Good-Citizen Lottery

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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 deed.

Question: What if there is a lottery payment to one of the **good citizen**s whose prize is funded by bad citizens?

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.

(Help me collecting examples: greenhouse gas emissions, littering, illegal parking and speeding, what else?)

(Example that I want to avoid: Voter turnout lottery funded by penalties collected from no turnouts)

Previous Studies

- 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

Setup

(Can be more general)

- n citizens.
- Citizen i accrues a benefit of acting bad, $B_i > 0$.
- Incomplete monitoring capacity: With probability $p \in (0, 1)$, the bad behavior is monitored and fined F.
- Assume $B_i - pF > 0$ for all i, so bad behavior is beneficial. (Otherwise the question becomes trivial.)
- Each player chooses either S (safely abide by law) or V (violate it).

Illustration

- Consider three homogeneous citizens, $B_i = B$ for all i.
- sort of a coordination game: neither (S,S,S) nor (V,V,V) is an equilibrium (under some parametric restrictions).
- Given two others playing S: I get 0 if I play S, and I get $B - pF > 0$ if I play V, so I should play V.
- Given two others playing V: I get $2pF$ if I play S, and I get $B - pF$ if I play V, so as long as $p > \frac{B}{3F}$, I should play S.
- A symmetric MSNE: playing S with probability δ, where

$$\delta = \frac{3 - \sqrt{4B/pF - 3}}{2}$$

(Note that we assume $B - pF > 0$ so $4B/pF > 4$.)

Analysis

For $n+1$ citizens,

- the expected payoff of playing S:

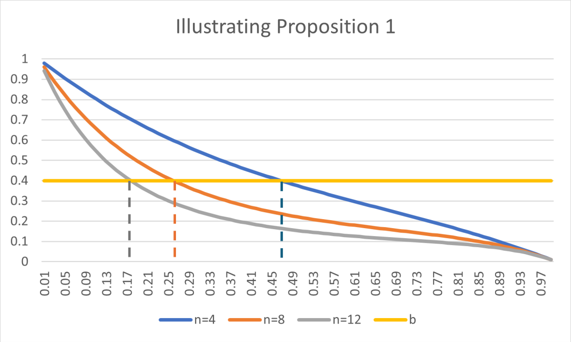
$$\binom{n}{0}\delta^n(1-\delta)^0 0+\binom{n}{1}\delta^{n-1}(1-\delta)\frac{pF}{n}+\binom{n}{2}\delta^{n-2}(1-\delta)^2\frac{pF}{n-1}+\cdots+\binom{n}{n}\delta^0(1-\delta)^n pF$$
$$=\sum_{i=1}^{n}\binom{n}{i}\delta^{n-i}(1-\delta)^i\frac{pF}{n+1-i}$$

  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

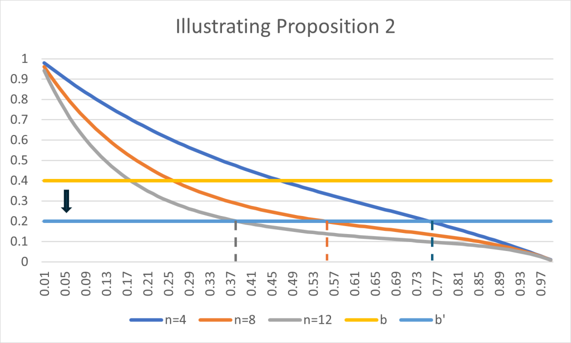
Proposition 1: $\frac{\Delta\delta^*}{\Delta n} < 0$ if $b \in (0, 1)$.



- Larger $n \Rightarrow$ less likely to play S, as long as $b \in (0, 1)$.
- 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.

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. Not that interesting.

Analysis

There are some factors not yet analyzed but worth mentioning. (needs to be done shortly...)

- Risk preferences: It is not straightforward to tell which action is more "risky". A relatively straightforward claim is, for sufficiently large *n*, risk-averse subjects' δ^* is larger. The winning prob. of the lottery is negligible, while the payoffs of V are volatile. For small *n*, V may be more attractive.
- Subjective probability weighting: It is well known that people subjectively overestimate small probabilities. (Otherwise why they wouldn't buy lotteries.)

Testable Hypotheses

Hypothesis

The overall compliance (the fraction of S actions) decreases in the population size if $p \in (\frac{B}{2F}, \frac{B}{F})$.

Hypothesis

The overall compliance (the fraction of S actions) increases in monitoring capacity p.

Hypothesis

For a sufficiently large n, the more risk averse, the citizens would prefer to choose S more.

Hypothesis

The more over-weighting the small probabilities, the more likely the citizen chooses S.

Remarks on the null hypotheses

- The null hypotheses are not "normative": I am not claiming that the findings must be consistent with what theory says.
- Those are benchmarks. We can learn more from what is different from theory, not from what is "as predicted".

Experimental Design

Varying n within subjects, varying p between subjects. In each session of 18 or 20 subjects, they play 12 similar games, wherein:

- A subject is randomly assigned to a group whose size is $n \in \{3, 6, 9, 18\}$ or $\{2, 5, 10, 20\}$. Their task is to choose one of the two items: a white ball and a box.
  (why abstract framing?)
- Unwrapping the box, a subject gets a red ball with probability $p \in \{0.3, 0.5\}$ and a blue ball with probability $1 - p$.
- By getting a blue ball, a subject earns a payoff of $B + b$. A red ball is associated with a payoff of $B - F + b$, where $b > 0$ is the base payoff to guarantee positive earnings for all.
- Choosing the white ball earns b. On top of that, one of the group members who chose the white ball is randomly selected to get an additional payoff of kF, where k is the number of the members who got the red ball.

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
$p = 0.3$ or $p = 0.5$												

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.)

Experimental Design, cont'd

Then, risk preference is measured independently, using Bomb Risk Elicitation Task (BRET).

- Choose a number of steps s between 1 and 100, and get paid $s\mathbf{1}_{s<x}$, where x is drawn from U[1,100].
- It is known to effectively capture the subject's risk preference.

Subjective probability weighting is elicited using a simple survey.
Post-experimental survey include typical things as well.
One of the 12 rounds is randomly selected to be paid. The earning from the BRET is added.

Experimental Design: parameters

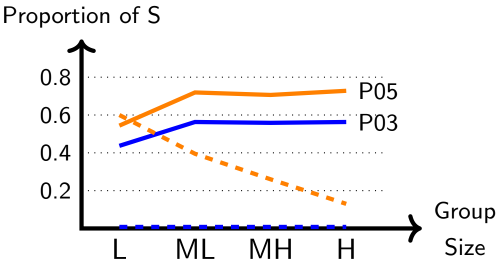
The experiment currency unit is tokens. (1 token= 100 KRW)

- base payoff $b = 100$
- $B = 140$, $F = 200$. So, choosing V results either 240 (=100+140) or 40 (=100+140-200).
- Choosing S results b. In case of the lottery winner, 200*number of red balls.
- BRET=1 token for each step. Expected payment = 25 tokens
- Given those parameters, $p = 0.3$ is outside of $(\frac{B}{2F}, \frac{B}{F})$. That is, there should be no S in theory for all n. With $p = 0.5$, proposition 1 works.

Experiment Procedure

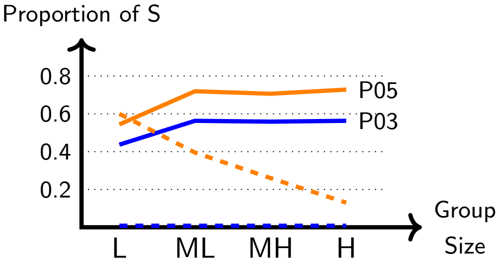
- Zoom-administered real-time online experiment
- LIONESS (Live Interactive ONline Experimental Server Software)
- at SKKU, in Korean
- 4 sessions each for P03 and P05. $74 + 76 = 150$ participants
- Random regrouping
- On average 18,800KRW; min 5,000KRW, max 75,000KRW.
- Starbucks e-gift cards corresponding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

Result 1



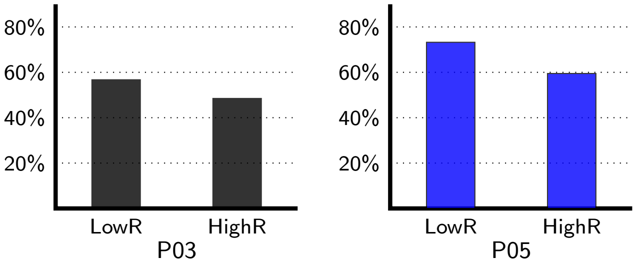
(Dashed lines are theoretical predictions when $n = 18$.)
In P03, the proportion of ball choices is larger than 0 ($p<0.001$).
In P05, the proportion increases in the group size ($p=0.031$).
This result rejects Hypothesis 1.

Result 2



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.

  (One unsatisfactory thing: BRET results were very noisy.)

Result 4

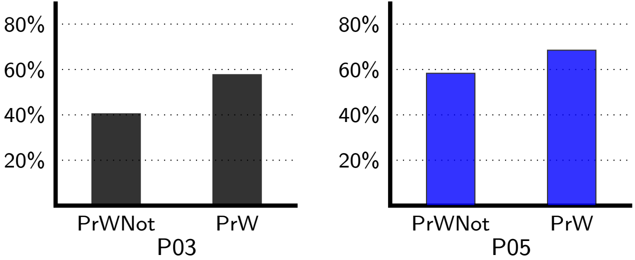


Figure 2: Proportion of Ball Choices By Probability Weighting Tendency

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

⇒ Citizen lottery may work with a large population as well.

Take-Away Messages (at the moment..)

- 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 turns out to be a complete opposite.
- May be a good sign. It suggest that the citizen lottery can work even with a large population.
- A bit of speculation: if tendencies of overweighting small probs $\propto$ reckless production of public bads, citizen lottery can be more effective.