Bid-auction based mechanism for location choice and price formation in land use microsimulations

ÉCOLE POLYTECHNIQUE FÉDÉRALE DE LAUSANNE

ENAC/EDMA 2011

Author Ricardo Hurtubia

Supervision Prof. Michel Bierlaire [1]

TRANSP-OR

[1] Transport and Mobility Laboratory (TRANSP-OR)

Motivation

Land use models help to forecast the future state of cities when confronting changes in demographics, socioeconomics the market conditions and the transport system. Residential location choice is one of the most important elements to model, because it defines the spatial distribution of households and, therefore, the socioeconomic structure of the city.

Approaches to location choice modeling

Choice:
- Households choose the maximum-utility location
- Households are price takers
- Simplified modeling of rents as a function of location attributes (insensitive to general market conditions)
- Requires total supply levels to be greater or equal than demand

Bid-auction:
- Locations (dwellings) are traded in auctions
- Best bid determines location and rents (prices)
- Requires to solve equilibrium (supply =demand) to determine bid level of households (incompatible with microsimulation due to aggregation)

A new approach for location choice microsimulation

A model is proposed where equilibrium is not required and prices are determined through auctions that take place in each modeling period. Location of households is microsimulated as an auction or a choice, depending on the general market conditions scenario: demand surplus or supply surplus.

The model considers that, in every period t, the willingness to pay of households h for location i is represented by a bid function:

$$B_{hi}^t = b_h^t + b_{hi}^t(z_i)$$

where: b_h^t is the bid-adjustment level as a reaction to the market conditions

b_{hi}^t is the value the households gives to the location attributes (z_i)

Demand surplus scenario

Given an (exogenous) excess of demand, households compete for the available dwellings. Each location "chooses" the best bidder following:

$$P_{h/i}^t = \frac{\exp(\mu B_{hi}^t)}{\sum_{g \in H} \exp(\mu B_{gi}^t)}$$

$P_{h/i}^t$: probability of household h being the best bidder for location i

H : set of households looking for a location

μ : scale parameter of the choice model

Supply surplus scenario

Given an (exogenous) excess of supply, households choose the location that maximizes their consumer surplus, understood as the willingness to pay (B_{hi}^t) minus the rent (r_i^t). The choices are simulated following the probability of a location i providing the maximum utility to a household h:

$$P_{i/h}^t = \frac{\exp(\mu(B_{hi}^t - r_i^t))}{\sum_{j \in S} \exp(\mu(B_{hj}^t - r_j^t))}$$

S : set of available locations

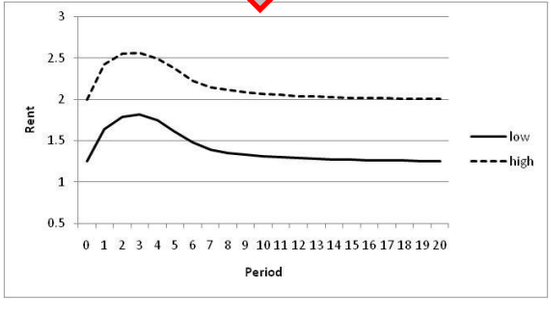
with the rent being modeled as the expected maximum bid in the previous period:

$$r_i^t = \frac{1}{\mu} \ln \left(\sum_{g \in H} \exp(\mu B_{gi}^{t-1}) \right)$$

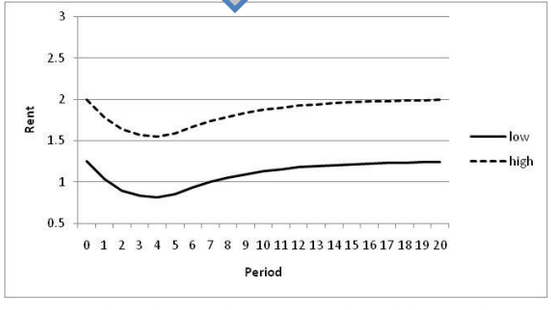
Bid adjustment

In each period, households adjust their bids in order to make the expected number of winning bids equal to one. This ensures that bids (and rents) will increase in a demand surplus scenarios and decrease in a supply surplus scenario

$$b_h^t = -\ln \left(\sum_{i \in S^t} \exp \mu \left(b_{hi}^t(z_i) - r_i^{t-1} \right) \right)$$



Simulated rents for high-end and low-end dwellings after a demand surplus shock



Simulated rents for high-end and low-end dwellings after a supply surplus shock

Preliminary results

Simulation of a synthetic city with 2 types of households (rich and poor) and two types of locations (high-end and low-end dwellings)

Future work

Implementation of a full-scale simulation for a real case study.