Land-Use Patterns and Commuting in Cork

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Big Picture

- OECD (2022) highlight how Ireland's transport infrastructure and network design is incompatible with goals to reduce car-use, as current arrangements have created "attractiveness traps" for sustainable modes.
  - Rising car-use, stagnating transit uptake, declining active travel … since 1986

- Travel behaviour is known to be influenced by numerous characteristics, a majority of which lie within policymakers remit:
  1. Explicit Costs – the €€€ associated with particular modes;
  2. Implicit Costs – variables like distance, convenience, and feasibility…

Literature and Theory

- *Alonso's monocentric model* sets the scene as a region characterised by a singular Central Business District surrounded by concentric rings of decreasing density and land-use intensity.
  - Populations disperse as distances from urban centres increase (increasing travel costs).

- *Hagerstrand's time-space geography* emphasizes how temporal constraints (as influenced by regional spatial structures) shape individual behaviours.
  - *Jacobs* emphasized the role of urban planning in influencing the travel requirements, and subsequent behaviours, of individuals.

- *Cervero* and *Kockelman, (1997)* put forward the **Three D's** as a framework for assessing the relationship between land-use patterns and travel.

The Core Idea (Ewing and Cervero, 2010)

› Town/Region A:

- High settlement densities and compact;
- High levels of land-use mixing and diversity;
- Multi-modal public transport infrastructure;
- Comprehensive active transport network

› Town/Region B:

- Low settlement densities and spatially dispersed settlements;
- High levels of land-use segregation;
- Uni-modal public transport infrastructure;
- Scattered/Sparse active transport network

Data

- 2022 Irish Census Small Area Population Statistics.
  - Aggregated individual-level socio-demographic and travel behaviour data.

- 2018 Urban Atlas and 2022 OpenStreetMap
  - Land-Use Patterns, Transport Infrastructure, Public Transport nodes.

- Dependent Variable: % of individuals travelling by X mode
  - **Socio-Demographics:** % of minorities; % of professional employees; % of single adults
  - **Travel-Specific:** % of households with 0 cars; % of individuals who commute < 15 mins;
  - **Geography:** relative entropy; transit connectivity; building density; local connectivity

Zooming in: Spatial Data

- Transport Infrastructure:
  - *Transcount* = the no. of access nodes present in each SA.

- Land-Use (The Three D's):
  - *Building* ***Density*** per SA.
  - *Land-Use* ***Diversity:*** $E_j = (-1) \cdot \sum_{j=1}^{k \geq 2} \frac{P_{kj} \cdot \ln(P_{kj})}{\ln(K)}$
  - *Area* ***Design*** = Mean distance from centroid to nearest 5 retail/leisure amenities.

Methods

- Four Spatial Durbin Models which takes the following functional form:

$$y_i = \delta W y_i + \beta x'_i + \gamma W X_i + \epsilon_i$$

- *y* is suspected to be influenced by neighbouring values of y and x (indirect effects) as well as influenced by values of x in the same area (direct effects).

- Model is tested using three distinct spatial weight matrices (all row standardised):
  1. *Queen Contiguity (Benchmark)*
  2. *Minimum Distance Thresholds (Qualitatively similar results)*
  3. *Tobler/Gravity Weights (Partial Disagreement)*

Dependent Variable = % of Walkers			
Variable	**Direct Impact**	**Indirect Impact**	**Total Impact**
perc_minority	-0.042**	0.139***	0.096***
promanagertech_perc	0.001	0.119***	0.120***
singleadult_perc	0.020	0.153***	0.173***
u15mins_perc	0.067***	0.118***	0.185***
X_0cars_perc	0.219***	0.203***	0.422***
urban	0.001	-0.010	-0.009
suburban	0.002	-0.025***	-0.023***
entropy	-0.001	0.048***	0.047***
transcount	0.001	-0.001	-0.000
building_density	-0.012	0.062	0.050
mean_dist_logged	0.001	0.001	0.002

› Partially align with (W)OLS results:

1. Lower levels of ownership associated with greater walking;
2. Spillover effects appear more powerful than direct effects.
3. Neighbours with high mixing induce greater walking;
4. Other BE variables lose significance

Dependent Variable = % of cyclists			
Variable	**Direct Impact**	**Indirect Impact**	**Total Impact**
perc_minority	-0.000	-0.053***	-0.053***
promanagertech_perc	0.022***	0.048***	0.071***
singleadult_perc	0.009	0.071***	0.081***
u15mins_perc	-0.010	-0.006	-0.016***
X_0cars_perc	0.014**	0.022**	0.036***
urban	0.001	0.005**	0.006***
suburban	0.001	0.011***	0.012***
entropy	0.003	0.004	0.007**
transcount	-0.001**	-0.001	-0.001**
building_density	-0.022**	0.064***	0.042***
mean_dist_logged	0.000	0.001	0.001

- Disagree with (W)OLS results:

1. Greater building density reduces cycling levels, but being surrounded by higher densities increases it (?);
2. Not living in rural areas is helpful;
3. Fewer cars per house induces more cycling.

Dependent Variable = % of transit users			
Variable	**Direct Impact**	**Indirect Impact**	**Total Impact**
perc_minority	0.030**	0.031	0.061***
promanagertech_perc	0.004	-0.016	-0.013
singleadult_perc	0.054***	-0.053***	0.001
u15mins_perc	-0.008	-0.097***	-0.105***
X_0cars_perc	0.126***	0.010	0.136***
urban	0.001	0.017***	0.018***
suburban	0.000	0.022***	0.022***
entropy	-0.002	0.031***	0.028***
transcount	-0.000	-0.001	-0.000
building_density	0.025	0.121***	0.146***
mean_dist_logged	0.000	0.001	0.001

- Partially align with (W)OLS results:

1. Fewer cars = more transit users;
2. Not living *around* rural areas is helpful;
3. Living *around* areas with high building densities and land-use mixing is helpful.
4. Spillovers appear important for influencing transit use.

Dependent Variable = % of car commuters			
Variable	**Direct Impact**	**Indirect Impact**	**Total Impact**
perc_minority	-0.249***	-0.052	-0.301***
promanagertech_perc	-0.035	-0.268***	-0.303***
singleadult_perc	-0.164***	-0.300***	-0.464***
u15mins_perc	0.068**	0.068**	0.135***
X_0cars_perc	-0.274***	-0.367***	-0.641***
urban	0.028***	0.060***	0.088***
suburban	0.024***	0.028***	0.052***
entropy	-0.021**	-0.071***	-0.092***
transcount	-0.001***	-0.001**	-0.002***
building_density	-0.055*	-0.310***	-0.255***
mean_dist_logged	0.002	0.002	0.003*

- Aligns with (W)OLS results:

1. Less cars per house and shorter commutes = less car-use;
2. Higher land-use mixing and higher building densities = less car-use;
3. Better connectivity = less car-use

Relevance To Policymakers

- Evidence persistently indicates that reducing the implicit costs of public and active transport stimulates increased public and active transport use.
  - It is not necessarily about making cars *more expensive to use*, as this can have undesirable distributional effects. It is more so about making other modes “better”.

- When people are not required to travel far, when people are able to live, work, and avail of amenities locally, their travel options become more flexible, something evidenced in aggregate behaviours.

- Strong spillover effects speak to the fact that travel behaviours depend on more factors than simply, the residential environment (O’Driscoll *et al.,* 2023b).

Conclusion and Next Steps

- Origin-Destination Connections allow researchers to identify key travel corridors, hubs, while also allowing for the identification of travel routes.
  1. Do particular geographies, cohorts, or OD-clusters face different mode-specific costs?
  2. The relationship between cost, distance, and mode use (Credit and O'Driscoll, X).

- Travel behaviours do not constitute a single decision. They change according to life circumstances and external stimuli, providing unique opportunities to detangle the web connecting socio-demographic and built environment variables.
  1. The role of infrastructure development in stimulating behavioural change?
  2. The role of changing landscape characteristics in stimulating behavioural change? (O'Driscoll, X)
  3. The role of changing life/work circumstances in stimulating behavioural change?

Thank you for listening ☺

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References

1. Cervero, R., and Kockelman, K. (1997). Travel demand and the 3Ds: Density, diversity, and design. Transportation Research Part D: Transport and Environment, 2(3), 199-219. https://doi.org/10.1016/S1361-9209(97)00009-6.
2. Ewing, R., & Cervero, R. (2010). Travel and the built environment a meta-analysis. Journal of the American Planning Association,76(3), 265–294. https://doi.org/10.1080/01944361003766766.
3. Gim, T. H. T. (2012). A meta-analysis of the relationship between density and travel behavior. Transportation, 39(3), 491–519. https://doi.org/10.1007/s11116-011-9373-6.
4. Nolan, A. A dynamic analysis of household car ownership. (2010). Transportation Research Part A: Policy and Practice, 44(6), 446-455. https://doi.org/10.1016/j.tra.2010.03.018.
5. O'Driscoll, C., Crowley, F., Doran, J., & McCarthy, N. (2023a). Land-use mixing in Irish cities: Implications for sustainable development. Land Use Policy, 128(5), 1–7. https://doi.org/10.1016/j.landusepol.2023.106615.
6. OECD. (2022). Redesigning Ireland's Transport for Net Zero. Paris: OECD. doi: 10.1787/b798a4c1-en.

References

7. O'Driscoll, C., Crowley, F., Doran, J., & McCarthy, N. (2023b). How the relationship between socio-demo-graphics, residential environments and travel influence commuter choices. Regional Studies, 30, 1–18. http:// doi.org/10.1080/00343404.2023.2199779.
8. O'Driscoll, C., Crowley, F., Doran, J., & McCarthy, N. (2023c). Measuring land-use mixing across the Republic of Ireland: source data comparisons. Journal of Maps, 19(1), 1-7. https://doi.org/10.1080/17445647.2023.2214165.
9. O'Riordan, V., Rogan, F., Ó Gallachóir, B., Mac Uidhir, T., & Daly, H. (2022). How and why we travel – Mobility demand and emissions from passenger transport. Transportation Research Part D: Transport and Environment,104,1–16. https://doi.org/10.1016/j.trd.2022.103195.
10. Reynolds-Feighan, A. (2003). Accessibility, transportation, infra-structure planning, and Irish regional policy: Issues and dilemmas. In E. O'Leary (Ed.),Irish regional development: A new agenda, 163–177.
11. Vega, A., & Reynolds-Feighan, A. (2008). Employment sub-centres and travel-to-work mode choice in the Dublin region. Urban Studies,45(9), 1747–1768. https://doi.org/10.1177/0042098008093377.
12. Vega, A., & Reynolds-Feighan, A. (2009). A methodological framework for the study of residential location and travel-to-work mode choice under central and suburban employment destination patterns. Transportation Research Part A: Policy and Practice, 43(4), 401–419. https://doi.org/10.1016/j.tra.2008.11.011.