SOCIAL SCIENCES

TECHNISCHE UNIVERSITÄT KAISERSLAUTERN

Explaining Regional Differences in Environmental Inequality

A Multi-Level Assessment of German Cities

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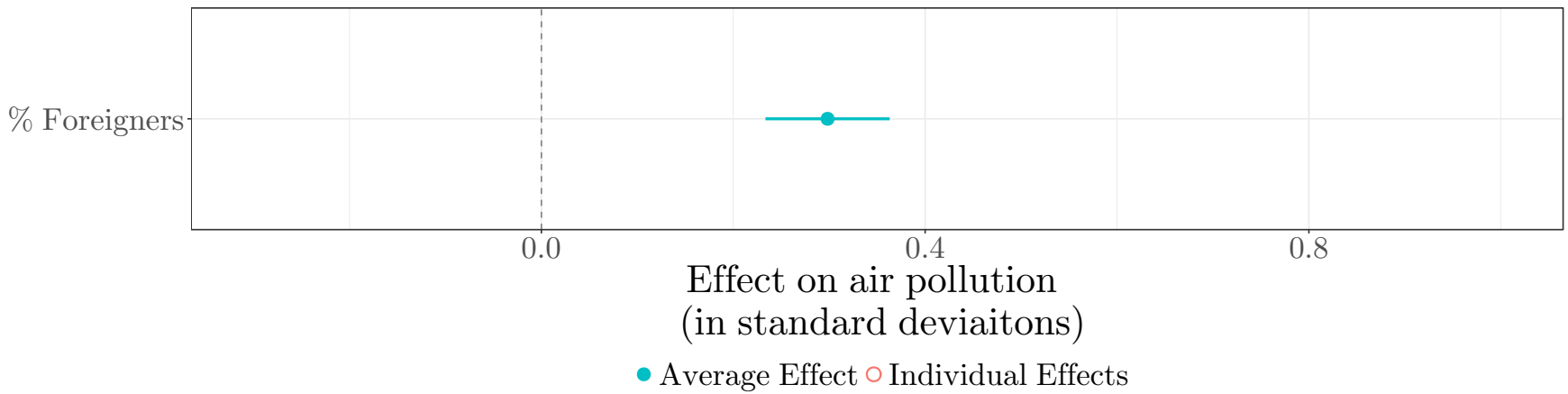
November 22, 2017

Analytische Soziologie
Venice

Aim of this study

Environmental inequality in Germany

- Foreign-minorities are affected by disproportionately high amount of environmental pollution



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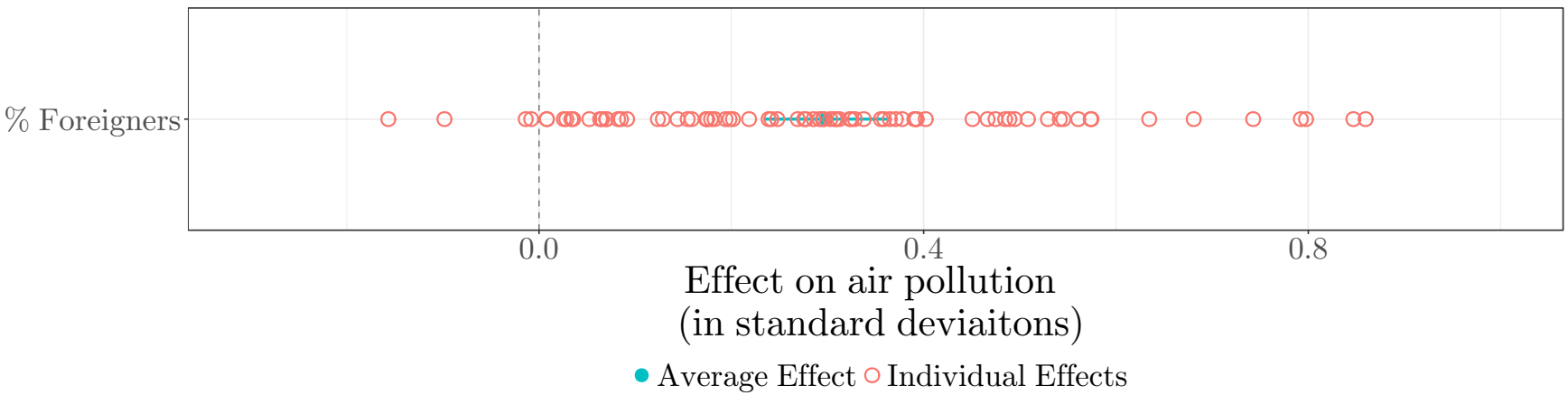

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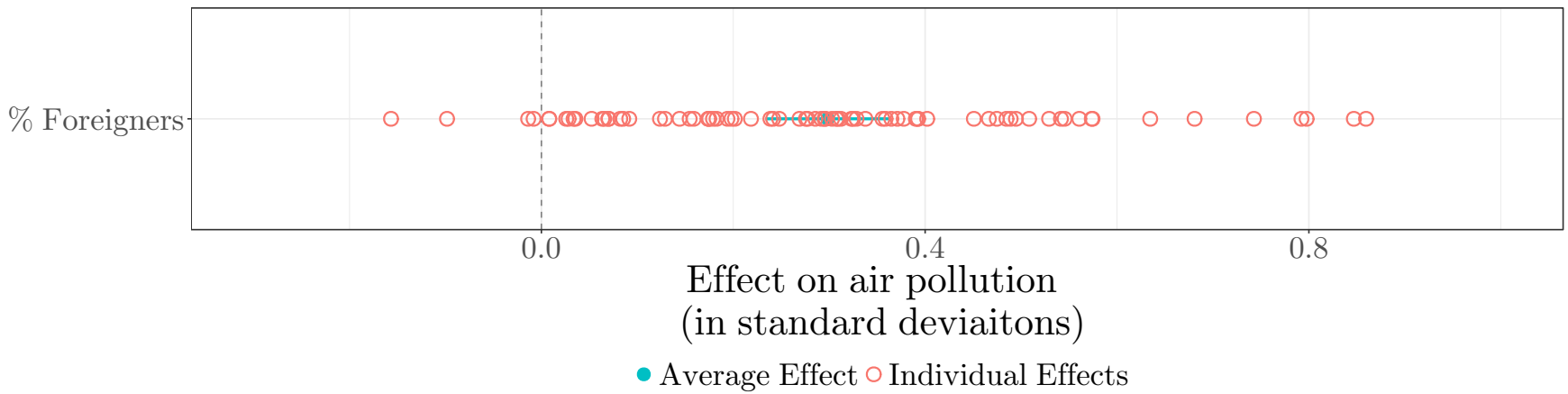

⇒ How can we explain this variation between the cities?

Theoretical Mechanisms

Selective siting

- Lower political protest of minorities
- Lower land / housing prices where minorities live

$\Rightarrow$ Facilities are sited close to minorities

Selective migration

- Socio-economic resources
- Housing discrimination

$\Rightarrow$ Minorities move into polluted areas

(Campbell et al., 2015; Crowder and Downey, 2010; Mohai and Saha, 2015)

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Between-city variation

Selective siting

- Political efficacy of majority group
- Residential segregation

Selective migration

- Economic inequality (minority vs. majority)
- Residential segregation

But:

- Do a poor job of explaining environmental inequality (Downey, 2007)
- Studies 'fail to take the spatial distribution of environmental hazards within metropolitan areas into account' (Downey, 2007, p. 970)

  See also Downey (2005); Elliott and Frickel (2015)

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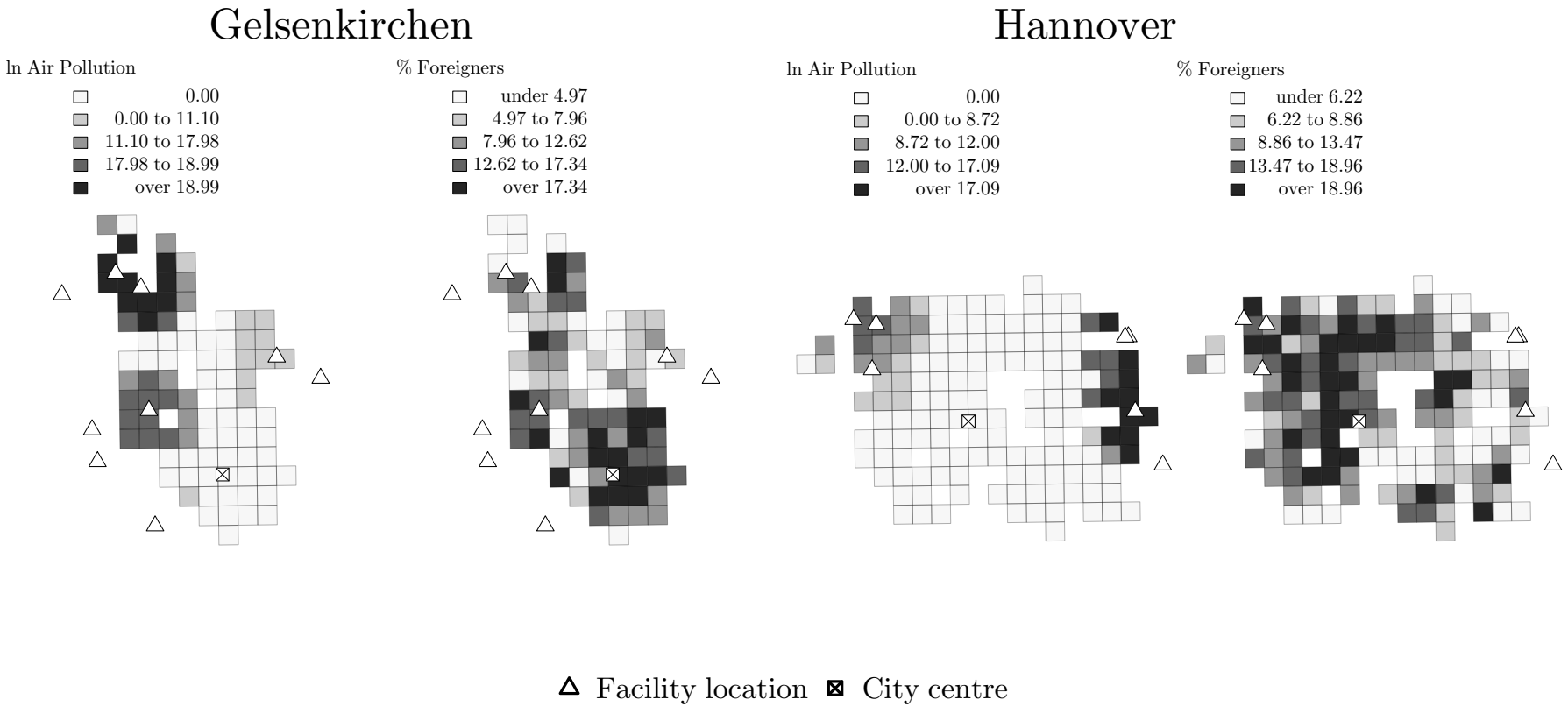
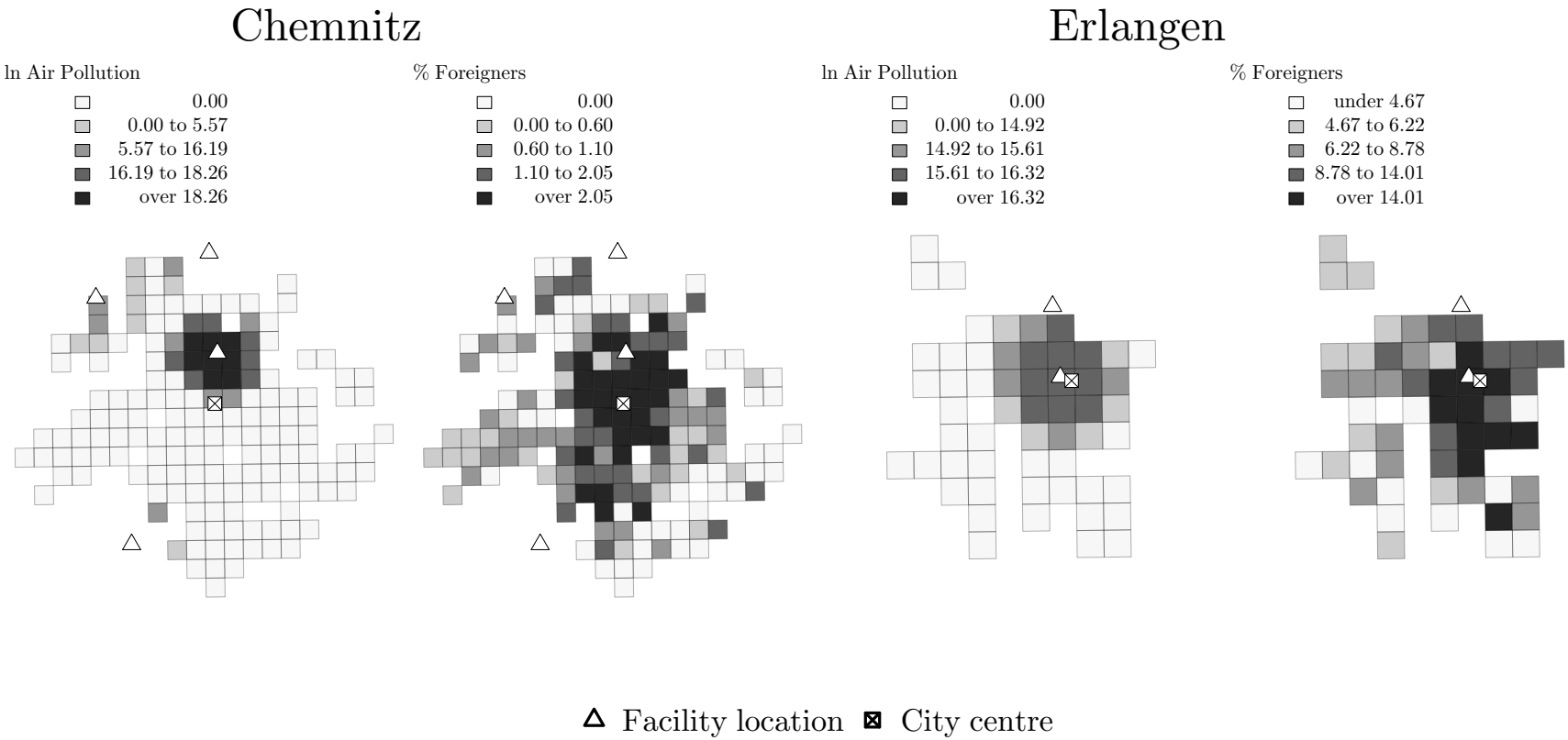
Low Environmental Inequality



⇒ Minorities cluster around the city centre

⇒ Pollution occurs far from the city centre

High Environmental Inequality



⇒ Minorities cluster around the city centre

⇒ Pollution occurs close to the centre

Data

German census 2011

- 1 km^2 grid over 79 German cities ($\geq$100,000 inhabitants)
- Final sample: 9,061 grid cells
- Average number of inhabitants: 2,650 (median: 1,717)
- Predictor variable: % foreigners
- Main controls: Population density, % vacant housing

E-PRTR

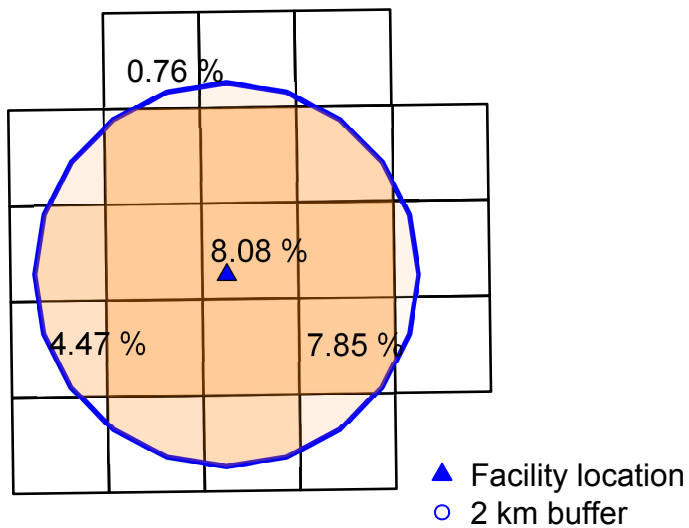
- Industrial facilities exceeding a pollutant-specific threshold
- 366 facilities reporting industrial emissions to air within cities
- Response variable: industrial air pollution (ln kg)

Merging Strategy

Proportional Overlap

- 2 km buffer around facility location
- Overlap of buffer and census cell
- Allocation proportionate to overlap

(e.g. Banzhaf and Walsh, 2008)



City level variables

INKAR 2011

- Economic Inequality: Unemployment ratio (non-Germans/Germans)
- Political efficacy: Voter turnout

Segregation

- Spatial information theory index $\tilde{H}_{2000}$ (Reardon and O'Sullivan, 2004)

Facility centrality

$$FC_i = \left(\frac{\frac{1}{M} \sum_{j=1}^{M} d_{ij}}{max(\tilde{\boldsymbol{d}}_i)} \right)^{-1},$$

where d_{ij} is the distance between each facility $j = 1, ..., M$ in the 2km surrounding of city i and the city's centre, and $\tilde{\boldsymbol{d}}_i$ a vector of the distances between the city centre and all coordinates of the city's boundary.

Method

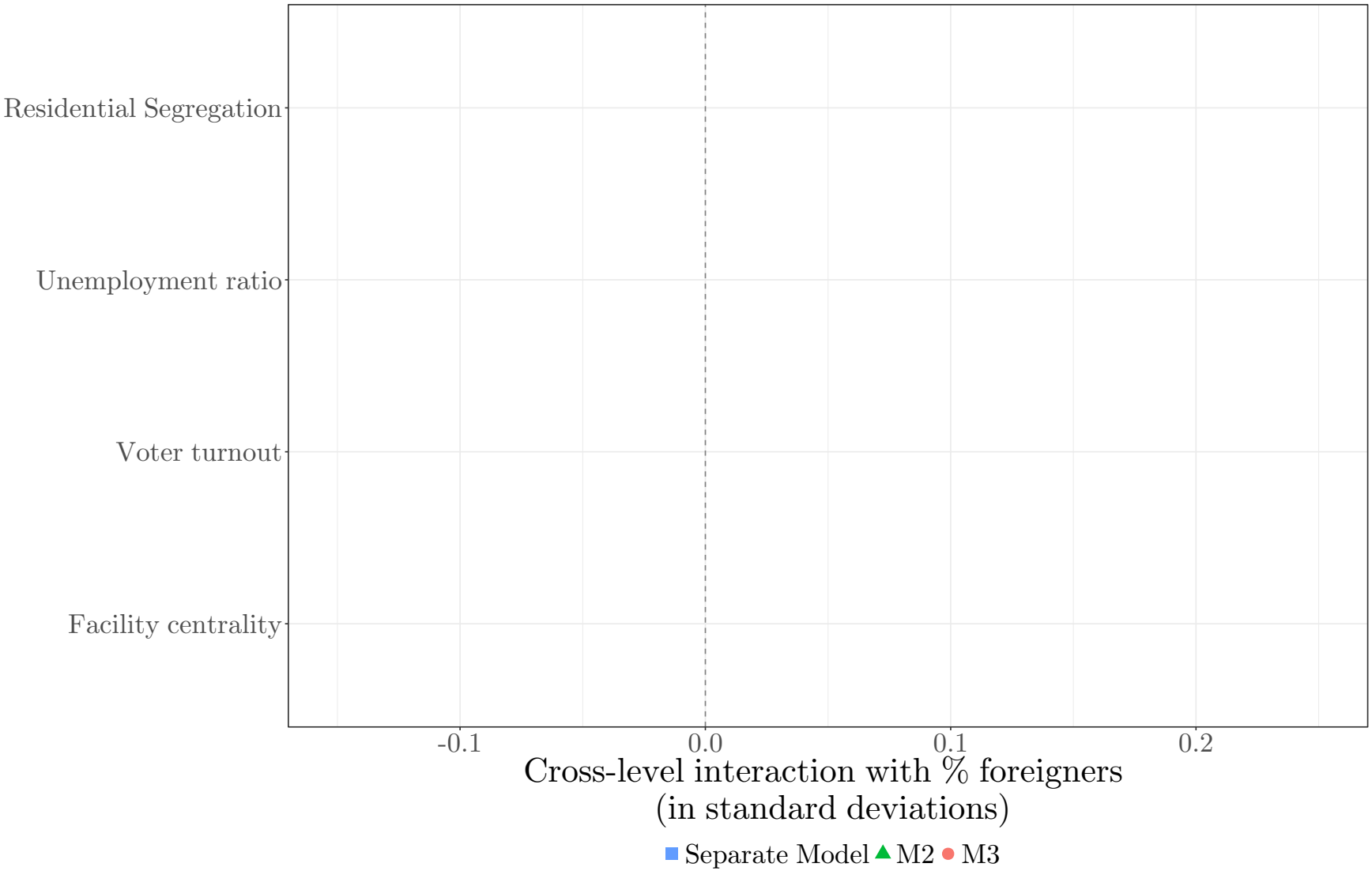
City-fixed effects multi-level model

- First level: within-city correlation
- Random slope: variation of within-effect between cities
- Parameter of interest: cross-level interaction

$$pollution_{ij} = \beta_{0j} + \beta_1 forgn_{ij} + \beta_2 forgn_{ij} segr_j + u_{1j} forgn_{ij} + \varepsilon_{ij},$$

for all $i = 1, ..., N$ observations and $j = 1, ..., J$ cities. This is achieved by within-group demeaning the data (Enders and Tofighi, 2007) and estimating a multilevel random-slope model.

Dependent variable: ln Pollution



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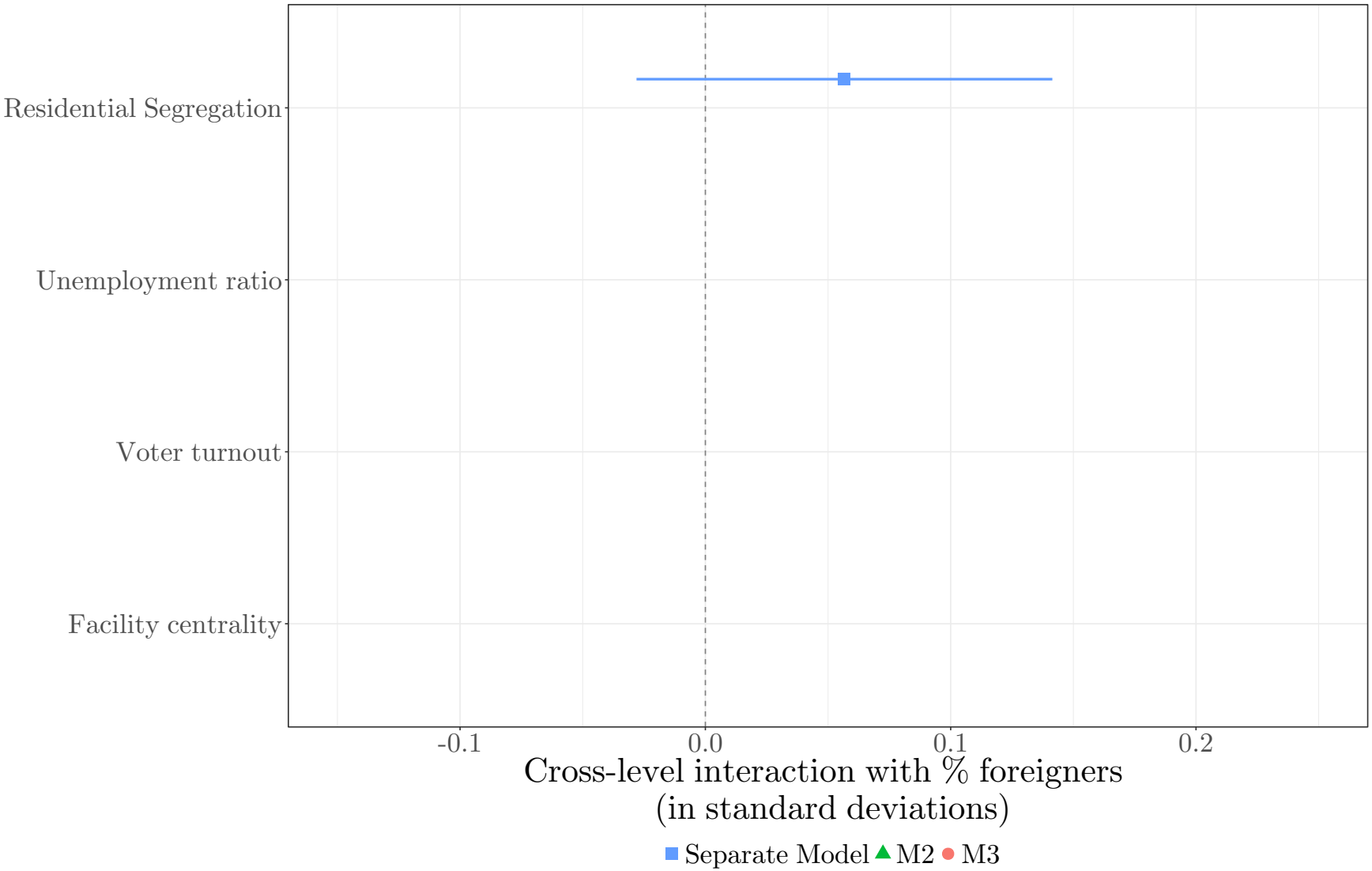

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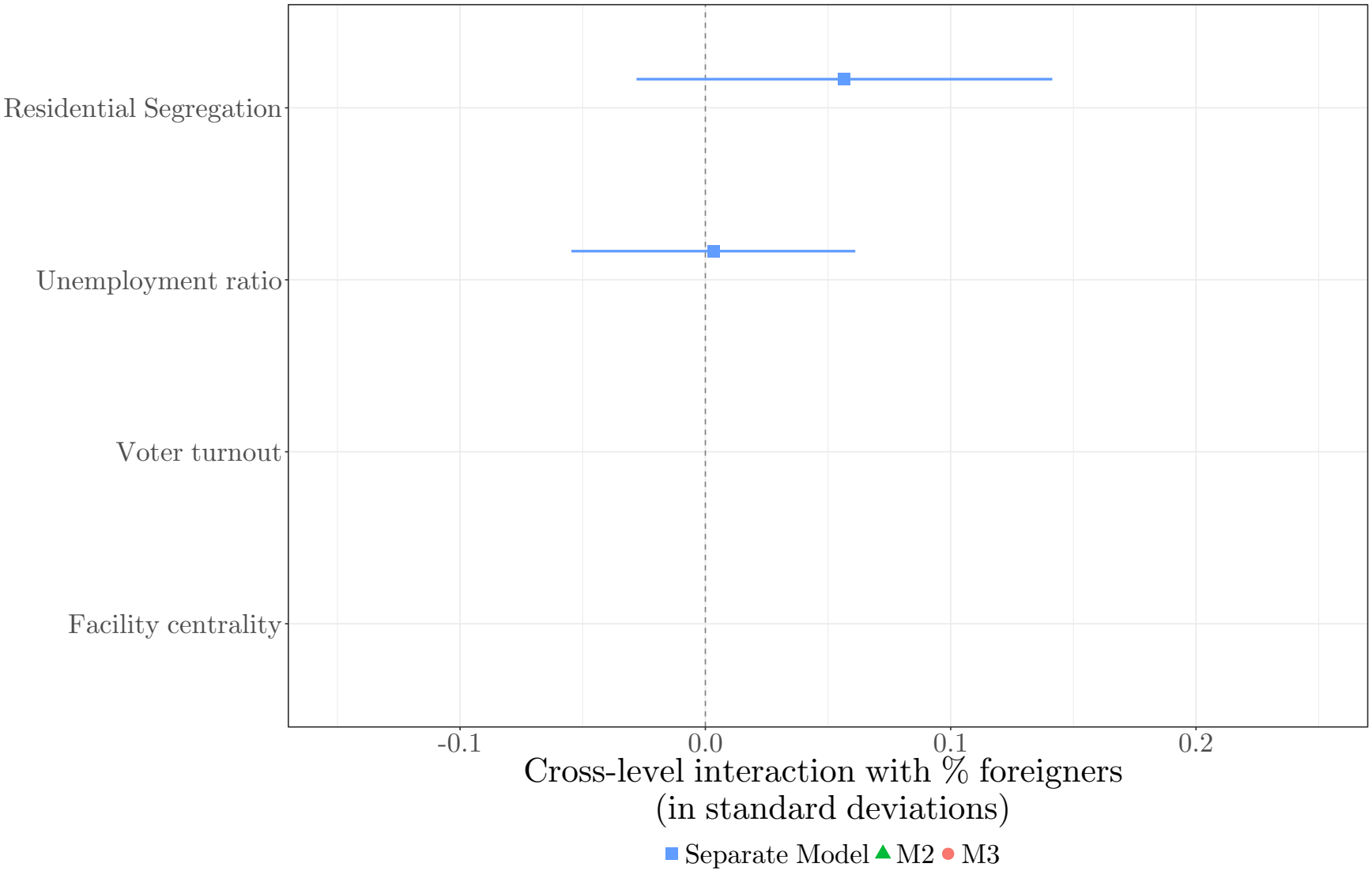

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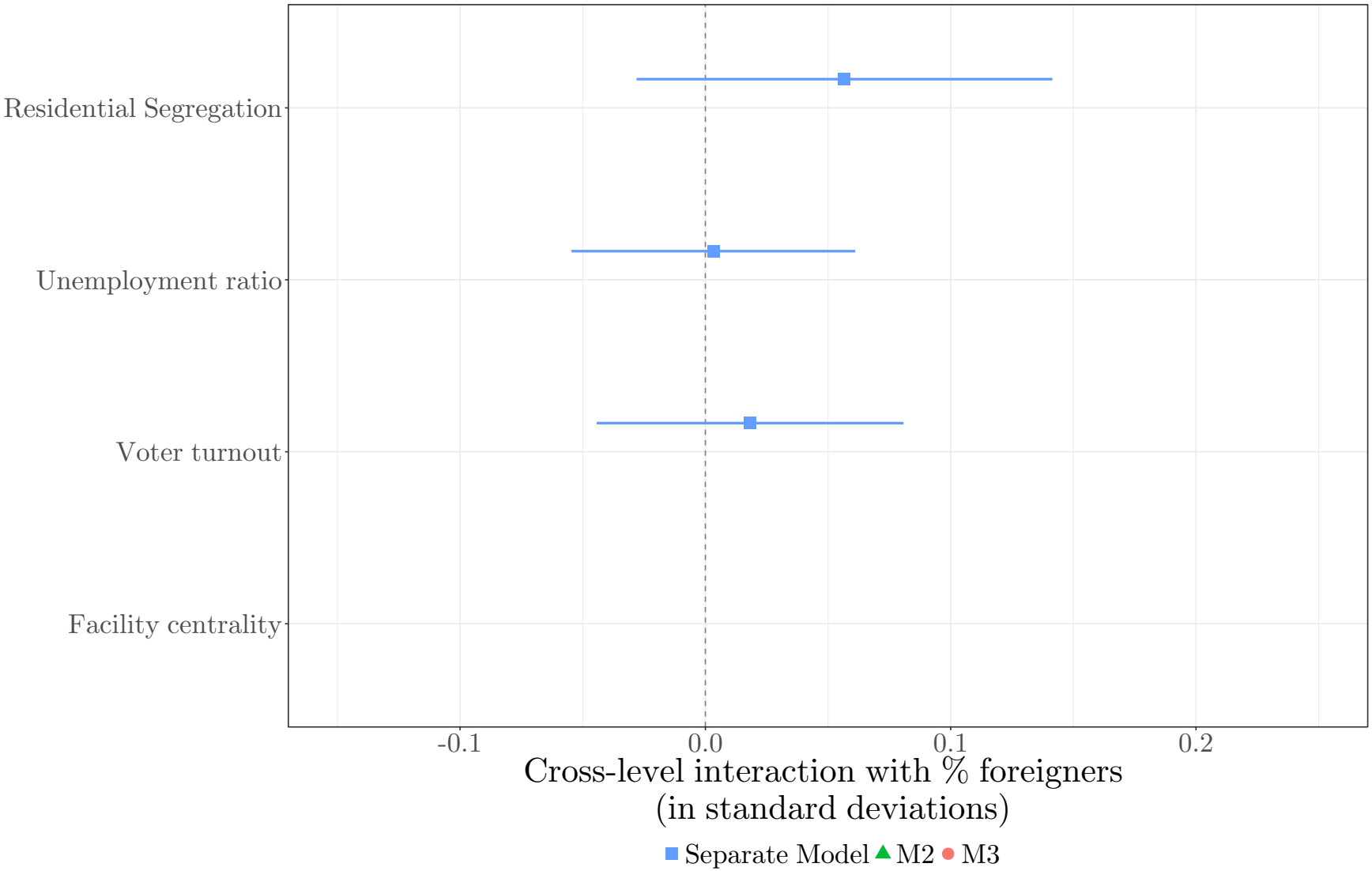

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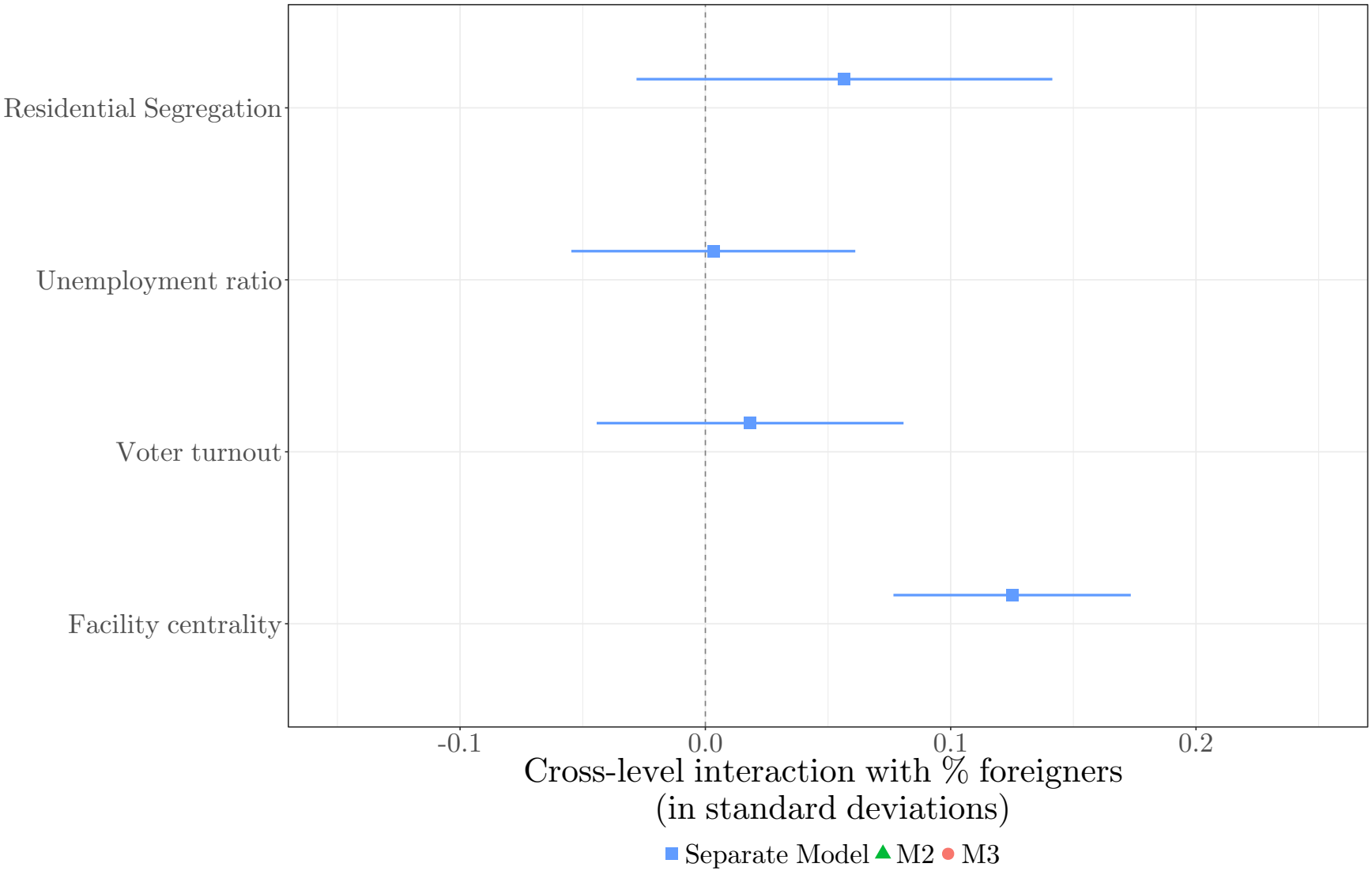

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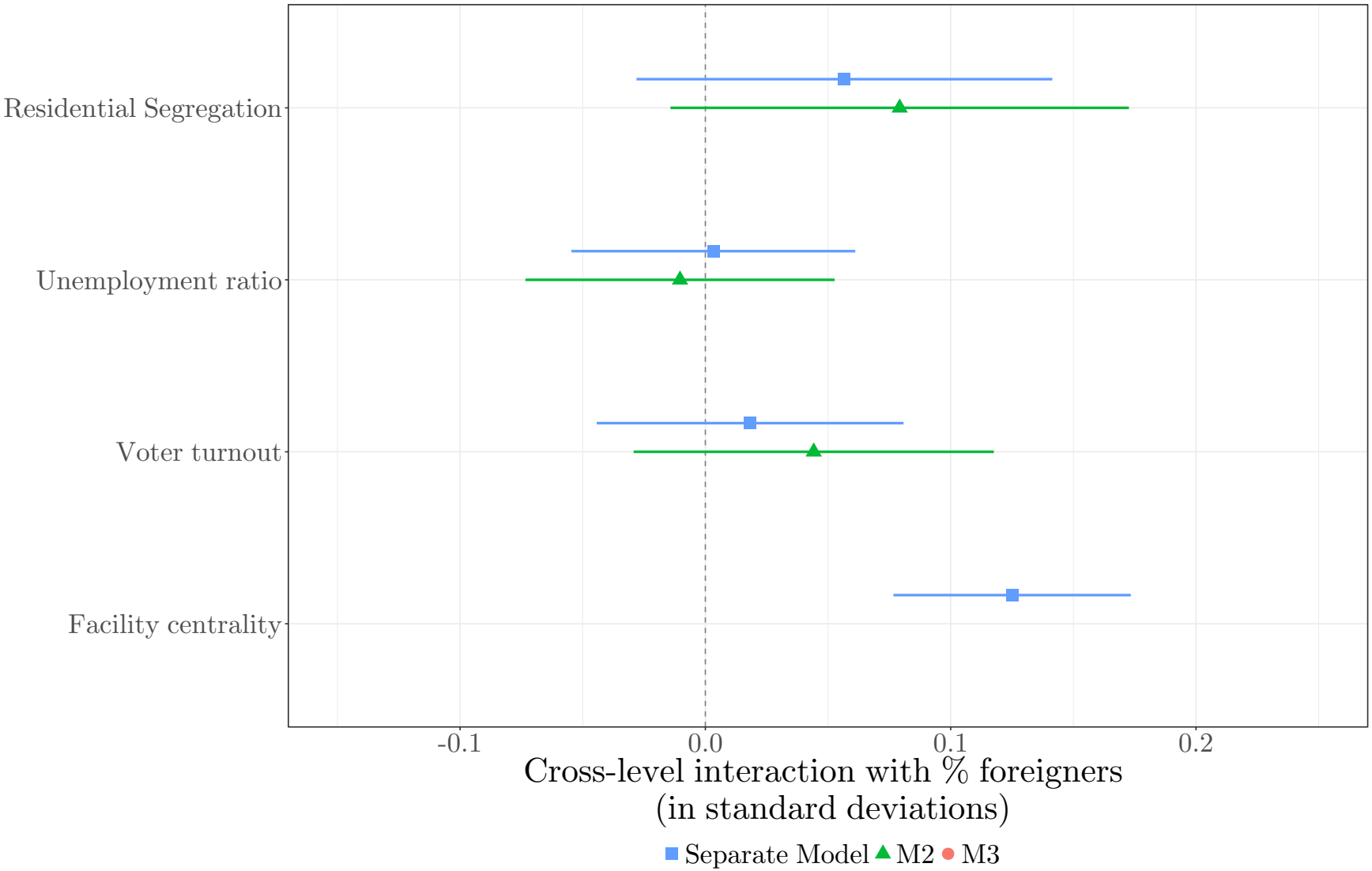

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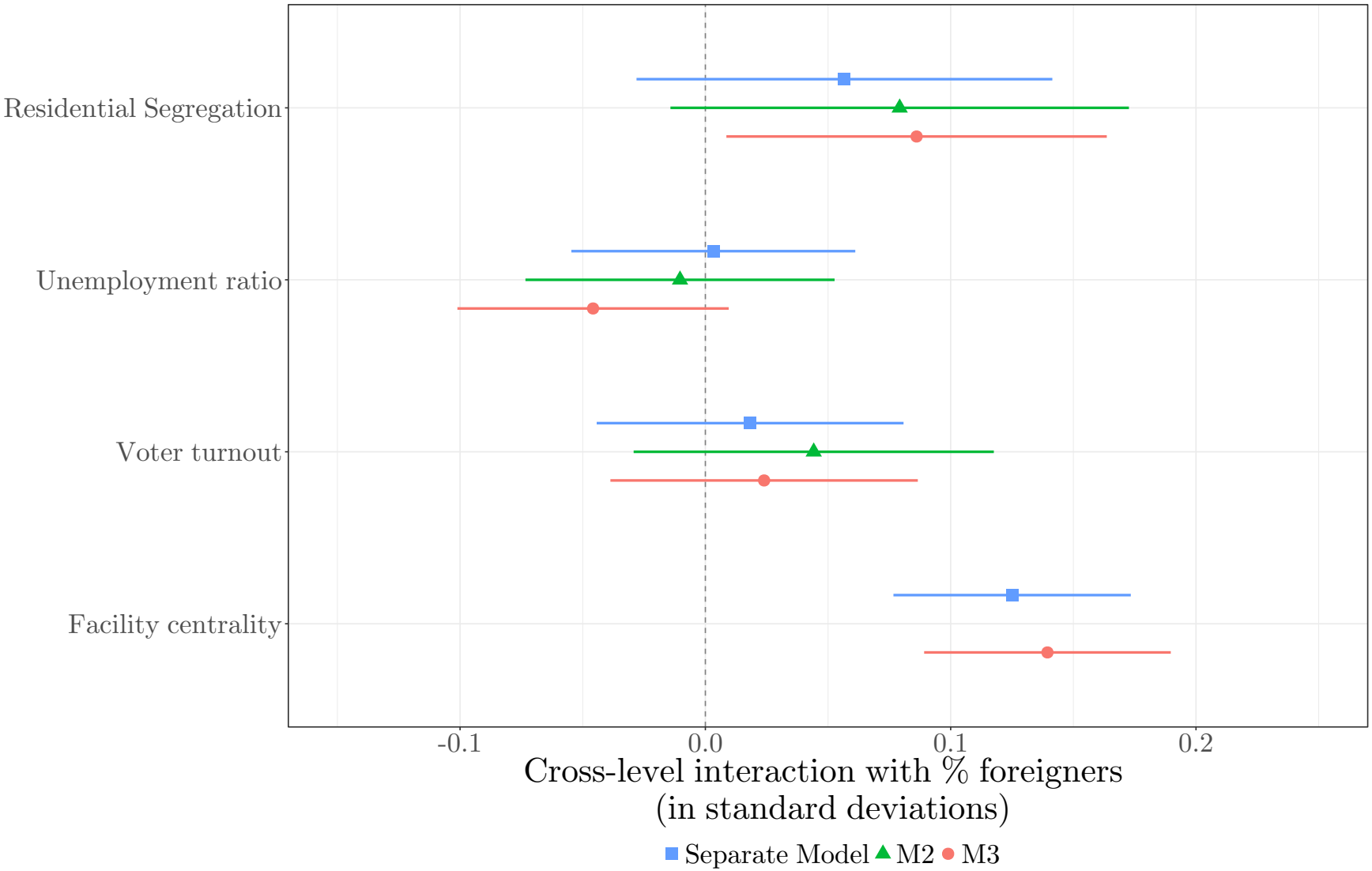

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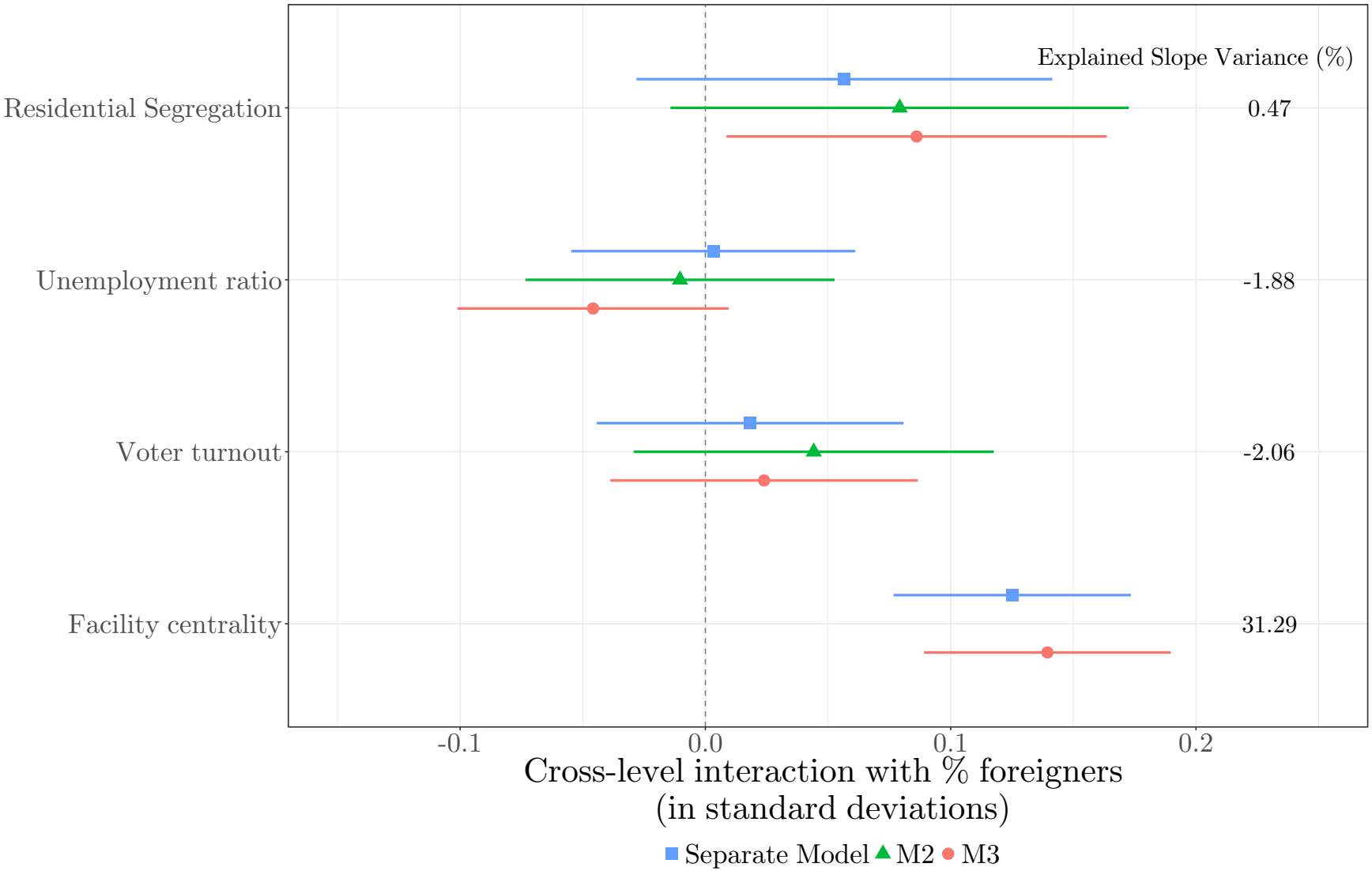

What does it mean?

1) Confounding mechanism

- Process 1: Minorities cluster in central cities
- Process 2: High pollution in inner cities

$\Rightarrow$ Two independent processes

2) Mediating mechanism

- Facilities are centrally sited *because* minority share is high
- Minorities cluster in inner city *because* pollution is high

$\Rightarrow$ Causal mechanism of selective siting or migration?

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Dependent variable: facility centrality

	M1	M2	M3	M4	M5
Centralization index[a]	0.021				0.215
	(0.114)				(0.158)
$\tilde{H}_{2000}$		−0.103			−0.178
		(0.113)			(0.148)
Unemployment ratio			0.295**		0.208†
			(0.109)		(0.122)
Voter turnout				0.243*	0.190
				(0.111)	(0.136)
R^2	0.000	0.011	0.087	0.059	0.130
Adj. R^2	−0.013	−0.002	0.075	0.047	0.083
Num. obs.	79	79	79	79	79

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\dagger}p < 0.1$. All variables are centered around their mean and scaled by their standard deviation. Standard errors in parentheses.
[a] Relative Centralization Index (RCE) as described in Massey and Denton (1988): proximity of the foreign population to the city centre relative to the proximity of the German population to the city centre.

Conclusion

Causal mechanisms of environmental inequality

- Challenges the importance of selective siting and migration
- Magnitude driven by centrality of minorities and pollution
- Independence of facility centrality and minority centrality?

Campbell et al. (2015)

- Simulations don't reach a realistic level of environmental inequality when just assuming selective siting and migration

Limitations

⇒ Only industrial air pollution
⇒ Only 'proxies' of selective siting & migration
⇒ Results are only descriptive
⇒ (Social) mechanism?

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Thank you very much!

Banzhaf, H. S. and Walsh, R. P. (2008). Do people vote with their feet? An empirical test of Tiebout's mechanism. *American Economic Review*, 98(3):843–863.

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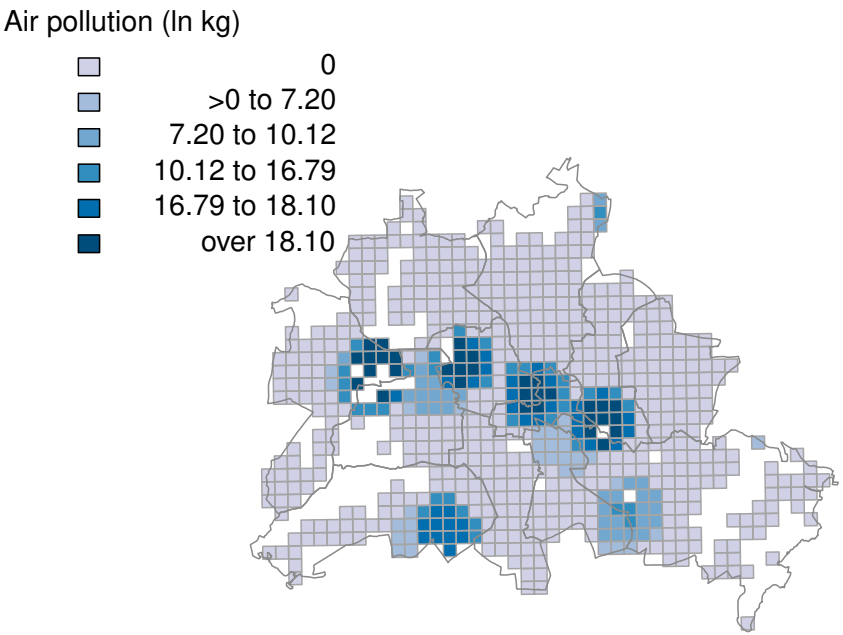
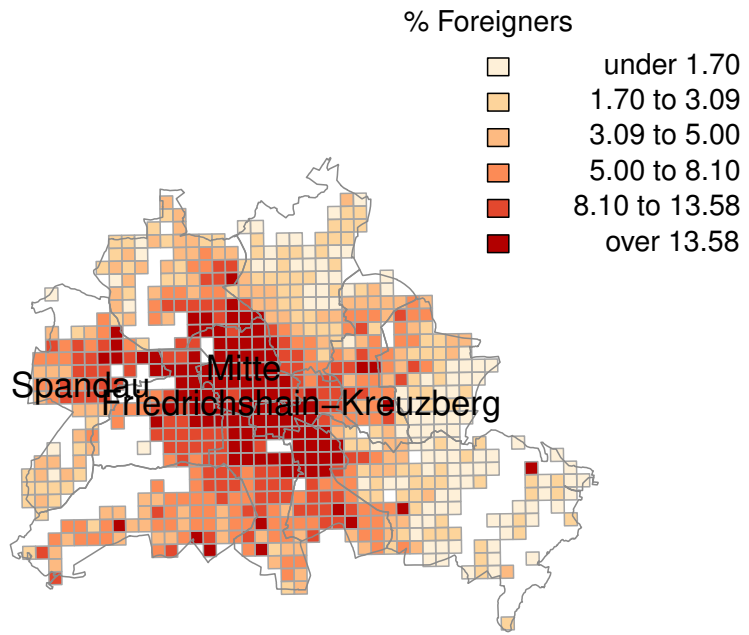
Summary Statistics

Table: Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
ln Air pollution	9,061	4.02	6.65	0.00	20.93
% Foreigners	9,061	9.00	8.43	0.00	87.10
Population	9,061	2,649.91	2,887.97	3.00	23,379.00
% 65 and older	9,061	20.57	7.44	0.00	99.60
% Vacant housing	9,061	3.50	3.54	0.00	60.00
Living space (m^2)	9,061	41.74	5.95	11.00	95.90
$\tilde{H}_{2000}$	79	0.03	0.01	0.01	0.08
$\tilde{D}_{2000}$	79	0.17	0.05	0.08	0.30
Unemployment ratio	79	2.34	0.37	1.28	3.43
Voter turnout	79	69.18	3.75	60.10	77.10
Facility centrality	79	2.78	2.18	0.00	17.78

Berlin


Air pollution (ln kg)
0
>0 to 7.20
7.20 to 10.12
10.12 to 16.79
16.79 to 18.10
over 18.10

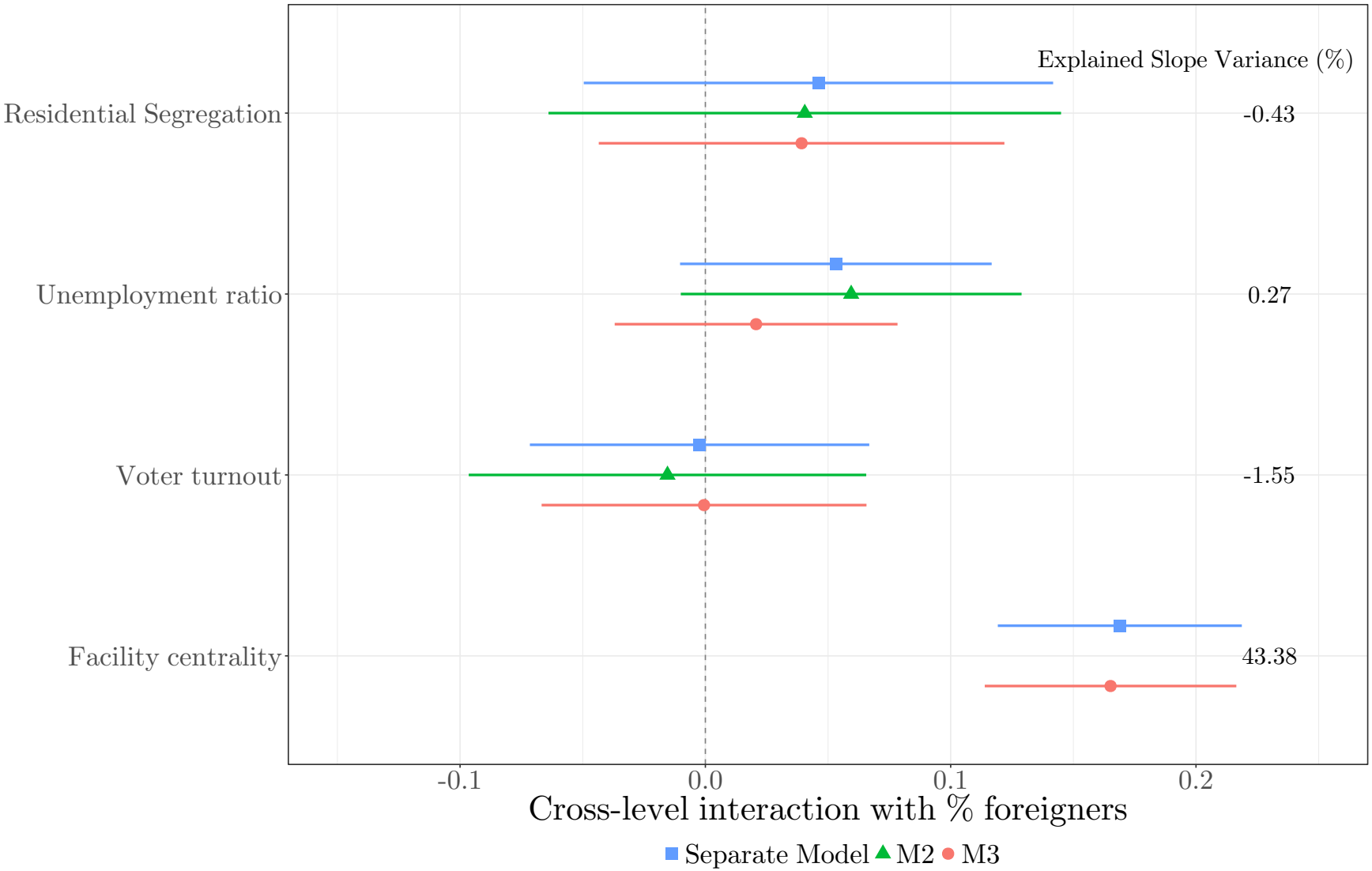

% Foreigners
under 1.70
1.70 to 3.09
3.09 to 5.00
5.00 to 8.10
8.10 to 13.58
over 13.58
Spandau
Mitte
Friedrichshain−Kreuzberg

Multilevel-Models

	M4	M5	M6
Census cell level			
% Foreigners	0.232^{***}	0.254^{***}	0.245^{***}
	(0.034)	(0.037)	(0.031)
Cross-level interactions			
% Foreigners $\times \tilde{H}_{2000}$		$0.079^{\dagger}$	0.086^{*}
		(0.048)	(0.040)
% Foreigners × Unemployment ratio		−0.010	−0.046
		(0.032)	(0.028)
% Foreigners × Voter turnout		0.044	0.024
		(0.037)	(0.032)
% Foreigners × Facility centrality			0.139^{***}
			(0.026)
Fixed effects	yes	yes	yes
Random slope	yes	yes	yes
AIC	23635.200	23680.777	23672.149
N	9061	9061	9061
N cluster	79	79	79
σ^2 % Foreigners	0.066	0.068	0.044
σ^2 Residual	0.780	0.780	0.780

$^{***}p < 0.001$, $^{**}p < 0.01$, $^{*}p < 0.05$, $^{\dagger}p < 0.1$. Multilevel models with group centered first level variables. All variables are scaled by their standard deviation. Standard errors in parentheses. Controls: Population, % 65 and older, % Vacant housing, Living space.

Dependent variable: ln Pollution (tox-weighted)



Spatial Model