Modeling residential burglars' target selection process at the house-level

Christophe Vandeviver

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Motivation for This Study

To date applications of the discrete spatial choice framework to burglars' target selection process have focused exclusively on intermediate outcomes and used **medium to large-sized spatial units of analysis**

Offender spatial decision-making is spatially structured and hierarchical

1. Larger target areas
   - E.g., municipalities, neighborhoods
2. Gradually more fine-grained
   - E.g., streets, face blocks
3. Ultimately a residential unit
   - E.g., house

A **residential unit** is naturally the smallest spatial unit of analysis in burglary target selection research

Objective for This Study

Apply the discrete spatial choice framework to recorded crime data spatial preferences at the house-level

Investigate which house-level attributes influence burglars' spatial decision-making

Previous applications of the discrete spatial choice framework to offenders' spatial decision-making are expanded in three ways:

1. Fine-grained spatial unit of analysis (house) aligns theory and method
2. Inclusion of house-level attributes allows combining insights from interviews, ethnography and experiments with discrete spatial choice
3. Large-scaled study area with 1.5 mill. inhabitants and 65 cities and towns

Offenders' Spatial Decision-Making

Rational choice perspective

- Optimization of rewards, efforts and risks
- Maximize benefits, minimize costs
- Assessed through environmental cues

Various environmental attributes at multiple levels of spatial aggregation affect offenders' spatial preferences, incl. **house-level attributes**

- E.g., type and size of house, signs of general upkeep, availability of multiple points of entry, type of material for doors and window frames

Distance between target and offender's home impedes interaction

- Overcoming distance takes effort, time, money and energy

Data

650 out of 801 detected residential burglaries committed by 650 unique burglars during 2006-12 in the Belgian province East Flanders

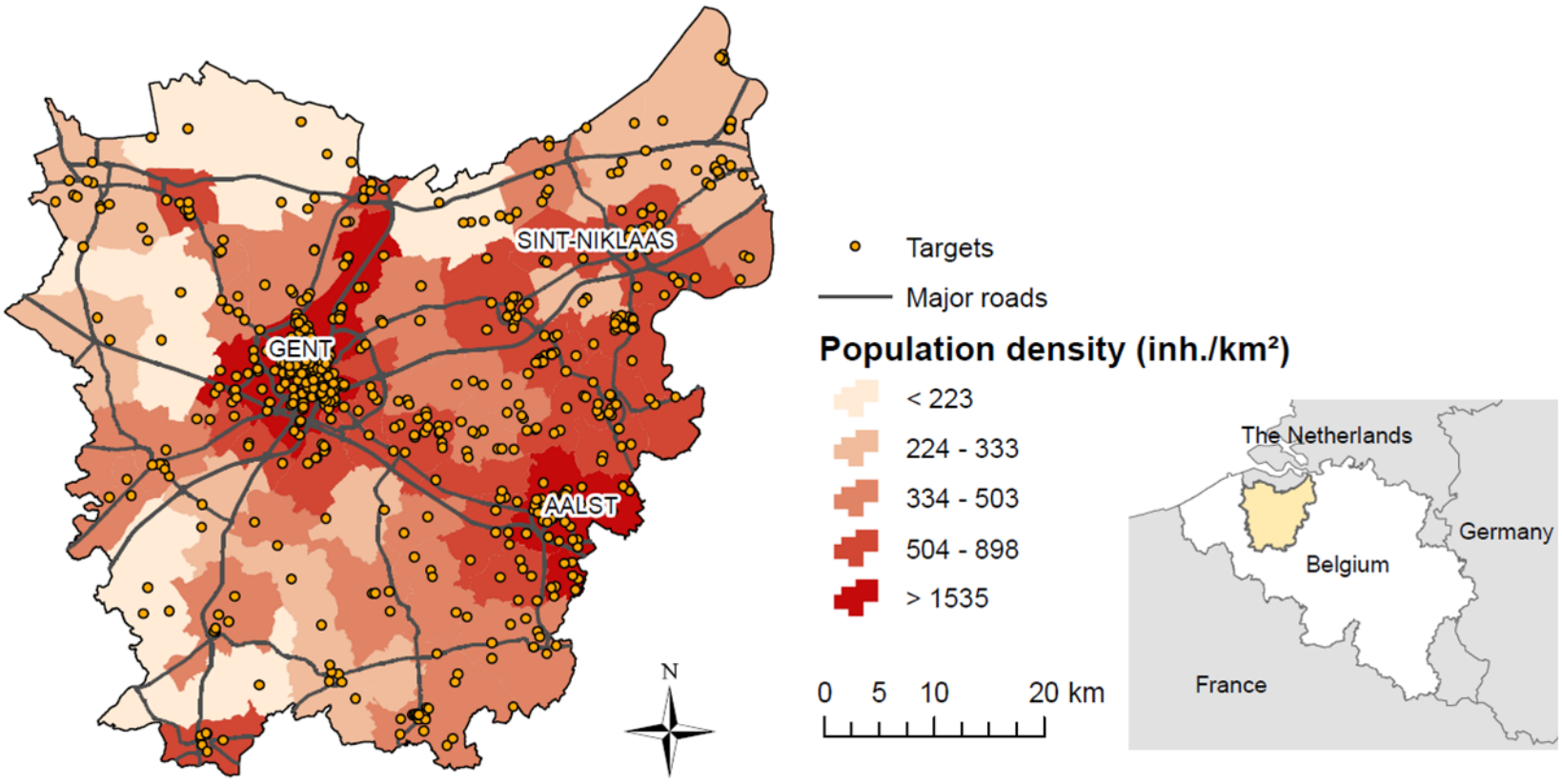
- For each burglar involved in multiple burglaries, one burglary is randomly sampled

Possible offending sites are contained within a choice set of **503,589 residences**

- Only houses, no apartments

House attributes are extracted from the the Belgian Land Registry

Study Area


SINT-NIKLAAS
GENT
AALST
N
Targets
Major roads
Population density (inh./km²)
< 223
224 - 333
334 - 503
504 - 898
> 1535
0 5 10 20 km
The Netherlands
Germany
Belgium
France

House Attributes

For each of the 503,589 dwellings in East Flanders the following attributes were extracted from the Belgian Land Registry database

- **Construction type**
  - Terraced 37%
  - Semi-detached 29%
  - Detached 34%
- One or more **floors** above ground 54%
- **Rooftop living floor** 60%
- **Garage** present 67%
- **HVAC** installed 63%
- **Built surface area** (in 1,000 sq m)
  - Mean (S.D.) 0.136 (.335)

In addition, **distance** between the offenders' homes and all possible alternatives was computed

Hypotheses

Hypothesis 1: *Higher* perceived **rewards** *increase* the likelihood that a house is burglarized

- Garage, built surface area

Hypothesis 2: *Lower* perceived **efforts** *increase* the likelihood that a house is burglarized

- HVAC, Distance

Hypothesis 3: *Lower* perceived **risks** *increase* the likelihood that a house is burglarized

- Construction type, Floors, Rooftop living floor

Discrete Spatial Choice Approach

Discrete choice framework applied to spatially referenced choices (Bernasco & Nieuwbeerta 2005)

Combines decision-makers, choice set, attributes & decision rule within a single model

Random utility maximization theory (McFadden 1973)

The conditional logit model:

$$U_{ij} = \beta X_{ij} + \epsilon_{ij}$$

where

- U_{ij} is the utility of house $_j$ for burglar $_i$
- β is a column vector of coefficients that is fixed over houses and burglars and has to be estimated empirically
- X_{ij} are observed variables (house attributes) that relate to house j and possibly burglar i as well
- ϵ_{ij} is a random error term that is independent and identically distributed (iid) extreme value

Model Estimation

Sampling of alternatives

- MLE with very large choice sets is computational intensive
- Full choice set: 327,332,850 decision-maker-by-alternatives combinations
- Sampled choice set: 40,916,200 decision-maker-by-alternatives combinations
  - 1/8th size of original choice set (Nerella & Bhat 2004)

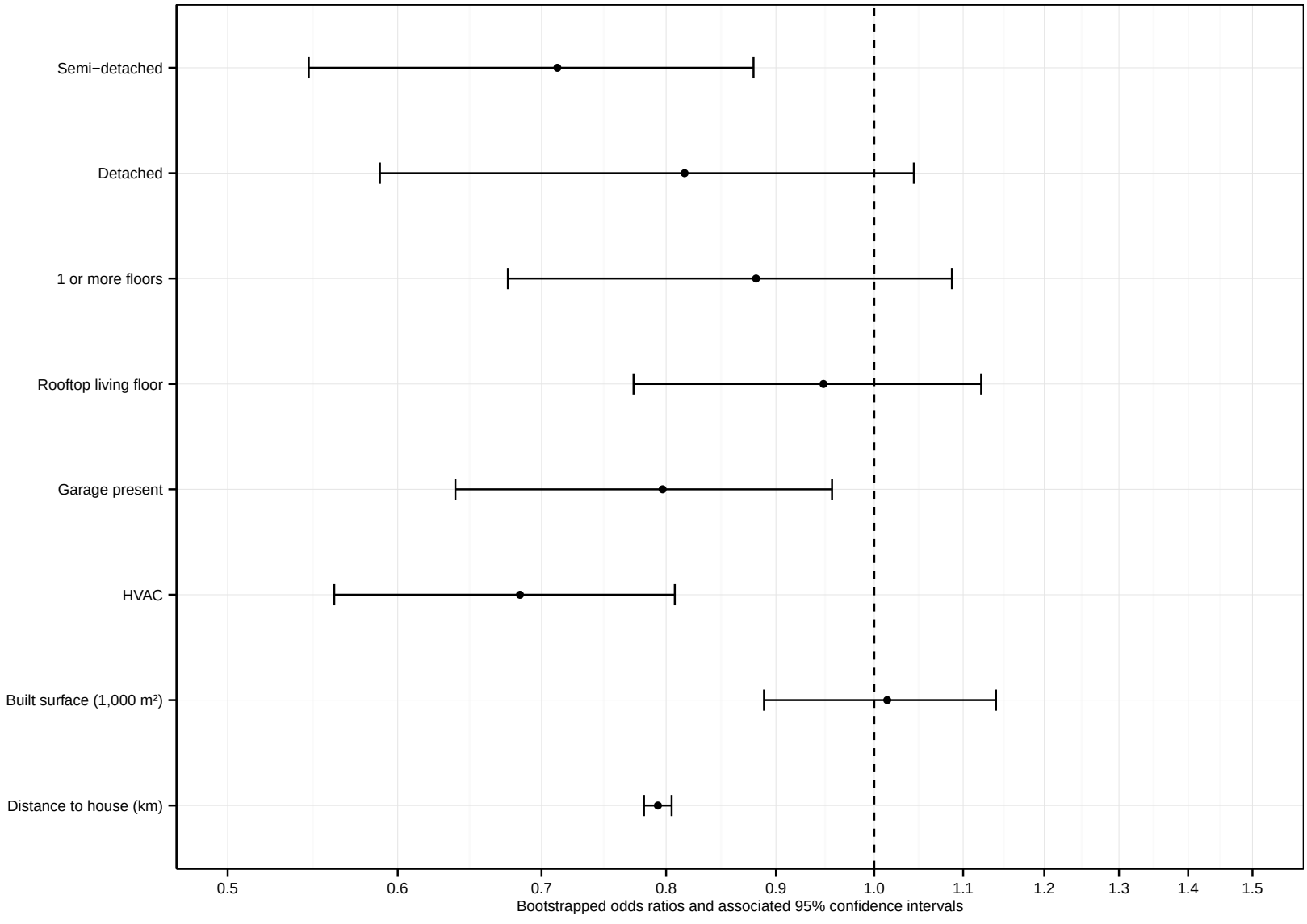
Bootstrapping procedure

- Conditional logit model estimation is repeated **20 times**
  - Each time with different random sample of 650 burglaries (out of 801)
  - For each burglary a different random sample of 62,947 non-burglarized houses is drawn from the full choice-set

Ghent Uni. High Performance Computing Environment

- Estimation remains computational and time intensive
- 2 linked dual socket Intel Xeon X5675 hexacore nodes with 96Gb physical memory
- R version 3.0.2., ICTCE 5.5.0, package *survival* proc *clogit*

Conditional Logit Model Results



Discussion of Results

Rewards are unimportant for burglars' spatial decision-making

- Reward-related attributes of dwellings do not inform burglars' target selection process (contra ethnography, but see Wright et al 1995: 49)
  - Cf. lack of effect of built surface
- Or its effect ran opposite our hypothesis
  - Cf. negative effect of garage present

Offenders seek to minimize **efforts** when selecting targets

- Distance decay: friction of distance
- Burglars seek out dwellings that are easier to break into
  - Cf. negative effect of HVAC

Risk-related information does not affect offenders' spatial decision-making

- Cognitive bias in ethnography?
  - Terraced houses have increased odds of selection (contra detached residences)

Conclusion

The discrete spatial choice framework can be applied to model offenders' spatial decision-making at micro-level spatial units of analysis with very large choice sets

This allows combining the power of the analytical framework of discrete spatial choice with the fine-grained understanding of ethnomethodology, experiment and offender interviews and closely aligning theoretical and empirical understanding of burglar target selection process

Our current understanding of the influence of house-level attributes on offenders' spatial decision-making is poor

Further Reading

Vandeviver, C., Neutens, T., Van Daele, S., Geurts, D., & Vander Beken, T. (In Press). A discrete spatial choice model of burglary target selection at the house-level. *Applied Geography*. http://dx.doi.org/10.1016/j.apgeog.2015.08.004

Contact Speaker

Dr. Christophe Vandeviver

- +32 9 264 97 16
- Christophe.Vandeviver@UGent.be

- Ghent University, Institute for International Research on Criminal Policy (IRCP)
- Universiteitstraat 4, 9000 Ghent, BELGIUM
- ircp.org
- UGent.be