homeownership rates and travel times to work.

6 Discussion

Casual observation suggests that the set of mechanisms that charities use to raise money from contributed goods and services is small. When an auction is chosen, it is typically a "live" (aka English) auction and when an auction is not used, the alternative is almost always a raffle. It is hard to tell exactly how beneficial these choices are for charities because other mechanisms (e.g., the all-pay auction) are considered so rarely, there are selection issues (live auctions tend to be used when an event is possible and raffles are used when one is not) and there is very little field data on which to base an assessment. In other words, it is hard to know whether charities choose prudently or fall victim to the "curse of the familiar".

We conducted an experiment with Rotary clubs to examine the relative performance of the small set of common formats and to test whether charities might do better by considering new, more novel, formats. Our results are unique because we are able to organize a large number of identical events, the events took place across the United States and, crucially, we were able to randomly assign auction formats to fundraisers.

To summarize our findings, we circle back to Section 3 and ask how well our results "jibe" with theory. Considering participation, Figure 1 predicted that the raffle and live formats would do better than the bucket and all-pay, which should be indistinguishable, and that the hybrid would do worst. We find this mostly though there is one significant exception. Our data suggests that the hybrid does much better than expected. Considering our bidding hypotheses (also based on Figure 1), we find that theory does a particularly good job of anticipating our field results. As predicted, the bucket does best followed by the two winner-pay formats and then the raffle. Likewise, theory predicts almost all of our revenue results. In this case, the one paradoxical result we find is that, instead of the winner pay formats (the hybrid and the live) doing better than the raffle, we find the opposite: the raffle does better than expected and the winner pay formats do worse.

Turning to the pragmatic lessons from our study, our data suggest that charities fair well when considering the broader "transformation problem." Our field auctioneers, were able to raise an average of \$190 using donated wine with a retail value of \$35. Considering the choice of a mechanism, three practical lessons arise from our experiment for charities. First, if we limit attention to the two mechanisms that are used with any regularity, we find that the raffle does much better than the live auction. Not only does the raffle generate almost three times as much revenue as the live auction, one can also expect more donors to participate in the raffle than in the live auction, a result that might be important for the development of a donor "warm list". Second, in reference to the theory of charity auctions, we confirm that choosing from the broad category of all-pay mechanisms, including the first-price auction, the bucket auction and the raffle, does improve revenue (three-fold, on average) compared to the two winner-pay mechanisms we considered - the live and hybrid auctions. Further, considering only the all-pay mechanisms, the efficient first-price all-pay does raise slightly more money than the raffle, though the differential is small and not always significant. Third, and most important, our results suggest that charities are probably sacrificing a considerable amount of money by not considering other formats. Not only is perhaps the most common option, the live auction, an inferior choice, both in terms of revenue and participation, in this case the curse of the familiar is at its strongest - the most common format did not just perform poorly, it performed worse than every other mechanism tested.

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8 Appendix 1 - proof of proposition 1 (all-pay auctions)

Following Goeree et al. (2005) and Carpenter et al. (2010a) we derive Bayes-Nash equilibria with "cutoff" participation strategies. To begin, we require that $\sigma^j(v)$ are such that a player with valuation v has no incentive to mimic the strategy of a player with a different valuation $\hat{v}$. That is, the equilibrium strategy satisfies the first order condition

$$\frac{\partial EU^j(v,\hat{v})}{\partial \hat{v}} = 0$$

for $\hat{v} = v$. As demonstrated in the aforementioned papers, the solutions to these equations are given by

$$\sigma^j(\underline{v}, v) + k_j$$

where

$$\sigma^a(\underline{v}, v) = (n-1)\int_{\underline{v}}^{v} \frac{xf(x)F(x)^{n-2}}{1-\alpha}dx$$

$$\sigma^b(\underline{v}, v) = (n-1)\int_{\underline{v}}^{v} \frac{xf(x)F(x)^{n-2}}{(1-\alpha)-(1-\alpha n)F(x)^{n-1}-\alpha(n-1)F(x)^{n-2}}dx$$

and k_j are the constants of integration for $j = a, b$.

As both mechanisms (a) and (b) are auctions, in equilibrium a bidder with a valuation of v_i wins with a probability of $F(v_i)^{n-1}$. Assuming that bidders with valuations below v_i do not participate, the payoff of bidder i who bids b_i in the all-pay auction is

$$EU^a(v_i, b_i) = F(v_i)^{n-1}v_i - (1-\alpha)b_i + \alpha R^a_{-i}(\sigma^a_{-i}(v_{-i})) - c$$

where $R^a_{-i}(\sigma^a_{-i}(v_{-i}), b_i)$ is the total expected contribution of the other bidders. As $R^a_{-i}(\sigma^a_{-i}(v_{-i}))$ does not depend on b_i, it follows that $\frac{\partial EU^a(v_i,b_i)}{\partial b_i} = -(1-\alpha) < 0$ and it is therefore optimal for bidder i to bid $b_i = 0$.

Following this strategy, a bidder with a valuation of $v_i = v^{ab}$ has an expected payoff of zero. Bidders with lower valuations would have a negative expected payoff and thus prefer not to participate. The equilibrium constant of integration is thus $k_a = -\sigma^a(\underline{v}^{ab}, \underline{v})$. Similarly, in the bucket auction if bidders with valuations below v_i do not participate, and bidder i bids b_i, his expected payoff is given by

$$EU^b(v_i, b_i) = F(v_i)^{n-1}v_i - (1-\alpha)b_i(1 - F(v_i)^{n-1}) + \alpha R^b_{-i}(\sigma^b_{-i}(v_{-i}), b_i) - c$$

where $R^b_{-i}(\sigma^b_{-i}(v_{-i}), b_i)$ is the total expected contribution of the other bidders.

Note that the bid of bidder i has an impact on the total contributions of the other bidders only when there is exactly one rival with a valuation greater than v_i, the probability of which is $(n-1)F(v_i)^{n-2}(1 - F(v_i))$. Hence, $\frac{\partial R^b_{-i}(\sigma^b_{-i}(v_{-i}),b_i)}{\partial b_i} = (n-1)F(v_i)^{n-2}(1 - F(v_i)) < 1$. It follows that $\frac{\partial EU^a(v_i,b_i)}{\partial b_i} < -(1-2\alpha) < 0$ and therefore bidding $b_i = 0$ is optimal for the threshold bidder. Hence $\underline{v}^{ab}$ is the participation threshold and the constant of integration is $k_b = -\sigma^b(\underline{v}^{ab}, \underline{v})$.

The expected revenue of the k^{th} price all-pay auction is derived in Goeree et al. (2005). Using their results for the revenues of the first price and second price all-pay auction, and after rearranging terms, we obtain the expressions reported in the proposition. To demonstrate the ranking $R^b > R^a$, we show that that the integrand of the bucket auction, I^b, is greater than the integrand of the all-pay auction, I^a. This difference equals

$$I^b - I^a = \left[\frac{x(1-F(x)^{n-1})}{(1-\alpha) - (1-\alpha n)F(x)^{n-1} - \alpha(n-1)F(x)^{n-2}} - \frac{x}{1-\alpha}\right][F(x)^{n-2}(1 - F(x))f(x)]dx$$

or

$$\left[\frac{x(1-F(x)^{n-1})(1-\alpha) - x[(1-\alpha) - (1-\alpha n)F(x)^{n-1} - \alpha(n-1)F(x)^{n-2}]}{[(1-\alpha) - (1-\alpha n)F(x)^{n-1} - \alpha(n-1)F(x)^{n-2}](1-\alpha)}\right][F(x)^{n-2}(1 - F(x))f(x)]dx$$

and, therefore the difference can be written as

$$\left[\frac{-x(F(x)^{n-1})(1-\alpha) + (1-\alpha n)xF(x)^{n-1} + \alpha(n-1)xF(x)^{n-2}]}{[(1-\alpha) - (1-\alpha n)F(x)^{n-1} - \alpha(n-1)F(x)^{n-2}](1-\alpha)}\right][F(x)^{n-2}(1 - F(x))f(x)]dx$$

The numerator of the expression in the first squared brackets reduces to

$$-\alpha(n-1)xF(x)^{n-1} + \alpha(n-1)xF(x)^{n-2} = \alpha(n-1)xF(x)^{n-2}(1 - F(x)) > 0$$

and we can see that the denominator in the same expression is also positive because,

$$[(1-\alpha) - (1-\alpha n) - \alpha(n-1)](1-\alpha) > 0$$

As a result, the difference is positive and the revenue claim follows.

9 Appendix 2 - numerical methods

As noted, the equilibrium in the raffle cannot be derived in closed form, and in this appendix we describe the procedure used for approximating the equilibrium strategies numerically. This procedure is used to derive the results presented in Table 1. Our approach is partially based on the routines developed by Wasser (2013) for the numerical approximation of equilibrium strategies of a Tullock contest with private cost information.[11] In particular, we adapt the routines therein to take into account that bidders compete in a raffle, have private information about valuations, and can choose whether to participate or not.

We begin by discretizing the valuation space $[\underline{v}, \overline{v}]$ using a grid size $\Delta = \frac{\overline{v}-\underline{v}}{100}$, which creates a discrete version of the raffle with valuation points $\{v^1, v^2, \ldots, v^{101}\}$ where $v^k = \underline{v}+(k-1)\Delta$ for $k = 1, 2, \ldots, 101$. We note that a Bayes-Nash equilibrium has to fulfill the conditions presented in Proposition 3. The expression on the left hand-side of the second expression is an $(n-1)$ dimensional integral, which we approximate it using quasi-Monte Carlo integration. A candidate for an equilibrium is derived numerically as a solution to condition this second condition for all discrete valuation points. As it is not clear whether in equilibrium all player types participate, we consider first the game with the full support $[\underline{v}, \overline{v}]$. After deriving the candidate equilibrium strategy, we calculate the expected surplus of the bidder with the lowest valuation $v^1 = \underline{v}$. This is given by the left hand-side of the first condition in Proposition 3 when the expression is evaluated for $v^r = v^1$. If the expected surplus of this bidder is equal to or exceeds c, we conclude that all player types participate (i.e. the probability of participation is 1) and the derived candidate equilibrium strategy is actually the equilibrium strategy under endogenous participation. Otherwise, we assign to the player type $v^1 = \underline{v}$ a bid of zero (i.e. this player type does not participate) and consider the reduced strategy set $[v^2, \overline{v}]$. Using the above method, we solve again for a candidate equilibrium.

We use this procedure iteratively: in case the expected payoff of bidder type v^k is still below c, we assign this bidder type a bid of zero and further consider the game with support $[v^{k+1}, \overline{v}]$ for $k = 2, 3 \ldots, 101$. This iterative process continues until we reach k for which the expected payoff of player type v^k equals or exceeds c, and this valuation is taken as an approximation of the threshold value v^rspecified by condition the first condition in Proposition 3.

[11] We would like to thank Cédric Wasser for generously sharing his Matlab routines.

10 Appendix 3 - instructions from the field experiment

You are about to participate in a charity fundraiser. The bottles of wine have been provided by a research grant from the National Science Foundation. All the proceeds from this event will be donated directly to this local Rotary chapter.

[All-pay] Here are the rules:

• Bidders make one bid in a sealed envelope.

• The auction is "all-pay" – regardless of winning or losing, all bidders will be asked to pay the amount of their bids. Please enclose payment with your bid.

• All the bid envelopes will be collected and the highest bid will be identified (ties will be broken randomly).

• The highest bidder wins the two bottles of wine.

[Bucket] Here are the rules:

• To start, all bidders will be given 30 chips worth $5 each (more chips are available if necessary).

• Bidders will form a circle and a bucket will be passed from bidder to bidder.

• To stay in the auction, each bidder must place one chip in the bucket each time it comes to him or her. Bidders who decide to pass the bucket without adding a chip drop out of the auction.

• You must pay $5 for each chip that you add to the bucket, regardless of whether you win or lose.

• The auction winner is the person who puts the last chip in the bucket. This will be the only person who has added a chip every time the bucket has come around.

[Hybrid] Here are the rules:

• All participants interested in placing a bid on the two bottles of wine must first pay a $5 entry fee, which also buys you a 50-50 lottery ticket.

1. 50-50 Lottery:

• Participants pay $5 to bid in the auction and are given one lottery ticket.

• At the end of the auction, one lottery winner will be selected at random.

• The lottery winner's cash prize is 50% of the lottery proceeds (and the rest goes to this Rotary chapter).

2. Wine Auction:

• All bidders will be given bidder numbers.

• The auctioneer will start the auction by announcing an opening bid; he will then ask for bids to increase.

• Raise your bidder number to indicate your willingness to bid on the two bottles of wine prize at the price called by the auctioneer.

• The highest bidder wins the two bottles of wine and pays his or her bid. Following the auction, the lottery cash prize and the wine will be awarded separately.

[Live] Here are the rules:

• All bidders will be given bidder numbers.

• The auctioneer will start the auction by announcing an opening bid; he will then ask for bids to increase.

• Raise your bidder number to indicate your willingness to bid on the two bottles of wine at the price called by the auctioneer.

• The highest bidder wins the two bottles of wine and pays his or her bid.

[Raffle] Here are the rules:

• Each participant will be allowed to privately purchase as many raffle tickets as he or she wants.

• Each raffle ticket costs $5.

• After each participant has had a chance to buy as many tickets as he or she wants, the winning ticket for the two bottles of wine will be selected randomly.

We accept cash, check or credit card. Thank you for supporting this chapter of Rotary!