Journal of Public Economics xxx (2017) xxx-xxx

Contents lists available at ScienceDirect

Journal of Public Economics

journal homepage: www.elsevier.com

Using raffles to fund public goods: Lessons from a field experiment☆

Jeffrey Carpenter*, Peter Hans Matthews

Department of Economics, Middlebury College, Middlebury, Vermont 05753, USA

ARTICLE INFO

Article history:
Received 27 April 2016
Received in revised form 20 April 2017
Accepted 25 April 2017
Available online xxx

Keywords:
Public good
Fundraising
Incentives
Philanthropy
Raffle
Tullock contest
Field experiment

JEL classification:
H41
D03
D64
C93

ABSTRACT

Despite a long tradition of using lotteries, raffles and similar mechanisms to fund public goods, there has been little systematic study of the design features of these mechanisms and how the resulting incentives affect the level of provision. Partnering with a charity that provides public goods locally, we conducted a field experiment in which participants were randomly assigned to one of four raffle treatments to examine the effectiveness of alternative incentive schemes designed to encourage either participation or "volume." Contrary to theory which anticipates that gains can be made mostly on volume, our results indicate that significant revenue gains are available on both margins. Indeed, the large opportunity cost of using the standard linear raffle (in which the price per chance to win is fixed) that we find suggests the importance of mechanism design when considering the voluntary provision of public goods.

1. Introduction

The historical record suggests that voluntary contributions to fund public goods using mechanisms like lotteries and raffles have always been a viable alternative to taxation. The overseers of Roman public finance, for example, relied on both of these means to fund the Empire. Soon after Emperor Augustus started a lottery to fund the building of roads between 29 BCE and 14 CE, Nero raffled off horses and slaves to rebuild after the Rome fire of 64 CE (Baker, 1958). Considering the importance of educational lotteries to the finances of many American states (Jones, 2015), raffles and lotteries continue to be important fundraising mechanisms.

In the standard raffle, tickets are sold at a fixed price and therefore one's chance of winning is a simple linear function of one's expenditure. There is no reason to believe, however, that the standard linear scheme is optimal. The research question we consider is whether one can increase the level of provision by manipulating the incentives at both the extensive and intensive margins of the mechanism. On the extensive margin, we ask whether the allocation of winning chances can be redesigned to encourage participation and, if so, what the consequences for revenue might be. On the intensive margin, we ask whether the allocation mechanism can be redesigned to encourage donors to purchase more tickets, conditional on participation. Our field experiment was designed to examine these fundamental questions and to shed light on how mechanism design can affect the provision of public goods.

The related theoretical literature has shown that modeling charitable fundraisers by including "revenue proportional benefits" in models of familiar mechanisms like raffles and auctions is not innocuous and that important principles like revenue equivalence can fail. For our study this work implies that on theoretical grounds alone there is some reason to believe that a redesigned raffle could indeed enhance provision. For example, it is sometimes said (e.g., Goeree et al., 2005) that raffles are just inefficient "all-pay auctions" because the participant who spends or "bids" the most is not a certain winner, just the most probable one. If participants with high valuations for the donated good purchased tickets expecting more than proportional increases in the likelihood of winning, they might spend more. In other words, a *convex* raffle in which the marginal number of tickets received increases as one spends more might extend the mechanism's

? We acknowledge the financial support of Middlebury College and the National Science Foundation (SES 0617778). We also thank the coeditor, three referees and the seminar participants at Oxford, The University of Leicester, The University of East Anglia and the New England Experimental Economics workshop for their comments.

* Corresponding author at: IZA, Schaumburg-Lippe-Straße 5-9, Bonn 53113, Germany
Email addresses: jpc@middlebury.edu (J. Carpenter); pmatthew@middlebury.edu (P.H. Matthews)

http://dx.doi.org/10.1016/j.jpubeco.2017.04.005
0047-2727/© 2016 Published by Elsevier Ltd.

intensive margin - conditional on participating at all, people might decide to purchase more tickets.

On the extensive margin, one reason that people seem to like to participate in raffles is the perception that everyone, even someone who purchases a single ticket, has a chance to win. This is broadly consistent with the Clotfelter and Cook (1990) "chance to buy hope" hypothesis, and with some anecdotal evidence reported in Carpenter et al. (2008). With this in mind, one could instead construct a *concave* raffle, in which the marginal number of tickets received actually decreases as participants spend more. Potential donors who are equity-minded, for example, might be more willing to participate because "anyone can win," especially in cases where the marginal cost of tickets rises very sharply after the first few.

It is worth underscoring, however, that these incentives work in opposite directions. In the concave raffle, more potential donors will participate but each will purchase a small(er) number of tickets, while in the convex raffle, fewer participants should each purchase more tickets. From a common reference point, say the expenditure of $5 for five tickets in each format, in the convex raffle participants should purchase more tickets because they find it easier to overcome the externality emitted from additional purchases by other participants. Here the marginal cost of another ticket falls and so if one's competitor buys another ticket reducing one's chances to win it is less costly to nullify this externality. This is different in the concave raffle, however. Here, because the marginal cost of another ticket is increasing, if your competitor buys another ticket, it is increasingly costly to recover.

Despite their implications for the provision of public goods, both the theoretical and empirical literatures on raffles are small. However, because the incentives of lotteries and all-pay auctions are related to those of raffles, it is important to situate our study in this broader (though still developing) literature. Beginning with theory, Morgan (2000) was influential because it integrated lotteries into the provision of a public good, showing that the combined mechanism could, in some circumstances, raise more money. However, the lottery mechanism posited by Morgan (2000) is the simple linear one mentioned above in which the chances of winning accumulate proportionately with the expenditure. As we see in Section 2, Morgan's model can be generalized by considering a more flexible contest success function like that proposed by Tullock (1980). In particular, when the chances of winning accrue disproportionately to very generous donors, the raffle converges to an all-pay auction similar to the models discussed in Goeree et al. (2005) and Engers and McManus (2007). Additionally, when the raffle/lottery aspect of this hybrid mechanism dominates the public good one, the large literature on contests is instructive (e.g., Baye et al., 1994; Szidarovszky and Okuguchi, 1997; Cornes and Hartley, 2005; Corchon, 2007 or Chowdhury and Sheremeta, 2011).

In the end, however, the question as to which margin matters more for raffle organizers is an empirical one. Informed by the existing theory and our modest contribution to this literature and in the spirit of Mason's (2013) recent case for using field experiments to "put charity to the test," we conducted an experimental evaluation of the effects of convex and concave schemes on raffle revenues and the provision of a public good. We sold raffle tickets door-to-door in Addison County, Vermont to benefit a local charity and randomly assigned households to one of four treatments: a standard linear raffle in which the marginal number of tickets remained constant as one's expenditure increased, a convex raffle in which the marginal number of tickets received increased, and two concave raffles in which the marginal number of additional tickets fell as one spent more. The two concave raffles differ in the severity of their incentives. In what we call the concave raffle, the marginal number of tickets falls gradually as one increases one's expenditure (a natural opposite of the convex raffle) and in what we call the "pay what you want" raffle every participant who contributes the minimum receives the same fixed number of tickets but (like Gneezy et al., 2010) is free to contribute whatever they like above the minimum. Here the incentives are sharp and fairness is particularly salient: every participant is allocated exactly the same number of tickets and there is no way to increase your chances of winning by spending more.

The predictions of our model on the extensive and intensive margins follow directly from the intuition provided above, though the ultimate question is which pricing scheme should raise the most money? We find that though the countervailing effects of convexity on efficiency and contributions are balanced to some extent by the effect on participation of making the raffle less convex, in the end the intensive margin dominates. In other words, theory predicts that to maximize contributions to the public good, the raffle organizer should opt for the convex raffle - though fewer people will participate, their comparatively large donations will more than compensate.

The results from our three more conventional treatments: the concave, linear and convex raffles jibe to a great extent with theory. Revenue per solicitation is lowest in the concave raffle, higher in the linear and greater still in the convex raffle. However, in the limit, the concave raffle converges to our pay what you want raffle (wherein additional expenditures do not increase one's chances of winning the prize) which does surprisingly well, in complete contradiction to the incentives. Because of its defining feature - that you can't improve your odds of winning by spending more - no one should donate to the pay what you want raffle but the same observation makes the raffle seem fair (or so informal debriefings suggested). Perhaps because of this fairness the pay what you want raffle actually defied theory and begot considerably more contributors than any other format, enough so that it also raised more revenue (per solicitation) than the linear benchmark.

Couching our results in terms of previous empirical work, at the broadest level of comparison, like the relevant lab studies, we confirm that adding a raffle to the standard voluntary contribution mechanism does improve donations, though the foci of these lab studies are considerably different. While Morgan and Sefton (2000) focus on linear lotteries, Dale (2004) compares the standard lottery to a self-financing, pari mutuel form of lottery, Lange et al. (2007) investigate how donations are determined by the number of prizes available and Goerg et al. (2016) develop a two-stage raffle to improve public good provision, our study concentrates on how the individual incentives provided by the contest success function can affect participation, contributions and revenue. Considering our field setting, which differentiates our experiment from those just discussed, our study is perhaps closest to Landry et al. (2006) who also solicit donations to a local charity, door-to-door. In the spirit of their lab work (Lange et al., 2007), the authors of this paper compare single- and multiple-prized lotteries to the voluntary contribution mechanism, finding again that lotteries are effective at increasing contributions.

Given that the limiting case of our convex raffle is the all-pay auction, our results also dovetail with the nascent experimental literature assessing whether auctions can increase contributions to a public good too. Orzen (2008) compares both lotteries and all-pay auctions to the voluntary contribution mechanism in a lab experiment and finds that both alternative mechanisms yield larger contributions, with the first-price all-pay doing better than the lottery, a result that is consistent with both our theory and results. The comparison of lotteries and all-pay auctions has also been studied in the lab by others, including Schram and Onderstal (2009) who confirm Orzen's results that an all-pay auction does better than the linear lottery and both do better than the voluntary contribution mechanism. Other studies, however, offer more mixed results. For example, Corazzini et al. (2010) find that, while both the all-pay and the lottery do better than the voluntary contributions, the lottery outperforms the auction, a result echoed more recently by Duffy and Matros (2016). For some insight into why the all-pay auction doesn't always do better than the linear lottery, Onderstal et al. (2013) find that fewer people bid in the all-pay, an aspect of fundraising on which we focus.

Because of our use of the Tullock contest success function to generalize the raffle pricing scheme, our study also contributes to the larger empirical literature on contests initiated by the lab study of Millner and Pratt (1989). Like Millner and Pratt (along with other lab studies like Davis and Reilly (1998) and Potters et al. (1998)), we find that the parameterization of the contest success function does affect behavior and that participants adjust in the anticipated direction. Considering the more recent review by Dechenaux et al. (2015) which includes rank order tournaments along with contests and all-pay auctions, our study also contributes by virtue of its field setting. The authors of the review report that fewer than 15% of the contest studied were conducted in the field and the vast majority of this small number were completed in the past five years.

In the next section we develop a generalization of Morgan's original 2000 model of the use of raffles to enhance contributions to a public good. Though modest, our theoretical contributions are a consequence of the research question we consider. Specifically, we generalize the contest success function of the standard raffle to form hypotheses about how participants will respond on the intensive margin and we examine the participation choice to make predictions on the extensive margin too. In Section 3 we describe the details of our field experimental protocol. In Section 4 we present our main results and we discuss the implications of these results in the last section of the paper.

2. Charitable raffle design

We first describe a simple model that provides the intuition for the raffle modifications we propose. Based on the standard formulation of Morgan (2000), suppose there are N potential (risk neutral) donors indexed $i = 1 \ldots N$, each of whom has an endowment, w_i, to spend on raffle tickets. Active donors pay a fixed entry fee, c, and spend x_i for chances to win a prize, R, which is financed by the funds raised.

Donors benefit from the public good generated by their collective contributions. Each donor, regardless of her donation, receives a benefit $\alpha > 0$ per dollar raised above the cost of the prize. Altogether, the quasi-linear utility faced by each potential raffle contributor is:

$$U_i = \left(w_i - x_i\right) + \left(\frac{x_i^\beta}{\sum x_i^\beta}\right) R + \alpha\left(\sum x_i - R\right) - c.$$

The small innovation here, adopted to suit our purposes, is that we utilize the generalized contest success function, $x_i^\beta / \sum x_i^\beta$, offered by Tullock (1980). As one can easily see, the standard, linear, raffle is just the special case where $\beta = 1$. However, when $\beta > 1$, chances of winning accrue faster to donors who spend more (our convex raffle) and when $\beta < 1$, they accrue more slowly (our concave raffle). In other words, the raffle becomes closer to its efficient cousin, the all-pay auction, as β rises past one and it more closely resembles the completely fair, pay what you want, mechanism in which the prize is allocated randomly to one of the donors as $\beta \to 0$.

Compared to the standard voluntary contribution mechanism in which the upper bound on α is one to prevent it being rational to donate everything, the raffle bound is more restrictive to assure that the expected payoff at the equilibrium is positive but declining in the number of participants (i.e., the familiar dissipation of rents from the contest literature). Intuitively, when α is low enough the contest incentives of the raffle dominate and when it is high enough, the public good aspect of the decision dominates, including the incentive to free ride. When α is larger than $\frac{1}{N}$, the public good more than subsidizes one's investment in tickets so donors should spend more on them but when alpha is below this threshold, the subsidy is not enough on its own to justify the purchase of tickets.[1]

To examine the intensive margin, donors maximize U_i by correctly choosing x_i. The first order condition, after a bit of simplification, is just:

$$R\left[\frac{\left(\sum_{j \neq i} x_j^\beta\right) \beta x_i^{\beta-1}}{\left(\sum x_i^\beta\right)^2}\right] = 1 - \alpha$$

and allowing $x_i = x_j = x$ at the symmetric equilibrium, we find:

$$x^* = \frac{\beta(N-1)R}{N^2(1-\alpha)},$$

an increasing function of β. The conditions for a symmetric pure strategy equilibrium to exist are similar to those of a standard Tullock contest. In particular, the second order condition is satisfied, as in the usual case, when $\beta \leq \frac{N}{N-2}$ but our public good component and fixed entry cost naturally affect the threshold for the expected return at the symmetric equilibrium to be positive. In our case, the condition is

$$(\alpha N - 1)\left(\frac{\beta(N-1)R}{N^2(1-\alpha)}\right) + \left(\frac{1}{N} - \alpha\right) R > c,$$

which again depends on the difference between α and $\frac{1}{N}$ as mentioned above, but at its essence is just a more complicated version of the standard rent dissipation condition that is easily recovered by setting α and c to zero (see Baye et al., 1994 for more details). Most importantly, note that the symmetric equilibrium confirms our intuition that, on the intensive margin, we should expect participants to increase their donations to charity as raffles become more efficient - more "convex."

Considering the extensive margin, we follow a standard method for analyzing endogenous entry into contests based on Corcoran (1984), one that has been used more recently in Morgan et al. (2012). Specifically, we exploit the fact that in any pure strategy equilibrium,

[1] More specfically, the upper bound on α is $\frac{1}{N}$ because here the return from the public good to each donor at the symmetric equilibrium is just $\frac{1}{N}(Nx^*) = x^*$ which is exactly what it costs each donor to buy raffle tickets in the first place. In other words, when $\alpha = \frac{1}{N}$ the implied subsidy provided by the public good just equals one's expenditure on tickets. As a result, donors expect a net payoff from the raffle of zero because not only is the cost of the tickets purchased covered by the return from the public good, they each gain an expected prize of $\frac{R}{N}$ which is just erased by their share of the "public good cost", $-\frac{1}{N}R$.

the number of participants is determined by the marginal entrant who drives the expected benefit from participating below an outside option, in this case the expected payoff from not buying any tickets but still receiving the benefit from the public good generated by the $N-1$ active participants.

Evaluated at x^*, the expected utility of participants is, after some simplification,

$$w_i + R\left(\frac{1}{N} - \alpha\right)\left[1 - \frac{\beta(N-1)}{N(1-\alpha)}\right] - c$$

which is decreasing in N (again as long as the return on the public good is not too large i.e., $\frac{1}{N} > \alpha$) and equal to the expected payoff from not participating,

$$w_i + \alpha\left[(N-1)\frac{\beta(N-1)}{N^2(1-\alpha)} - R\right],$$

for the marginal donor. Simplifying this equality allows us to assess the equilibrium number of entrants as a function of β. The positive root of the resulting expression $\left(\frac{c}{R}\right)N^2 - (1-\beta)N - \beta = 0$ yields N^*. Most importantly, this N^* is also decreasing in β. In other words, our intuition about the extensive margin is also correct. Making the raffle more convex should enhance donations, but it will likely come at the expense of participation.

In the end, the level of provision of the public good i.e., the revenue generated in the fundraiser, is the ultimate measure of performance. Compared to the common, linear baseline, does increasing its convexity cause the raffle to yield more revenue from fewer, more aggressive, donors or does one need to make the raffle less convex because only then will the resulting larger donor base dominate? Given we have calculated the equilibrium donation and the number of active donors, total contributions at the symmetric equilibrium are simply the product of the two, once N^* has been substituted into the expression for x^*. In Fig. 1 we examine how the level of provision of the public good varies with the convexity/concavity of the contest success function, β.[2] In the first panel (on the left) we more clearly see the implications of increasing the convexity of the raffle on the number of active donors. The number of participants falls quickly initially and then stabilizes, to some extent, past the baseline, linear, raffle. At the same time, as β increases the equilibrium donation continues to rise at an increasing rate until $\beta \approx 1.5$ (center panel). When all is said and done, as one can see in the rightmost panel, the fall in participation does not overwhelm the fact that donations increase rapidly. In other words, the model predicts that focussing on the intensive margin should dominate - to maximize contributions to the public good, charities should continue to increase the convexity of the raffle.[3]

3. Methods

Randomized field experiments have recently revolutionized the way that empirical work has been conducted both in economics generally (Angrist and Pischke, 2009) and, more specifically, in the economics of public goods and charity (Ledyard et al., 1995; List, 2008). The real benefit of this methodology is that one can confidently estimate causal effects with modest samples. If participants are randomized to treatment any observed or unobserved traits should be balanced and their effects will therefore be orthogonal to the estimated treatment effects.

To implement the treatments of our experiment, we first decided on five "donation levels" that would be the common link between treatments along with a \$500 prize. We picked round amounts that would be prominent and facilitate making change in the field. Participants could donate \$5, \$10, \$20, \$40 or \$60. In accordance with the Tullock structure used in Section 2, what changed from treatment to treatment was the number of raffle tickets that the participant received for each donation. The details of our treatments are illustrated in Table 1.

Our linear raffle was designed to be straightforward and representative of what is typically utilized by charitable organizations. For a \$5 donation, participants were given 5 tickets, they received 10 tickets for \$10, 20 tickets for \$20, and so on such that the marginal (and average) cost was constant and set at \$1.

By comparison, the convex treatment was designed to enhance the efficiency of the raffle and incent larger donations by disproportionately awarding chances of winning to those participants who donated more. We simply implemented the convex raffle as a quantity discount with decreasing marginal (and average) cost. Here the cost per ticket fell from \$1 to \$0.50 as the participant purchased more. In other words, 5 raffle tickets were given for a \$5 donation, 13 were given for \$10, 30 for \$20 and 70 were given for \$40. For a \$60 donation convex participants were given 120 tickets, twice the number received by their linear counterparts.

Because the concave raffle was supposed to encourage a sense that "anyone can win" and therefore participation, we imposed a quantity penalty that increased in severity. In this case, the cost per ticket increased with the expenditure from \$1 to \$2. The concave raffle started with 5 tickets for \$5 but only rewarded 9 tickets for a \$10 donation, only 15 for \$20, 25 for \$40 and just 30 for \$60, half the number given in the linear treatment.

Our pay what you want raffle (PWYW) is novel for a number of reasons. The PWYW raffle is an extreme version of the concave raffle in that all participants received the same number of tickets, regardless of their donations (i.e., the Tullock $\beta = 0$). In other words, participants could not affect their chances of winning the prize by donating more. As a result, all participants had exactly the same chance of winning the prize which makes the mechanism "fair." This fairness should enhance participation, both in theory and in practice. Notice also that any donation above the \$5 minimum, must have been voluntary because donating more did not increase one's odds of winning the prize. This observation makes the PWYW treatment a nice benchmark comparison to the literature on voluntary contributions (e.g., Landry et al., 2006 or DellaVigna et al., 2012).[4] In fact, the PWYW treatment allows us to cleanly ask whether the incentives to donate more to increase one's chances of winning a prize crowd in (or crowd out) voluntary contributions. If we see a lower frequency of donations above the minimum in the PWYW raffle, it must be because strategic incentives crowd in donations. However, if the frequency of

[3] Though the algebra is dense, this result can be proven to be true generally, as long as the cost of participation is not too high compared to the raffle prize.

[2] The figure is drawn using the following parameter values: $\alpha = 0.15$, $c = 0.1$, $R = 2$.

[4] In fact, one could argue that previous comparisons of raffles and voluntary contributions are problematic in that two things change - in raffles and lotteries there is a prize which is not present when eliciting voluntary contributions and raffle participants can affect their chances of winning the prize, a different strategic element. In our implementation all formats offer a prize so only strategic concerns differ between treatments.

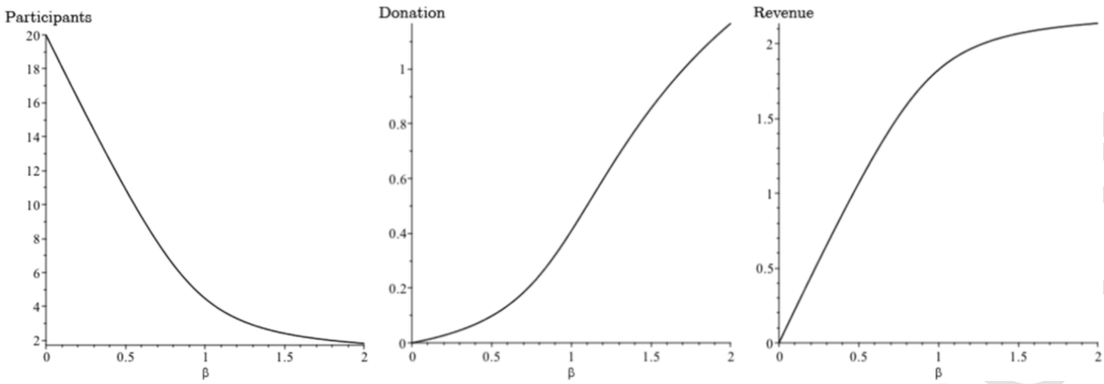

Fig. 1. Public good provision by raffle convexity, β (Note: the left panel illustrates the effect of raffle convexity on participation, the middle panel depicts donations and the right panel shows how public good revenue depends on β).

Table 1
Raffle treatment parameters.

	PWYW ($\beta = 0$)			Concave ($\beta = 0.85$)			Linear ($\beta = 1$)			Convex (	
Donation	T	C/T	MC	T	C/T	MC	T	C/T	MC	T	C/
\$5	5	\$1.00	1.00	5	\$1.00	1.00	5	\$1.00	1.00	5	\$1
\$10	5	\$2.00	−	9	\$1.11	1.25	10	\$1.00	1.00	13	\$0
\$20	5	\$4.00	−	15	\$1.33	1.67	20	\$1.00	1.00	30	\$0
\$40	5	\$8.00	−	25	\$1.60	2.00	40	\$1.00	1.00	70	\$0
\$60	5	\$12.00	−	30	\$2.00	4.00	60	\$1.00	1.00	120	\$0

Note: T is tickets received, C/T is cost per ticket, and MC is marginal cost.

non-minimum donations is larger in the PWYW, strategic incentives must crowd out altruism (as discussed in Bowles and Polania-Reyes, 2012).

It is important to note that one could buy 5 tickets for \$5 in all four raffles and we told our participants that our goal was to get 100 contributions (per treatment). Not only was this done to manage the expectations of the participants about how many tickets might be sold (and that at best they could expect to break even on a \$5 donation), we did it to equalize the incentives surrounding an expenditure of \$5, identified in the broader literature as a useful benchmark. In their experiment on door-to-door fundraising, for example, Landry et al. (2006) compared lotteries with single and multiple cash prizes to simple voluntary contributions and found that in the single prize lottery, the average contribution, conditional on participation, was \$4.39. We standardized incentives at this level so that improvements (or otherwise) could be defined relative to the representative experience of fundraisers. Returning to the model in Section 2, this required \$5 expenditure fills the role of the fixed entry fee, c.

To describe the exact protocol in more detail, the prize for each of the raffles was a \$500 gift certificate that was redeemable at five unique local restaurants, all managed by the same holding company.[5] To promote the fundraiser, we ran weekly full- or half-page advertisements in the local newspaper and hung posters around the data collection area at local gathering places (e.g., grocery stores and shop windows). As an act of beneficence, the restaurant holding company donated three-quarters of the total prize value (i.e., \$1500 of the \$2000) which also helped extend the external validity of the study by allowing us to list the holding company as the donor in all the advertisements.

All the proceeds from the raffles went to a well-known local poverty relief organization started in 1965 to complement the Johnson administration's "war on poverty." The organization's mission is to provide food assistance (via a food bank) and other basic needs (such as heating fuel assistance), job training and counseling to individuals and families in the surrounding county. The organization receives donations via the local chapter of the United Way and runs a number of fundraisers each year, making our raffle seem as part of "standard practice" to the local community.

Throughout the month of April 2014, our research assistants, in teams of two, visited approximately 1750 homes in Addison County, Vermont and during 849 of these visits, someone answered the door. Given the population density in western Vermont, 849 observations represent a significant sample.[6] All visits took place on weekdays during the early evening. Prior to knocking on the door, the research assistants randomized each home into one of the four raffles by drawing colored chips from an opaque bag. If the door was opened, the research assistants followed a standardized script (which appears as an appendix) that varied only in the description of the number of tickets that would be awarded for each donation. For each treatment a laminated table was used to illustrate the mapping from donation levels to tickets purchased. The assistants accepted cash or checks made out directly to the beneficiary. Following the exchange, the research assistants recorded whether or not a donation had been made, the number of tickets purchased and their identification numbers (for the subsequent drawing of the prize winners). Once off the stoop, they also recorded the home's address and the gender and estimated the age of the person who made the donation decision.

After all the raffle data was consolidated from the field, we made use of administrative records from the poverty relief organization and the local town clerks to add information on whether the households had previously given directly to the organization and the assessed values of the homes we visited. We collected data on previous donations to account for "warm list" affects (à la Landry et al. (2010)) and the home assessments were gathered to provide a proxy for wealth as a correlate of the demand for voluntary contributions.

4. Results

Considering all the home visits conducted by our solicitor teams, the door was answered by someone approximately half the time, resulting in 849 donation decisions being observed. During 434 of

[5] The protocol for our experiment was reviewed and approved by the Middlebury College IRB.

[6] According to the census, in 2010 Addison County had 36,820 residents and 14,141 households.

these visits (51%) the respondent made a donation. These 434 purchases were distributed in such a way that we achieved our stated target of gathering roughly 100 donations per raffle. Considering the sum of these donations, we raised a total of $4263 using $2000 worth of donated prizes. Compared to a benchmark in this literature our fundraising results were similar. Our response and purchase rates are slightly better than, but in the same ballpark as, those in Landry et al. (2006) obtained for their single prize lottery (38% and 45%, respectively). However, the mean expenditure, conditional on participation, in our sample was considerably larger: $9.82 versus $4.39. We are comfortable, then, with our protocol, even as we acknowledge the benefits of our location and identification with our local beneficiary.

Table 2 presents summary data on the characteristics of the homes we visited and the people who answered the door, by treatment. Overall, 57% of the people who answered the door were female, the average estimated age of these people was 51 years, and 17% had previously given to the beneficiary (i.e., they were on the warm list). Given the similarities in the disaggregated data, we seem to have achieved random assignment to treatment. Using t-tests to check, the lowest observed p-value, 0.13, comes from comparing the frequency of female respondents in the convex and PWYW raffles.

We now proceed by examining the differences that arise between treatments. We begin by examining the extensive margin - to what extent are people more (or less) likely to donate in the four treatments? We then examine the intensive margin - conditional on giving, do people give more in some mechanisms than in others? Finally, we consider the combined effects of participation and giving by looking at the difference that matters most to charities, the one in mean donations, including any zeros.

We evaluate performance on the extensive margin by comparing participation rates across our four treatments. These rates are summarized in the leftmost panel of Fig. 2 for the 849 cases in which the door was opened. As one can see, the participation rates hover around 50%, the overall rate of giving. For example, in the linear, benchmark, format 48% of respondents donated. By comparison, the convex raffle yielded slightly greater participation (52%), though not significantly more ($z = 0.88$, $p = 0.38$). The concave raffle which was expected to enhance participation actually yielded fewer donations (46%), but, again, the difference is not significant in the raw data ($z = 0.44$, $p = 0.66$). The more extreme version of the concave raffle, the PWYW, however, does appear to elicit more donations. Here the 62% participation rate is significantly greater than the linear point of reference ($z = 2.63$, $p < 0.01$).[7]

For a more rigorous evaluation of participation, consider Table 3. In the first column the dependent variable is one when a donation is made (and 0 otherwise) and the omitted format is the linear benchmark. Though the experiment is balanced, we include the other observables we collected because the resulting estimates are also interesting. To make the point estimates easier to interpret we report linear probability results and robust standard errors.[8] Contrary to theory, which predicts that participation will fall monotonically as the convexity of the raffle increases, the concave raffle attracts almost 2 percentage points fewer donors compared to the linear raffle (n.s.) and the convex does about 4 percentage points better (n.s.). In other words, the response on the extensive margin to increasing raffle convexity is essentially flat. That said, the PWYW raffle does boast a

Table 2
Treatment balance on observables.

	PWYW ($\beta = 0$)	Concave ($\beta = 0.85$)	Linear ($\beta = 1$)	Convex ($\beta = 1.15$)
Female (I)	0.60 (0.49)	0.60 (0.49)	0.57 (0.50)	0.53 (0.50)
Estimated age	51.13 (14.17)	50.71 (15.93)	50.51 (14.88)	51.05 (14.71)
Previous donor (I)	0.17 (0.37)	0.17 (0.38)	0.17 (0.38)	0.17 (0.38)
Home value (÷ 100*k*)	2.42 (1.57)	2.49 (1.47)	2.51 (1.59)	2.44 (1.47)

Note: means and (standard deviations).

participation rate almost 14 percentage points greater than the linear ($p < 0.01$) so, although we do not find as strong a response on the extensive margin as expected, it is the case that an extremely concave raffle does result in the highest rate of participation.[9] Considering our administrative controls, we confirm a number of important results reported in the related literature on fundraising. Respondents on the warm list are approximately 20% more likely to give again and a hundred thousand dollar increase in the value of one's home is associated with being 3 percentage points more likely to give. As a robustness check, Table A1, column 1, in the appendix replicates these results using regressions that include solicitor team fixed effects.[10]

Switching focus to the intensive margin, in the center panel of Fig. 2 we present the mean positive donations for each raffle treatment. Recall that theory predicts that making the raffle more convex (i.e., increasing β) should enhance performance on the intensive margin. Setting aside the PWYW raffle for the moment, theory seems to be confirmed. While the concave raffle garners donations that average $7.80, the linear raffle tops this amount by more than a dollar, $9.03 ($t = 1.58$, $p = 0.11$), and the convex raffle does even better, averaging $11.94 (compared to the linear $t = 2.57$, $p = 0.01$). Given it is an extreme version of the concave raffle, we are surprised to see that the PWYW raffle actually yielded an average donation of $10.29, though this is not significantly greater than what was gathered by either the convex or linear raffles ($t = 1.10$, $p = 0.27$ and $t = 0.96$, $p = 0.34$, respectively).

In the second column of Table 3, we expand our analysis of the intensive margin and confirm that, as predicted, the concave raffle does not do well. The mean donation in the linear raffle is $1.35 larger ($p = 0.07$) and the convex raffle donation is $3.99 larger ($p < 0.01$). Continuing with the convex raffle, it not only does significantly better than the concave one, it also gathered positive donations that are $2.63 ($p = 0.01$) larger, on average, than those in the linear raffle. Again, the surprise is that the PWYW did so well ($3.07 more than in the concave, $p = 0.02$) considering donors cannot improve their odds of winning by topping the $5 minimum donation. Returning to the controls, conditional on giving, previous donors tend to give more than five dollars more than new ones ($p < 0.01$) and donors give $0.83 more for each hundred thousand dollar increase in the value of their homes ($p < 0.01$). Again, adding solicitor team fixed effects changes these results very little. These robustness checks can also be examined in the appendix (Table A1, column 2).

So far the data indicate that charities wanting to expand participation should focus on formats that stress fairness while those trying to squeeze larger donations out of a smaller group of donors might consider emphasizing efficiency. When all is said and done, however,

[8] Using probit regressions instead results in estimates that are identical to those in Table 3.

[7] The PWYW raffle also yields significantly higher participation than the concave ($p < 0.01$) and convex ($p = 0.06$) raffles. None of the other differences are significant in the raw data.

[10] We also considered clustering the standard errors by solicitor team but there simply were not enough teams to make doing so efficient.

[9] The PWYW also does significantly better on the extensive margin than both the concave ($p = 0.07$) and the convex raffles ($p < 0.01$).

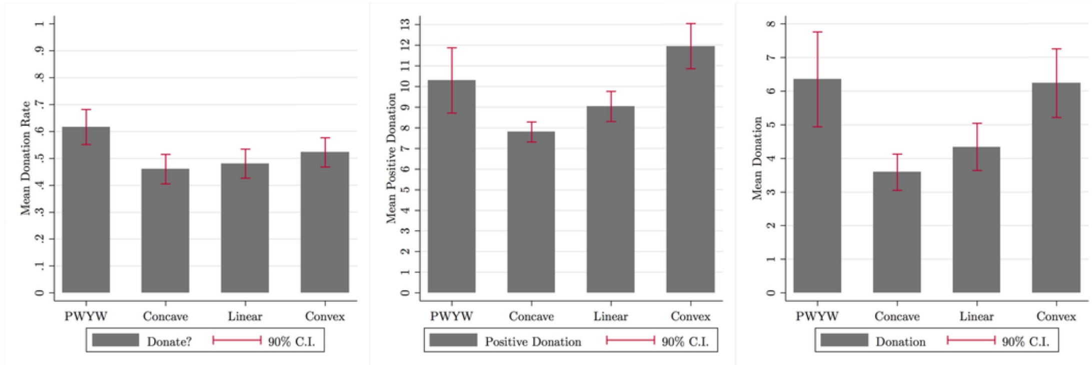

Fig. 2. Donation behavior by treatment (Note: the leftmost panel reports differences on the extensive margin, the center panel reports differences on the intensive margin and the rightmost panel reports combined effects; bars organized in increasing order of $\beta \in [0, 0.85, 1, 1.15]$).

Table 3
Examining treatment differences.

	(1)	(2)	(3)
Convex - Qty. discount (I)	0.047	2.633**	1.966***
	(0.045)	(1.056)	(0.708)
Concave - Qty. penalty (I)	−0.019	−1.355*	−0.700
	(0.046)	(0.744)	(0.519)
Pay What You Want (I)	0.138***	1.718	2.077**
	(0.051)	(1.376)	(0.950)
Female (I)	0.077**	−0.196	0.587
	(0.034)	(0.926)	(0.565)
Estimated age < 30 (I)	−0.000	1.065	−0.067
	(0.078)	(2.141)	(1.301)
Estimated age ¿ 60 (I)	−0.073*	−0.814	−1.198**
	(0.039)	(0.798)	(0.550)
Previous donor (I)	0.196***	5.277***	5.285***
	(0.044)	(1.365)	(1.082)
Home value (hundred thousands)	0.031**	0.830***	0.577***
	(0.014)	(0.281)	(0.202)
Constant	0.343***	5.881***	1.9828***
	(0.049)	(1.036)	(0.658)
Dependent variable	Donate?	Donation¿0	Donation≥ 0
Observations	849	434	849
R^2	0.055	0.117	0.108

Note: OLS with robust (standard errors); * p<0.10, ** p<0.05, *** p<0.01.

charities are most concerned about the total amount raised (or the amount raised per solicitation), the combined effects of participation and giving. To assess "the bottom line" result of our field experiment we now consider all the donation data, including the zeros.

In the rightmost panel of Fig. 2 we present the mean donation for each raffle format, including zeros for all the instances in which a respondent answered the door but did not donate. Starting with the formats that performed less well, in the baseline, linear, format the mean donation is \$4.34, an amount that is 75 cents larger than the poorest performing format, the concave treatment, but the difference is not quite significant ($t = 1.40$, $p = 0.16$). However, both the concave and linear raffles perform less well overall than either of the other two formats. Apparently there are two "paths" to raising a greater than typical amount. In the convex raffle where efficiency is emphasized the mean contribution raised per solicitation is \$6.23, an amount significantly greater than both the linear and concave raffles ($p \leq 0.01$ in both cases). As an alternative, in the PWYW format which stresses the fact that every participant has the same chance of winning, the mean gift is \$6.35, again an amount significantly greater than both the linear and concave formats ($p \leq 0.02$ for both). Interestingly, contrary to theory which predicts that the intensive margin should dominate, we see no clear best way to run a raffle - the mean contributions in the convex and PWYW do not differ significantly ($p = 0.91$).

We conclude our presentation of the results with a discussion of the third column in Table 3 which presents an ordinary least squares analysis based on the entire sample of donations. Column (1) indicates, again, that both the efficiency-focussed convex raffle and the fairness-focussed PWYW raffle do significantly better than the standard linear raffle. At the same time, a comparison of the convex and PWYW point estimates confirms that they do equally well compared to the linear raffle ($p = 0.91$). Considering the other possible determinants of contributions, we see an effect of being older than middle-aged - older respondents give less. In addition, previous donors give approximately twice as much and wealthier respondents, as measured by the assessed value of their homes, also give more ($p < 0.01$ for both). As is the pattern, appendix Table A1, column 3, reports the results, which change little, when solicitor fixed effects are added.

5. Discussion

This is one of the first studies to use a field experiment to assess the effectiveness of different raffle designs, a question with substantial implications for the provision of public goods. Although the standard linear raffle is ubiquitous, quantity discounts are not uncommon, so it is important to know whether altering the mechanism to make it more efficient is attractive to high-value participants. In addition, while we are sure that few people have participated in raffles with explicit quantity penalties, the power of the experimental method is that it allows us to test whether other motivations influence mechanism performance.

Our results would seem to be mixed news for fundraisers. The bad news is that the most commonly used mechanism, the standard linear raffle, is unlikely to maximize revenue, but the good news is that there appear to be (at least) two paths to enhanced raffle performance. One recommendation, epitomized by the convex raffle, advises charities to make the mechanism more efficient (and, hence closer to an all-pay auction) so that participants will be incentivized to contribute more. We see this clearly in our field data. Conditional on participating, donors give a third more in the efficient format and this benefit comes without the predicted loss of participation. The second prescription advocates ways to emphasize the fairness of the raffle, the simplest of which is to create a raffle in which everyone has exactly the same chance of winning as in our pay what you want raffle. In this case, more people participate because it truly is the case that "anyone can win." As posited, we find that in the field participation does increase substantially (by 14%), but we also find that the framing of a "fair" raffle matters tremendously because our simple quantity penalty (the concave raffle) does poorly, mostly because participants failed to find it as intuitive as the PWYW (based on the informal comments we received in the field after the solicitations had concluded). Upon reflection, what is interesting is that a mechanism like the PWYW is more common that one might think. In many membership and donation drives by public radio and television, prizes are awarded randomly among participants, regardless of donation.

This leaves the more fundamental question of whether the strategic incentives surrounding a prize crowd in or crowd out voluntary contributions. Recall that one of the interesting features of the PWYW raffle is that any donation above the $5 minimum must be voluntary because it has no impact on one's chances of winning. Consequently, if people give less in the PWYW than in the other formats, it must be the case that the incentive to increase your chances of winning the prize crowds in donations. If, on the other hand, donations are greater in the PWYW, these strategic incentives must crowd out donations. Considering the incidence of donating more than the $5 minimum, in the PWYW 23.38% of donors give more than the minimum. The same figure is 19.57%, 18.42% and 29.74% in the linear, concave and convex treatments, respectively. Only the convex treatment, which explicitly incents volume, does better than the PWYW. Looking, instead, at donation amounts, we find that mean voluntary giving (i.e., in excess of the $5 minimum) in the PWYW is $18.97, it is $17.17 in the convex raffle, $15.00 in the linear raffle, and $12.14 in the concave raffle. Given donations are, on average, lower with incentives than without and people are somewhat more likely to make a voluntary donation without incentives, it appears that there is little evidence of voluntary contributions being crowded in by the incentive to win the prize (and some that they are crowded out).

In the end, the lessons learned via this experiment could have large implications for the provision of local public goods like the charity with which we partnered. As we found, the opportunity cost of using the standard raffle format is considerable and there appear to be two straightforward ways to increase contributions. In addition, these two options allow organizations to tailor their approach to the profile of their constituency, adding another potentially important degree of freedom, one that will have to be assessed in future studies.

Appendix A. Appendix

A.1. Raffle solicitor scripts

A.1.1. (Note: organization names have been redacted)

Hi, our names are _ _ _ _ and _ _ _ _ _ _ and we're raising money for XYZ. XYZ is an organization in Addison County dedicated togiving access to the tools and resources necessary to meet the community's basic needs. This past year, XYZ provided relief to homes that were being hit by the harsh winter. This has depleted its heating and food assistance budgets, and they need your support.

To raise money, we are conducting a charity raffle. All proceeds of this raffle will benefit XYZ.

This raffle has the prize of a $500 gift certificate redeemable at local restaurants. These restaurants are The ABC Café, The DEF Bistro, The GHI, The JKL and The MNO. We will draw the winning ticket during the first week of May and notify the winner.

(Show Pricing Scheme Laminate)

[LINEAR] In this raffle, you will receive 5 tickets for a donation of $5, 10 tickets for $10, 20 tickets for $20 and so forth. Here are the different contributions you can make and the corresponding number of tickets you will receive. The cost of each ticket is the same regardless of how many tickets you buy. We expect 100 people to participate in the raffle.
[CONVEX] In this raffle, you will receive 5 tickets for a donation of $5, 13 tickets for $10, 30 tickets for $20 and so forth. Here are the different contributions you can make and the corresponding number of tickets you will receive. The cost of each ticket decreases as you buy more tickets. We expect 100 people to participate in the raffle.
[CONCAVE] In this raffle, you will receive 5 tickets for a donation of $5, 9 tickets for $10, 15 tickets for $20 and so forth. Here are the different contributions you can make and the corresponding number of tickets you will receive. The cost of each ticket increases as you buy more tickets. We expect 100 people to participate in the raffle.
[PWYW] In this raffle, you will receive 5 tickets for any donation of $5 or more. We would like you to donate whatever you want, 5, 10, 20, 40, or 60 dollars, for the 5 tickets. We expect 100 people to participate in the raffle.

Any questions? Would you like to make a donation to XYZ and enter the raffle?

A.1. Robustness (solicitor team fixed effects)

Table A1
Fixed effect models of the raffle treatment differences.

	(1)	(2)	(3)
Convex - Qty. discount (I)	0.052	2.542**	1.985***
	(0.045)	(1.041)	(0.694)
Concave - Qty. penalty (I)	−0.010	−1.303*	−0.616
	(0.046)	(0.768)	(0.519)
Pay What You Want (I)	0.129**	1.399	1.870**
	(0.051)	(1.310)	(0.924)
Female (I)	0.064*	−0.384	0.461
	(0.034)	(1.000)	(0.579)
Estimated age < 30 (I)	−0.010	1.555	0.278
	(0.082)	(2.147)	(1.363)
Estimated age ¿ 60 (I)	−0.074*	−0.703	−1.082*
	(0.039)	(0.853)	(0.551)
Previous donor (I)	0.182***	5.293***	5.276***
	(0.044)	(1.344)	(1.068)
Home value (hundred thousands)	0.031**	1.037***	0.607**
	(0.016)	(0.366)	(0.238)
Constant	0.226***	6.930***	1.211
	(0.079)	(2.017)	(1.040)
Dependent variable	Donate?	Donation¿0	Donation≥ 0
Observations	849	434	849
R^2	0.080	0.131	0.126

Note: OLS with robust (standard errors); solicitor team fixed effects added; * p<0.10, ** p<0.05, *** p<0.01.

References

Angrist, J., Pischke, J.-S., 2009. Mostly Harmless Econometrics. Princeton University Press, Princeton and Oxford.

Baker, L., 1958. Should we have a national lottery?. Challenge 6, 13–17.

Baye, M., Kovenock, D., de Vries, C., 1994. The solution to the Tullock rent-seeking game when R >2: mixed-strategy equilibria and mean dissipation rates. Public Choice 81, 363–380.

Bowles, S., Polania-Reyes, S., 2012. Economic incentives and social preferences: substitutes or complements?. J. Econ. Lit. 50, 368–425.

Carpenter, J., Holmes, J., Matthews, P., 2008. Charity auctions: a field experiment. Econ. J. 118, 92–113.

Chowdhury, S., Sheremeta, R., 2011. Multiple equilibria in Tullock contests. Econ. Lett. 112, 216–219.

Clotfelter, C., Cook, P., 1990. On the economics of state lotteries. J. Econ. Perspect. 4, 105–119.

Corazzini, L., Faravelli, M., Stanca, L., 2010. A prize to give for: an experiment on public good funding mechanisms. Econ. J. 120, 944–967.

Corchon, L., 2007. The theory of contests: a survey. Rev. Econ. Des. 11, 69–100.

Corcoran, W., 1984. Long-run equilibrium and total expenditures on rent-seeking. Public Choice 43, 89–94.

Cornes, R., Hartley, R., 2005. Asymmetric contests with general technologies. Econ. Theory 26, 923–946.

Dale, D., 2004. Charitable lottery structure and fund raising: theory and evidence. Exp. Econ. 7, 217–234.

Davis, D., Reilly, R., 1998. Do too many cooks always spoil the stew? An experimental analysis of rent-seeking and the role of a strategic buyer. Public Choice 95, 89–115.

Dechenaux, E., Kovenock, D., Sheremeta, R., 2015. A survey of experimental research on contests, all-pay auctions and tournaments. Exp. Econ. 18, 609–669.

DellaVigna, S., List, J., Malmendier, U., 2012. Testing for altruism and social pressure in charitable giving. Q. J. Econ. 127, 1–56.

Duffy, J., Matros, A., 2016. All-pay auctions versus lotteries as provisional fixed-prize fundraising mechanisms: theory and evidence. In: Working paper.

Engers, M., McManus, B., 2007. Charity auctions. Int. Econ. Rev. 48, 953–994.

Gneezy, A., Gneezy, U., Nelson, L., Brown, A., 2010. Shared social responsibility: a field experiment in Pay-What-You-Want pricing and charitable giving. Science 329, 325–327.

Goeree, J.K., Maasland, E., Onderstal, S., Turner, J., 2005. How (not) to raise money. J. Polit. Econ. 113, 897–918.

Goerg, S., Lightle, J., Ryvkin, D., 2016. Priming the charitable pump: an experimental investigation of two-stage raffles. Econ. Inq. 54, 508–519.

Jones, D., 2015. Education's gambling problem: earmarked lottery revenues and charitable donations to education. Econ. Inq. 53, 906–921.

Landry, C., Lange, A., List, J., Price, M., Rupp, N., 2006. Toward an understanding of the economics of charity: evidence from a field experiment. Q. J. Econ. 121, 747–782.

Landry, C., Lange, A., List, J., Price, M., Rupp, N., 2010. Is a donor in hand better that two in the bush? Evidence from a natural field experiment. Am. Econ. Rev. 100, 958–983.

Lange, A., List, J., Price, M., 2007. Using lotteries to finance public goods: theory and experimental evidence. Int. Econ. Rev. 48, 901–927.

Ledyard, J., 1995. Public goods: a survey of experimental research. In: Kagel, J., Roth, A. (Eds.), The Handbook of Experimental Economics. Princeton University Press, Princeton, pp. 111–194.

List, J., 2008. Introduction to field experiments in economics with applications to the economics of charity. Exp. Econ. 11, 203–212.

Mason, D., 2013. Putting charity to the test: a case for field experiments on giving time and money in the nonprofit sector. Nonprofit Volunt. Sect. Q. 42, 193–202.

Millner, E., Pratt, M., 1989. An experimental investigation of efficient rent-seeking. Public Choice 62, 139–151.

Morgan, J., 2000. Financing public goods by means of lotteries. Rev. Econ. Stud. 67, 761–784.

Morgan, J., Orzen, H., Sefton, M., 2012. Endogenous entry in contests. Econ. Theory 51, 435–463.

Morgan, J., Sefton, M., 2000. Funding public goods with lotteries: experimental evidence. Rev. Econ. Stud. 67, 785–810.

Onderstal, S., Schram, A., Soetevent, A., 2013. Bidding to give in the field. J. Public Econ. 105, 72–85.

Orzen, H., 2008. Fundraising through competition: evidence from the lab. In: CeDEx Discussion Paper No. 2008–11.

Potters, J., de Vries, C., van Winden, F., 1998. An experimental examination of rational rent-seeking. Eur. J. Polit. Econ. 14, 783–800.

Schram, A., Onderstal, S., 2009. Bidding to give: an experimental comparison of auctions for charity. Int. Econ. Rev. 50, 431–457.

Szidarovszky, F., Okuguchi, K., 1997. On the existence and uniqueness of pure Nash equilibrium in rent-seeking games. Games Econ. Behav. 18, 135–140.

Tullock, G., 1980. Efficient rent-seeking. In: Buchanan, J., Tollison, R., Tullock, G. (Eds.), Toward a Theory of Rent-Seeking Society. Texas A&M University Press, College Station.