Evaluating Neighbourhood Policing using Bayesian Hierarchical Models
No Cold Calling in Peterborough, England

Guangquan Li\textsuperscript{1}, Robert Haining\textsuperscript{2}, Sylvia Richardson\textsuperscript{1} and Nicky Best\textsuperscript{1}

\textsuperscript{1}Department of Epidemiology and Biostatistics
Imperial College London

\textsuperscript{2}Department of Geography
University of Cambridge

British Society of Criminology Conference, July 3-6, 2011
Evaluating neighbourhood policing initiatives

Neighbourhood policing programs in general are best evaluated with a “local focus” (Mason 2009\(^1\)) and those evaluations based on quantitative data need to be able to examine such data rigorously to provide statistical evidence of changes over time and with reference to well defined control groups.

Outline

Background

Evaluation framework

Results and Conclusions
Outline

Background

Evaluation framework

Results and Conclusions
Background: Cold Calls

- “Cold calling” is defined as a visit, or in the first place a telephone call that may be followed by a visit, by a trader (or someone linked to a trader whether or not they supply goods or services) and which takes place without the consumer expressly requesting the initial contact.

- “Cold calling” is often associated with rogue trading and distraction burglary.
**Background: The NCC project**

- Initiated by the Cambridgeshire and Peterborough Distraction Burglary and Rogue Trader Task Force, the “No Cold Calling” (NCC) project aims to reduce the impacts of distraction burglary and rogue trading in terms of (i) the number of incidents and (ii) the public’s fear of crime.

- The NCC project in Peterborough (popn. 160,000) was first implemented in selected areas during 2005 and extended to more areas in 2006.

- In addition to setting up signage to discourage cold calling, every resident was visited in the targeted areas and given an information pack containing literature advising how to avoid becoming a victim and the steps to take when answering the door.

- An initial assessment of the scheme by the Cambridgeshire Police reported high levels of satisfaction amongst residents in the NCC-targeted areas who generally expressed increased confidence in dealing with cold callers.

- **However, to date, there has been no assessment of the scheme based on offence data.**
Data on “No Cold Calling”

<table>
<thead>
<tr>
<th>COA_code</th>
<th>Postcode</th>
<th>Area name</th>
<th>Number of targeted dwellings</th>
<th>Started</th>
<th>Number of dwellings in COA</th>
<th>Coverage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>NCC 2005</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>00JANC0016</td>
<td>PE3 8JU Hanover Court, Bretton</td>
<td>42</td>
<td>10/03/2005</td>
<td>122</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>00JANE0006</td>
<td>PE1 2NL Kimbolton Court, Millfield</td>
<td>48</td>
<td>28/01/2005</td>
<td>150</td>
<td>32</td>
</tr>
<tr>
<td>3</td>
<td>00JANE0010</td>
<td>PE1 3RR Eaglethorpe, New England</td>
<td>28</td>
<td>28/01/2005</td>
<td>151</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>00JANG0013</td>
<td>PE1 5JD Mellows Close, Eastfield</td>
<td>12</td>
<td>25/01/2005</td>
<td>131</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>00JANH0003</td>
<td>PE6 7TZ Boxgrove Close, Eye</td>
<td>8</td>
<td>03/06/2005</td>
<td>126</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>00JANQ0023</td>
<td>PE2 6XN Napier Place, Orton Wistow</td>
<td>54</td>
<td>17/03/2005</td>
<td>103</td>
<td>52</td>
</tr>
<tr>
<td>7</td>
<td>00JANT0027</td>
<td>PE4 7PS Bevishall, Paston</td>
<td>45</td>
<td>20/07/2005</td>
<td>127</td>
<td>35</td>
</tr>
<tr>
<td>8</td>
<td>00JANY0010</td>
<td>PE4 6QT Dudley Avenue, Walton</td>
<td>10</td>
<td>20/12/2005</td>
<td>122</td>
<td>8</td>
</tr>
<tr>
<td><strong>NCC 2006</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>00JANG0025</td>
<td>PE1 4SL Keys Park Mobile Home Park</td>
<td>100</td>
<td>22/08/2006</td>
<td>168</td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>00JANH0003</td>
<td>PE6 7XF Woad Court</td>
<td>28</td>
<td>19/10/2006</td>
<td>126</td>
<td>22</td>
</tr>
<tr>
<td>11</td>
<td>00JAPB0010</td>
<td>PE3 6LA Thorpe Avenue</td>
<td>36</td>
<td>27/09/2006</td>
<td>128</td>
<td>28</td>
</tr>
</tbody>
</table>
Data on “No Cold Calling”

<table>
<thead>
<tr>
<th>COA_code</th>
<th>Postcode</th>
<th>Area name</th>
<th>Number of targeted dwellings</th>
<th>Started</th>
<th>Number of dwellings in COA</th>
<th>Coverage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCC 2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>00JANC0016</td>
<td>Hanover Court, Bretton</td>
<td>42</td>
<td>10/03/2005</td>
<td>122</td>
<td>34</td>
</tr>
<tr>
<td>2</td>
<td>00JANE0006</td>
<td>Kimbolton Court, Millfield</td>
<td>48</td>
<td>28/01/2005</td>
<td>150</td>
<td>32</td>
</tr>
<tr>
<td>3</td>
<td>00JANE0010</td>
<td>Eaglesthorpe, New England</td>
<td>28</td>
<td>28/01/2005</td>
<td>151</td>
<td>19</td>
</tr>
<tr>
<td>4</td>
<td>00JANG0013</td>
<td>Mellows Close, Eastfield</td>
<td>12</td>
<td>25/01/2005</td>
<td>131</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>00JANH0003</td>
<td>Boxgrove Close, Eye</td>
<td>8</td>
<td>03/06/2005</td>
<td>126</td>
<td>6</td>
</tr>
<tr>
<td>6</td>
<td>00JANQ0023</td>
<td>Napier Place, Orton Wistow</td>
<td>54</td>
<td>17/03/2005</td>
<td>103</td>
<td>52</td>
</tr>
<tr>
<td>7</td>
<td>00JANT0027</td>
<td>Bevishall, Paston</td>
<td>45</td>
<td>20/07/2005</td>
<td>127</td>
<td>35</td>
</tr>
<tr>
<td>8</td>
<td>00JANY0010</td>
<td>Dudley Avenue, Walton</td>
<td>10</td>
<td>20/12/2005</td>
<td>122</td>
<td>8</td>
</tr>
<tr>
<td>NCC 2006</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>00JANG0025</td>
<td>Keys Park Mobile Home Park</td>
<td>100</td>
<td>22/08/2006</td>
<td>168</td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>00JANH0003</td>
<td>Woad Court</td>
<td>28</td>
<td>19/10/2006</td>
<td>126</td>
<td>22</td>
</tr>
<tr>
<td>11</td>
<td>00JAPB0010</td>
<td>Thorpe Avenue</td>
<td>36</td>
<td>27/09/2006</td>
<td>128</td>
<td>28</td>
</tr>
</tbody>
</table>

Outcome measure

- Rogue trading is an under reported crime and the number of cases is small;
- Distraction burglary events are also very few in number.
## Data on “No Cold Calling”

<table>
<thead>
<tr>
<th>COA_code</th>
<th>Postcode</th>
<th>Area name</th>
<th>Number of targeted dwellings</th>
<th>Started</th>
<th>Number of dwellings in COA</th>
<th>Coverage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>NCC 2005</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 00JANC0016</td>
<td>PE3 8JU</td>
<td>Hanover Court, Bretton</td>
<td>42</td>
<td>10/03/2005</td>
<td>122</td>
<td>34</td>
</tr>
<tr>
<td>2 00JANE0006</td>
<td>PE1 2NL</td>
<td>Kimbolton Court, Millfield</td>
<td>48</td>
<td>28/01/2005</td>
<td>150</td>
<td>32</td>
</tr>
<tr>
<td>3 00JANE0010</td>
<td>PE1 3RR</td>
<td>Eagleshorpe, New England</td>
<td>28</td>
<td>28/01/2005</td>
<td>151</td>
<td>19</td>
</tr>
<tr>
<td>4 00JANG0013</td>
<td>PE1 5JD</td>
<td>Mellows Close, Eastfield</td>
<td>12</td>
<td>25/01/2005</td>
<td>131</td>
<td>9</td>
</tr>
<tr>
<td>5 00JANH0003</td>
<td>PE6 7TZ</td>
<td>Boxgrove Close, Eye</td>
<td>8</td>
<td>03/06/2005</td>
<td>126</td>
<td>6</td>
</tr>
<tr>
<td>6 00JANQ0023</td>
<td>PE2 6XN</td>
<td>Napier Place, Orton Wistow</td>
<td>54</td>
<td>17/03/2005</td>
<td>103</td>
<td>52</td>
</tr>
<tr>
<td>7 00JANT0027</td>
<td>PE4 7PS</td>
<td>Bevishall, Paston</td>
<td>45</td>
<td>20/07/2005</td>
<td>127</td>
<td>35</td>
</tr>
<tr>
<td>8 00JANY0010</td>
<td>PE4 6QT</td>
<td>Dudley Avenue, Walton</td>
<td>10</td>
<td>20/12/2005</td>
<td>122</td>
<td>8</td>
</tr>
<tr>
<td>NCC 2006</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 00JANG0025</td>
<td>PE1 4SL</td>
<td>Keys Park Mobile Home Park</td>
<td>100</td>
<td>22/08/2006</td>
<td>168</td>
<td>60</td>
</tr>
<tr>
<td>10 00JANH0003</td>
<td>PE6 7XF</td>
<td>Woad Court</td>
<td>28</td>
<td>19/10/2006</td>
<td>126</td>
<td>22</td>
</tr>
<tr>
<td>11 00JAPB0010</td>
<td>PE3 6LA</td>
<td>Thorpe Avenue</td>
<td>36</td>
<td>27/09/2006</td>
<td>128</td>
<td>28</td>
</tr>
</tbody>
</table>

### Outcome measure

- Rogue trading is an under reported crime and the number of cases is small;
- Distraction burglary events are also very few in number.
- So, analysis here is based on all reported burglary in a dwelling events, acting as a surrogate measure for rogue trading and distraction burglary, two household-related acquisitive offences.
- Unit of analysis: the Census Output Area (COA) level
Locations of the NCC-COA
Trend patterns from raw data

2005/2006 NCC groups (10 COA)

Annual Burglary rate per 100 dwellings

<table>
<thead>
<tr>
<th>Year</th>
<th>Overall (without NCC)</th>
<th>Individual NCC</th>
<th>Aggregated NCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2002</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2003</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2005</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Positive impact of policy?
Outline

Background

Evaluation framework

Results and Conclusions
Strategy for evaluation

- Comparing burglary rates before and after the implementation of the NCC scheme;
  - Difference between the two time periods is indicative of the influence of the policy.

- The use of control areas helps to differentiate how much of the change may be due to the policy impact and how much of the change may be due to other external factors.
- Dealing with sparsity of data; small number of burglary events by data aggregation.
- Assessing the overall impact by hierarchical/multilevel modelling of local impacts.
- Separating signal from noise.
Strategy for evaluation

- Comparing burglary rates before and after the implementation of the NCC scheme;
  - Difference between the two time periods is indicative of the influence of the policy.

- Comparison is done after adjusting for systematic changes in burglary rates in other non-NCC areas;
  - The use of control areas helps to differentiate how much of the change may be due to the policy impact and how much of the change may be due to other external factors.
Strategy for evaluation

- Comparing burglary rates before and after the implementation of the NCC scheme;
  - Difference between the two time periods is indicative of the influence of the policy.

- Comparison is done after adjusting for systematic changes in burglary rates in other non-NCC areas;
  - The use of control areas helps to differentiate how much of the change may be due to the policy impact and how much of the change may be due to other external factors.

- Deal with sparsity of data (i.e., small number of burglary events) by
  1. data aggregation → assessing the overall impact.
Strategy for evaluation

- Comparing burglary rates before and after the implementation of the NCC scheme;
  - Difference between the two time periods is indicative of the influence of the policy.

- Comparison is done after adjusting for systematic changes in burglary rates in other non-NCC areas;
  - The use of control areas helps to differentiate how much of the change may be due to the policy impact and how much of the change may be due to other external factors.

- Deal with sparsity of data (i.e., small number of burglary events) by
  1. data aggregation → assessing the overall impact.
  2. hierarchical/multilevel modelling of local impacts → assessing both overall and local impacts.
  → separate signal from noise
Constructing the control group

- To form the control group, areas are selected on the basis of having similar local characteristics (e.g., burglary rates or deprivation scores) to those in the NCC-targeted group.
- In order to obtain a reliable control trend, Lower Super Output Area (LSOA) is the basic areal unit for the control group.
Constructing the control group

- To form the control group, areas are selected on the basis of having similar local characteristics (e.g., burglary rates or deprivation scores) to those in the NCC-targeted group.
- In order to obtain a reliable control trend, Lower Super Output Area (LSOA) is the basic areal unit for the control group.

<table>
<thead>
<tr>
<th>ID</th>
<th>Matching criterion</th>
<th>No. of LSOAs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>All LSOAs in Peterborough</td>
<td>88</td>
</tr>
<tr>
<td>2</td>
<td>±10% burglary rate of the NCC group in 2005</td>
<td>9</td>
</tr>
<tr>
<td>3</td>
<td>±20% burglary rate of the NCC group in 2005</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>±30% burglary rate of the NCC group in both 2004 and 2005</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>LSOAs containing the NCC-targeted COAs (but excluding the NCC-targeted COAs)</td>
<td>10</td>
</tr>
<tr>
<td>6</td>
<td>LSOAs that had “similar” multiple deprivation scores (MDS) as those for the NCC LSOAs in 2004</td>
<td>46</td>
</tr>
</tbody>
</table>
Evaluation procedure

Data from control group

Data from NCC group
Evaluation procedure

Control trend pattern

Data from control group

Data from NCC group
Evaluation procedure

Data from control group

Data from NCC group

Control trend pattern

Annual burglary counts

Year
Evaluation procedure

Data from control group

Data from NCC group

Control trend pattern

F(t, b)
Impact function

Annual burglary counts

Year

NCC implementation
Evaluation procedure

Control trend pattern

Data from control group

Data from NCC group

Year

Departure pattern

Magnitude of departure

F(t, b)

Impact function

Annual burglary counts

NCC implementation
Evaluation procedure

Data from control group

Control trend pattern

\[ b_i \sim N(\mu, \sigma^2) \]

for modelling local impacts

\[ F(t, b_i) \]

Impact function

Data from NCC group

Annual burglary counts

NCC implementation
Outline

Background

Evaluation framework

Results and Conclusions
Overall NCC impact

Figure: Percentage change in burglary rate in the NCC group relative to control group 1, which consists of all 88 LSOAs in Peterborough. These changes are estimated from the aggregated NCC data.

All three impact functions consistently reveal an overall positive effect associated with the NCC-targeted areas.
Local and overall impacts (using the linear function)

Figure: Percentage change in burglary rates after the first year of NCC implementation compared to various control groups.
Heterogeneity of local impacts

Figure: The relationship between local impacts and coverage rates.

Some of the variability in local NCC impacts may be due to the coverage rates.

- The larger the proportion of properties in a COA that were visited the greater the impact of the NCC scheme.
Heterogeneity of local impacts

- There are two possible explanations:
  - “threshold effect” - The NCC scheme would not have a measurable impact (in terms of reducing/stabilising burglary rates) unless the number of properties that were visited exceeds a threshold.
  - “dilution effect” - Because COA is the unit of analysis here, the NCC impact, even though it is present, could be “diluted” when the NCC areas constitute only a tiny proportion of the households in that COA.

Neither of these explanations for the coverage rate effect undermines our overall assessment of the policy's success.
Heterogeneity of local impacts

- There are two possible explanations:
  1. “A threshold effect”
     - The NCC scheme would not have a measurable impact (in terms of reducing/stabilising burglary rates) unless the number of properties that were visited exceeds a threshold.

- Neither of these explanations for the coverage rate effect undermines our overall assessment of the policy’s success.
Heterogeneity of local impacts

- There are two possible explanations:

1. "A threshold effect"

   → The NCC scheme would not have a measurable impact (in terms of reducing/stabilising burglary rates) unless the number of properties that were visited exceeds a threshold.

2. "A dilution effect"

   → Because COA is the unit of analysis here, the NCC impact, even though it is present, could be "diluted" when the NCC areas constitute only a tiny proportion of the households in that COA.
Heterogeneity of local impacts

There are two possible explanations:

1. “A threshold effect”

   → The NCC scheme would not have a measurable impact (in terms of reducing/stabilising burglary rates) unless the number of properties that were visited exceeds a threshold.

2. “A dilution effect”

   → Because COA is the unit of analysis here, the NCC impact, even though it is present, could be “diluted” when the NCC areas constitute only a tiny proportion of the households in that COA.

Neither of these explanations for the coverage rate effect undermines our overall assessment of the policy’s success.
Conclusions: The NCC scheme

- NCC scheme led to an overall success
  → an overall 16% (95% CI: -2%, 34%) reduction per year in burglary rate was estimated.

- This suggests a positive impact of the NCC policy which had the effect of stabilising the burglary rate in the targeted areas while overall burglary rates were going up.

- The linear impact function is better in describing the data than the other two, suggesting a gradual and persistent change.

- There exists different impacts between targeted-COAs, perhaps due to local differences in implementing the scheme.
Conclusions: The evaluation framework

- We have presented a methodology for evaluating small area neighbourhood policing initiatives, paying close attention to
  (a) “local focus” (assessing local impacts)
  (b) providing statistical evidence of changes over time and
  (c) making comparisons to well defined control groups.

- To deal with the sparse local data, a hierarchical framework is used to borrow information across areas/time points;

- Placing the analysis in a Bayesian framework means that uncertainty associated with the reference trend estimates can be propagated into measuring the policy’s impact.

- Another advantage of the Bayesian framework is that direct quantitative answers to policy-relevant questions can be easily obtained
  → for example, the probability that the NCC scheme was successful in a particular area.
Acknowledgement

- This work was supported by the Economic and Social Research Council (ESRC) through the National Centre for Research Methods, BIAS II node (This report is available for download at www.bias-project.org.uk).

- Thanks to Cambridgeshire Constabulary for making available to us its recorded offence data.