Modeling the target selection process of residential burglars in Flanders at the community and house-level

Lower risk compensates increased travel effort

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Introduction

Burglars' target selection process

- Distance decay: most burglars prefer nearby targets
- Some burglars select remote targets (e.g., Polisenska 2008, Rattner & Portnov 2007, Smith et al. 2009, Van Daele & Vander Beken 2009)

Why do burglars select remote targets?

- What municipality and house-level attributes mediate effect of distance?

Current application

- Discrete spatial choice approach
- Ultimate outcome: residence, 500,000+ alternatives
- 1 province, 3,000km^2, 1.5 mill. inhabitants , 12 cities & 53 towns

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Theoretical framework

Advantages of selecting remote targets

- Higher profits (e.g., Morselli & Royer 2008, Snook 2004)
- Reduced risk of detection & chance of arrest (e.g., Capone & Nichols 1978)
- But … cause or effect?
  - Financial info is uncertain/unavailable when target is selected (Vandeviver, Van Daele & Vander Beken 2014)
  - Police info exchange may explain reduced chance of arrest (Lammers & Bernasco 2013)

Burglars' target selection process

- Environmental attributes at multiple levels of spatial aggregation
- Optimization of rewards, efforts & risks

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Discrete spatial choice approach

Discrete choice framework

- Random utility maximization (McFadden 1973)
- Decision-makers, choice & alternatives, attributes, decision rule
- Conditional logit model
- Preferred method of studying location choice (Bernasco & Nieuwbeerta 2005)

Sampling of alternatives

- ML estimation is computationally extremely intensive
  - 650 burglars * 503,589 alternatives = 327,332,850 decision-maker-by-alternative combs.
- Solution: random sample of alternatives
  - Min. 1/8th size of choice set (Nerella & Bhat 2004)
  - 650 burglars * 62,948 alternatives = 40,916,200 decision-maker-by-alternative combs.

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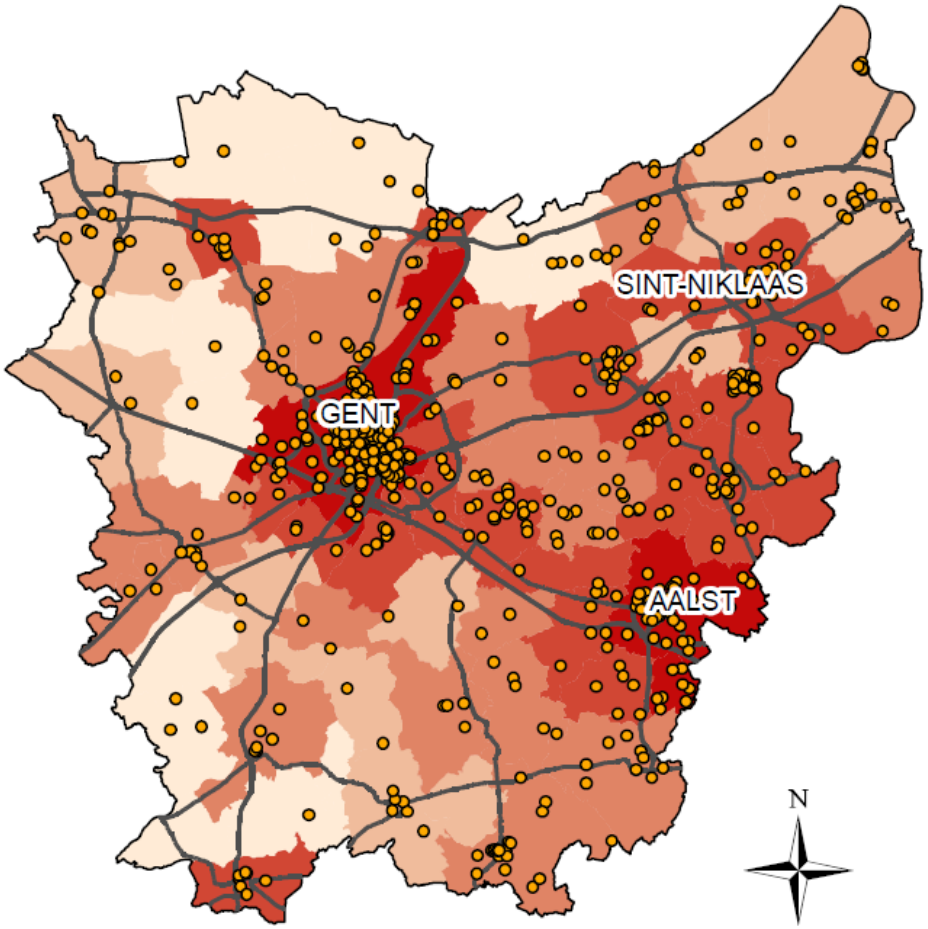
Study area



3,000km²
1.5 mill. inhabitants
12 cities & 53 towns

Targets

Major roads

Population density (inh./km²)

< 223

224 - 333

334 - 503

504 - 898

> 1535

0 5 10 20 km

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Data

Decision-makers & choices

- Belgian Federal Police
- Period: 2006-2012
- 650 burglaries committed by unique, single offenders

Attributes & alternatives

- Municipality characteristics (Statbel & Belgian Federal Police)
  - 65 municipalities
  - E.g., real estate value, population density, residential mobility, clearance rate
- Housing data (Belgian Land Registry)
  - 503,589 residences
  - E.g., construction type, number of floors, rooftop living floor, number of garages, central heating, built surface

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Overview of environmental cues in models

Spatial aggregation	Attribute	Criterion
Municipality	Real estate value Population density	**Reward**
	Highway present Road density	**Effort**
	Ethnic heterogeneity Residential mobility Clearance rate	**Risk**
Residence	Number of garages Built surface	**Reward**
	Central heating Construction type Distance	**Effort**
	Number of floors Rooftop living floor	**Risk**

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Method

Ghent Uni. High Performance Computing environment

- Model estimation time- and resource-intensive
  - Walltime: 22 hrs. for sampling of alternatives & 24 hrs. for model estimation
- 1 'Dugtrio' node
  - 4 dual socket Intel Xeon X5675 hexacore w/ 192 GB physical memory
- R v. 3.0.2 w/ ICTCE 5.5.0
  - Package 'survival'

Main & interaction effects

- Main effects model: all choice criteria are equally important
- Interaction effects model: choice process of burglars weighing target specific attributes and distance simultaneously

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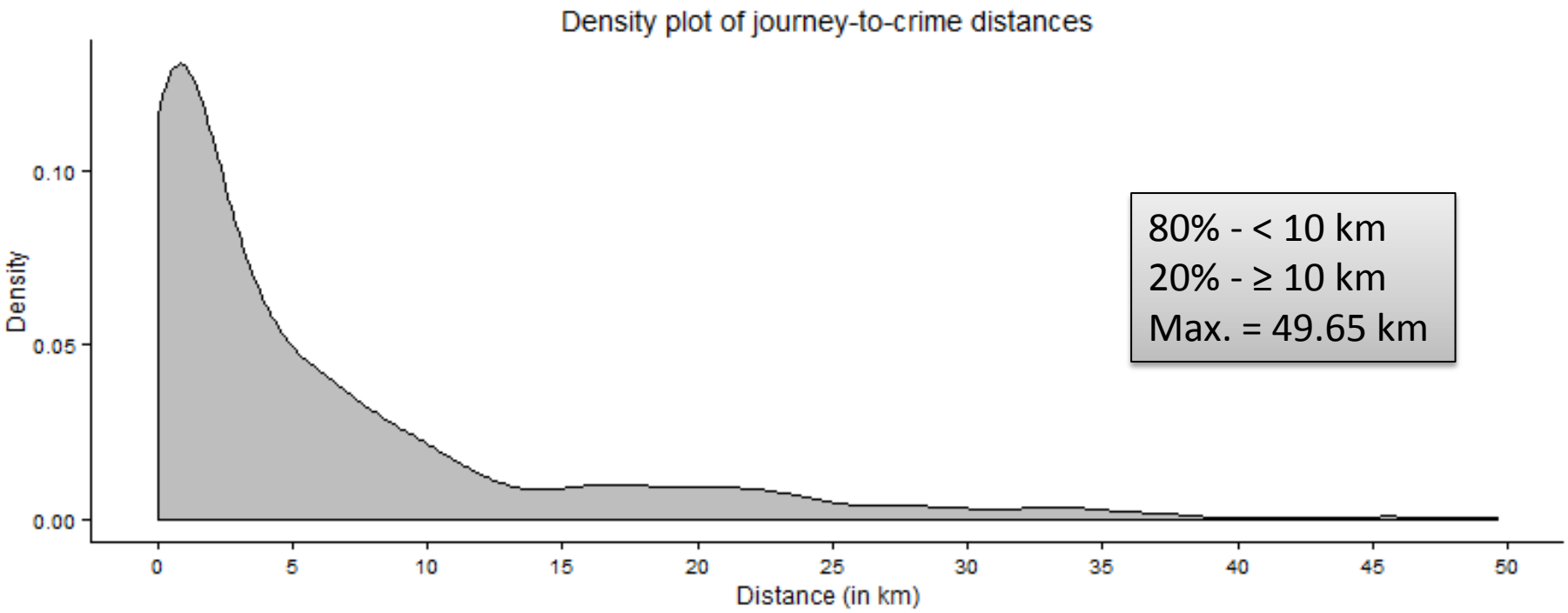
Results: JTC length



80% - < 10 km
20% - ≥ 10 km
Max. = 49.65 km

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Spatial aggregation	Attribute	OR	Interpretation
	Real estate value	.99	--
	Population density	.94	--
	Highway present	.80	--
Municipality	Road density	.99	--
	Ethnic heterogeneity	**1.14****	**Lower risk, higher odds of selection**
	Residential mobility	.89	--
	Clearance rate	**1.05****	**Higher risk, higher odds of selection (!)**
	1 or more garages	**.82***	**Higher reward, lower odds of selection**
	Built surface	1.00	--
	Central heating	**.68*****	**Higher effort, lower odds of selection**
Residence	**Semi-detached**	**.75***	**Lower effort, lower odds of selection (!)**
	Detached	.85	--
	Distance	**.80*****	**Higher effort, lower odds of selection**
	1 or more floors	.87	--
	Rooftop living floor	.93	--

Results: Main effects only model

General target selection process of burglars

Reward is unimportant

- Residences w/ 1 or more garages have ↓ odds of selection
  - Burglars select potentially less rewarding residences
- Residence-related attributes do not inform burglars' target choice (>< ethnography)

Minimal effort

- Distance ↓ odds of selection
  - Distance decay
- Residences w/o central heating have ↑ odds of selection
  - Easier to break into
- Terraced houses have ↑ odds of selection
  - Cognitive bias in ethnography?
- Effort assessed through residence-related attributes

Risk

- Ethnic heterogeneity rate ↑ odds of selection
- Clearance rate ↑ odds of selection
  - Unable to assess objective risk (cf. Van Daele & Vander Beken 2011)
- Risk assessed through municipality-related attributes

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Spatial aggregation	Distance*Attribute	OR	Interpretation (for remote residences …)
	D*Real estate value	1.00	--
	D*Population density	.99	--
	D*Highway present	**.95***	**Lower effort, lower odds of selection (!)**
Municipality	D*Road density	1.00	--
	D*Ethnic heterogeneity	**1.02****	**Lower risk, higher odds of selection**
	D*Residential mobility	1.02	--
	D*Clearance rate	1.00	--
	D*1 or more garages	1.00	--
	D*Built surface	1.00	--
	D*Central heating	.97	--
Residence	D*Semi-detached	1.03	--
	D*Detached	.98	--
	D*1 or more floors	**.95****	**Conv.: Lower risk, higher odds of selection**
	D*Rooftop living floor	**.95****	**Conv.: Lower risk, higher odds of selection**

Results: Interaction effects model

Burglars actively deploy compensation strategies when targeting remote residences (cf. Vandeviver, Van Daele & Vander Beken 2014)

Lower risk compensates increased travel efforts

- When distance is taken into account, risk-related residence attributes gain importance
- Not just a lucky coincidence, but actively deployed compensation strategy (cf. theoretical framework)

Perceived rewards are unimportant

- No effect of reward-related attributes
- Targeting remote residences is not compensated by higher perceived reward

Reduced efforts to reach target are unimportant

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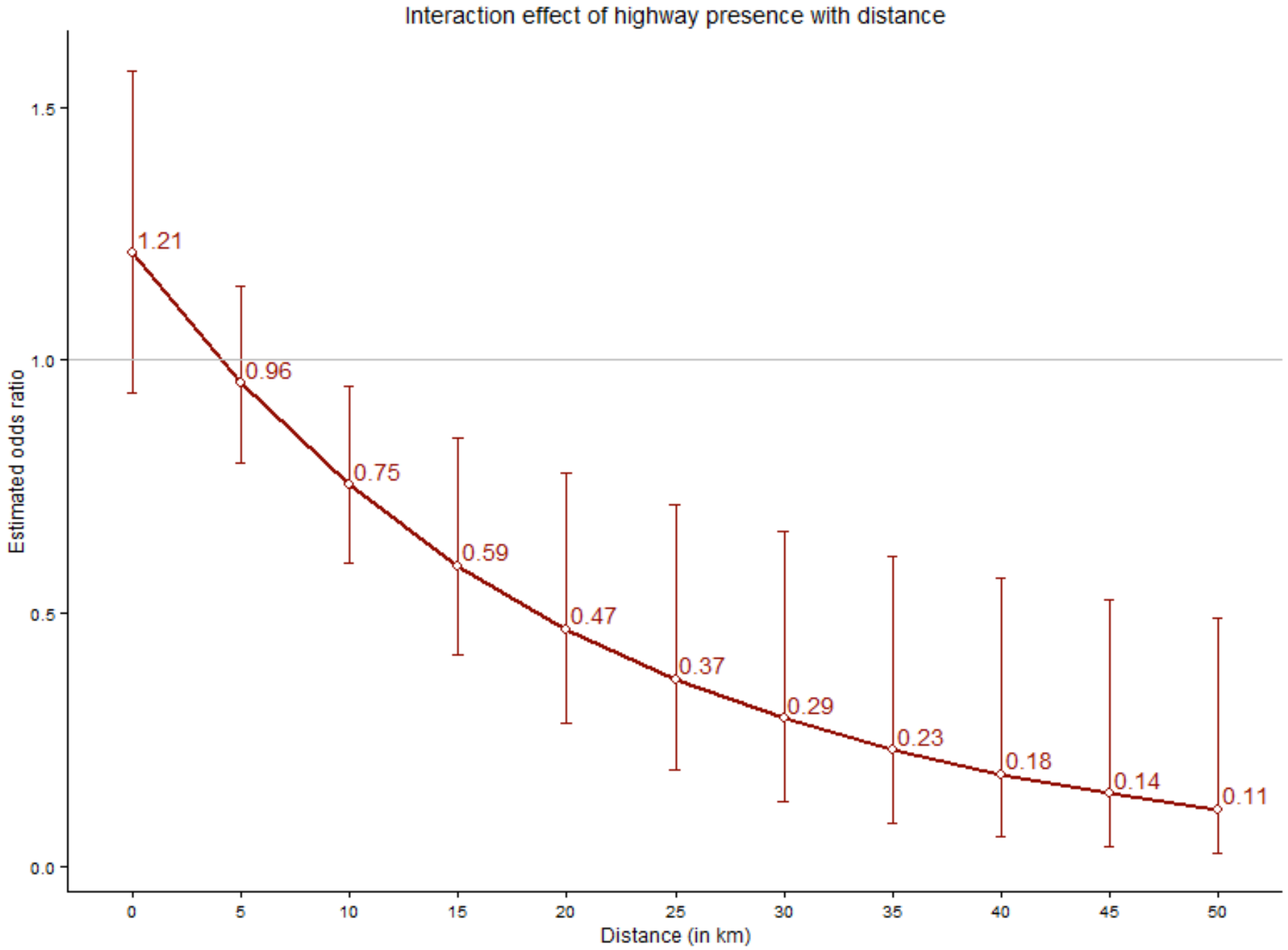
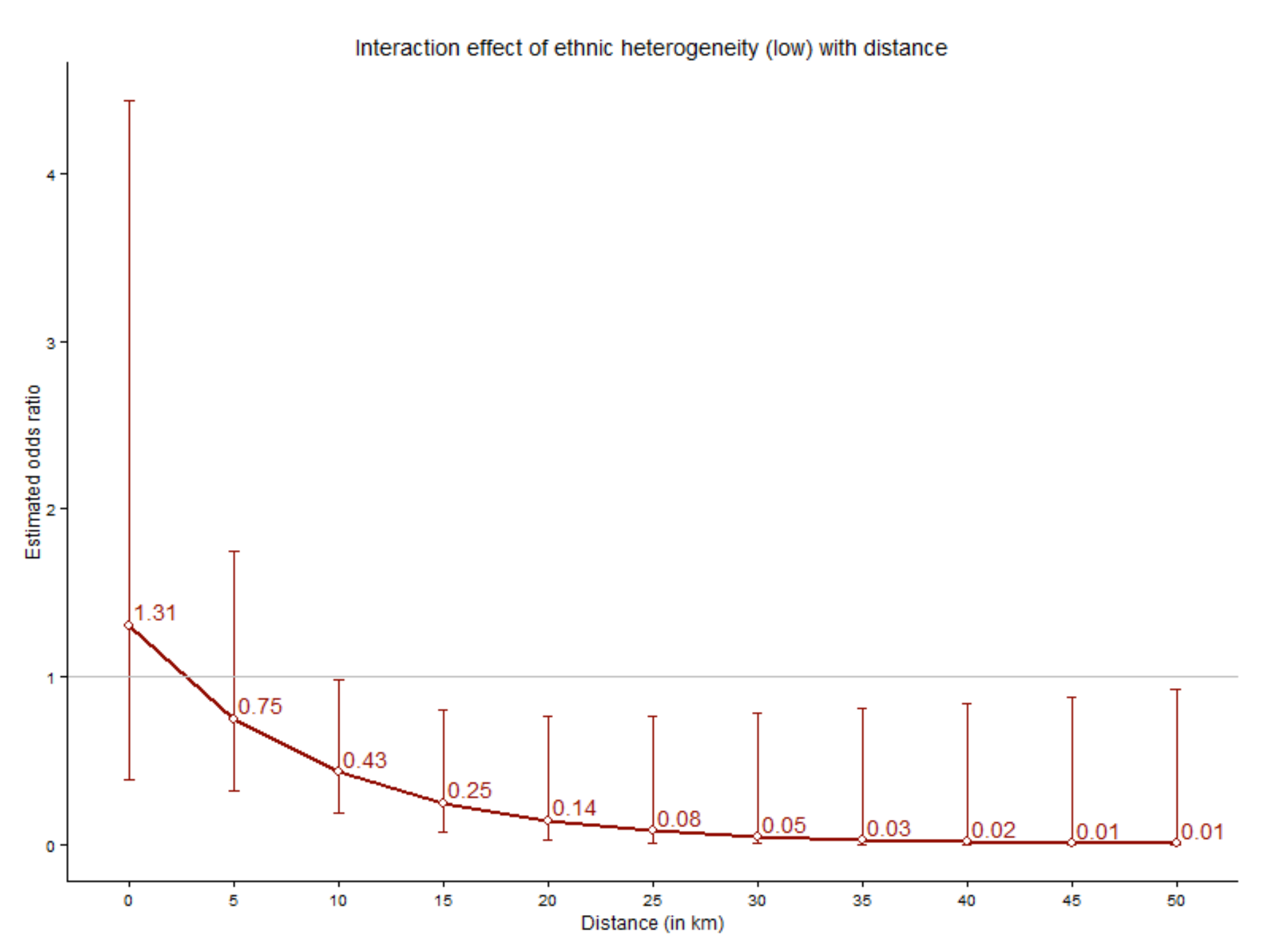
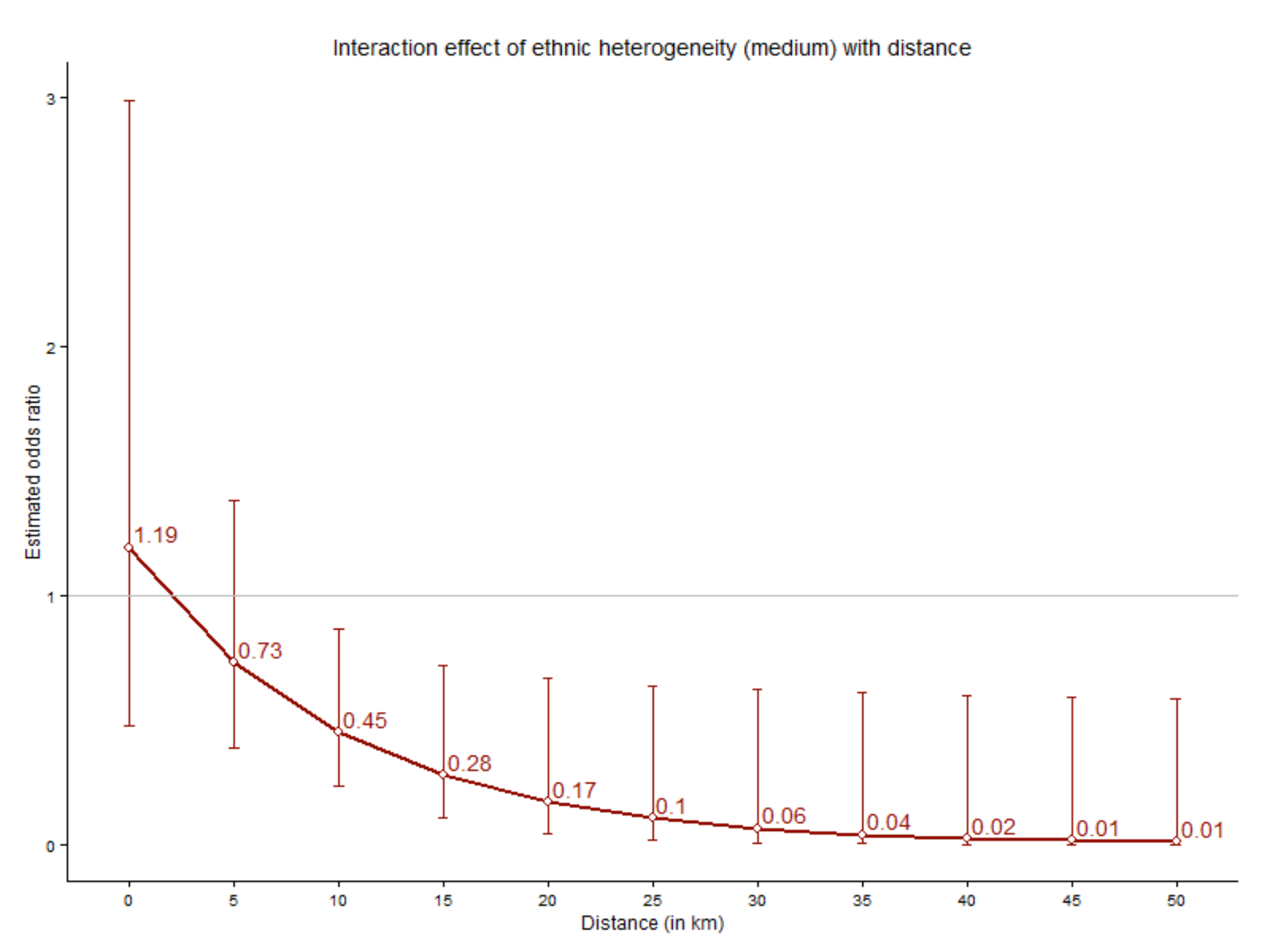
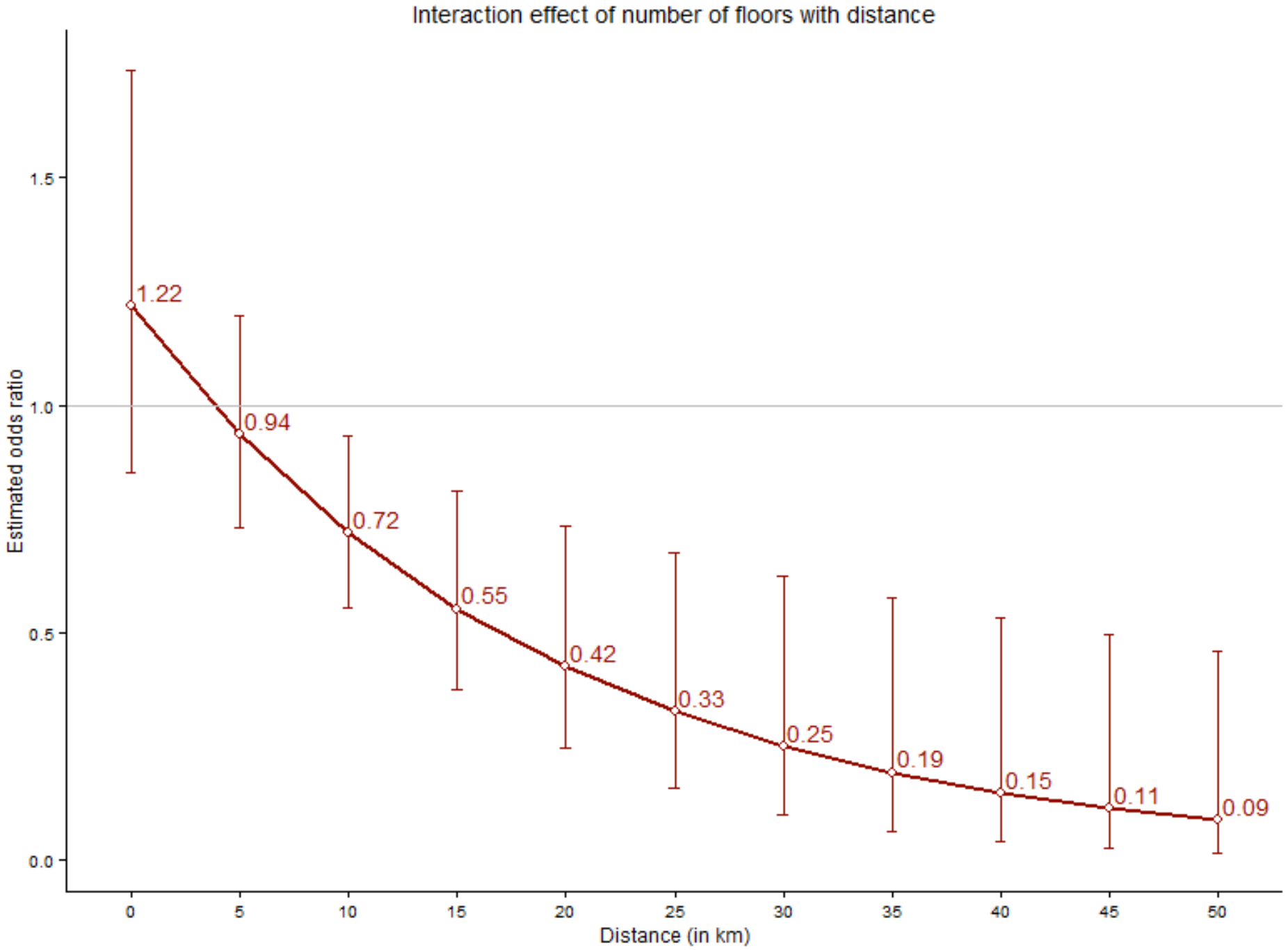
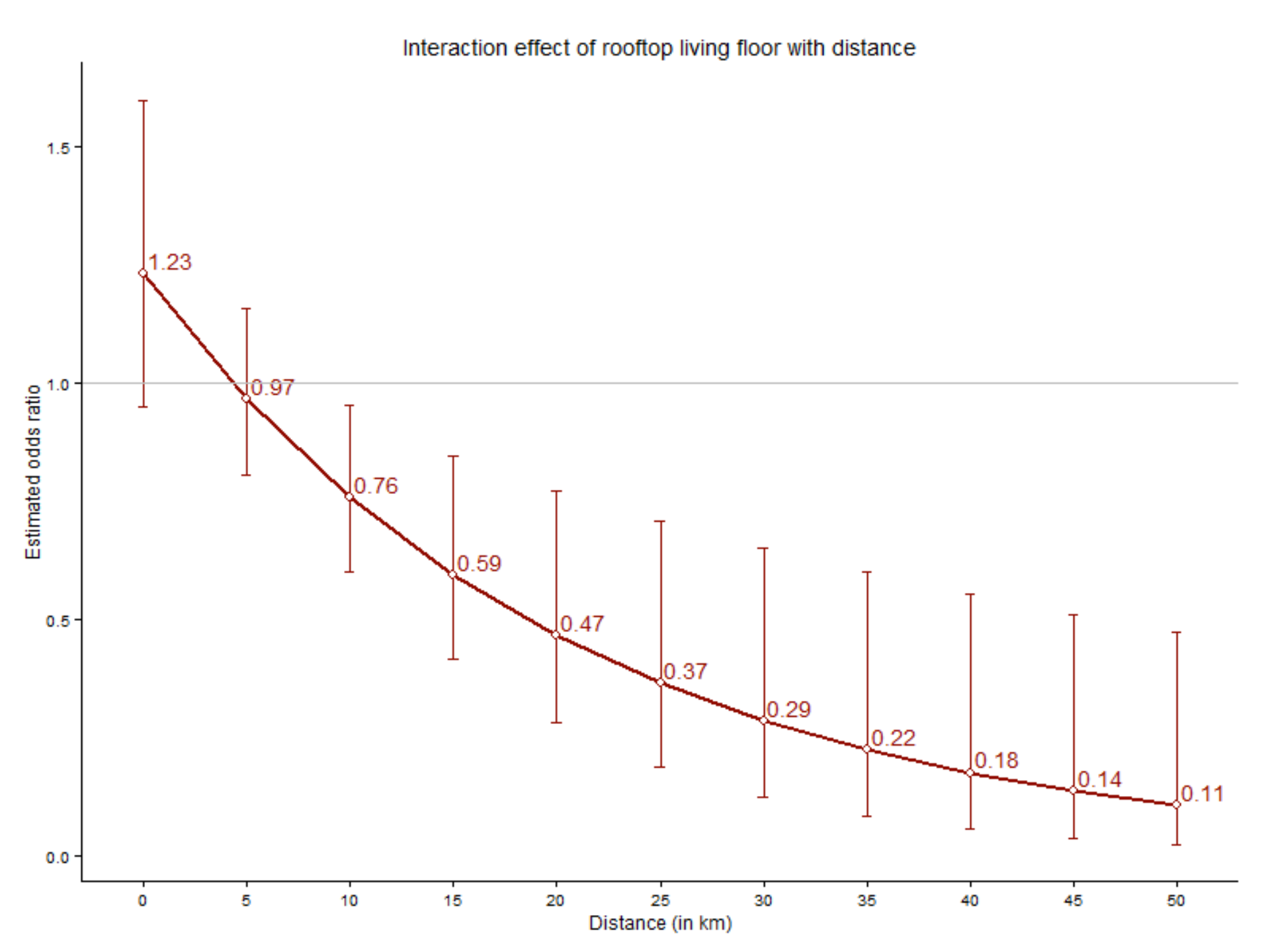

Interaction effect of highway presence with distance
Estimated odds ratio
1.5
1.0
0.5
0.0
1.21
0.96
0.75
0.59
0.47
0.37
0.29
0.23
0.18
0.14
0.11
0
5
10
15
20
25
30
35
40
45
50
Distance (in km)


Interaction effect of ethnic heterogeneity (low) with distance
Estimated odds ratio
0
1
2
3
4
1.31
0.75
0.43
0.25
0.14
0.08
0.05
0.03
0.02
0.01
0.01
0
5
10
15
20
25
30
35
40
45
50
Distance (in km)


Interaction effect of ethnic heterogeneity (medium) with distance
Estimated odds ratio
3
2
1
0
1.19
0.73
0.45
0.28
0.17
0.1
0.06
0.04
0.02
0.01
0.01
0
5
10
15
20
25
30
35
40
45
50
Distance (in km)


Interaction effect of number of floors with distance
Estimated odds ratio
1.5
1.0
0.5
0.0
1.22
0.94
0.72
0.55
0.42
0.33
0.25
0.19
0.15
0.11
0.09
0
5
10
15
20
25
30
35
40
45
50
Distance (in km)


Interaction effect of rooftop living floor with distance
Estimated odds ratio
1.5
1.0
0.5
0.0
1.23
0.97
0.76
0.59
0.47
0.37
0.29
0.22
0.18
0.14
0.11
0
5
10
15
20
25
30
35
40
45
50
Distance (in km)

Conclusion

Distance decay but 20% prefer remote targets

Lower risk compensates travel effort

- Targets with reduced risk are preferred
- Actively deployed compensation strategy

Perceived rewards are unimportant

- Distance is not compensated by selecting potentially more rewarding targets
- Opposite effect is observed!

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