An Agent-Based Model of Origin-Destination Estimation (ABODE)

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Matching home and work

• The question of where people work has been a topic of interest for transportation professionals and others

  • The gravity model especially has been the working horse of the profession for a long time

  • While it does lead to reasonable aggregate patterns, it ignores the mechanisms of home-work matching

  • It remains an aggregate model
Matching home and work

• Demand more from our planning models
  • Demand management, emissions control
  • Behavioral realism and sensitivity to different tastes and constraints

• We propose an agent based model that is extensible and also based on the behavioral realities of matching home and work
  • By working at the individual level, the persons characteristics and constraints can be used to paint a more complete picture of their travel patterns
  • Creates room for coherent extensions
The Traditional Approach
Travel time and Information
Travel time, Information, Skills
Travel time, Information, Skills, Wages
Is the way we search important?

- Different search methods bring information together differently.
- How we search can inform what our commute will look like.
ABODE

• Given the location of workers and work places, where do people work?
  • A disaggregate model worker and job matching
    • Agent actions rooted in actual behavior
    • Job Search
    • Skills, wages, commute
    • Screening, bargaining
    • Intuitive
    • Easily extensible
Worker Behavior

- Searchers have incomplete information about labor market
- Cost
- Human Capacity
- Information barriers
- Economic benefits of hiring through referrals
- Neighborhood targeting by employers
Worker Behavior

• Decisions subject to known and pursued alternatives
  • Wages
  • Long term goals
  • Commute
  • Alternatives
    • Stay at current job / stay unemployed ...
Employers Screen

• Objective criteria: Easier to model
  • Skills, education, experience
  • History of conflicts, lateness, job hopping
• Discriminatory practices and biases: More difficult to capture
The model

- Agents
  - Job centers: Geographic locations where firms are located
  - Firms: Institutions that house jobs
  - Jobs: Positions that require employees with particular skills and offer wages in exchange
  - Workers: Agents that trade their skills to wages and have a sensitivity to commute
  - Residences: Locations where workers live
Active Agent Characteristics

• Workers
  • Possess skills
  • Wage requirements
  • Unemployed or employed
  • Search intensity
  • Selection framework among alternative offers
  • Prefer shorter commutes all things equal

• Jobs
  • Skill requirements
  • Offer wages
  • Open or taken
  • Screening procedure
  • Selection framework among qualified applicants
ABODE

Flowchart

• Workers sample from advertised positions
• Decisions can be set to be probabilistic
• Global stopping rule
  • No change in employment for any worker
• 500 iterations
Commute Outcomes from Simplified Models

Case 1

- No skill differentiation
- No wage differentiation
  - Most work in own quadrant
  - No incentives for longer commutes
Tests: Simplified models

Case 1i

No skill differentiation

Wage differentiation

• Wage differentiation leads to longer commutes
Tests: Simplified models

Case III

Skill differentiation

Wages increase with skills but no wage differentiation at a skill level

• To the extent available, workers take positions in their own quadrant

• Longer commutes arise from mismatch of skills and workplaces
Testing model with Minnesota Data

- Subset of 2000 TBI data for Twin Cities used
- Used 805 individuals that were:
  - Single earner and had only one job
  - had a geocoded home and employment site
  - had reported education level
Testing model with Data

- Modifications to the basic model
- Skills replaced by education level
- Starting asking and offer wages taken as a percentage of actual wages
Simulation results

- Distance comparisons
- Reasonable overall commute distribution
- Underestimates very close distances
  - Some of this may be due to relocation effects which are not explicitly modeled in ABODE
Simulation results

Wage comparisons

• Lower and higher end wages more in line with observed wages

• Not very well matched at the middle of the wage range

• Relationship between education and wages in the TBI is limited.
Summary

- Using a toy urban area we show that the model leads to reasonable outcomes
  - Agents select the closest work place when wage and skill differentiation is absent.
  - Relaxing these assumptions increases the observed commute.
  - Wage dispersion increases the average home to work distance significantly.
Summary

• Using Minnesota data, the commute results on aggregate capture the trends in the observed data.

• Illustrate that the behavior rules as implemented lead to reasonable patterns.

• But weaknesses were present in replicating the income data.

• In part this weaknesses is the result of using data collected to be used in a traditional gravity model.

• Did not include details on the job seeker and employment opportunities that are key to the current model.
Try out the model

• http://street.umn.edu/ABODE.html
Thank you!