Does random auditing reduce tax evasion in the lab?

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Motivations

• Empirical context
  – Water extraction from aquifers in coastal zones
  – High risk of saline intrusion
  – Under-reporting of water extraction

• Designing mechanisms to reduce misreporting
  – Random auditing + Fine
  – Collective penalties (e.g. ambiant tax, ... )
This study

• Authorities have limited information and limited budget
• Objective: minimizing the number of agents who cheat
• Mechanism with probabilistic audit
• Conditionnal audit probability (conditionned on past observed behavior)

Greenberg (1986)
Assumptions (1)

• In each period, each agent receives a random income $y$
• Players report income $z \leq y$
• Net income
  – If not audited: $y - T(z)$ \hspace{1cm} (N.B. $T(y) \leq y$)
  – If audited:
    • Truthfull reporting: $y - T(y)$
    • Cheating: $y - T(z) - P(y,z)$ with $P(y,z) > T(y) - T(z)$
• Audit probability: $p > 0$
• Audit is perfect
Assumptions (2)

- Agents live an infinite number of periods
- Agents are risk-neutral
- Myopic behaviour
- $p_i(y)$ is the smallest audit probability for which player $i$ reports truthfully
- Myopic players cheat for $p < p_i(y)$ whatever $y$
- (there exists $\rho > 0$, such that for all $y$ and all $i$, $p_i(y) > \rho$)
Assumptions (3)

• \( r \) = audit probability determined by the tax authority’s budget constraint (exogenous)
  – If \( r = 1 \) all players report truthfully
  – If \( r < \rho \) all players will cheat
  – If \( \rho < r < p_i(y)_{\text{max}} \) some players will cheat

• \( \Rightarrow \) they can increase their utility by cheating until they are audited, and then stop cheating

• The tax authorities try to minimize the number of tax evaders in the population \( n_1 \)
Predictions (1)

No cheating detected

Group 1

Audit proba $p_1 > 0$

Audit and truthfull report

Group 2

Cheating detected $\Rightarrow$ Fine

Audit proba $p_2 < p_1$

Group 3

Cheating detected $\Rightarrow$ Fine

Audit proba $p_3 = 1$
Predictions (2)

All players cheat

Group 1

n₁ players

(αN)

No player cheats

Group 2

n₂ players

(1 − α)N

No player cheats

Group 3

0 player
Experimental design (1)

• Income stream: each subject receives a randomly selected income between 100 and 1000 yens at each period
• Infinite lifetime (cont. prob = 0.9)
• Many lives: each subject experiences several lives.
• Ending: end time announced at the beginning. After end time, no new sequence could start. Running sequence were allowed to be continued during a maximum extra-time of 15mn.
• Payment: One sequence randomly selected and paid out
Experimental design (2)

• Two-treatments:
  
  – T1 = low audit probability:
    Group 1 : \( p_1 = \frac{1}{3} \)
    Group 2 : \( p_2 = \frac{1}{4} \)
  
  – T2 = high audit probability:
    Group 1 : \( p_1 = \frac{1}{2} \)
    Group 2 : \( p_2 = \frac{1}{3} \)

• Penalty
  
  \[ P(y,z) = (y - z) \times a \]
## Summary of the data

<table>
<thead>
<tr>
<th></th>
<th>Low audit</th>
<th>High audit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of subjects</td>
<td>36</td>
<td>38</td>
</tr>
<tr>
<td>Average number of sequences (min/max)</td>
<td>7 (3/12)</td>
<td>9 (4/16)</td>
</tr>
<tr>
<td>Average number of periods (min/max)</td>
<td>31 (21/82)</td>
<td>30 (21/82)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>7630</td>
<td>10180</td>
</tr>
</tbody>
</table>
Proportions of subjects in groups

<table>
<thead>
<tr>
<th></th>
<th>Predicted</th>
<th>Estimated</th>
<th>Predicted</th>
<th>Estimated</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Group 1</strong></td>
<td>43%</td>
<td>50%</td>
<td>40%</td>
<td>46%</td>
</tr>
<tr>
<td><strong>Group 2</strong></td>
<td>57%</td>
<td>28%</td>
<td>60%</td>
<td>28%</td>
</tr>
<tr>
<td><strong>Group 3</strong></td>
<td>0%</td>
<td>20%</td>
<td>0%</td>
<td>26%</td>
</tr>
</tbody>
</table>

*Low audit*  
\(p_1 = \frac{1}{3}, p_2 = \frac{1}{4}\)

*High audit*  
\(p_1 = \frac{1}{2}, p_2 = \frac{1}{3}\)
Under-reporting

Group 1
- Low audit: 48.2%
- High audit: 42.0%

Group 2
- Low audit: 15.1%
- High audit: 13.7%

Group 3
- Low audit: 2.8%
- High audit: 6.6%

Legend:
- Low audit: Blue
- High audit: Purple
Beginning and end behaviour

high audit probability

- Group 1:
  - Average 2 first sequences: 58.8%
  - Average 2 last sequences: 29.1%

- Group 2:
  - Average 2 first sequences: 49.6%
  - Average 2 last sequences: 17.8%
Evolution of the frequency of fraud with repetition

Low audit

<table>
<thead>
<tr>
<th>Seq</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>seq 1</td>
<td>36</td>
<td>20</td>
</tr>
<tr>
<td>seq 2</td>
<td>36</td>
<td>16</td>
</tr>
<tr>
<td>seq 3</td>
<td>36</td>
<td>10</td>
</tr>
<tr>
<td>seq 4</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>seq 5</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>seq 6</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>seq 7</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>seq 8</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>seq 9 et +</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

Legend: 
- **Blue** - Group 1
- **Red** - Group 2
Frequency of fraud according to income (low audit)
Frequency of fraud per income level for each group (low audit)

- Group 1: 7.41%, 21.27%, 41.84%, 0.93%, 3.80%, 10.11%, 0.0%, 10.0%, 20.0%, 30.0%, 40.0%, 50.0%, 60.0%, 70.0%, 80.0%
- Group 2: 10.0%, 20.0%, 30.0%, 40.0%, 50.0%, 60.0%, 70.0%, 80.0%, 90.0%, 100.0%, 110.0%, 120.0%, 130.0%, 140.0%, 150.0%, 160.0%, 170.0%, 180.0%, 190.0%, 200.0%, 210.0%, 220.0%, 230.0%, 240.0%, 250.0%, 260.0%, 270.0%, 280.0%, 290.0%, 300.0%, 310.0%, 320.0%, 330.0%, 340.0%, 350.0%, 360.0%, 370.0%, 380.0%, 390.0%, 400.0%, 410.0%, 420.0%, 430.0%, 440.0%, 450.0%, 460.0%, 470.0%, 480.0%, 490.0%, 500.0%, 510.0%, 520.0%, 530.0%, 540.0%, 550.0%, 560.0%, 570.0%, 580.0%, 590.0%, 600.0%, 610.0%, 620.0%, 630.0%, 640.0%, 650.0%, 660.0%, 670.0%, 680.0%, 690.0%, 700.0%, 710.0%, 720.0%, 730.0%, 740.0%, 750.0%, 760.0%, 770.0%, 780.0%, 790.0%, 800.0%, 810.0%, 820.0%, 830.0%, 840.0%, 850.0%, 860.0%, 870.0%, 880.0%, 890.0%, 900.0%, 910.0%, 920.0%, 930.0%, 940.0%, 950.0%, 960.0%, 970.0%, 980.0%, 990.0%, 1000.0%
Frequency of fraud according to income (high audit)
Frequency of fraud per income level for each group (high audit)
Individual strategies

1. Predicted strategy (15%)
   Group 1: Fraud the whole income almost always
   Group 2: No fraud (almost always)

2. Predicted strategy for high income only (23%)
   Group 1: Fraud the whole income only for high income
   Group 2: No fraud (almost always)

3. Cheating more frequently as income increases (27%)
   Fraud if income is high in both groups
Predicted strategy
(low audit)

<table>
<thead>
<tr>
<th>ID</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>80,00</td>
<td>0,00</td>
</tr>
<tr>
<td>4</td>
<td>75,74</td>
<td>0,00</td>
</tr>
<tr>
<td>7</td>
<td>72,03</td>
<td>8,41</td>
</tr>
<tr>
<td>29</td>
<td>72,60</td>
<td>5,45</td>
</tr>
<tr>
<td>30</td>
<td>96,36</td>
<td>0,00</td>
</tr>
<tr>
<td>31</td>
<td>86,79</td>
<td>5,08</td>
</tr>
</tbody>
</table>
Predicted strategy for high income (Low audit)

<table>
<thead>
<tr>
<th>ID</th>
<th>Group 1</th>
<th>Group 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>47.03</td>
<td>2.15</td>
</tr>
<tr>
<td>6</td>
<td>41.30</td>
<td>5.88</td>
</tr>
<tr>
<td>9</td>
<td>48.48</td>
<td>3.95</td>
</tr>
<tr>
<td>11</td>
<td>46.24</td>
<td>10.81*</td>
</tr>
<tr>
<td>24</td>
<td>48.61</td>
<td>16.67*</td>
</tr>
<tr>
<td>27</td>
<td>52.88</td>
<td>3.16</td>
</tr>
<tr>
<td>34</td>
<td>44.04</td>
<td>0.00</td>
</tr>
</tbody>
</table>

* Below 3.5% after sequence 1

- Low incomes : $y \leq 350$
- High incomes : $y \geq 750$
- Middle incomes : $350 < y < 750$
Summary

• Mechanism to minimize fraud based on random auditing and segregation
• Group 1 : subjects fraud less frequently than predicted, and fraud only a part of their income
• Group 2 : subjects fraud too frequently
• In both groups fraud is more frequent as income increases
Feasibility

\[ p_1 \alpha + p_2 (1 - \alpha) \leq r \quad \rho \alpha < r \]

\[ p_1 = \frac{\rho}{2} \]

\[ p_2 = \frac{\alpha}{1 - \alpha} \times \frac{\rho}{2} \]

\[ p_3 = 1 \]