DYNAMIC MODELLING APPROACHES AND EMPIRICAL EVIDENCE

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Why Dynamic Modelling?

Response to changes in transport supply, prices, policy and socio-economic factors is not instantaneous but occurs over time

Adjustment possibilities limited in the short run

- costs of adjustment
- imperfect information & expectations
- current circumstances & commitments
- habit & resistance to change

Greater flexibility in the long run, so the response will build up over time

Long-run effects > short-run effects

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Advantages of Dynamic Modelling

- describes *changes* in travel behaviour
- captures both short- & long-run relationships
- gives information about the time scale of effects
- can analyse effects of factors which vary little at one point in time - e.g. prices
- can accommodate asymmetry, the influence of habit, or expectations

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Dynamic Modelling Approaches

Basic requirements:

- model must relate current demand to past or future values of explanatory variables

Commonly used models:

- Partial adjustment model: relates demand to explanatory variables and demand in previous period
- Error-correction model: relates change in demand to changes in explanatory variables and levels of all variables in previous period

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Partial Adjustment Model

Long-run (desired) demand: $Q_t^* = \beta X_t$

Assume: a proportion (δ) of the difference between actual and desired demand is closed each period

$$Q_t - Q_{t-1} = \delta\,(Q_t^* - Q_{t-1})$$

Solving for Q_t and substituting for long-run demand

$$Q_t = \delta\beta X_t + (1-\delta)\,Q_{t-1}$$

Short-run effect $\delta\beta$

Long-run effect β

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Error Correction Model

Long-run demand: $Q_t^* = \beta X_t$

Assume: change in Q depends on change in X (impact effect) and the deviation from equilibrium in the previous period (error correction mechanism)

$$Q_t - Q_{t-1} = \gamma(X_t - X_{t-1}) + \phi\,(Q_{t-1} - Q_{t-1}^*)$$

Substituting for long-run demand

$$Q_t - Q_{t-1} = \gamma(X_t - X_{t-1}) + \phi\,Q_{t-1} - \phi\beta X_{t-1})$$

Short-run effect γ

Long-run effect β

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Choice of Model

Partial adjustment model:

- requires stationary variables, otherwise estimates inconsistent
- the response to all variables has the same lag structure

Error correction model:

- does not require stationary variables
- more general lag structure

In many cases, little difference between PAM & ECM

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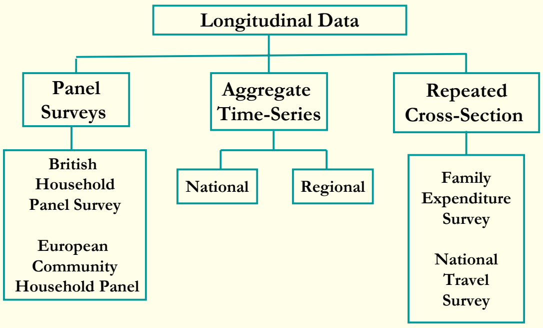
Data for Dynamic Transport Modelling



Empirical Evidence

Aggregate time-series (pooled cs-ts data)

demand for local bus services

Repeated cross-section data (pseudo-panel)

car ownership

Panel data

choice of commuting mode

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Local Bus Travel - Data

STATS100A - bus operator data provided to DfT
- vehicle miles, passenger journeys & receipts
- aggregated into 46 English counties
- 10 years: 1987 to 1996

Regional Statistics
- population
- disposable income

National Statistics
- motoring costs
- retail prices

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Local Bus Travel: Model

- Pooled cross-section time-series model
- Dependent variable: bus journeys per capita
- Independent variables:
  - income per capita
  - service: bus kms per capita
  - bus fare: passenger receipts per journey
  - motoring costs
- Dynamics
  - PAM (ECM also used, results similar)
- County specific fixed effects

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Local Bus Travel: Estimated Elasticities

	SR	LR
Income	-0.39	-0.82
Fare	-0.33	-0.68
Motoring costs	0.32	0.66
Service (VKm)	0.49	1.03
Time for 95% of LR effect	4.5 years	

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Car Ownership - Data

Family Expenditure Survey
- cars, socio-economic & demographic variables
- 14 years: 1982 to 1995
- 16 cohorts by year of birth of household head in 5-year bands

National Statistics
- car purchase costs
- car running costs
- public transport fares
- retail prices

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Car Ownership: Model

- Pseudo-panel model
- Dependent variable: cars per HH (cohort mean)
- Independent variables:
  - household income (cohort mean)
  - number of adults & children (cohort mean)
  - % in rural/urban areas (cohort mean)
  - car purchase & running costs
  - public transport fares
- Dynamics: PAM
- Weighting: observations in each cohort-year
- Random effects & autocorrelated errors

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Car Ownership: Estimated Elasticities

elasticities calculated at middle income

	SR	LR
Income	0.24	0.65
Car purchase costs	-0.12	-0.33
Car running costs	-0.19	-0.51
Public transport fares(VKm)	(0.09)	(0.24)
Time for 95% of LR effect	6.3 years	

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Commuting Mode - Data

British Household Panel Survey
- individuals who travel to work in at least 2 consecutive years
- 11 years: 1991 to 2001
- over 37000 observations
- 10000 individuals
- average of 4 years per individual

National Statistics
- car purchase prices
- fuel prices
- retail prices

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Commuting Mode: Model

- Binary Probit model
- Dependent variable = 1 if car; = 0 otherwise
- Independent variables:
  - socio-economic & geographic
  - company car
  - car purchase costs & motor-fuel prices
- Differences between men & women
- Dynamics (state dependence)
  - lagged dependent variable
- Unobserved heterogeneity
  - random effects for individuals
- Correction for attrition

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Commuting Mode: Estimated Elasticities

change in probability of commuting by car given a 1 % change in variable

	SR	LR
Income	0.03	0.09
Car purchase costs	-0.20	-0.49
Fuel price	-0.21	-0.52
Time for 95% of LR effect	6 years	

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Conclusions

- Significant dynamic effects in all empirical studies
- Long-run elasticity more than 2x short-run
- Adjustment is slow: 95% of total effect takes between 4 and 6 years
- Use of static elasticity will either under- or over-estimate effects of changes in prices etc at a given point in time
- Forecasts based on static demand model will be inaccurate

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References

Commuting mode

J Dargay: The journey to work: an analysis of mode choice based on panel data, paper presented at the European Transport Conference, Strasbourg, France, October, 2005.

Bus Travel

J Dargay & M Hanly: The Demand for Local Bus Services in England, *Journal of Transport Economics and Policy*, Volume 36, Part 1, January, pp. 73-91, 2002.

Car ownership

J Dargay & P Vythoulkas: Estimation of Dynamic Car Ownership Model: A Pseudo-panel Approach, *Journal of Transport Economics and Policy*, 33(3) pp. 283-302, 1999.

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