

# URBAN EXODUS OR RURAL SHRINKAGE?

REGIONAL MIGRATION AND ATTRACTIVINESS IN A TIGHT  
DUTCH HOUSING MARKET

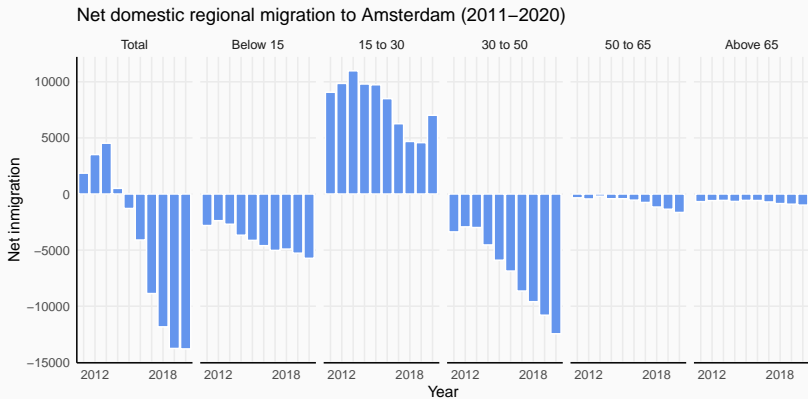
---

Thomas de Graaff

September, 2021

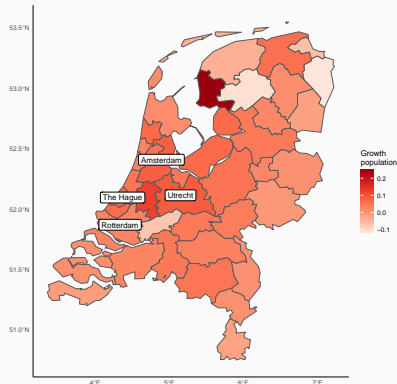
Vrije Universiteit Amsterdam  
Tinbergen Institute Amsterdam

# Urban Exodus?



# Dutch population growth 2012–2020

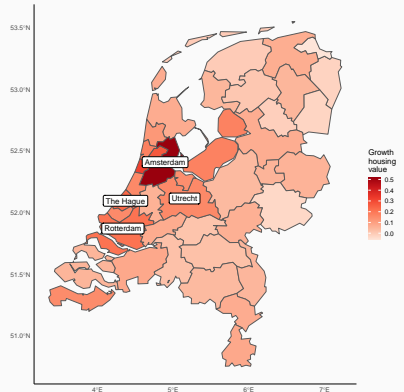
- NUTS-3 regions
  - originally (1970) labour market regions
- Last decade:
  - homogeneous population growth
  - **few** peripheral regions “shrink”
- Domestic migration
  - slightly more **within** regions than **between**
  - growth is the **same**



# Tight Dutch housing market

- Average housing price: €410,000
- Change last year +20%
- **Waiting list** social renting  
Amsterdam: 13 years
- Large **shortage** of housing
- Decrease in housing **transactions**

Growth property tax value



# Housing market, urban regions and interregional migration: why bother?

- Possible drivers of urban out-migration?
  - **suburbanisation** of poverty (Hochstenbach and Musterd, 2018)
  - **crowding-out** of the housing market by short-term rentals (Koster et al., 2021)
  - **Influx** of high-skilled migrants (Beckers and Boschman, 2019)
  - Relative increase in attractivity of **satellite** cities (Donovan et al., 2021)

# Housing market, urban regions and interregional migration: why bother?

- Possible drivers of urban out-migration?
  - **suburbanisation** of poverty (Hochstenbach and Musterd, 2018)
  - **crowding-out** of the housing market by short-term rentals (Koster et al., 2021)
  - **Influx** of high-skilled migrants (Beckers and Boschman, 2019)
  - Relative increase in attractivity of **satellite** cities (Donovan et al., 2021)
- Large literature on **external** effects of home-ownership (Dietz and Haurin, 2003)
  - **negative**: moving costs (Oswald, 1996, 1999)

# My contributions to the literature

- Large empirical (economic) literature on impact home-ownership as drivers of interregional migration, but:
  - usually concerns **marginal** effect of home-ownership
  - less attention for the whole **network** (e.g., Amsterdam effect)
- 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/region
  - Social renting is an **urban** phenomenon (e.g.  $\approx$  30–40% in Amsterdam)

# So, this paper

**Does what?** Estimates the impact of housing market structure on Dutch interregional migration flows using a multilevel gravity model

- UK context by Congdon (2010)
- social relations model cf. Koster and Leckie (2014)
- *Statistical Rethinking* from McElreath (2020)
- ggplot2 code from Kurz (2020)

**Aim** To simultaneously assess the impact of housing market structure and region specific effects on domestic migration flows



## Why a **multilevel** approach for the gravity model?

There are at least two **levels** in migration (I use three)

## Why a **multilevel** approach for the gravity model?

There are at least two **levels** in migration (I use three)

**Observed migration flows** Migration between  $i$  and  $j$  with friction (e.g., distance) attributes (obs =  $R^2 - R$ )



## Why a **multilevel** approach for the gravity model?

There are at least two **levels** in migration (I use three)

**Observed migration flows** Migration between  $i$  and  $j$  with friction (e.g., distance) attributes (obs =  $R^2 - R$ )



**Observed push & pull factors** Attributes of  $i$  and  $j$  (obs =  $R$ )



## Why a **multilevel** approach for the gravity model?

There are at least two **levels** in migration (I use three)

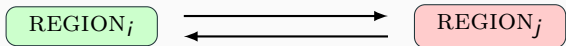
**Observed migration flows** Migration between  $i$  and  $j$  with friction (e.g., distance) attributes (obs =  $R^2 - R$ )



**Observed push & pull factors** Attributes of  $i$  and  $j$  (obs =  $R$ )



**Observed flows within regional dyads** migration from  $i \rightarrow j$  is correlated with migration from  $j \rightarrow i$  (obs =  $\frac{R^2 - R}{2}$ )



## 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?

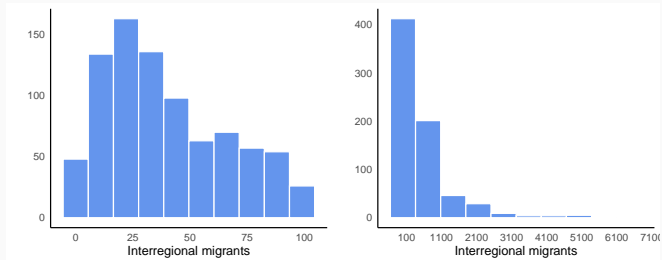
- Hierarchical, mixed effects, varying intercept/parameter, shrinkage, partial pooling models
- Increasingly used for model performance and flexibility
- Simultaneous modeling at various levels (e.g., cities, regions, flows, individuals)
  - no two-stage models anymore
  - precision (standard errors)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

## 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 at all levels
- Partial pooling: For example, origin specific effects are drawn from a distribution:  $\phi_i \sim \mathcal{N}(0, \sigma)$ 
  - $\sigma \rightarrow 0$  : complete pooling
  - $\sigma \rightarrow \infty$  : no pooling (fixed effects)

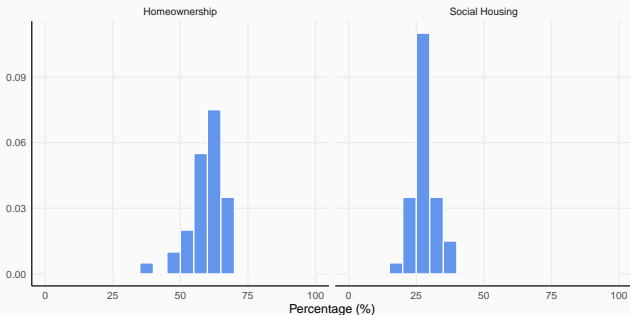


# Data: migrations flows in 2018



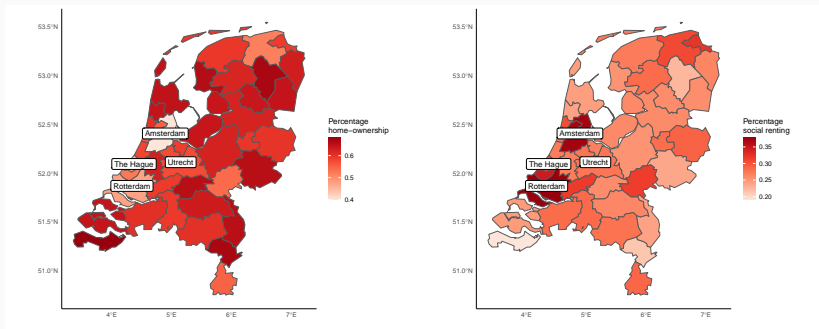
- Panel for the period 2012–2020
  - estimation: 2012–2019
  - out-of-sample prediction: 2020
- Migration flows **between** 40 Dutch regions
- Variance  $\gg$  mean: **over-dispersion**

# Data: regional housing structure in 2018



- Positive correlation between regional population and share social renting (0.46)
- Negative correlation between regional share social renting and share home-ownership ( $-0.88$ )

## Data: regional housing structure in 2018 (cont.)



**Figure 1:** Share of home-ownership (left) and social renting (right)

# Modeling framework: traditional gravity modeling

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

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

- what about **zeros** in  $\text{Migrants}_{ij}$ ?
- 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<sup>1</sup>

- Counts of migrants
- Constraints should hold

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

- poisson: ✓
  - negative binomial: ✗
- 
- Multilevel structure controls for overdispersion

---

<sup>1</sup>We urge researchers to resist the siren song of the Negative Binomial (Head and Mayer, 2014)

## Modeling framework: multilevel gravity modeling

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

# Modeling framework: multilevel gravity modeling

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

$$\log(\lambda_{ijt}) = \alpha + o_i + d_j + t_t + \text{dyad}_{ij} +$$

$$\beta_1 \ln(\text{pop}_{it}) + \beta_2 \ln(\text{pop}_{jt}) + \gamma \ln(\text{dist}_{ij}) +$$

$$\beta_3 \ln(\text{home}_{it}) + \beta_4 \ln(\text{home}_{jt}) + \beta_5 \ln(\text{soc}_{it}) + \beta_6 \ln(\text{soc}_{jt})$$

(linear model)

# Modeling framework: multilevel gravity modeling

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

$$\begin{aligned} \log(\lambda_{ijt}) = & \alpha + o_i + d_j + t_t + \text{dyad}_{ij} + \\ & \beta_1 \ln(\text{pop}_{it}) + \beta_2 \ln(\text{pop}_{jt}) + \gamma \ln(\text{dist}_{ij}) + \\ & \beta_3 \ln(\text{home}_{it}) + \beta_4 \ln(\text{home}_{jt}) + \beta_5 \ln(\text{soc}_{it}) + \beta_6 \ln(\text{soc}_{jt}) \end{aligned}$$

(linear model)

$$\begin{pmatrix} o_i \\ d_j \end{pmatrix} \sim \mathcal{N} \left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_i^2 & \rho_{ij} \\ \rho_{ij} & \sigma_j^2 \end{pmatrix} \right\} \quad (\text{regional varying effects})$$



# Modeling framework: multilevel gravity modeling

Migrants<sub>ijt</sub> ~Poisson( $\lambda_{ijt}$ ) (flow of migrants)

$$\begin{aligned}\log(\lambda_{ijt}) = & \alpha + o_i + d_j + t_t + \text{dyad}_{ij} + \\ & \beta_1 \ln(\text{pop}_{it}) + \beta_2 \ln(\text{pop}_{jt}) + \gamma \ln(\text{dist}_{ij}) + \\ & \beta_3 \ln(\text{home}_{it}) + \beta_4 \ln(\text{home}_{jt}) + \beta_5 \ln(\text{soc}_{it}) + \beta_6 \ln(\text{soc}_{jt})\end{aligned}$$

(linear model)

$$\begin{pmatrix} o_i \\ d_j \end{pmatrix} \sim \mathcal{N} \left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_i^2 & \rho_{ij} \\ \rho_{ij} & \sigma_j^2 \end{pmatrix} \right\}$$

(regional varying effects)

$$\begin{pmatrix} \text{dyad}_{ij} \\ \text{dyad}_{ji} \end{pmatrix} \sim \mathcal{N} \left\{ \begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_{\text{dyad}}^2 & \rho \\ \rho & \sigma_{\text{dyad}}^2 \end{pmatrix} \right\}$$

(dyad varying effects)

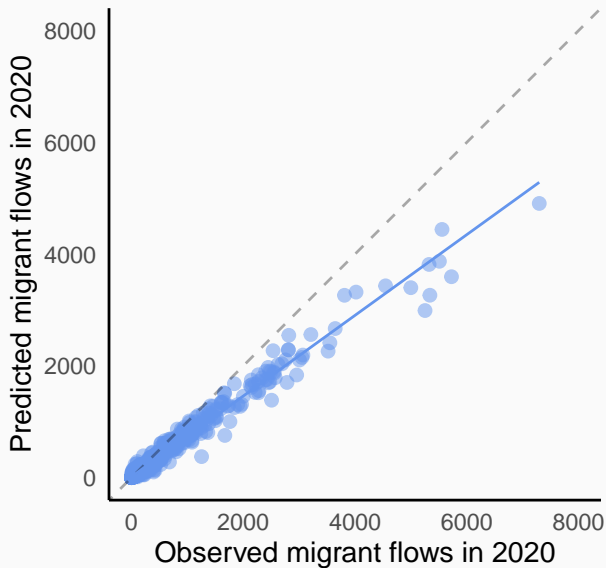
# Main Estimation results

parameter	no varying effects	with varying effects
intercept	<b>4.48</b>	<b>4.49</b>
origin:		
log(population)	<b>0.77</b>	<b>0.32</b>
log(homeownership)	<b>-1.67</b>	<b>1.60</b>
log(social renting)	<b>-1.82</b>	<b>-0.26</b>
destination:		
log(population)	<b>0.84</b>	<b>0.55</b>
log(homeownership)	<b>-1.14</b>	<b>0.17</b>
log(social renting)	<b>-1.47</b>	<b>0.87</b>
migrants flow:		
log(distance)	<b>-1.39</b>	<b>-1.63</b>
standard deviations:		
origin		<b>0.67</b>
destination		<b>0.44</b>
dyad		<b>0.39</b>
correlation		
origin-destination		<b>0.78</b>
dyad		<b>0.80</b>

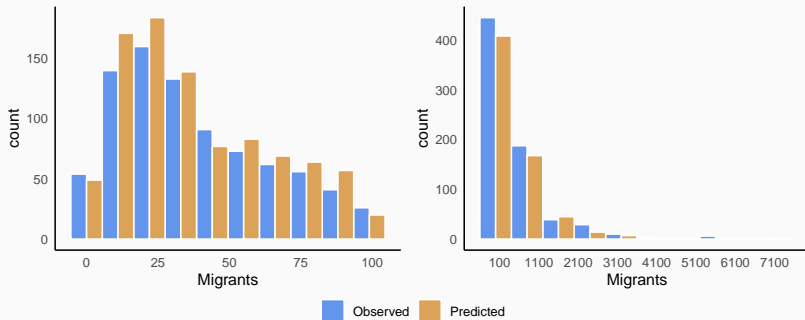
**Bold:** 89% credible intervals do not include zero

Samples are drawn using the NUTS sampler from STAN using 4 chains, each with 4,000 iterations and 1,000 warm-up samples

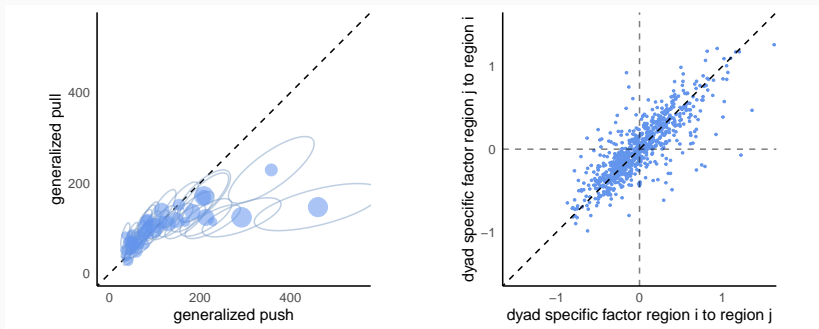
## Out-of-sample prediction for 2018 ( $R^2 = 0.98$ )



## Out-of-sample prediction for 2020 (cntd.)



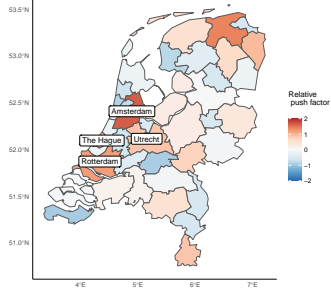
# Correlation patterns



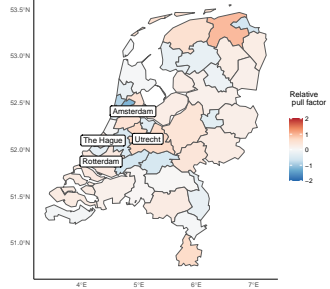
**Figure 2:** Correlation (0.78) between unobserved push and pull factors region (left) and flows (correlation = 0.8) within dyad pairs (right)

# Asymmetric push and pull factors

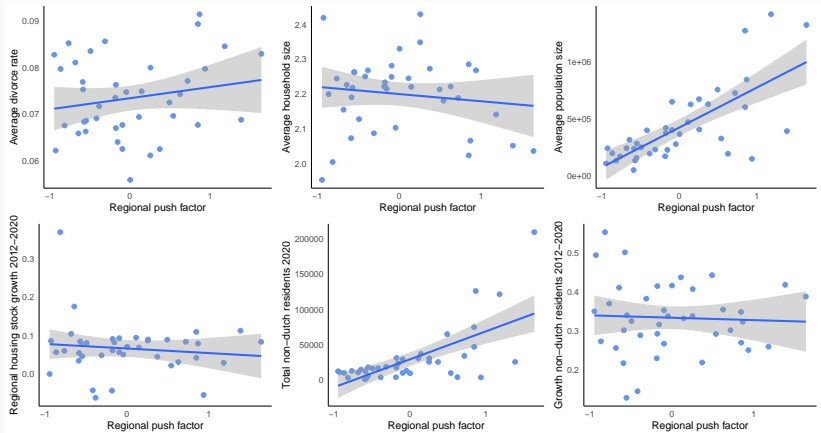
Regional origin effect



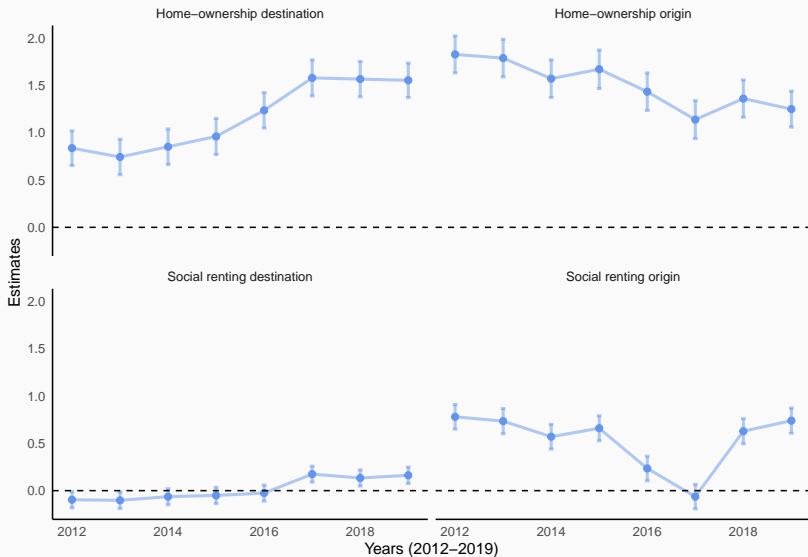
Regional destination effect



# Determinants of push factors?



# Sensitivity check: temporal stability?





## Sensitivity check: spatial autocorrelation?

- spatial autocorrelation in regional effects:

$$o_i, d_j \sim \mathcal{N}(0, \mathbf{K})$$

$$\mathbf{K}_{ij} = \eta^2 \exp(-\rho^2 \mathbf{D}_{ij})$$

- results remain robust

# Sensitivity check: spatial autocorrelation?

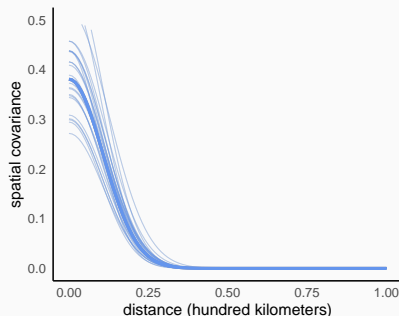
- spatial autocorrelation in regional effects:

$$o_i, d_j \sim \mathcal{N}(0, \mathbf{K})$$

$$\mathbf{K}_{ij} = \eta^2 \exp(-\rho^2 \mathbf{D}_{ij})$$

- results remain robust

Modest spatial autocorrelation



# Conclusions

## Main results:

- home-ownership has a **positive** impact on regional domestic migration
  - social renting to a lesser extent
- large urban areas have large **push** effects
  - effect is different from housing market structure
  - **similar** to and **larger** than push effects in periphery

## Speculation:

- home-ownership is a proxy for satellite communities close to major urban areas?
- tourism, short stay (high-skilled), and large housing investment companies drive natives out?

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

[https://github.com/Thdegraaff/migration\\_gravity](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.



Beckers, P. and S. Boschman (2019). "Residential choices of foreign highly skilled workers in the Netherlands and the role of neighbourhood and urban regional characteristics". In: *Urban Studies* 56.4, pp. 760–777.



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.



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.

## References ii



Donovan, S., T. de Graaff, A. Grimes, H. L. de Groot, and D. C. Maré (2021). "Cities with Forking Paths? Agglomeration Economies in New Zealand 1976-2018". In:



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



Hochstenbach, C. and S. Musterd (2018). "Gentrification and the suburbanization of poverty: Changing urban geographies through boom and bust periods". In: *Urban Geography* 39.1, pp. 26–53.



Koster, H. R., J. van Ommeren, and N. Volkhausen (2021). "Short-term rentals and the housing market: Quasi-experimental evidence from Airbnb in Los Angeles". In: *Journal of Urban Economics* 124, p. 103356.



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.



McElreath, R. (2020). *Statistical rethinking: A Bayesian course with examples in R and Stan*. CRC press.



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.