

A longitudinal mixed logit model for estimation of push and pull effects in residential location choice

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Motivation

- Substantial interest in how people's attitudes and behaviour are influenced by where they live
- Important to understand how people 'choose' neighbourhoods
 - Neighbourhood characteristics can influence moves both out of an area (**push factors**) and into an area (**pull factors**)
 - Expect push and pull effects to differ by individual characteristics and to change over the life course
 - **Recognise that residential location preferences are often constrained**

Research aims

- Develop a model for effects of area characteristics on residential location choice over time
 - Distinguish effects of characteristics of area r on decision to *move out of* r (**push**) and on decision to *move into* r (**pull**)
 - Allows sensitivity to area characteristics to depend on observed and unobserved household characteristics
- Implement in computationally-efficient software (Stat-JR)
- Illustrate method in longitudinal study of residential choice in England

Two-stage approaches

- 1 Model push effects of area characteristics on probability of out-migration (e.g. Lee et al. 1994; van Ham & Clark 2009)
 - Silent on what 'pulls' household to new area
- 2 Among movers, model change in area characteristics between origin and destination (e.g. Clark et al. 2006; Rabe & Taylor 2010)
 - Allows only one dimension of neighbourhood quality to be considered at a time

Discrete-choice models

- Increasingly used to analyse neighbourhood choice (e.g. Hedman et al. 2011, Bruch and Mare 2012)
- Mimics decision process where household chooses from a set of potential destination areas
- Not restricted to recent movers and can consider multiple area characteristics simultaneously

BUT

- Previous research has not fully exploited longitudinal data
- No previous attempt to distinguish push and pull effects

Overview of our approach

Joint model of push and pull effects on decision to move, and pull effects on choice of location among movers.

- Longitudinal discrete-choice model of residential location at year t within labour market area at $t - 1$
- Each year a household can decide to stay in current area or move to a new area
- Attributes of areas can promote both outward migration (push factors) and inward migration (pull factors)
- Allow importance of push and pull factors to vary according to observed and unobserved household characteristics

Definition of neighbourhood and choice set

English TTWAs



- **Neighbourhood** is a Lower Super Output Area (LSOA)
 - 32,482 LSOAs in England (\approx 1500 residents per LSOA)
- **Choice set** contains LSOAs within current Travel-to-Work Area (TTWA)
 - 166 TTWAs in England
 - 4 to 5467 LSOAs per TTWA, mean = 196

Simple multinomial logit model for area choice

$p_{rit} = \Pr(\text{household } i \text{ chooses area } r \text{ in year } t).$

Choice between areas s and r depends on their characteristics z_{st-1} and z_{rt-1} and whether resident in either area at $t - 1$.

1. Resident in r at $t - 1$

$$\log \left(\frac{p_{sit}}{p_{rit}} \right) = \alpha + \beta z_{rt-1} + \gamma z_{st-1}$$

α 'inertia' effect

β push effect of z in current area r

γ pull effect of z in potential area s

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2. Resident in neither at $t-1$

$$\log\left(\frac{p_{sit}}{p_{rit}}\right) = \gamma(z_{st-1} - z_{rt-1})$$

γ pull effect of s over r

Example: Push and pull effects of area deprivation

Suppose higher z indicates higher deprivation.

Resident in r at $t - 1$:

$$\log(p_{sit}/p_{rit}) = \alpha + \beta z_{rt-1} + \gamma z_{st-1}$$

Resident in neither r nor s at $t - 1$:

$$\log(p_{sit}/p_{rit}) = \gamma(z_{st-1} - z_{rt-1})$$

$\beta > 0 \implies \uparrow z$ in current area $r \uparrow$ probability of moving out of r

$\gamma < 0 \implies \uparrow z$ in potential area $s \downarrow$ probability of choosing s over r

Differential push and pull effects

Allow importance of z as a push and pull factor to depend on household characteristics.

- Interactions between z and observed household covariates x
- Random coefficients for (α, β, γ)
 - Unobserved household heterogeneity in mobility propensity and in push and pull effects of z
 - i.e. propensity to choose r over s varies between households according to importance of z
 - Relaxes 'independence of irrelevant alternatives' assumption

Handling large choice sets

Let R_{it} be number of neighbourhoods in choice set for household i at year t .

- Analysis file has R_{it} records for each household-wave
- Without restriction on choice set $R_{it} = 32,000!$
- Two approaches to handle large choice set:
 - Restrict to areas in travel-to-work area at $t - 1$
 - Use random subset of choice set and weight by inverse selection probability

Efficient estimation in Stat-JR software

Stat-JR: TREE Start again Dataset + **imd_dist_808** Template + **code1logitortbq23** **Ready (14)** Settings

Observation ID: `pwind` [remove](#)

Individual ID: `pid` [remove](#)

Choice ID: `area` [remove](#)

Do you want choice level random effects? Yes [remove](#)

Response variable: `y` [remove](#)

Do you want individual level random effects? Yes [remove](#)

Variables random at both the individual level and fixed: `d_d_imd_nd_imd_nd_0ls` [remove](#)

Do you want them to be correlated? Yes [remove](#)

Do you want any predictors that are fixed but not random? Yes [remove](#)

Predictor variables not random at individual level:

```
pid
wave
area
pwind
logq2
y
d
d_imd
d_sgnochf_imd
d_sgnochm_imd
d_sgch_imd
d_cpch04_imd
d_cpch510_imd
d_cpch1115_imd
d_cpch16p_imd
d_prent_imd
d_srent_imd
d_frent_imd
d_lmic_imd
d_birh_imd
d_rent_own_imd
d_f_othrent_imd
```

<http://www.bristol.ac.uk/cmm/software/statjr/>

Data

Area characteristics

- Index of Multiple **Deprivation** at LSOA level
- **Distance** (km) between current LSOA and each potential LSOA (pull effect only)

Individual-level data

- British Household Panel Survey, 1998–2008
- Individuals age 18–59 at year t
- Only one record retained for intact couples at $t - 1$ and t
- Household characteristics and events: Income, household type, tenure, change in tenure, birth

Main effects of deprivation and distance

	Coeff.*	95% CI
Push: Deprivation (β)	0.301	(0.121, 0.482)
Pull: Deprivation (γ_1)	-0.699	(-0.839, -0.566)
Pull: Distance (γ_2)	-0.642	(-0.681, -0.604)

- **Push:** Effect of 1 SD \uparrow in deprivation in current area on moving out
- **Pull:** Effect of 1 SD \uparrow in deprivation in potential area (1km \uparrow in distance from current area) on moving there

*Effects are for reference categories of x : childless couple, homeowners, mean log income, no birth or tenure transition between $t - 1$ and t .

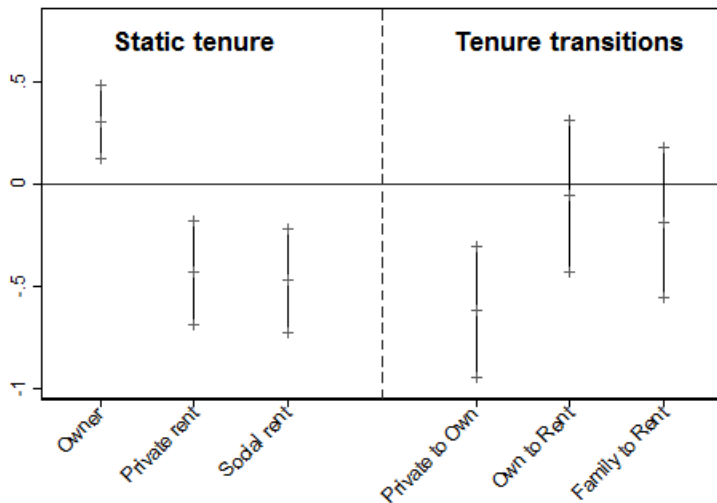
Deprivation and distance effects by household income

Pull: Deprivation

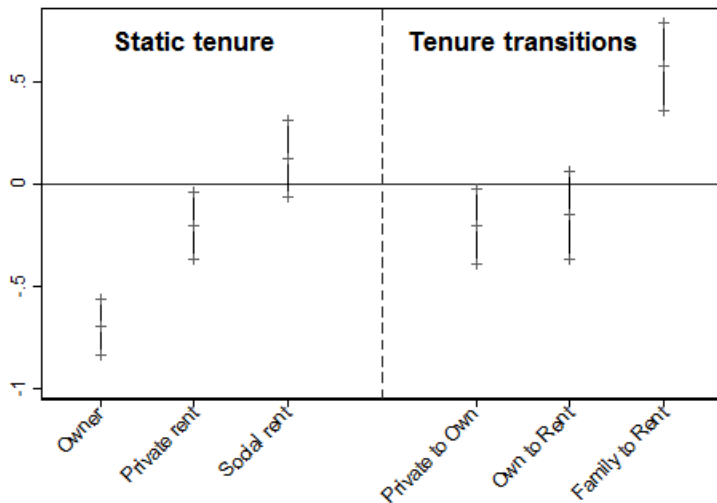
	Coeff.	95% CI
Reference group (incl. mean income)	-0.699	(-0.839, -0.566)
Log(income)	-0.044	(-0.068, -0.020)

- Income strengthens aversion to deprivation when choosing a new area
- No impact of income on either push effect of deprivation or effect of distance from current neighbourhood

Push effects of deprivation by housing tenure at $t - 1$ and t



Pull effects of deprivation by housing tenure at $t - 1$ and t



Push/pull effects of deprivation by household type and recent birth

- **Household type**

- Weaker push effect of deprivation for single parents than for other household types
- Aversion to deprivation when choosing new area is weaker among couples with older children

- **Birth between $t - 1$ and t**

- Strengthens push effect of deprivation
- BUT also weakens aversion to deprivation when choosing new area

Summary of differential pull effects of distance

- **Household type.** Distance from current area most important for single parents and couples with school-age children
- **Tenure.** Distance has weaker effect among private renters (moving within rental sector)
- **Tenure change.** Distance less important for households whose move coincides with tenure change

Some directions for future research

- Consider other area characteristics (e.g. crime, barriers to housing and services, school quality)
- Which area characteristics matter for location choice of specific groups, e.g. families?
- Focus on differences by SES in relative importance of area characteristics: constraints vs. choice

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