Impact of Influential Observations on Enumeration and Variance Estimation in the National Crime Victimization Survey

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Statement of Problem

- Outliers and influential observations on estimates from samples
- Enumeration of crime victimizations: Small percent of victims report a very large number of incidents
- Examine the impact of various enumeration strategies for extreme observations on estimates
Outliers

- Outlying observation is one that appears to deviate markedly from other members of the sample in which it occurs (Eltinge & Cantwell 2006; Chambers, 1985; Dixon, 1950; Grubbs 1969)

Type of outlier (Chambers 1985)

- Measurement/Gross Error
- Non-Representative
- Representative
Statement of Problem

Outlier: key component is influence

Including outliers results in extreme weights and increased volatility:

- Large shifts in point estimates
- Observation accounts for large proportion of estimate
- Large increases in variance, reduction of power
- Large shifts in point estimates over time
Statement of Problem

Outlier detection/identification and treatment

• What is an outlier?
  ▪ Various techniques that identify outliers
    • Standard deviations from the mean
    • Visual inspection
    • Statistical techniques/distance/index of influence or leverage
    • Examine for influential data points

• What should you do with an outlier?
  ▪ Treatment types
    • Include
    • Eliminate/Trim
    • Downweighting/Winsorization/Imputation strategies
    • Model-based alternatives (Elliott and Little, 2000)
National Crime Victimization Survey (NCVS)

Household survey
- Sample of persons 12 or older
- Rotating panel design, interviewed every 6 months for 3 years
- 160,000 interviews (in-person or phone)
- 87% HH and 87% person response rate

NCVS estimation:
- Annual totals counts and rates of crime
- Annual change

Counts and rates for key subdomains:
- Type of crime- violent and property crimes
- Victim characteristics- gender, age, race/ethnicity, etc.
- Incident characteristics- reported to police, injury, weapon use, etc.
Victimization: NCVS estimation

Data collection

- Respondent asked: Recall, date, and enumerate every criminal incident within reference period (6 months)

- Most report 0 or 1 incidents, but a small percentage report a very high number (a finding consistent across victimization surveys, various populations, and crime types)
Figure 1. Number of victimization per victim reported in the 6-month reference period, NCVS 1993-2012
Victimization: NCVS estimation

Data collection

- Respondent asked: Recall, date, and describe every criminal incident within reference period (6 months)

- Most report 0 or 1 incidents, but a small percentage report a very high number (a finding consistent across victimization surveys, various populations, and crime types)

- High volume repeat victims- high burden to recall, date, and describe accurately every incident

- Tension between burden and accuracy
Victimization: series incidents

NCVS data collection procedure: cap incidents collected in field

Most victimizations surveys use a capping method to data collection and estimation:
- Crime Survey for England and Wales (formerly British Crime Survey) – cap at 5 incidents
- Mexico’s Encuestas Nacionales Sobre Iseguridad (ENSI) - cap at 5 incidents
- Canadian Victimization Survey (GSS Cycle 18)- up to 20 but estimation capped at 3

NCVS “series incident” protocol
1. Record number of times incident occurred
2. Record all incidents that can be recalled in separate detail
3. 6 or more incidents that are similar in detail are grouped and details of the last incident are recorded (Series incident)
Figure 2. Number of victimizations by series victim, NCVS 1993-2012
Figure 2. Number of victimizations by series victim, NCVS 1993-2012
Figure 3. Number of series incidents reported per year, NCVS, 1993-2012
Figure 4. Percent of violent crime that are series incidents, NCVS, 1993-2012
Victimization: NCVS series incidents

Series incidents: substantively important victims
3 general categories of assaults:

- Domestic violence: intimate partners or other family members
- School violence
- Workplace violence (e.g., police officers/security guards, medical workers).

Series protocol addresses the recall and burden issues for the respondent, but at the cost of less information.

How should these cases be handled?

Estimation strategies - reduce bias and contain volatility/variance

Count series:
- 0 (exclude)
- 1
- cap to median (6-10)
- actual respondent estimate (6-750)

Examine impact:
- Point estimate
- Standard error
- Coefficient of variation

Violent crime counts:
- Total violence
- Rape/sexual assault
- Robbery
- Aggravated assault
- Simple assault
Figure 5. Measures of central tendency for victimization weights by series enumeration scheme, 1993-2012

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<th>weight size</th>
<th>Mode</th>
<th>Median</th>
<th>Mean</th>
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<tr>
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<tr>
<td>series=actual</td>
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</table>
Enumeration strategies

Figure 6. Total violence, point estimates and coefficient of variation, 1993, 2012

Counts

CV

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<thead>
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<th>1993</th>
<th>2012</th>
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<tr>
<td>actual</td>
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<table>
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<th>1993</th>
<th>2012</th>
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<tr>
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<tr>
<td>actual</td>
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</table>
Enumeration strategies
Figure 7. Total rape/sexual assault, point estimates and coefficient of variation, 2012

Counts

<table>
<thead>
<tr>
<th>0</th>
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<tr>
<td>200,000</td>
<td>300,000</td>
<td>500,000</td>
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</table>

Series= 4 additional observations

CV

<table>
<thead>
<tr>
<th>0</th>
<th>1</th>
<th>capped</th>
<th>actual</th>
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</thead>
<tbody>
<tr>
<td>0.0%</td>
<td>5.0%</td>
<td>10.0%</td>
<td>20.0%</td>
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</table>

Rape/sexual assault
Enumeration strategies

Figure 8. Total simple assault, point estimates and coefficient of variation, 2012
Enumeration strategies

Figure 9. Type of crime, percent increase point estimates (victimization counts), 2012

<table>
<thead>
<tr>
<th>Type of Crime</th>
<th>Percent Increase</th>
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<tbody>
<tr>
<td>Rape/sexual assault</td>
<td>120</td>
</tr>
<tr>
<td>Robbery</td>
<td>0</td>
</tr>
<tr>
<td>Agg aslt</td>
<td>20</td>
</tr>
<tr>
<td>Simple aslt</td>
<td>40</td>
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</tbody>
</table>
Enumeration strategies

Figure 10. Crime type, coefficient of variation, 2012

CV

0.0%
5.0%
10.0%
15.0%
20.0%
25.0%
30.0%
35.0%
40.0%

Rape/sexual assault
Robbery
Agg aslt
Simple aslt

0
1
capped
actual
Summary/Conclusions

• High volume repeat victims pose challenges to data collection and estimation

• Reporting actual respondent counts produces extreme and influential weights resulting in:
  • Large increases in point estimates
  • Large shifts in annual change
  • Large increases in variance, reduction in statistical power
  • Relatively rare crimes such as rape/sexual assault experience large increases in volatility, other crime types less susceptible (e.g., robbery)
  • Relatively common incidents such as simple assault account for a large number of series, but less prone to large shifts because of the large number of total observations.

• Capping series incidents with the median estimate reduces the impact on the estimate and variance while balancing substantive accuracy.

• Concerns: Inliers for subdomains and small area estimation