HOUSING MARKET AND MIGRATION REVISITED

A Bayesian multilevel gravity model for Dutch municipalities

Thomas de Graaff

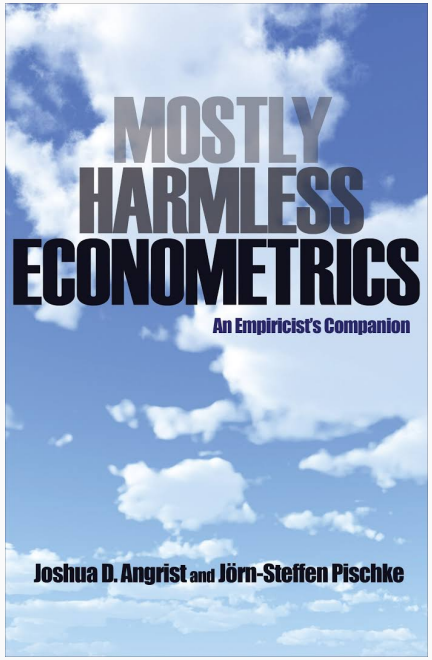
June 4, 2019

Vrije Universiteit Amsterdam
Department of Spatial Economics

Background: two different cultures (Breiman, 2001)

In economics:

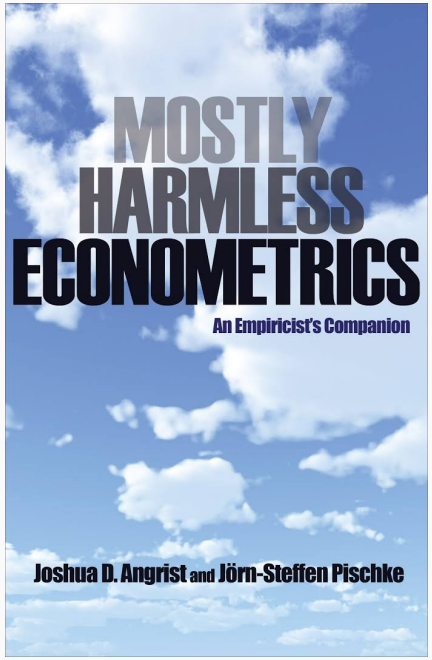
- causal impact of x on y
- average treatment effect



Background: two different cultures (Breiman, 2001)

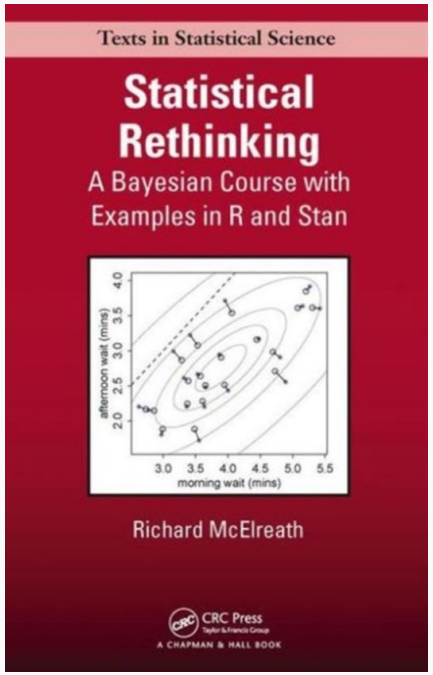
In economics:

- causal impact of x on y
- average treatment effect



Outside economics:

- model performance
- prediction of total effect



Background empirical application

- Aggregate homeownership has negative impact on labour market performance, because of increased moving costs (Oswald, 1996, 1999)

- Large empirical literature (mostly on individual decisions)

- Literature on impact of social renting on migration flows is scarce (De Graaff et al., 2009)
  - Social renting rights only valid within city (but Boyle, 1998)
  - Social renting is an urban phenomenon ($\approx$ 40% in Amsterdam)

This paper

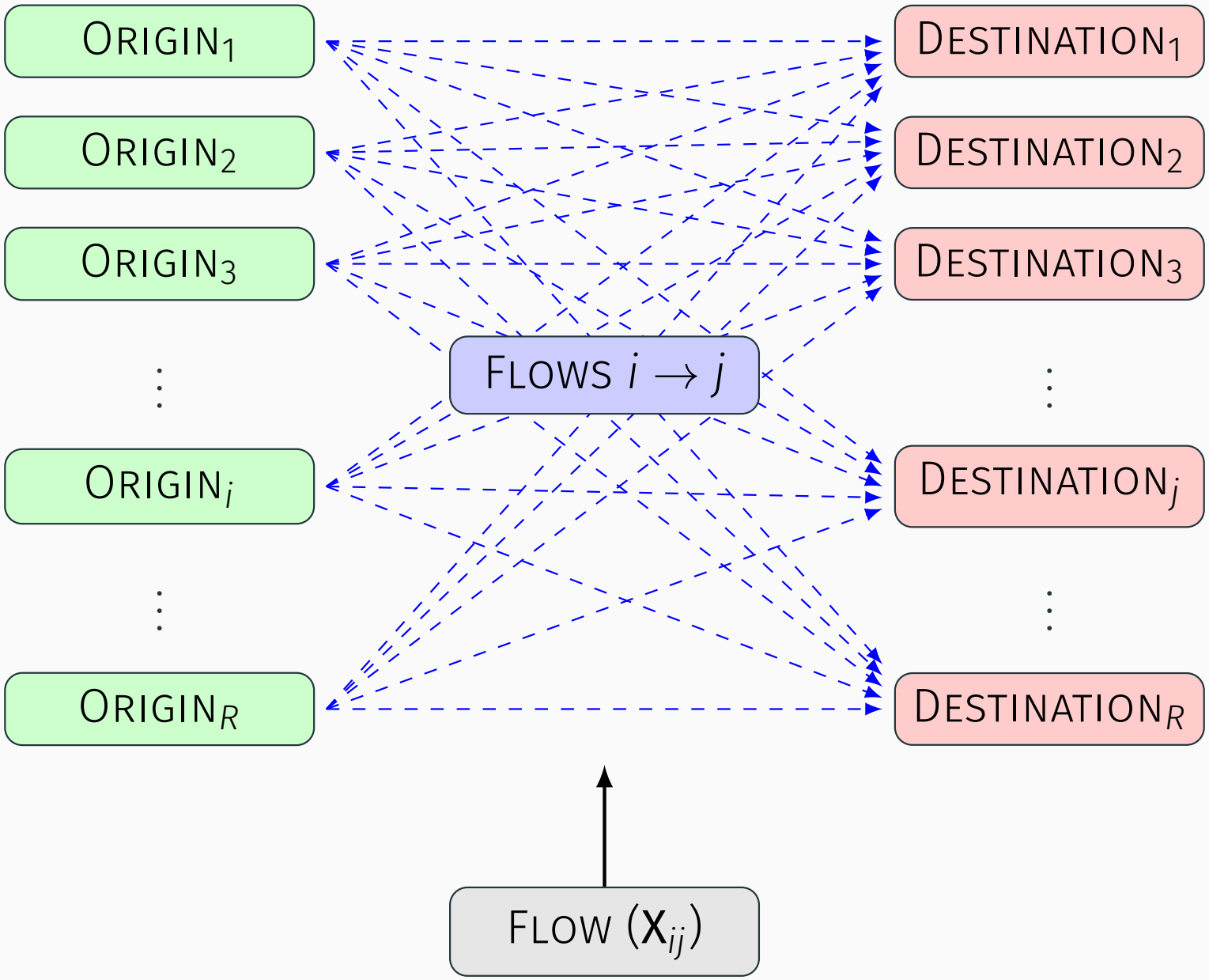
Does what? Revisits the impact of housing market structure (homeownership and social renting) on within-country migration flows using a Bayesian multilevel gravity model (Congdon, 2010)

Aim to be able to predict all changes in incoming and outcoming migration flows of, e.g., Amsterdam, when housing market structure changes whilst accounting for origin and destination specific effects (Ranjan and Tobias, 2007)

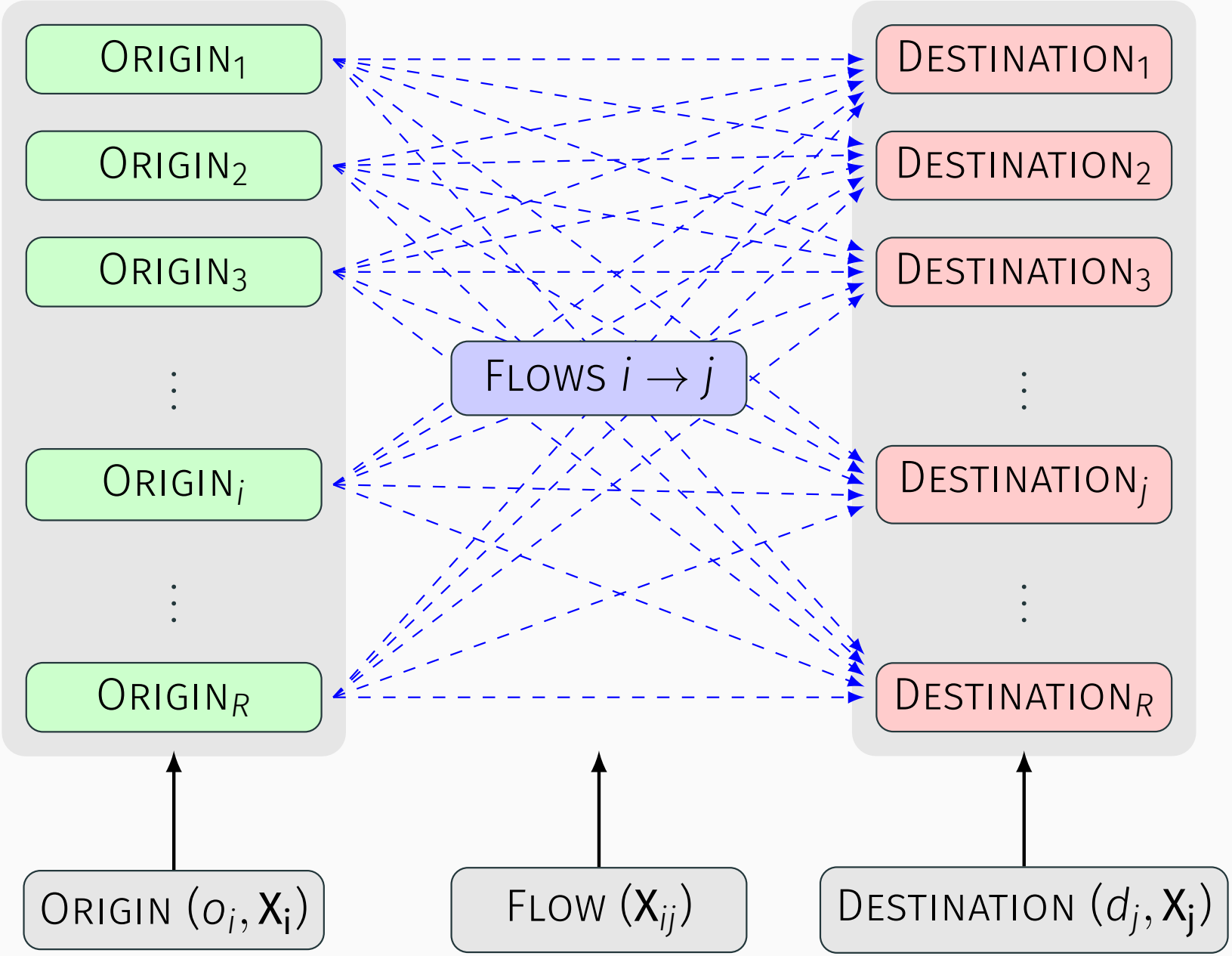
Gravity model data structure

ORIGIN_1	DESTINATION_1
ORIGIN_2	DESTINATION_2
ORIGIN_3	DESTINATION_3
$\vdots$	$\vdots$
ORIGIN_i	DESTINATION_j
$\vdots$	$\vdots$
ORIGIN_R	DESTINATION_R

Gravity model data structure



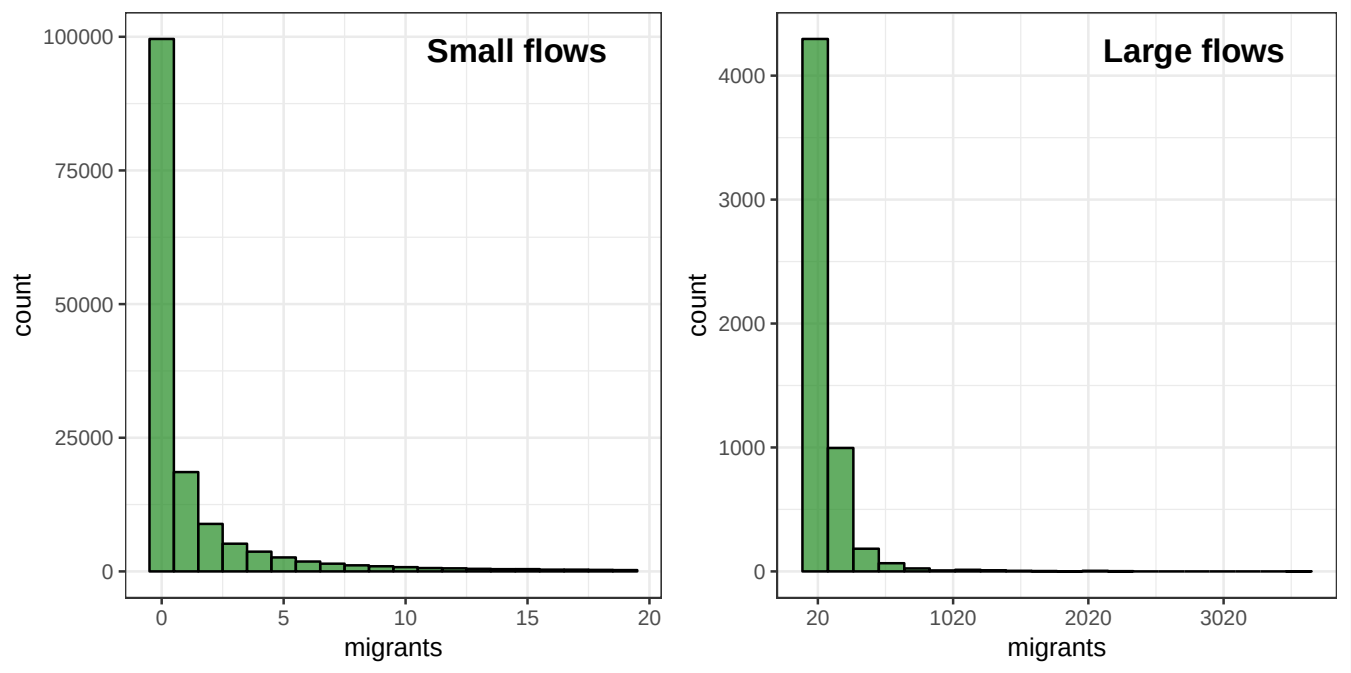
Gravity model data structure



Why a Bayesian multilevel approach?

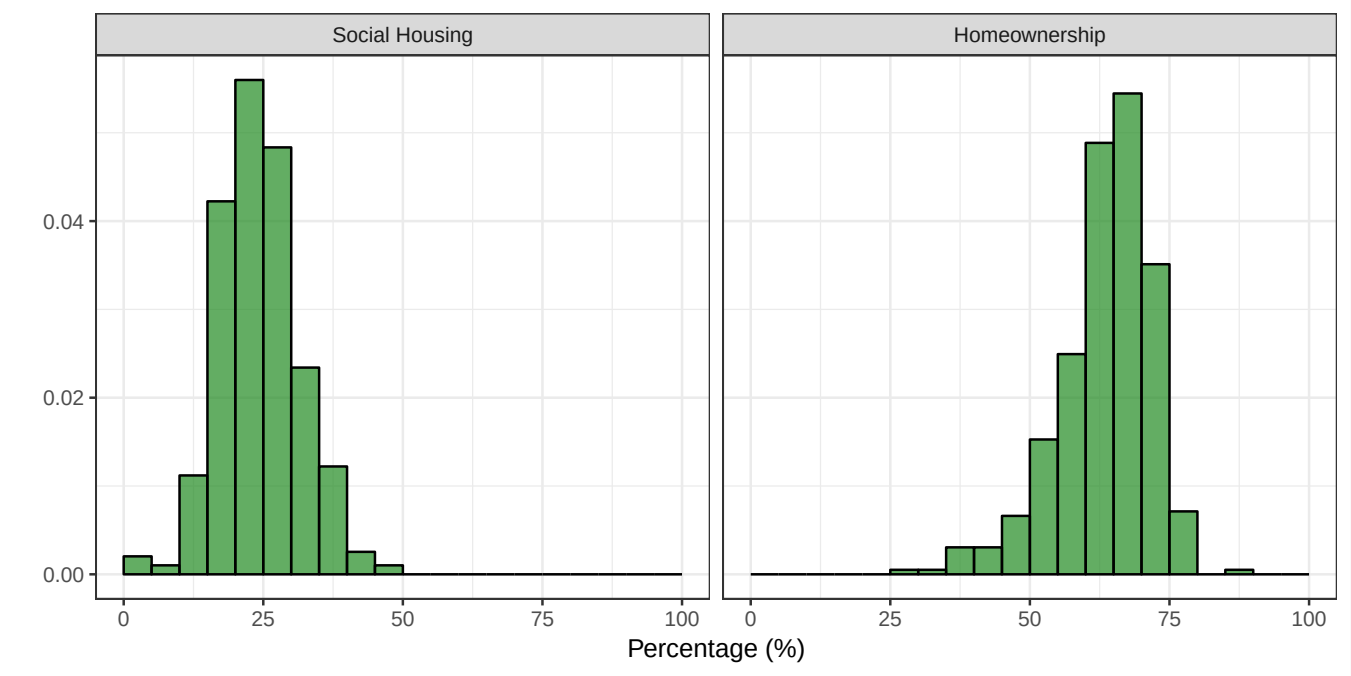
- Frequently used—increases model performance and flexibility
- Simultenous modeling at various levels (e.g., cities, regions, flows, individuals)
  - No two-stage models anymore
- Many definitions (in a Bayesian context):
  - mixed effects, varying intercepts/parameter, shrinkage, partial pooling
- Estimates the level effects from a distribution, usually $\sim$ Normal(α, σ)
  - $\sigma \longrightarrow 0$: complete pooling
  - $\sigma \longrightarrow \infty$: no pooling (fixed effects)

Data: migrations flows



- Individual migrations flows between 393 Dutch cities in 2015
- Variance is 4 times expectation (dispersion)

Data: municipal housing structure



- Positive correlation between city size and social renting (0.4)
- Negative correlation between social renting and homeownership (−0.84)

Modeling framework: traditional gravity modeling

$$\log(\text{migrants}_{ij}) = o_i + d_j + \gamma \log(\text{dist}_{ij}) + \epsilon_{ij}$$

Adopting fixed effects for multilateral resistance (Anderson and Van Wincoop, 2003), but

- what about zeros?
- how to incorporate municipal housing structure?
- dispersion and heteroskedasticity (Silva and Tenreyro, 2006)

Modeling framework: multilevel gravity modeling

$$\text{Migrants}_{ij} \sim \text{GammaPoisson}(\lambda_{ij}, \tau)$$ (outcome variable)

Modeling framework: multilevel gravity modeling

$$
\begin{aligned}
\text{Migrants}_{ij} &\sim \text{GammaPoisson}(\lambda_{ij}, \tau) && \text{(outcome variable)} \\
\log(\lambda_{ij}) &= \alpha + o_{\text{mun}[i]} + d_{\text{mun}[j]} + \\
&\quad \beta_1 \log(\text{pop}_i) + \beta_2 \log(\text{pop}_j) + \\
&\quad \beta_3 \log(\text{home}_i) + \beta_4 \log(\text{home}_j) + \\
&\quad \beta_5 \log(\text{soc}_i) + \beta_6 \log(\text{soc}_j) + \\
&\quad \beta_7 \log(\text{dist}_{ij}) && \text{(linear model)}
\end{aligned}
$$

Modeling framework: multilevel gravity modeling

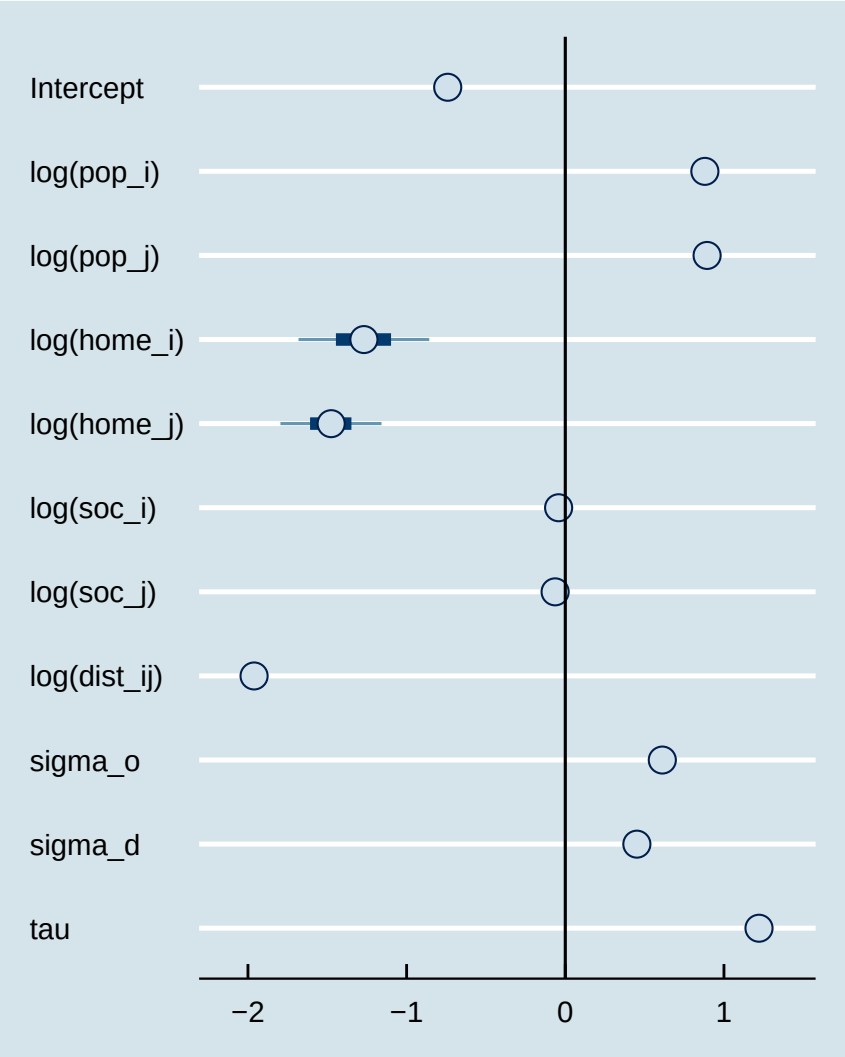
$$
\begin{aligned}
\text{Migrants}_{ij} &\sim \text{GammaPoisson}(\lambda_{ij}, \tau) && \text{(outcome variable)} \\
\log(\lambda_{ij}) &= \alpha + o_{\text{mun}[i]} + d_{\text{mun}[j]} + \\
&\quad \beta_1 \log(\text{pop}_i) + \beta_2 \log(\text{pop}_j) + \\
&\quad \beta_3 \log(\text{home}_i) + \beta_4 \log(\text{home}_j) + \\
&\quad \beta_5 \log(\text{soc}_i) + \beta_6 \log(\text{soc}_j) + \\
&\quad \beta_7 \log(\text{dist}_{ij}) && \text{(linear model)} \\
o_{\text{mun}} &\sim \text{Normal}(\alpha_o, \sigma_o) && \text{(origin effects)} \\
d_{\text{mun}} &\sim \text{Normal}(\alpha_d, \sigma_d) && \text{(destination effects)}
\end{aligned}
$$

Modeling framework: multilevel gravity modeling

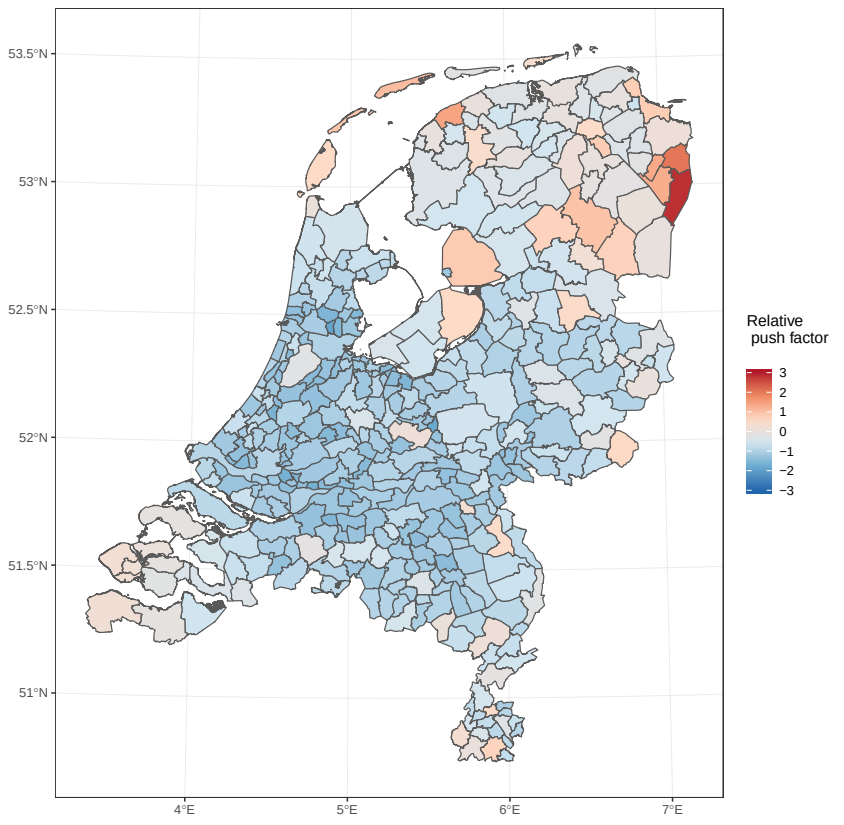
$$
\begin{aligned}
\text{Migrants}_{ij} &\sim \text{GammaPoisson}(\lambda_{ij}, \tau) && \text{(outcome variable)} \\
\log(\lambda_{ij}) &= \alpha + o_{\text{mun}[i]} + d_{\text{mun}[j]} + \\
&\quad \beta_1 \log(\text{pop}_i) + \beta_2 \log(\text{pop}_j) + \\
&\quad \beta_3 \log(\text{home}_i) + \beta_4 \log(\text{home}_j) + \\
&\quad \beta_5 \log(\text{soc}_i) + \beta_6 \log(\text{soc}_j) + \\
&\quad \beta_7 \log(\text{dist}_{ij}) && \text{(linear model)} \\
o_{\text{mun}} &\sim \text{Normal}(\alpha_o, \sigma_o) && \text{(origin effects)} \\
d_{\text{mun}} &\sim \text{Normal}(\alpha_d, \sigma_d) && \text{(destination effects)} \\
\beta_1, \ldots, \beta_7 &\sim \text{Normal}(0, 2) && \text{(priors)} \\
\alpha_o, \alpha_d &\sim \text{Normal}(0, 2) && \text{(priors)} \\
\sigma_o, \sigma_d &\sim \text{HalfCauchy}(0, 1) && \text{(priors)} \\
\tau &\sim \text{Gamma}(0.01, 0.01) && \text{(prior)}
\end{aligned}
$$

Hamiltonian Monte Carlo (HMC) estimation results

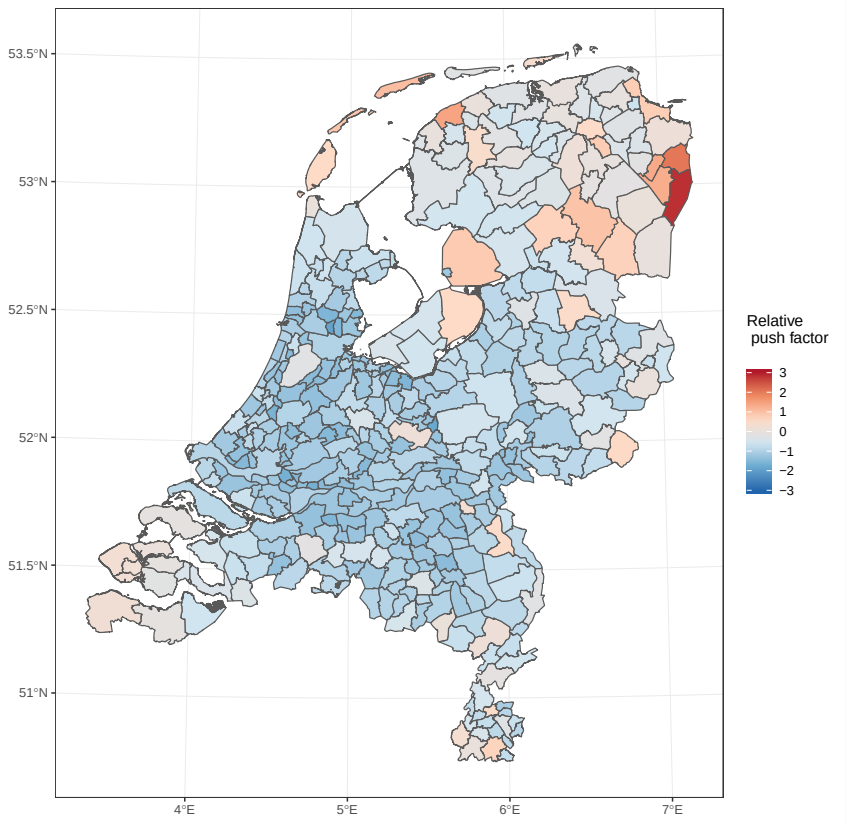
Parameter	mean	sd
Intercept	−0.74	0.04
$\log(\text{pop}_i)$	0.89	0.03
$\log(\text{pop}_j)$	0.88	0.04
$\log(\text{home}_i)$	−1.48	0.19
$\log(\text{home}_j)$	−1.27	0.25
$\log(\text{soc}_i)$	−0.04	0.04
$\log(\text{soc}_j)$	−0.06	0.03
$\log(\text{dist}_{ij})$	−1.96	0.01
σ_o	0.45	0.02
σ_d	0.61	0.02
τ	1.22	0.01

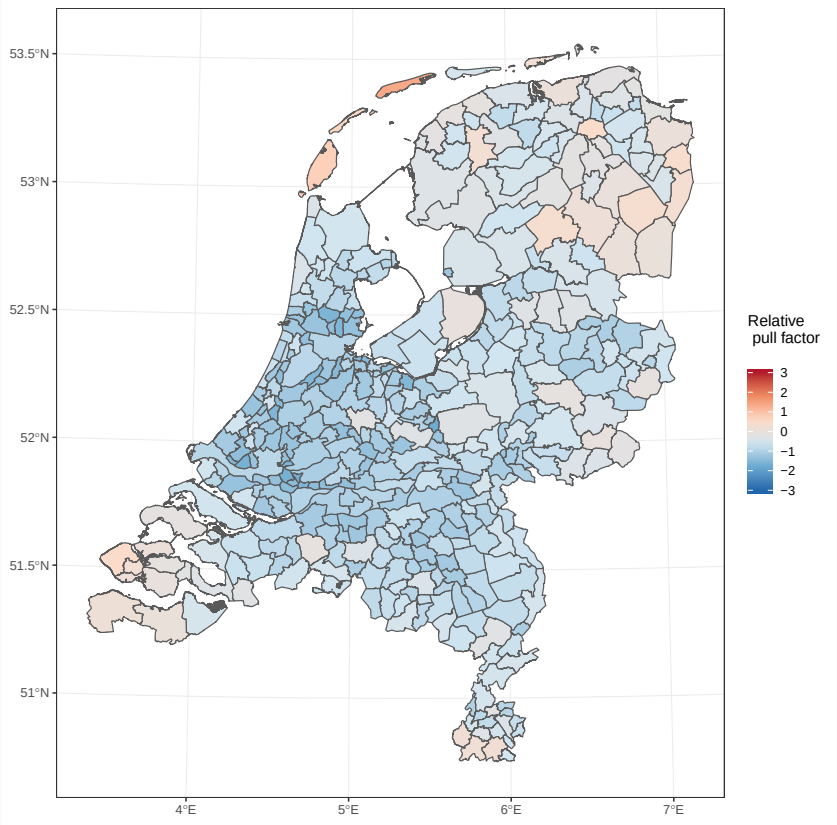


d_{mun} as measure of attractivity?

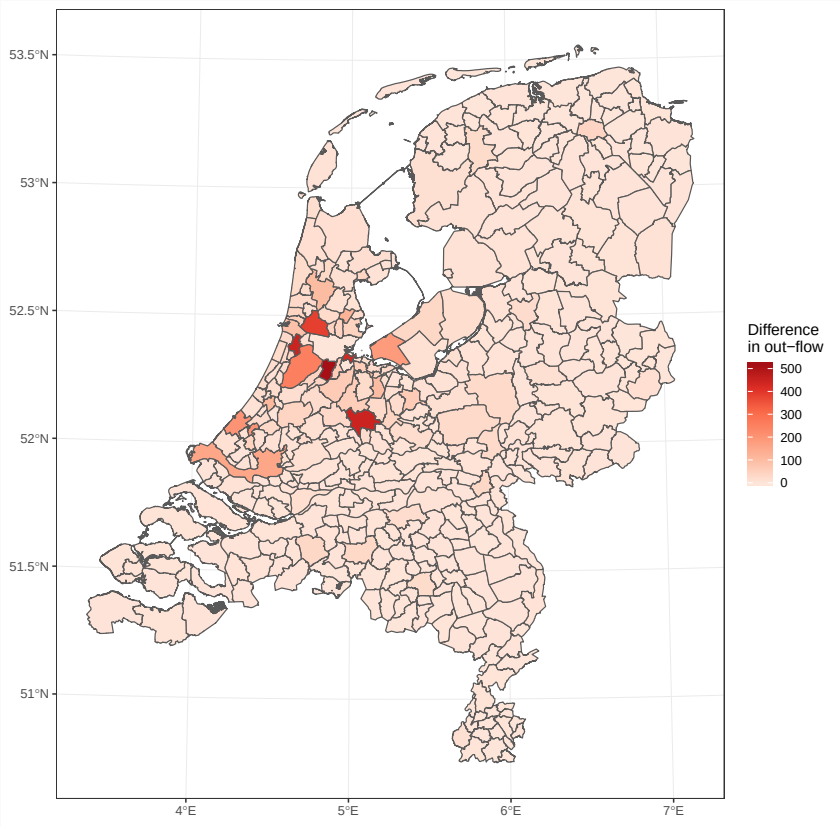


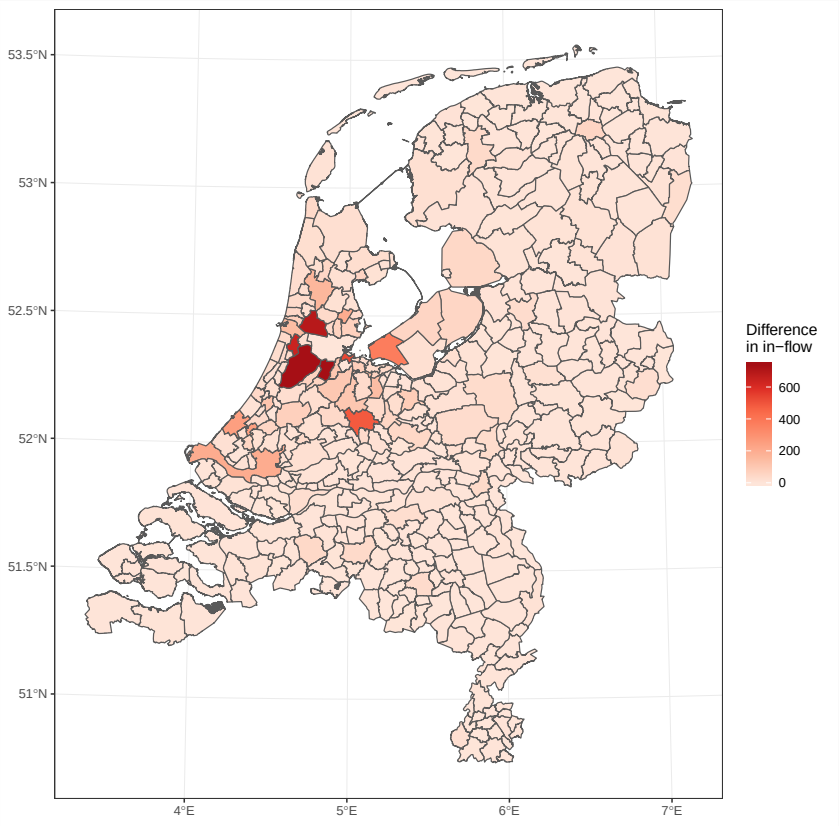
d_{mun} as measure of attractivity?





Home-ownership rate in Amsterdam decreases with 10%?





Conclusions

With respect to migration flows:

- homeownership has an elasticity well below -1
- social renting has negative elasticity as well, but close to zero
- most migration dynamics outside the most popular areas

Multilevel gravity framework

- flexible and powerful
- suitable for predictions within and outside sample
- with good model specification, estimation runs smoothly
- not very scalable; 154,056 obs. $\approx$ 6 hrs. of estimation

Supplementary materials

Paper, data and code can be retrieved from the project's GitHub page:

`https://github.com/Thdegraaff/migration_gravity`

Questions?

References i

- Anderson, J. E. and E. Van Wincoop (2003). "Gravity with gravitas: a solution to the border puzzle". In: *American economic review* 93.1, pp. 170–192.
- Boyle, P (1998). "Migration and housing tenure in South East England". In: *Environment and Planning A* 30.5, pp. 855–866.
- Breiman, L. et al. (2001). "Statistical modeling: The two cultures (with comments and a rejoinder by the author)". In: *Statistical science* 16.3, pp. 199–231.
- Congdon, P. (2010). "Random-effects models for migration attractivity and retentivity: a Bayesian methodology". In: *Journal of the Royal Statistical Society: Series A (Statistics in Society)* 173.4, pp. 755–774.
- De Graaff, T., M. Van Leuvensteijn, and C. Van Ewijk (2009). "Homeownership, social renting and labor mobility across Europe". In: *Homeownership and the labour market in Europe*, pp. 53–81.
- Oswald, A. J. (1996). *A conjecture on the explanation for high unemployment in the industrialized nations: Part I*. Tech. rep.

References ii

Oswald, A. J. (1999). “The housing market and Europe’s unemployment: a non-technical paper”. In: *Homeownership and the labour Market in Europe*.

Ranjan, P. and J. L. Tobias (2007). “Bayesian inference for the gravity model”. In: *Journal of Applied Econometrics* 22.4, pp. 817–838.

Silva, J. S. and S. Tenreyro (2006). “The log of gravity”. In: *The Review of Economics and statistics* 88.4, pp. 641–658.