Good-Citizen Lottery

Duk Gyoo Kim

Yonsei University

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My Broader Research Question

How does random, as opposed to meritocratic, allocation of the awards and penalties via a lottery affect efficiency of resource allocations and social welfare?

Good-Citizen Lottery: Question

- Public bads incur social costs. We aim to collectively minimize the production of public bads.
- "Evil pays more": Good citizens are typically unpaid for their good deeds.

Question: Would a lottery paying one of the **good citizen**s whose prize is funded by bad citizens be effective in reducing social costs?

Motivation

- Check this partially fake news.

There's a speed camera lottery in Stockholm, Sweden where drivers who drive at or under the speed limit are entered to win money. The prize fund comes from the fines paid by people who were speeding.

Greenhouse gas emissions, littering, illegal parking, and speeding are examples of situations where good citizen behaviors are costlier.

Previous Studies; skip

It is not rare to use lotteries for nonstandard situations.

- Kim (2021): vaccination lottery
- Kim (2023): penalty lottery
- Gerardi et al. (2016), Duffy and Matros (2014): turnout lottery
- Kearny et al. (2010), Filiz-Ozbay et al. (2015): savings lottery
- Morgan (2000), Morgan and Sefton (2002): lottery to fund public goods
- Björkman Nyqvist et al. (2018): lottery incentivizing safer sexual behavior
- Volpp et al. (2008), Levitt et al. (2016): lottery for habit formation

Setup

- n citizens
- Each player chooses either S (safely abide by law) or V (violate it).
- Citizen i accrues benefit $B > 0$ of acting V
- Incomplete monitoring capacity: With probability $p \in (0, 1)$, action V is monitored and fined F. p is fixed.
- Assume $B - pF > 0$, so bad behavior is beneficial. (Otherwise the question becomes trivial.)
- The payoff of choosing S is 0 for 'most' cases, but when selected as a winner of the lottery, it is kF, where k is the number of players who chose V and got monitored.

Analysis

Let $\delta^* \in [0, 1]$ be the (symmetric) eqbm. prob. of playing S. Let $b := \frac{B}{pF} - 1$, the normalized excess benefit of V.

- When $b \geq 1$, $\delta^* = 0$.
- When $b \in (0, 1)$, $\delta^* \in (0, 1)$.
- I build up hypotheses on δ^*.

Analysis/Hypotheses

When n gets larger, δ^* decreases.

- Intuition: The benefit of V is fixed. Given the same δ, the benefit of S monotone decreases in n.

When p (or F) gets larger, δ^* increases.

- Intuition: The benefit of V decreases. Very straightforward.

For sufficiently large n, risk-averse subjects' δ^* is larger.

- Intuition: The winning prob. of the lottery is negligible, while the payoffs of V are volatile. (For small n, V may be more attractive.)

Those who overestimate the small probability of winning the lottery would be more willing to play S.

- Intuition: Such overestimation essentially boosts up the (subjective) expected payoff of S.

Experimental Design

Case of 18 subjects, $p = 0.3$

Varying n within subjects, varying p between subjects. In each session of 18 subjects, they play 12 similar games, wherein:

- A subject is randomly assigned to a group whose size is $n \in \{3, 6, 9, 18\}$. Their task is to choose one of the two items: a white ball and a box.
- Unwrapping the box, a subject gets a red ball with probability $p = 0.3$ and a blue ball with probability $1 - p$.
- By getting a blue ball, a subject earns a payoff of 240. A red ball is associated with a payoff of 40.
- Choosing the white ball earns 100. Also, one of the group members who chose the white ball is randomly selected to get an additional payoff of $200k$, where k is the number of the members who got the red ball.
- The experiment currency unit is tokens. (1 token$=$ 100 KRW)

Experimental Design, cont'd

The subjects repeat the game in the mixed order in terms of n.

Round	1	2	3	4	5	6	7	8	9	10	11	12
n	6	9	18	3	9	6	18	3	9	6	3	18
P03						$p = 0.3$						
P05						$p = 0.5$						

- To control for the potential order effect, the same mixed order is used for all sessions. (Having randomly mixed order for sufficiently many sessions would be ideal. I struggled for recruiting subjects.)
- Given those parameters, $\frac{B}{pF} - 1 > 1$ when $p = 0.3$. Thus, treatment P03 works as a baseline because there must be **no treatment effect** in n, that is, no S for all n. With $p = 0.5$, there should be a **negative treatment effect** in n, in theory.

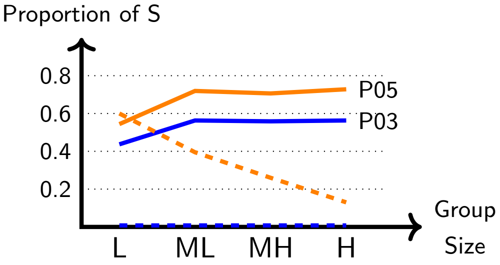
Experimental Design, cont'd

- Then, risk preference and subjective probability weighting are elicited using a simple survey. Post-experimental survey include typical things as well.
- One of the 12 rounds is randomly selected to be paid.

Experiment Procedure

- Zoom-administered real-time online experiment
- LIONESS (Live Interactive ONline Experimental Server Software)
- at SKKU, in Korean
- 4 sessions each for P03 and P05. $74 + 76 = 150$ participants
- Random regrouping
- On average 18,800KRW; min 5,000KRW, max 75,000KRW.
- Starbucks e-gift cards corresponding to the cash value

Results 1 and 2

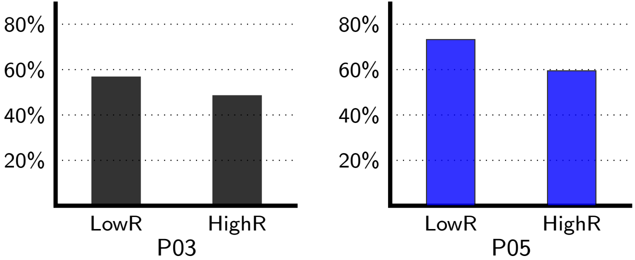


(Dashed lines are theoretical predictions when $n = 18$.)

- In P03, the proportion of ball choices is strictly larger than 0 ($p<0.001$). In P05, the proportion increases in the group size ($p=0.031$). This results reject Hypothesis 1.
- The proportion of ball choices in P05 is significantly larger than that in P03 ($p<0.001$), supporting Hypothesis 2.

What/who drives S then?

Result 3



(HighR: risk-taking tendency is high.)

Figure 1: Proportion of Ball Choices By Risk Preference

- More risk averse $\Rightarrow$ more likely to choose S, supporting Hyp 3.
- Aversion to strategic uncertainty seems to matter less. If it matters, V could have been more frequent for LowR subjects.

Result 4

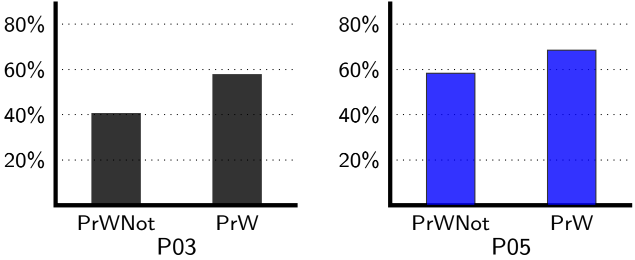


Figure 2: Proportion of Ball Choices By Probability Weighting Tendency

- Those who tend to subjectively weight small probabilities more are more likely to choose S, supporting Hypothesis 4.

$\Rightarrow$ Citizen lottery may work with a large population as well.

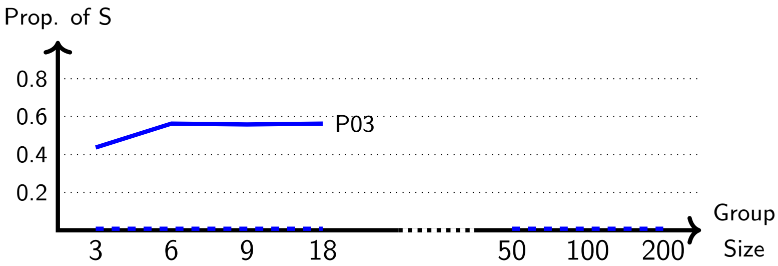
Take-Away Messages (so far)

- Theory predicts (and experimental findings show) that the proportion of good citizens
  - decreases (increases) in the population size;
  - increases (increases) in monitoring capacity;
  - increases (increases) in risk aversion;
  - increases (increases) in probability-weighting tendency.
- Experimental findings support the last three.
- The first one if complete opposite. It suggest that the citizen lottery can **work well** even for a large population, without a burden of securing budget or improving monitoring capacity.
- (A bit of speculation: if tendencies of overweighting small probs $\propto$ reckless production of public bads, citizen lottery can be more effective.)

New supplementary evidence

A common criticism: A group of (at most) 20 doesn't seem like a "large" group. Do you see the similar results when a group size becomes really large?

- I conducted an online experiment at Prolific. The data from 400 subjects were collected on Feb, 2025.
- The same setup with P03, but the group sizes are 50, 100, and 200. (Orders were randomized.)



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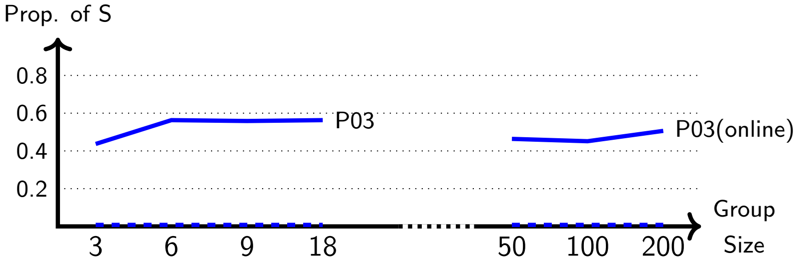


Appendix

For $n+1$ citizens,

- the expected payoff of playing S:

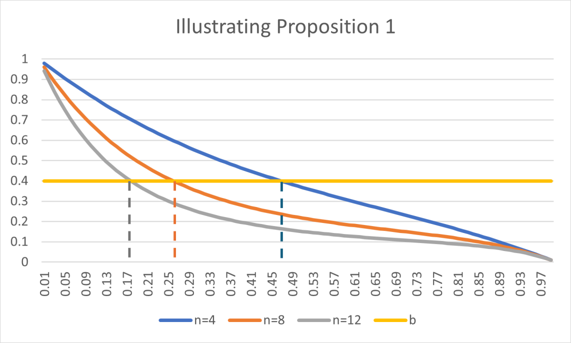
$$\binom{n}{0}\delta^n(1-\delta)^0 0+\binom{n}{1}\delta^{n-1}(1-\delta)\frac{pF}{n}+\binom{n}{2}\delta^{n-2}(1-\delta)^2\frac{pF}{n-1}+\cdots+\binom{n}{n}\delta^0(1-\delta)^n pF$$
$$=\sum_{i=1}^{n}\binom{n}{i}\delta^{n-i}(1-\delta)^i\frac{pF}{n+1-i}$$

  the expected payoff of playing V: $B-pF$

- $\delta^* \in (0,1)$ such that $B-pF=\sum_{i=1}^{n}\binom{n}{i}\delta^{n-i}(1-\delta)^i\frac{pF}{n+1-i}$
- Let $b := \frac{B}{pF}-1\in(0,1)$, the normalized excess benefit to the expected cost. δ^* such that $b=\sum_{i=1}^{n}\binom{n}{i}\delta^{n-i}(1-\delta)^i\frac{1}{n+1-i}$

Analysis

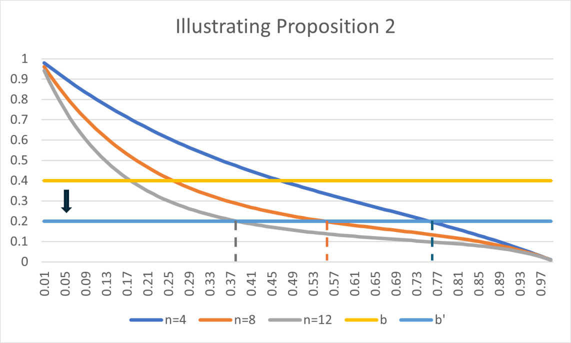
Proposition 1: $\frac{\Delta\delta^*}{\Delta n} < 0$ if $b \in (0, 1)$.



- Intuition: The benefit of V is fixed. Given the same δ, the benefit of S monotone decreases in n.
- Voluntary contributions for public good provision tend to decrease in n. This good-citizen lottery predicts it similarly.
- If $b > 1$, then $\delta^* = 0$ is a corner solution. $\frac{\Delta\delta^*}{\Delta n} = 0$ if $b > 1$.

Analysis

Proposition 2: $\frac{d\delta^*}{dp} > 0$ if $b \in (0, 1)$.



- Larger $p \Rightarrow$ more likely to play S, as long as $b \in (0, 1)$.
- Intuition: The excess benefit decreases. Very straightforward.