Modeling Household Residential Choice Behavior

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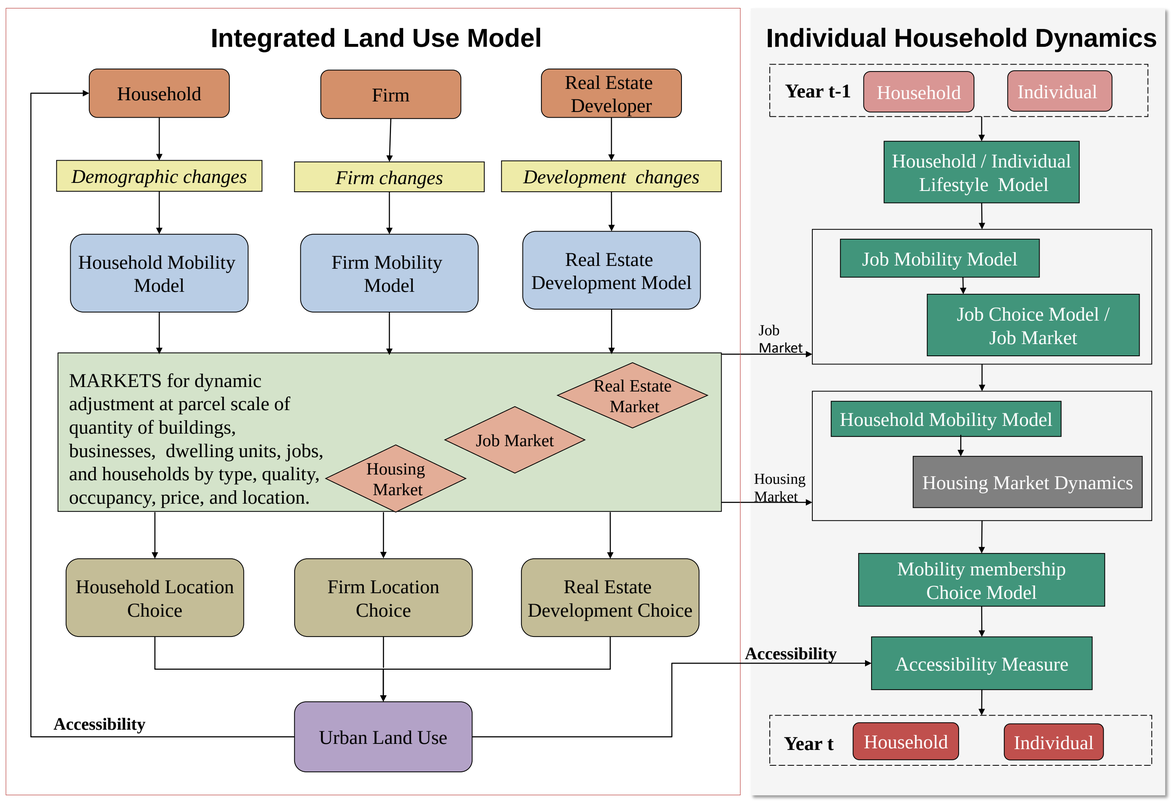
1. MOTIVATION & INTRODUCTION

- Human behavior--- fundamental to understanding urban mobility systems
  - Need comprehensive simulation of future scenarios
  - Increasingly cheap & abundant data streams enable microsimulation of human behavior
- **THIS RESEARCH: Modeling microscopic household residential choice**
  - Capture the household's interactions with other agents in the Singapore housing market
  - Use the **bid-rent approach** in simulating the interaction of buyers and sellers
  - Applying real Singapore data for calibration
  - Develop **a MICROSOPIC model** which allows dynamic interactions

2. RESEARCH FRAMEWORK: SIMMOBILITY, AN INTEGRATED LAND USE-TRANSPORTATION MODEL



3. HOUSEHOLD BEHAVIOR MODEL(S) CALIBRATION

Current Available Data : HITS 2008, Realis 2005-2011.

- Data matching process using Postal Code for year 2008 : Significant data loss-- 565 out of 1233 household left due to lack of transaction in 2008
- Matching Process for Postal Code: One postal code and many households. Random and Logit Assingment tested, selected random due better performance.

Preliminary Calibration : Known Static Methods

- ASSUPMTION 1: Exogenous supply--Dwellings and their prices are <u>given and fixed</u>
- ASSUPMTION 2: **SELLERS DECIDE** which offer to accept.
  - Each household enters the market with a bid price for each dwelling in the market
  - The seller of the dwelling picks the highest bidder and the price is the highest bid
- Estimate two <u>Random Bidding Models</u> to Singapore housing market:
  - Ellickson's model: Maximum random bid, ε_{tn}, Gumbel distributed, myopic households

$$p(t|z) = prob\{\widetilde{\varphi_t}(z) + \varepsilon_t^* > \widetilde{\varphi_{t'}}(z) + \varepsilon_{t'}^*; t \neq t', t' \in T\} \qquad p(t|z) = \frac{\exp\{\widetilde{\varphi_t}(z)\}}{\sum_{t' \in T} \exp\{\widetilde{\varphi_{t'}}(z)\}}$$

T: *set of household types*; $t \in T$ z: *a vector of dwelling characteristics*

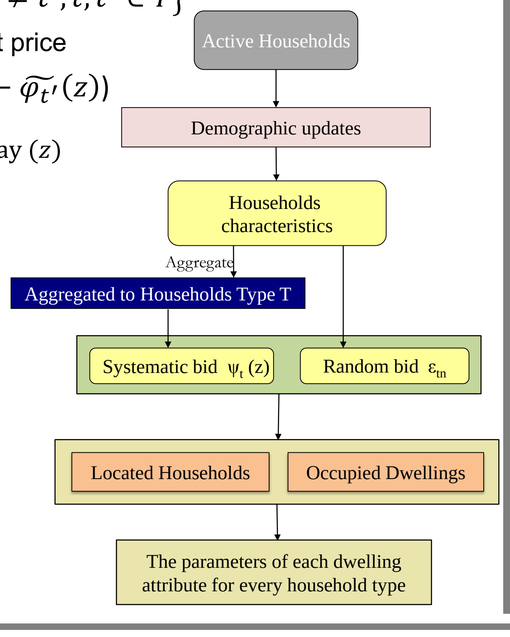
  - Lerman and Kern's model includes observed price, *P*, in Ellickson's model

$$\{\widetilde{\varphi_t} + \varepsilon_t = P^* and\ \widetilde{\varphi_{t'}}(z) + \varepsilon_{t'} \leq P^*; t \neq t', t, t' \in T\}$$

  - ε_{tn} Gumbel distributed, household's known highest price

$$f(t, P^*|z) = f_\varepsilon(P^* - \widetilde{\varphi_t}(z)) \prod_{t \neq t', t' \in T} F_\varepsilon(P^* - \widetilde{\varphi_{t'}}(z))$$

  - $\widetilde{\varphi_{t'}}$ is fully identified, so $\Delta\ bid\ (z) = \text{willingness to pay}\ (z)$



- Real Singapore private housing transaction data are used to calibrate the two models as a preliminary step
  - The household characteristics associated with the occupied dwelling is given
  - The transaction prices are the observed price in the current housing market
- The parameters of each dwelling attribute for every household type are used as input for the simulation process described in section 4

Initial Model Calibration

- **Model Specification**

Variable	Observed Variables
ASC	Alternative Specific Constant (that of Low Income- Small Family =0)
Area	The area of each dwelling on the housing market (in square foot)
Accessibility	Measured by the household head average travel time to work (from Hits 2008 travel times with "work" purpose)

- **Utility Function**

$$U_i = ASC_i + \beta_{Area} Area + \beta_{Acc} Accessibitliy + \varepsilon_i \quad (i \in all\ household\ groups)$$

- **Model Estimation with Initial Data**
  - Low Income : less than S$15,000 (base group)
  - Middle Income: between S$15,000 and S$40,000
  - High Income : over S$40,000

Ellickson's Model

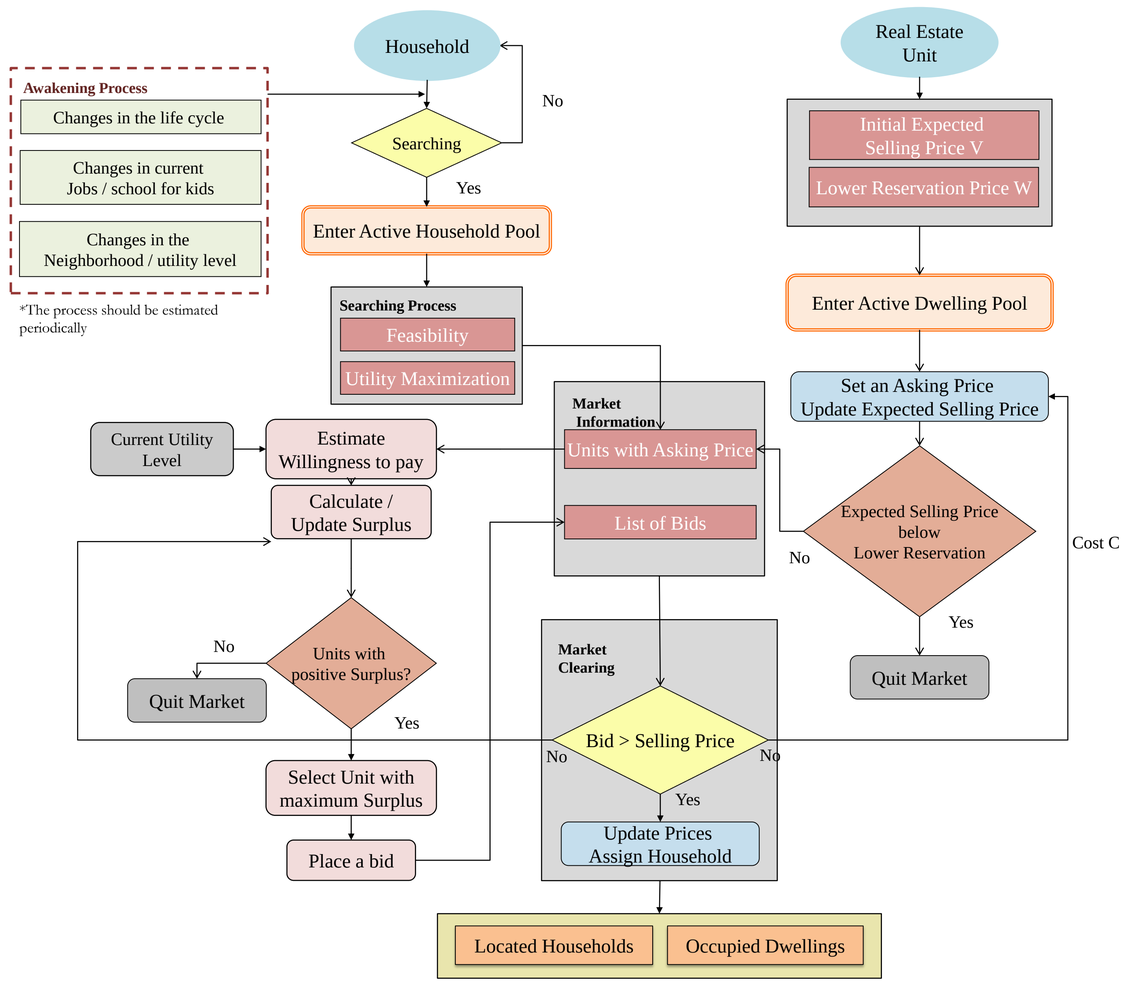
Parámeter	Value	Standard Error	T-test
ASC High Income	-0.74337	0.557242	-1.33401
Area High Income	0.140304	0.040742	3.443692
Accessibility High Income	-0.02328	0.007303	-3.18755
ASC Medium Income	-0.41953	0.519528	-0.80752
Area Medium Income	0.096391	0.039294	2.453092
Accessibility Medium Income	-0.00801	0.005932	-1.35097

4. PROPOSED MODEL AND NEXT STEPS

The new model aims to capture key interactions at a micro level

- Simulates **THE BARGAINING** in the behavior of both sides
  - The **Household** bids looking an asking price and considering a surplus
  - The **Seller** sets an asking price and accepts/rejects considering a reservation price
  - Booth the Seller and The Household updates their variable, considering optimization for the next event, until the property is sold or withdrawn from the market
- Add more **REALISTIC** assumptions
  - Simulates one-by-one match
  - Considers the cost of changing the asking price
  - The Bids ≤ Asking Price allows consumer surplus
- This new model is more **CAPABLE** of:
  - Simulate the dynamic of the real state market
  - Reproduce the market conditions
  - Estimates the consumers' surplus on each dwelling in the market

Dynamic Bidding Process



- Challenges & Shortcomings
  - High requirements for data : Asking Prices and Times on the Market
  - Calibration by simulation of the parameters that reproduce the dynamics of the model
  - Agent "awakening" and "searching" processes are not yet modeled

Acknowledgement

This research was supported by the National Research Foundation Singapore through the Singapore MIT Alliance for Research and Technology's <Future Urban Mobility IRG> research programme.