HOUSING MARKET AND MIGRATION REVISITED

A multilevel gravity model for Dutch municipalities

Thomas de Graaff

March 12, 2020

Vrije Universiteit Amsterdam
Tinbergen Institute Amsterdam

Background: two different cultures (Breiman, 2001)

In economics:

- causal impact of x on y
- focuses on $\hat{\beta}$
- marginal effect

Background: two different cultures (Breiman, 2001)

In economics:

- causal impact of x on y
- focuses on $\hat{\beta}$
- marginal effect

Outside economics:

- model performance
- focuses on $\hat{y}$
- prediction of total effect

Housing market and migration: why bother?

- Current Dutch housing market:
  - large shortage of dwellings (especially in popular, urban, regions and for private rental housing)
  - large yearly prices increases (8% in 2018)
  - decrease in number of houses sold
  - large regional variation

- Policy debates about changes in housing market structure
  - $\longrightarrow$ Increase home-ownership rates

- Large literature of external effects of home-ownership (Dietz and Haurin, 2003)
  - positive: savings, labor supply, health, maintenance, etc.
  - negative: migration (by increased moving costs) and on aggregate labour market performance (Oswald, 1996, 1999)

My contributions to the literature

- Large empirical (economic) literature on impact home-ownership on migration, but:
  - usually concerns marginal effect of home-ownership
  - less attention to predictions for the whole network

- Literature on impact of social renting on migration flows is scarce (De Graaff et al., 2009)
  - In the Netherlands social renting is a large phenomenon ($\approx$ 24% of total housing stock)
  - Social renting rights only valid within city
  - Social renting is an urban phenomenon (e.g. $\approx$ 40–50% in Amsterdam)

So, this paper

Does what? Revisits the impact of housing market structure (with focus on social renting) on within-country migration flows using a Bayesian multilevel gravity model

- UK context by Congdon (2010)
- Social relations model *cf.* Koster and Leckie (2014)

And Predict all changes in incoming and outcoming migration flows when housing market structure changes

Why a multilevel approach for the gravity model

CITY_1

CITY_2

CITY_3

$\vdots$

CITY_i

$\vdots$

CITY_I

Why a multilevel approach for the gravity model

Why a multilevel approach structure for the gravity model

Why a multilevel approach for the gravity model

Why a Bayesian multilevel approach?

- Hierarchical, mixed effects, varying intercept/parameter, shrinkage, partial pooling models

Why a Bayesian multilevel approach?

- Hierarchical, mixed effects, varying intercept/parameter, shrinkage, partial pooling models
- Increasingly used for model performance and flexibility

Why a Bayesian multilevel approach?

- Hierarchical, mixed effects, varying intercept/parameter, shrinkage, partial pooling models
- Increasingly used for model performance and flexibility
- Simultaneous modeling at various levels (e.g., cities, regions, flows, individuals)
    - no two-stage models anymore
    - precision (standard errors) is correct

Why a Bayesian multilevel approach?

- Hierarchical, mixed effects, varying intercept/parameter, shrinkage, partial pooling models
- Increasingly used for model performance and flexibility
- Simultaneous modeling at various levels (e.g., cities, regions, flows, individuals)
  - no two-stage models anymore
  - precision (standard errors) is correct
- Partial pooling: origin and destination specific effects are draws from a distribution: usually $\sim$ Normal(α, σ)
  - $\sigma \longrightarrow 0$: complete pooling
  - $\sigma \longrightarrow \infty$: no pooling (fixed effects)

Data: migrations flows

- Migration flows between 380 Dutch municipalities in 2018 ($\approx 144,000$ flows)
- Variance is 4 times expectation: over-dispersion

Data: municipal housing structure

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

Modeling framework: traditional gravity modeling

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

Origin and destination specific fixed effects for multilateral resistance (Anderson and Van Wincoop, 2003) , but:

- what about zeros in Migrants_{ij}?
- how to incorporate housing structure in the presence of o_i and d_j?
- over-dispersion and heteroskedasticity (Silva and Tenreyro, 2006)

Poisson versus negative binomial[1]

- Counts of migrants

- With Poisson & regional effects of origin and destination the following origin and destination constraints automatically hold

$$\sum_{j=1}^{R} \widehat{\text{Migrants}}_{ij} = O_i \qquad \sum_{i=1}^{R} \widehat{\text{Migrants}}_{ij} = D_j$$

- Does not apply with negative binomial

- Multilevel model accounts for dispersion

[1] *We urge researchers to resist the siren song of the Negative Binomial (Head and Mayer, 2014)*

Modeling framework: multilevel gravity modeling

$$\text{Migrants}_{ij} \sim \text{Poisson}(\lambda_{ij})$$ (flow of migrants)

Modeling framework: multilevel gravity modeling

$$\text{Migrants}_{ij} \sim \text{Poisson}(\lambda_{ij}) \qquad \text{(flow of migrants)}$$

$$\log(\lambda_{ij}) = \alpha + o_{\text{mun}[i]} + d_{\text{mun}[j]} + \qquad \text{(city effects)}$$

Modeling framework: multilevel gravity modeling

$$
\begin{aligned}
\text{Migrants}_{ij} &\sim \text{Poisson}(\lambda_{ij}) && \text{(flow of migrants)} \\
\log(\lambda_{ij}) &= \alpha + o_{\text{mun}[i]} + d_{\text{mun}[j]} + && \text{(city effects)} \\
&\quad \beta_1 \log(\text{pop}_i) + \beta_2 \log(\text{pop}_j) + \\
&\quad \beta_3 \log(\text{home}_i) + \beta_4 \log(\text{home}_j) + \\
&\quad \beta_5 \log(\text{soc}_i) + \beta_6 \log(\text{soc}_j) + \\
&\quad \beta_7 \log(\text{dist}_{ij}) && \text{(explanatory variables)}
\end{aligned}
$$

Modeling framework: multilevel gravity modeling

$$\text{Migrants}_{ij} \sim \text{Poisson}(\lambda_{ij}) \qquad \text{(flow of migrants)}$$

$$\begin{aligned}
\log(\lambda_{ij}) = \alpha + o_{\text{mun}[i]} + d_{\text{mun}[j]} + & \qquad \text{(city effects)} \\
\beta_1 \log(\text{pop}_i) + \beta_2 \log(\text{pop}_j) + & \\
\beta_3 \log(\text{home}_i) + \beta_4 \log(\text{home}_j) + & \\
\beta_5 \log(\text{soc}_i) + \beta_6 \log(\text{soc}_j) + & \\
\beta_7 \log(\text{dist}_{ij}) & \qquad \text{(explanatory variables)}
\end{aligned}$$

$$\begin{pmatrix} o_{\text{mun}} \\ d_{\text{mun}} \end{pmatrix} \sim \text{MVNormal}\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_o^2 & \sigma_o \sigma_d \rho \\ \sigma_o \sigma_d \rho & \sigma_d^2 \end{pmatrix} \right)$$

(varying region effects)

Modeling framework: multilevel gravity modeling

$$\text{Migrants}_{ij} \sim \text{Poisson}(\lambda_{ij}) \qquad \text{(flow of migrants)}$$

$$\begin{aligned}
\log(\lambda_{ij}) = \alpha + o_{\text{mun}[i]} + d_{\text{mun}[j]} + & \qquad \text{(city effects)} \\
\beta_1 \log(\text{pop}_i) + \beta_2 \log(\text{pop}_j) + & \\
\beta_3 \log(\text{home}_i) + \beta_4 \log(\text{home}_j) + & \\
\beta_5 \log(\text{soc}_i) + \beta_6 \log(\text{soc}_j) + & \\
\beta_7 \log(\text{dist}_{ij}) & \qquad \text{(explanatory variables)}
\end{aligned}$$

$$\begin{pmatrix} o_{\text{mun}} \\ d_{\text{mun}} \end{pmatrix} \sim \text{MVNormal}\left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_o^2 & \sigma_o \sigma_d \rho \\ \sigma_o \sigma_d \rho & \sigma_d^2 \end{pmatrix} \right)$$

(varying region effects)

$$\beta_7 \sim \text{Normal}(-1, 1) \qquad \text{(prior)}$$

$$\alpha, \beta_1, \ldots, \beta_6 \sim \text{Normal}(0, 2) \qquad \text{(priors)}$$

$$\sigma_o, \sigma_d \sim \text{HalfCauchy}(0, 1) \qquad \text{(priors)}$$

Estimation results

Parameter	mean	sd
Intercept	−0.34	0.05
$\log(\text{pop}_i)$	0.88	0.04
$\log(\text{pop}_j)$	0.91	0.05
$\log(\text{home}_i)$	−0.44	0.18
$\log(\text{home}_j)$	−0.69	0.22
$\log(\text{soc}_i)$	−0.08	0.03
$\log(\text{soc}_j)$	−0.08	0.04
$\log(\text{dist}_{ij})$	−1.88	0.01
σ_o	0.54	0.02
σ_d	0.43	0.02
ρ	0.88	0.01

Robustness checks for impact social renting

- impact $soc \approx 0$

Robustness checks for impact social renting

- impact $soc \approx 0$

- Robust to:
  - year
  - interaction effects with population & home-ownership
  - varying slopes (e.g, $o_{\text{mun}[i]} + \beta_{\text{mun}[i]} \log(\text{soc}_i)$)
  - Inclusion of household size

Robustness checks for impact social renting

- impact $soc \approx 0$
- Robust to:
  - year
  - interaction effects with population & home-ownership
  - varying slopes (e.g, $o_{\text{mun}[i]} + \beta_{\text{mun}[i]} \log(\text{soc}_i)$)
  - Inclusion of household size

Assuming the following causal graph (*dag*)

Observed versus predicted flows

- maximum observed flow: 3,573
- maximum predicted flow: 3,584

Correlation between origin an destination $\rho = 0.88$

d_{mun} as measure of attractivity?

Home-ownership rate in Amsterdam increases with 10% and social renting decreases with 10%

Conclusions

Flexibel and powerful Bayesian multilevel gravity model:

- homeownership has a a high negative impact on migration
- social renting has elasticity close to zero (Boyle, 1998)
  - social housing is almost a different ball game
  - no interaction with homeowership, private renting or household size

Now what?

- additional model structure
  - correlation between dyads (Migrants$_{ij}$ and Migrants$_{ji}$)
  - spatial autocorrelation in regional varying effects
  - create panel data
- Additional covariates (age, income)

Supplementary materials

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

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

Thank you!

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.

References ii

Dietz, R. D. and D. R. Haurin (2003). "The social and private micro-level consequences of homeownership". In: *Journal of urban Economics* 54.3, pp. 401–450.

Head, K. and T. Mayer (2014). "Gravity equations: Workhorse, toolkit, and cookbook". In: *Handbook of international economics*. Vol. 4. Elsevier, pp. 131–195.

Koster, J. M. and G. Leckie (2014). "Food sharing networks in lowland Nicaragua: an application of the social relations model to count data". In: *Social Networks* 38, pp. 100–110.

Oswald, A. J. (1996). *A conjecture on the explanation for high unemployment in the industrialized nations: Part I*. Tech. rep.

— (1999). "The housing market and Europe's unemployment: a non-technical paper". In: *Homeownership and the labour Market in Europe*.

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