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

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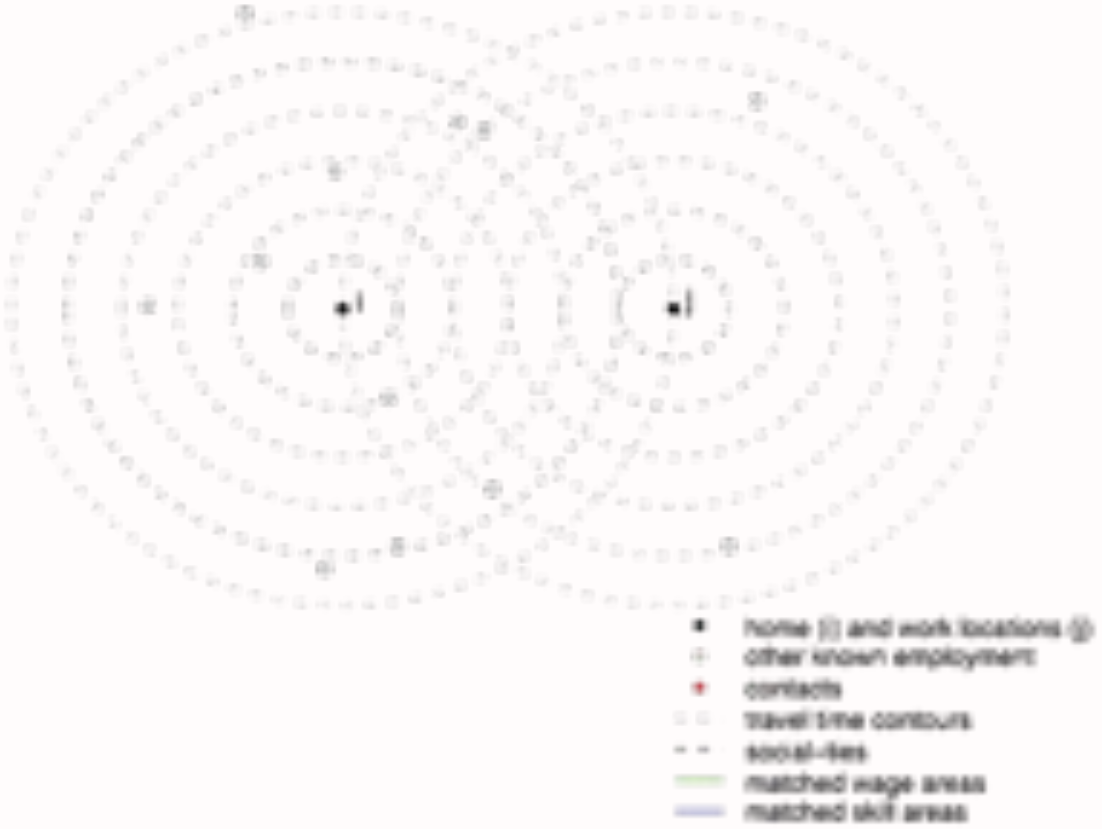
Matching home and work

- 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

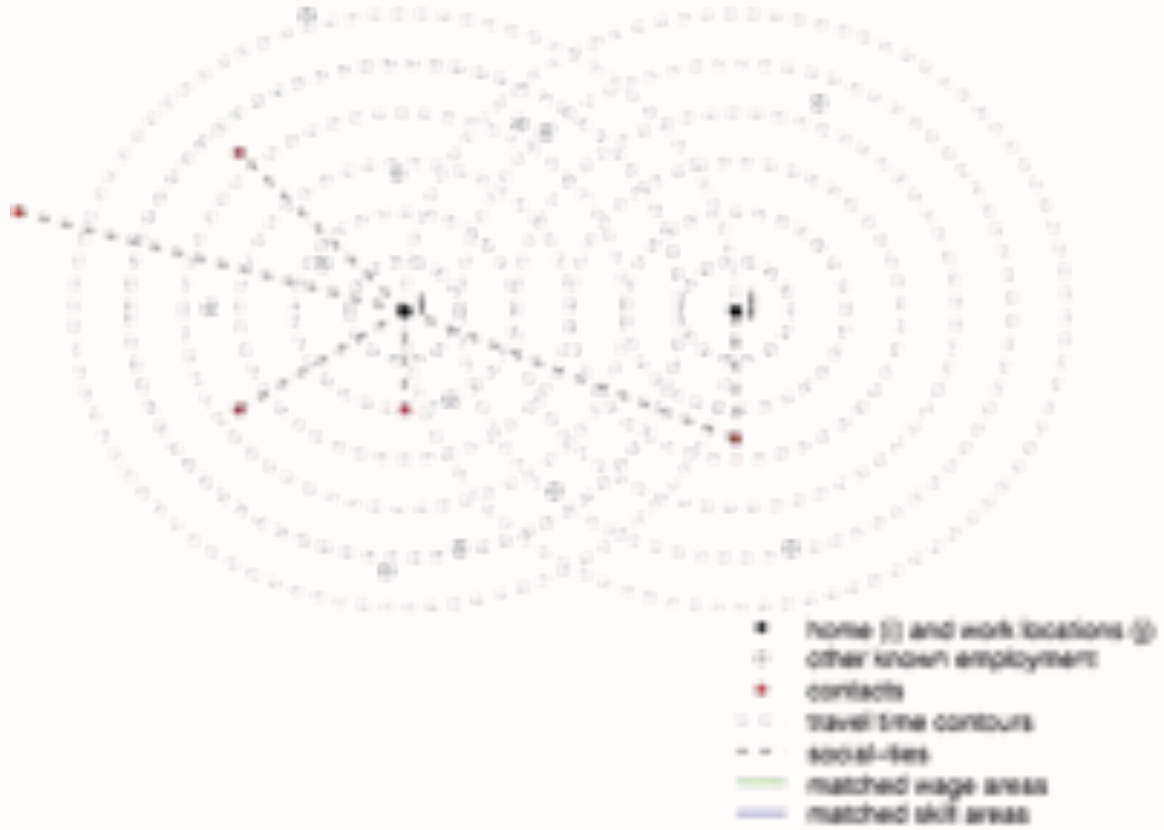
Matching home and work

- 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

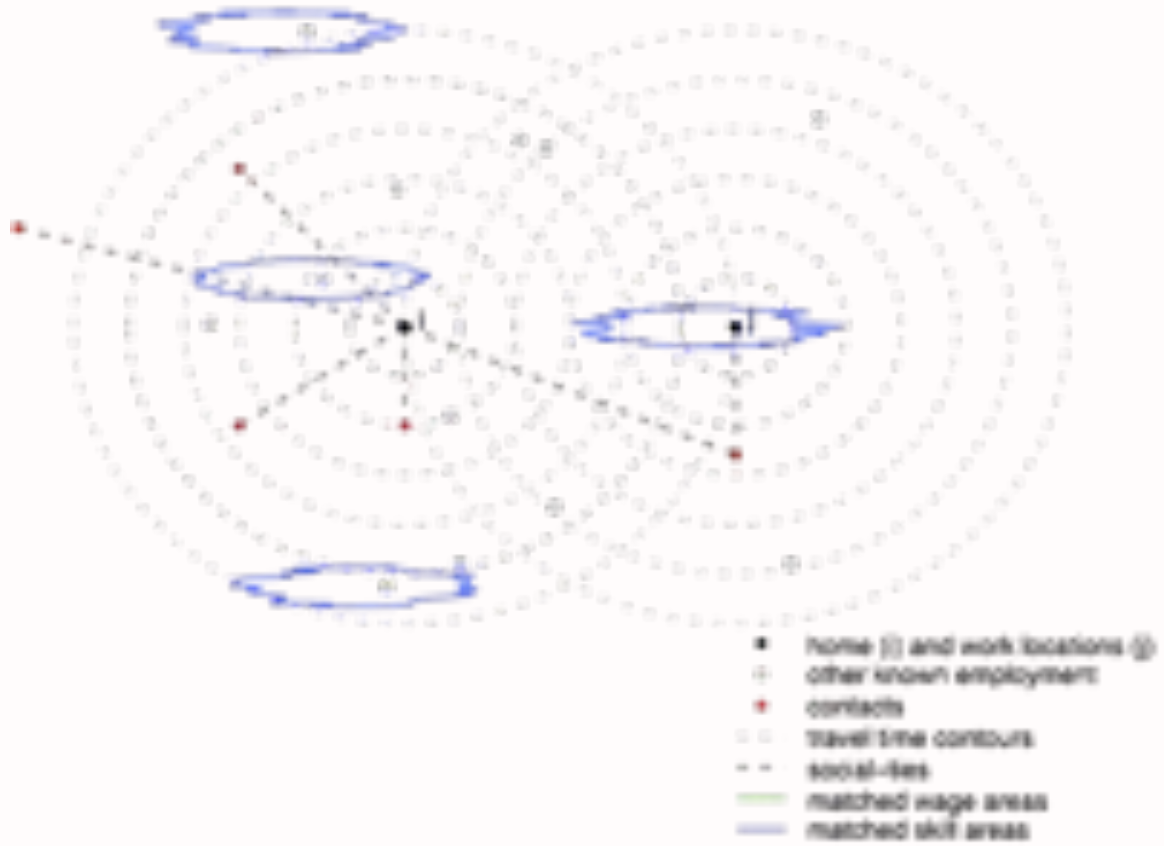
The Traditional Approach



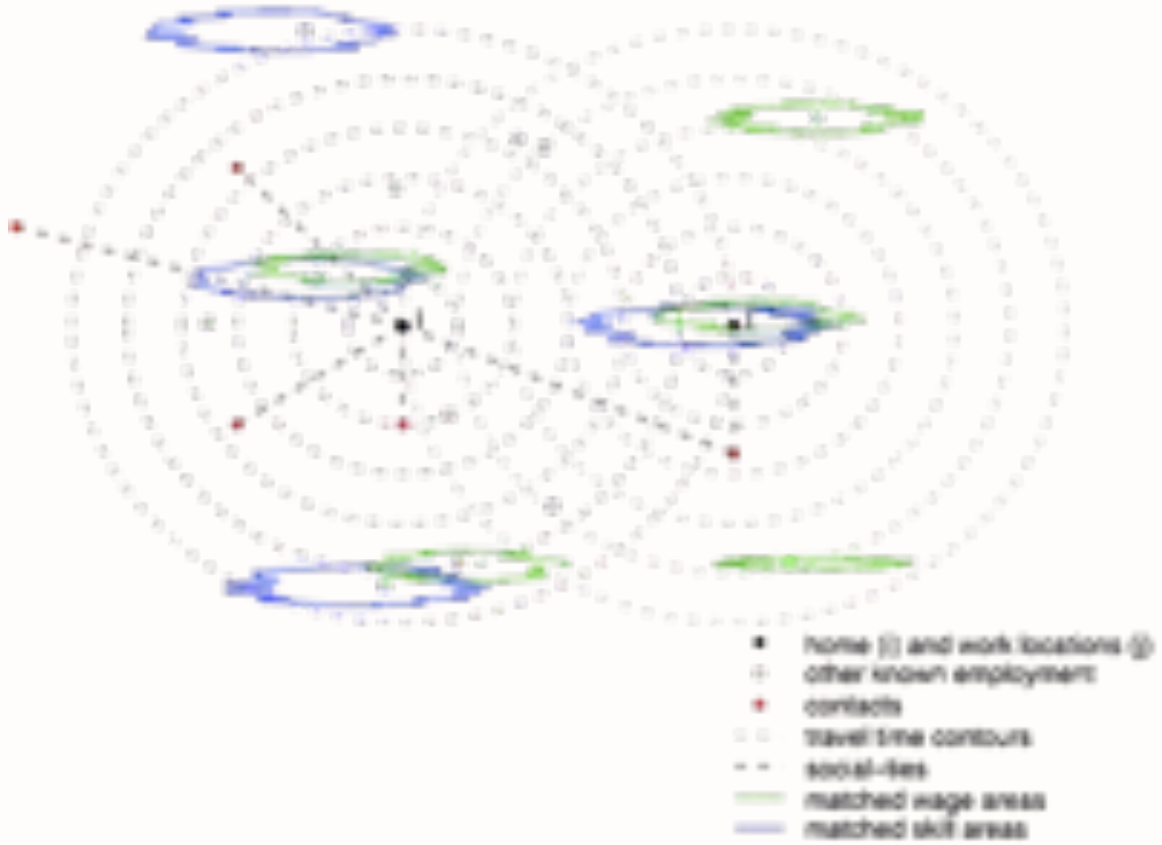
Travel time and Information



Travel time, Information, Skills

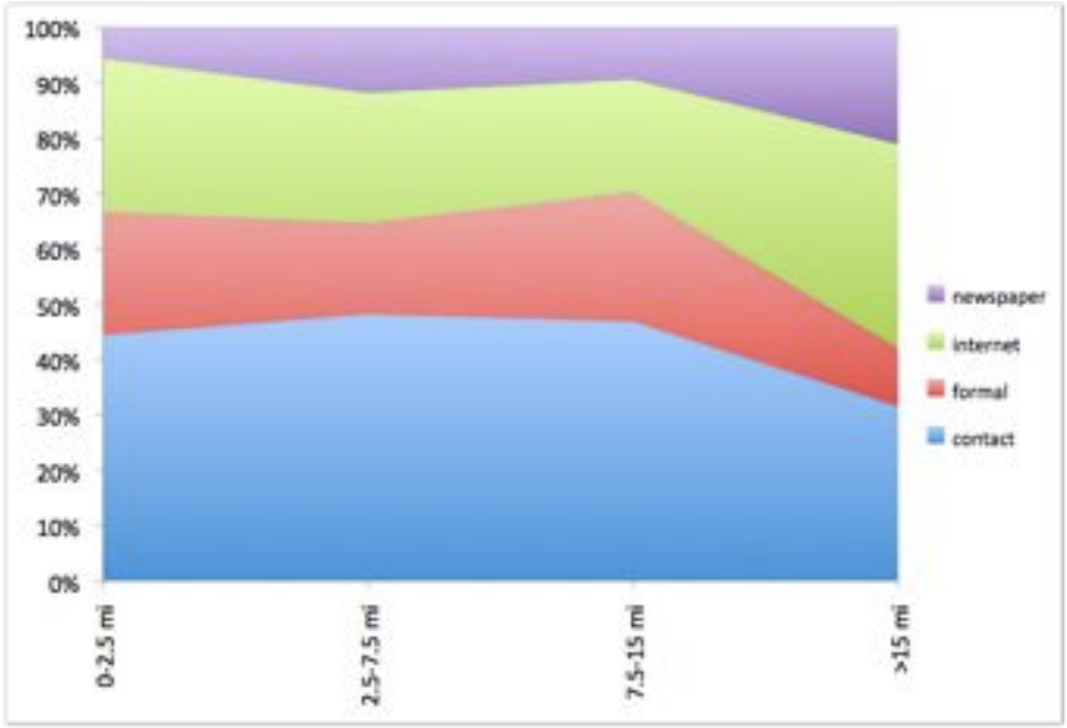


Travel time, Information, Skills,Wages



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 thier 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

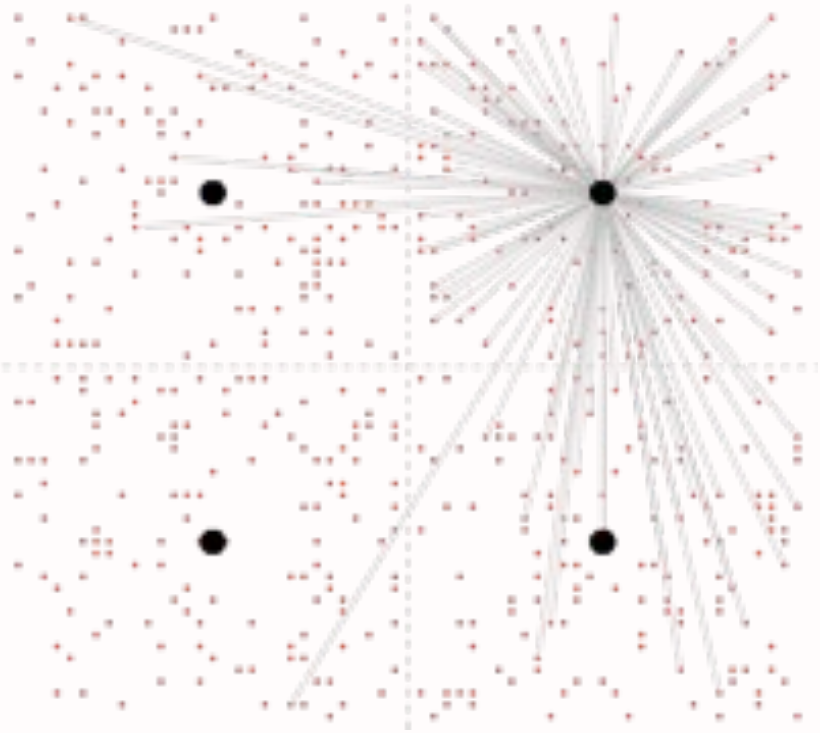
- Workers sample from advertised positions
- Decisions can be set to be probabilistic
- Global stopping rule
  - No change in employment for any worker
  - 500 iterations

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 1l

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

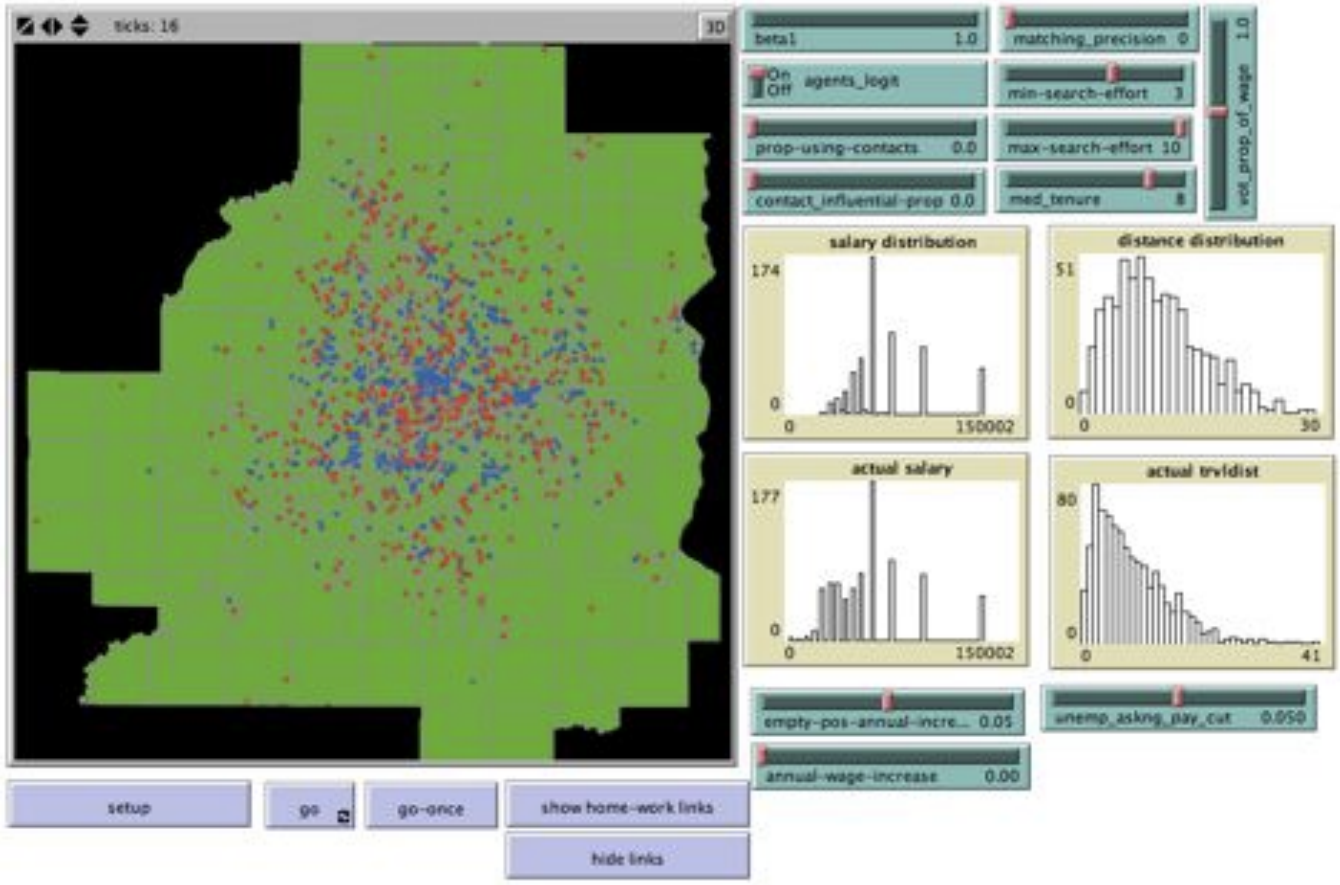
- To the extent available, workers take positions in their own quadrant
- Longer commutes arise from mismatch of skills and workplaces

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

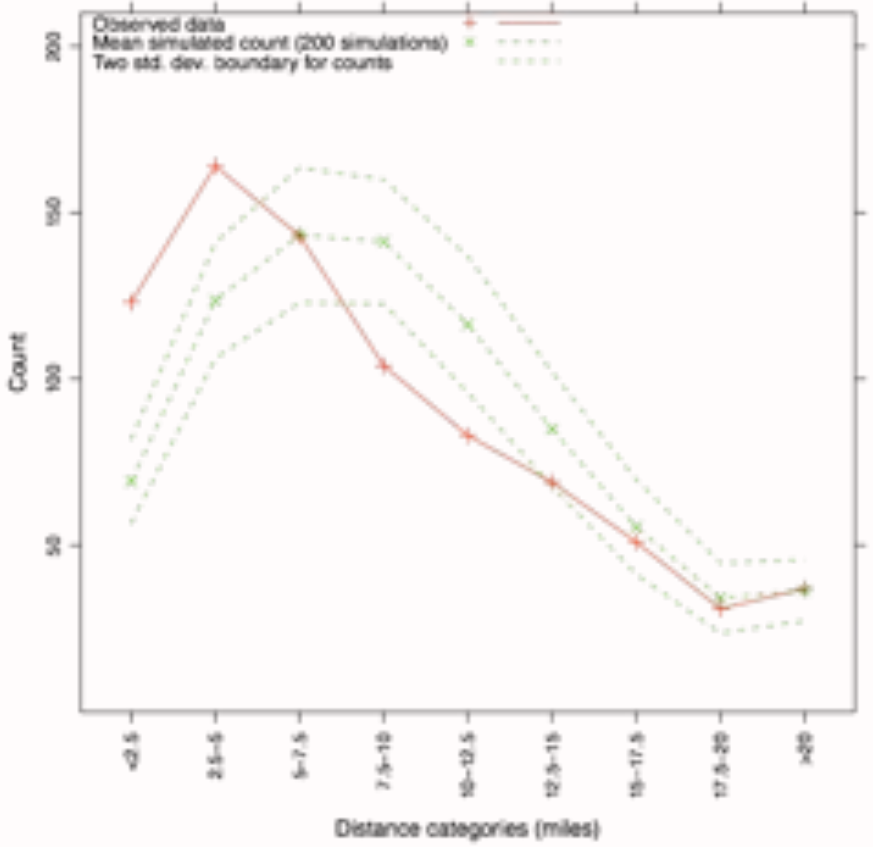


Simulation results

- **Distance comparisons**

- Reasonable overall commute distribution

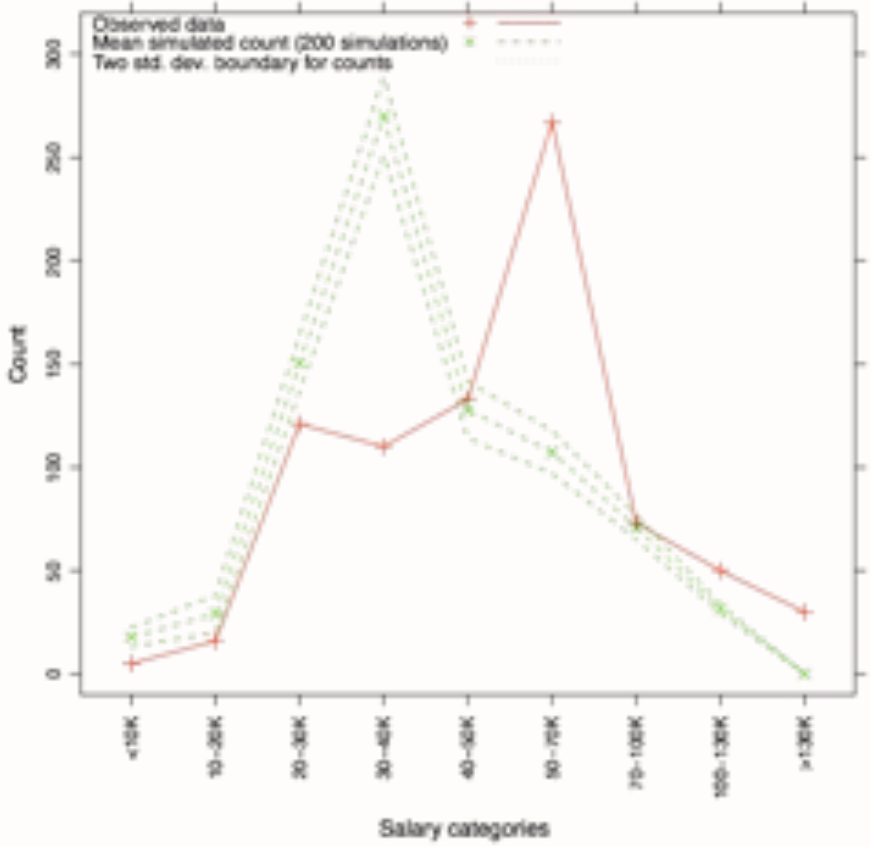
- Underestimates very close distances
  - Some of this may be due to relocation effects which are not explicitly modeled in ABODE



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!