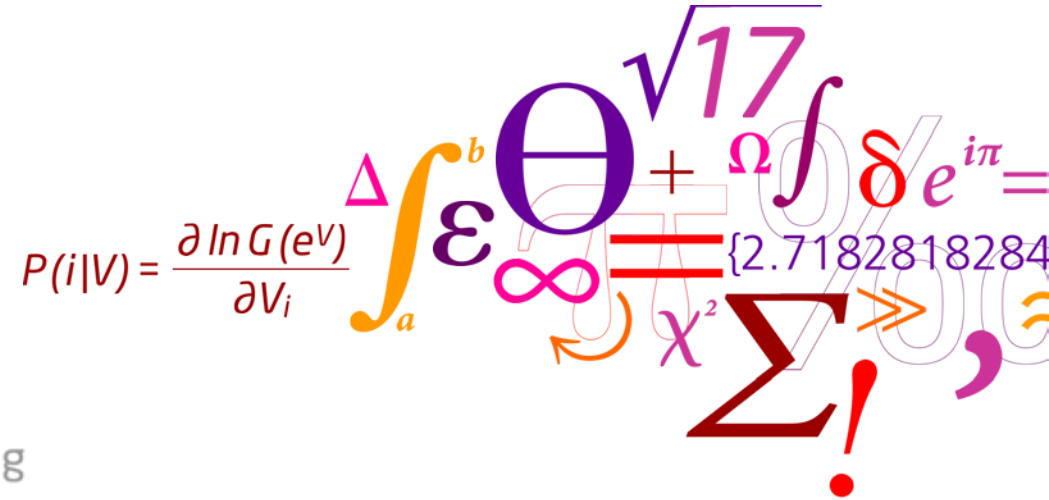
Location choice including intervening opportunities

Stefan E. Mabit,
Technical University of Denmark

ITM 2018



DTU Management Engineering
Department of Management Engineering

Outline

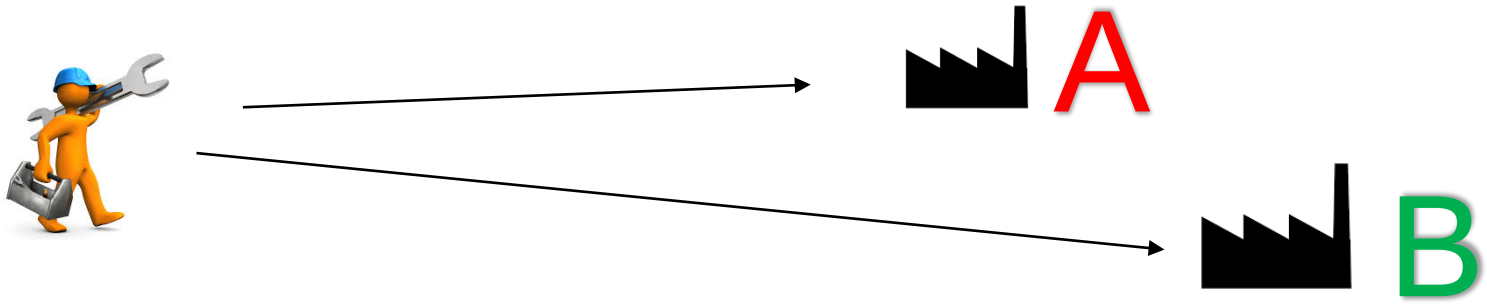
- Focus
- Theoretical considerations
- Data
- Modelling
- Discussion
- Conclusions and future work

Focus

- In a classical model, e.g. a gravity model it is a distance measure that controls the distribution of work locations.

- I analyse the effect of intervening opportunities. So what is an intervening opportunity?

- Consider a worker – looking for a work location



- In an intervening opportunity model, the distribution is driven by the amount of opportunities closer to a worker than a specific work location.

Theoretical considerations

- The gravity model

$$P(j|i) \propto m_j f(d_{ij})$$

where m_j is the pop/jobs in zone j.

- A classical version of the intervening opportunity model (Schneider, 1959) is given by

$$P(j|i) = e^{-\gamma s_{ij}} - e^{-\gamma(s_{ij}+m_j)}$$

where s_{ij} is the number of opportunities closer to i than j

- Recently, the radiation model (Simini et al. (2012), which is also based on intervening opportunities, has been suggested

$$P(j|i) = \frac{m_i\, m_j}{(m_i + s_{ij})(m_i + m_j + s_{ij})}$$

Theoretical considerations

- In transport planning, we tend to apply the gravity model or an aggregate logit model for aggregate modelling.

- If data are available at the disaggregate level, we tend to apply either a logit or a nested logit model.

- All of these are based on distance measures, e.g. network distance or a logsum.

- Consider a standard logit model for destination choice

$$P(j|i) = \frac{e^{V_j}}{\sum e^{V_k}}$$

- Here I investigate the inclusion of intervening jobs into that specification, i.e. $V_j = \beta' x + f(s_{ij})$.

Data

- I use data from the national Danish travel survey, TU.

- I tested both the context of a national travel distribution for all of Denmark and within a metropolitan area, i.e. the Greater Copenhagen Area, GCA.

Data on Denmark and the GCA

- The two areas are described (in 2010) by the following aggregate statistics

Variable	DK	GCA
Pop (millions)	5.5	1.8
Jobs (millions)	2.6	1.0
Area (sq. mi.)	16598	969
Zones	907	258
Sample sizes	54737	17668

- For both areas, I use 80% of the data for estimation and 20% for validation.

Modelling

- We set up a logit model. Based on the functional form of the radiation model, we enter the invervening opportunity variable in logs in the utility function. Concerning distance the ln(exp) form of a logsum support that it enters utility linearly but there are results, e.g. Carro et al. (2016), that support a power-law relationship between distance and distribution, i.e. distance should enter utility as ln(distance).

- The gives two base models with systematic utilities

$$V_j = \beta_1 * \ln(Jobs_j) + \beta' * \mathrm{x_j} + \beta_k * dist_k$$

$$V_j = \beta_1 * \ln(Jobs_j) + \beta' * \mathrm{x_j} + \beta_k * \ln(dist_k)$$

- To both of these we then add the variable $\ln(IntJobs_j)$ to capture the effect of intervening jobs.

A look at correlations

- The correlation within the data for all of DK for the two impedance measures

Variable	1	2	3	4
1) IntJobs	1	0.87	0.80	0.78
2) Dist	0.67	1	0.70	0.89
3) Ln(IntJobs)	0.75	0.48	1	0.79
4) Ln(dist)	0.69	0.92	0.62	1

Model estimation

- The two models motivated by theory give the following estimates

Variable	Estimate	z stat.	Estimate	z stat.
Ln(Jobs)	0.95	174	0.93	172
Pop/Area	-0.03	-18	-0.08	-49
Central Cph.	-0.02	-1	0.08	4
Home zone	-0.61	-20	-2.39	-87
Home mun.	0.91	70	0.82	61
Ln(IntJobs)	-0.17	-53	-0.17	-49
Distance/10	-0.42	-215		
Ln(dist)			-1.30	-148
LL at conv.		-215582		-228267
LL val. sam.		-53806		-57097

Discussion of the model

- I also tested the two other ln/lin combinations of dist and Intjobs. The models fit worse to the data but the coefficient on intervening opportunities was again significant.

- The models are validated using the 20% holdout sample. The results show that the model fits in the hold-out sample have the same pattern as for the estimation sample.

- Results for the capital region, GCA, are similar. But the effect of intervening jobs drops in size and significance. It is -0.07 (15.3) in the preferred model.

Conclusion

- The results show that there could be a potential of both including some distance measure and some intervening opportunity measure in a distribution model.

- Next, I will try to confirm this on other countries.

- An issue with the suggested model is that we loose the behavioural theory underlying RUM-based choice models. So a future task is to find a behavioural model that nests both the RUM-based logit model and a model that includes intervening opportunities.

- The literature shows that transport researchers looked at these issues at the aggregate level in the 80s. It seems to have stopped while other fields have keept on analysing the effect of intervening opportunities.

Thank you for your attention

Questions?

Literature

- Carro et al. (2016) Modelling the relationship between income and commuting distance.

- Lenormand, M., Bassolas, A., and Ramasco, J.J. (2016) “Systematic comparison of trip distribution laws and models”, Journal of Transport Geography 51, pp. 158-169.

- Schneider, M. (1959) Gravity models and trip distribution theory.

- Simini, F., Gonzalez, M.C., Martian, A. Barabasi, A.L. (2012) A universal model for mobility and migration patterns. Nature 484, pp. 96-100.

- Stouffer, S.A. (1940)”Intervening opportunities: a theory relating mobility and distance”, Am. Sociol. Rev. 5, pp. 845-867.