Comparative analysis of hedonic rents and maximum bids in a land-use simulation context

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Outline

1. Motivation
2. Bid-auction approach
3. Bid-choice equivalence
4. Hedonic rent models
5. Simulation experiment
6. Simulation results
7. Conclusions / Discussion

Motivation

- Evolution of land use (location choice) models:
  - Aggregated → Disaggregated
  - Equilibrium → Dynamic microsimulation
  - Bid-auction / Choice
- Bid approach: consistent with economic theory. Usually implemented in equilibrium models
- Choice approach: easier to implement. Hedonic rents
- Hedonic rent models take some simplifying assumptions

Bid-auction approach

- Assumption: auction market (Alonso, 1964; Ellickson, 1981)
- Willingness to pay of household *h* for a residential unit *i* can expressed in the form of a bid: B_{hi}
- Probability of household *h* being the best bidder for location *i*:

$$P_{h/i} = \frac{\exp(\mu B_{hi})}{\sum_g \exp(\mu B_{gi})}$$

- Rent: expected maximum bid:

$$r_i = \frac{1}{\mu} \ln \left(\sum_g \exp(\mu B_{gi}) \right)$$

Bid-choice equivalence

- Choice approach assumes that households are price takers
- The utility (consumer surplus) can be written as:

$$V_{hi} = B_{hi} - r_i$$

$$\longrightarrow \quad P_{i/h} = \frac{\exp(\mu(B_{hi} - r_i))}{\sum_j \exp(\mu(B_{hj} - r_j))}$$

- If prices are the outcome of an **auction**, the location distribution is the same for the bid and choice approaches (Martínez 1992, 2000)

Hedonic rents

- Assumption: rents can be described as a function of the location attributes (z_i)… if a market equilibrium has been reached (Rosen, 1974)

- In general $$r_i = \sum_k \alpha_k z_{ik} \longrightarrow \alpha_k = \frac{\partial r_i}{\partial z_{ik}}$$

- From the bid approach:

$$\frac{\partial r_i}{\partial z_{ik}} = \sum_h \left(\frac{\partial \left(\ln \left(\sum_g \exp(B_{gi}) \right) \right)}{\partial B_{hi}} \cdot \frac{\partial B_{hi}}{\partial z_{ik}} \right) \longrightarrow \frac{\partial r_i}{\partial z_{ik}} = \sum_h \left(P_{h/i} \cdot \beta_{hk} \right)$$

Simulation experiment

Objective

Compare rents obtained from :

- Maximum bid (logsum)
- Different specifications of hedonic rent models

Simulation experiment

- Synthetic city with:
  - 10 zones (i)
  - 3 types of residential units (v)
  - 3 types of household (h)

$$B_{hvi} = \beta_{hz} z_i + \beta_{hy} y_v + \beta_{hH_1} H_{1i} + \beta_{hH_3} H_{3i} + b_h$$

parameter	$h = 1$	$h = 2$	$h = 3$
β_{hz}	1.5	1.0	0
β_{hy}	1.5	1.0	0
β_{hH_1}	1.5	1.0	0
β_{hH_3}	-1.5	-1.0	0

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Simulation experiment

- b_h represents adjustments in the bid accounting for:
  - Rich households realizing that they don't have to bid their full willingness to pay
  - Poor households realizing that, in order to locate somewhere, they have to increase their bid
- Equivalent to ensure that all households are located somewhere

$$H_h = \sum_{vi} S_{vi} P_{h/vi} \quad \longrightarrow \quad b_h = -\ln\left(\sum_{vi} S_{vi} \exp\left(B_{hvi} - r_{vi}\right)\right) \quad \forall h$$

Simulation experiment

- Simulation of location choices following bid approach

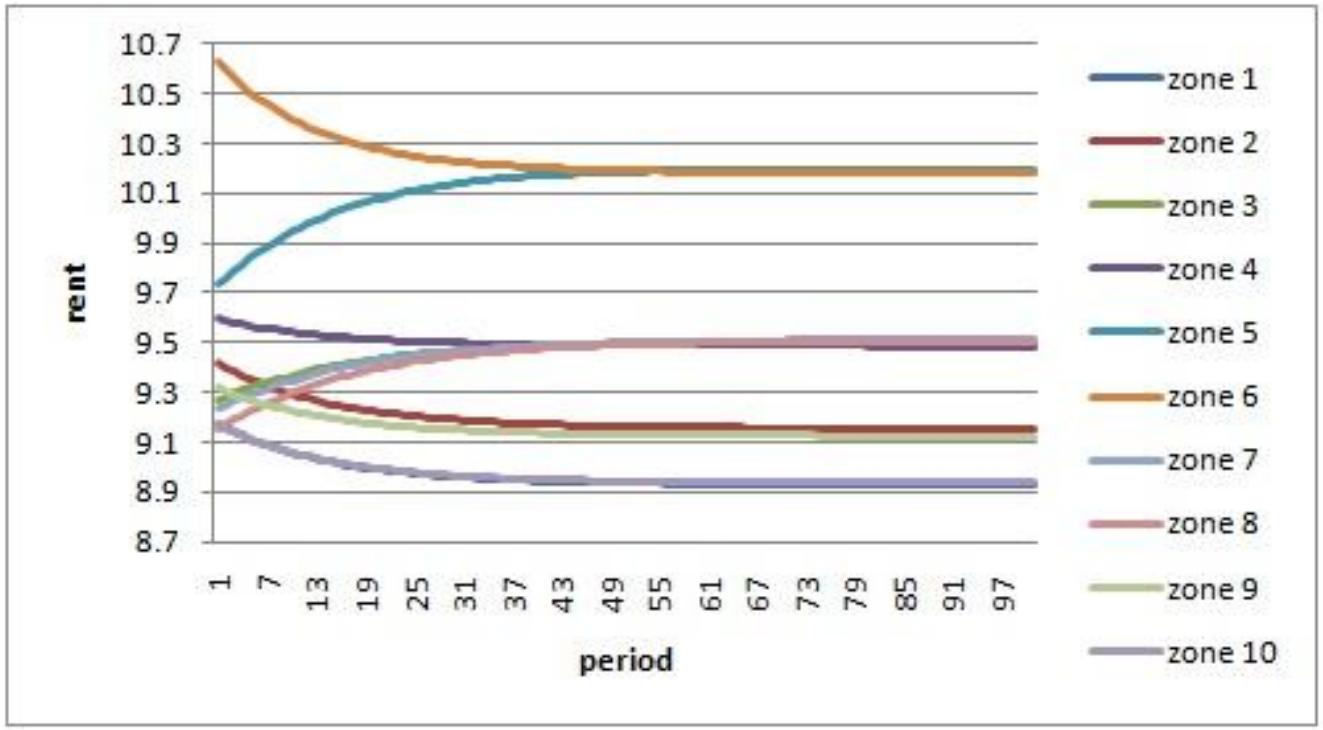
$$P_{h/vi} = \frac{H_h \exp(B_{hvi})}{\sum_g H_g \exp(B_{gvi})} \qquad r_{vi} = \ln\left(\sum_g H_g \exp(B_{gvi})\right)$$

- In each period:
  1. A fraction of the households relocate
  2. All households adjust their bids
  3. Rents are recalculated

- 2 scenarios:
  a) Constant income distribution
  b) Increment of high income / decrease of low income

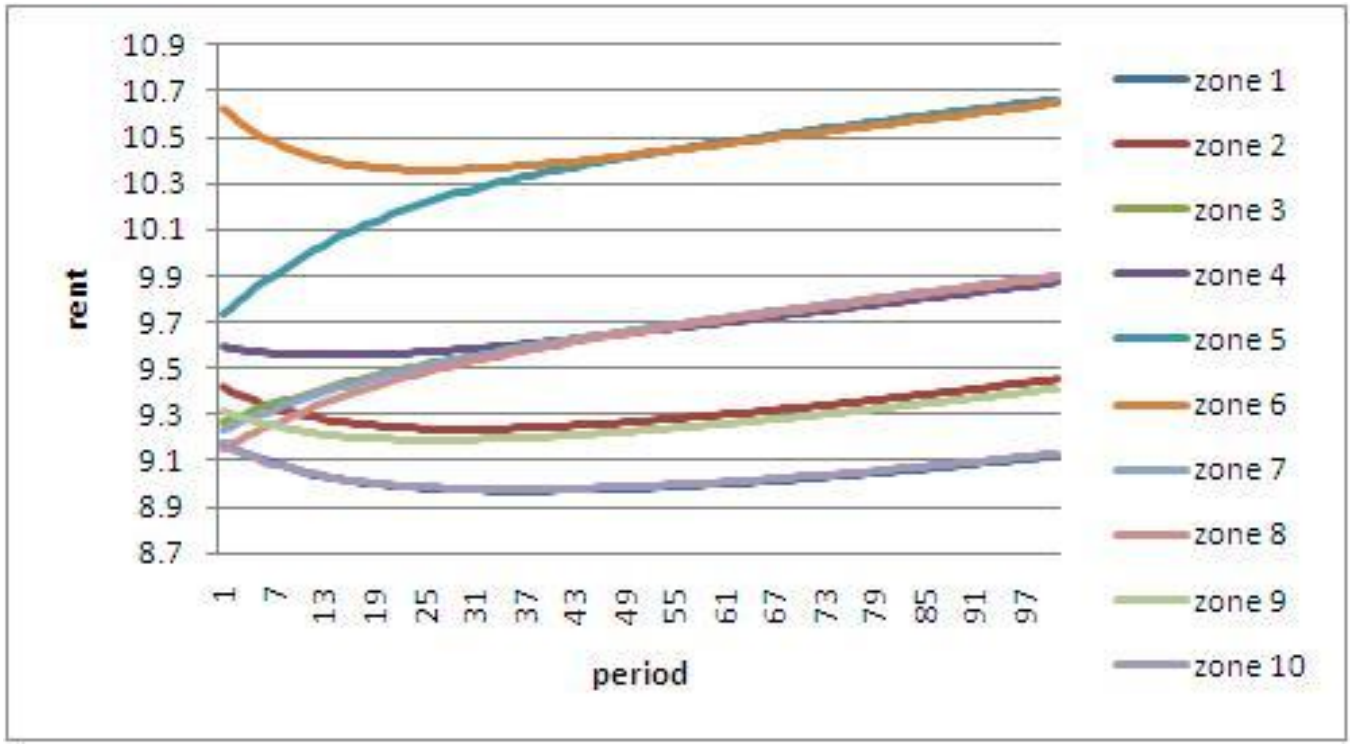
Simulation results (a)

- Logsum rents by zone



Simulation results (b)

- Logsum rents by zone



Simulation experiment

- Hedonic rent models to compare:
- "naive":

$$r_{vi} = c + \alpha_z z_i + \alpha_y y_v + \alpha_{H_1} H_{1i} + \alpha_{H_3} H_{3i}$$

- Pseudo-logsum:

$$r_{vi} = c + \sum_h P_{h/vi} \left(\alpha_{hz} z_i + \alpha_{hy} y_v + \alpha_{hH_1} H_{1i} + \alpha_{hH_3} H_{3i} \right)$$

- Pseudo-logsum2:

$$r_{vi} = c + \sum_h \frac{H_{hi}}{H_i} \left(\alpha_{hz} z_i + \alpha_{hy} y_v + \alpha_{hH_1} H_{1i} + \alpha_{hH_3} H_{3i} \right)$$

Simulation experiment

- Estimation over data generated for period 1

- "naive"

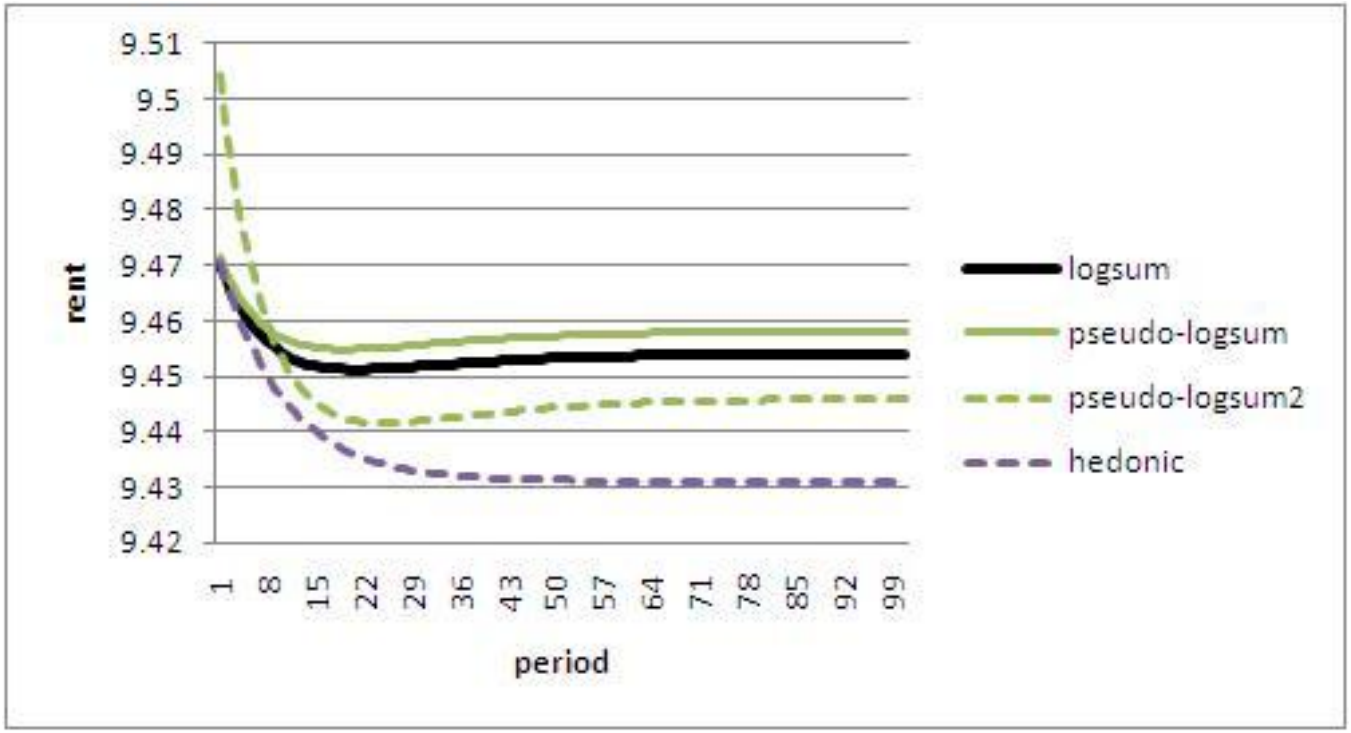
parameter	estimate	std-error
c	8.555	0.011
α_z	0.825	0.005
α_y	0.927	0.004
α_{H_1}	1.007	0.013
α_{H_3}	-0.822	0.018
R^2=0.991		

- pseudo-logsum

parameter	estimate for $h=1$	estimate for $h=2$	estimate for $h=2$
c	8.776 (3.21E-05)		
α_{hz}	1.232 (2.09E-04)	0.634 (1.09E-04)	0.302 (1.56E-04)
α_{hy}	1.241 (1.79E-04)	0.629 (1.30E-04)	0.306 (2.03E-04)
α_{hH_1}	1.238 (5.03E-04)	0.630 (3.16E-04)	0.305 (3.25E-04)
α_{hH_3}	-1.244 (1.26E-03)	-0.626 (6.48E-04)	-0.308 (1.90E-04)
R^2=0.995			

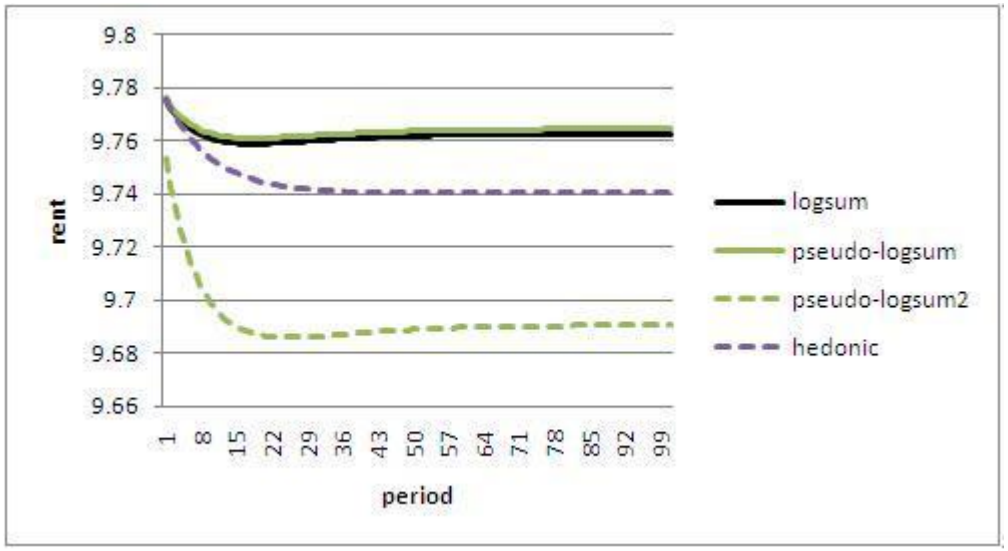
Simulation results (a)

- Average rents

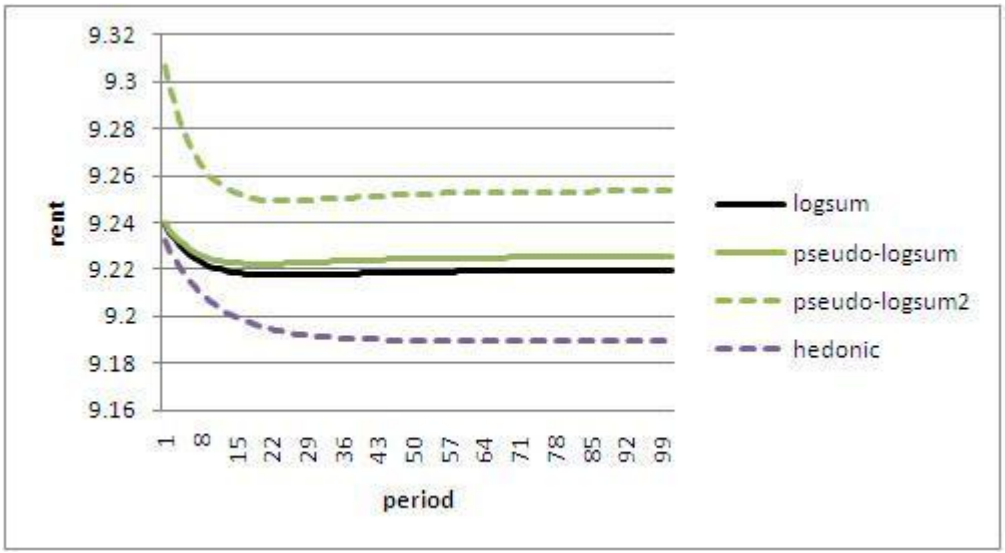


Simulation results (a)

- Rents by housing unit type
  - "Big" (type 1)

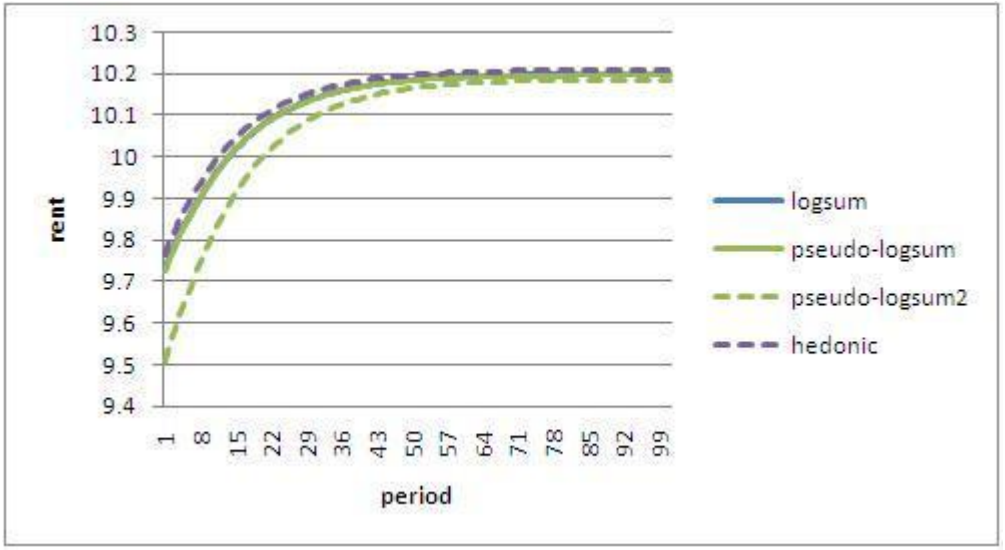


  - "Small" (type 3)

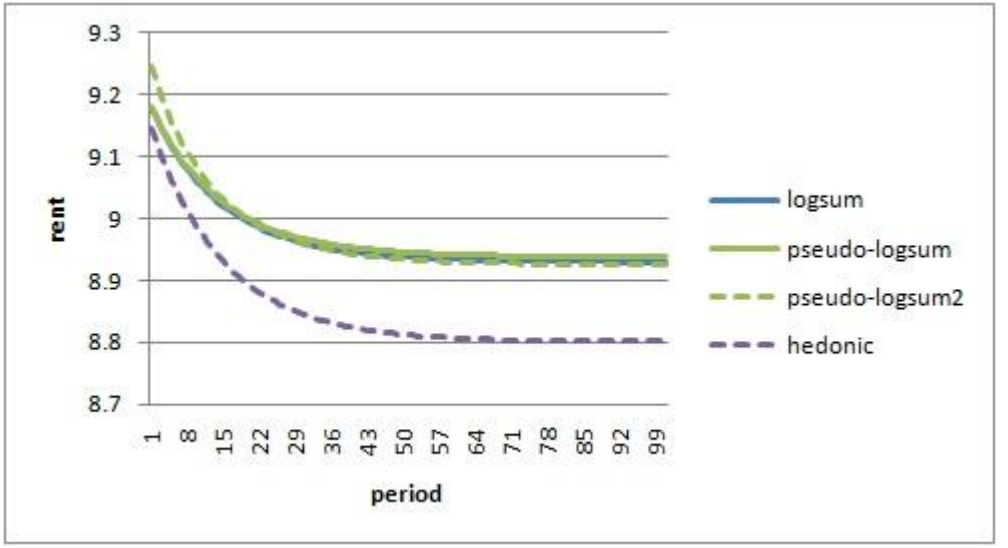


Simulation results (a)

- Rents by zone
- High income (zone 5)

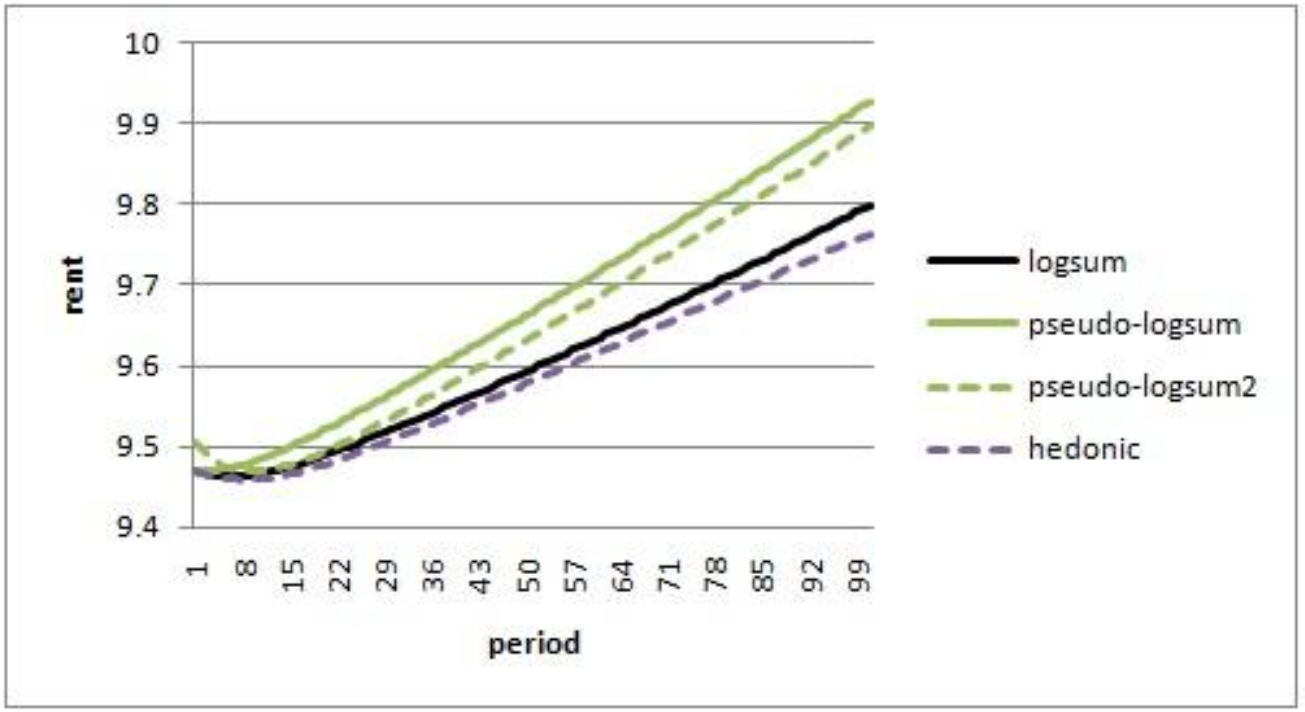


Low income (zone 1)



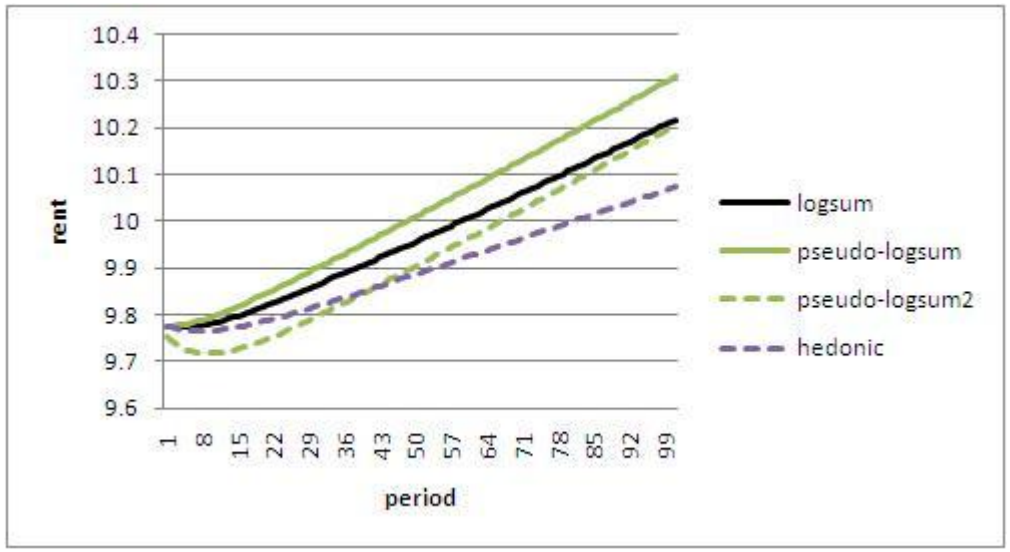
Simulation results (b)

- Average rents

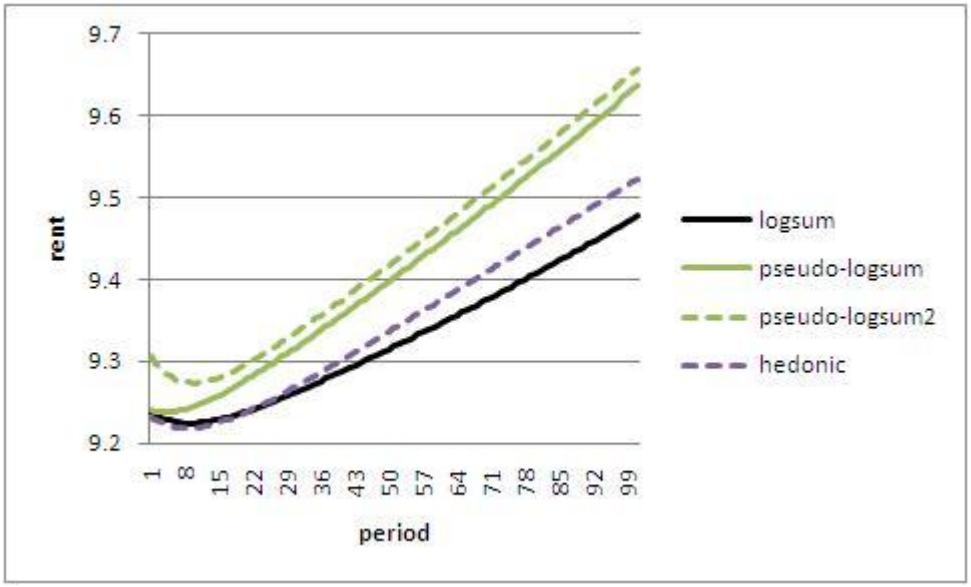


Simulation results (b)

- Rents by housing unit type
  - "Big" (type 1)

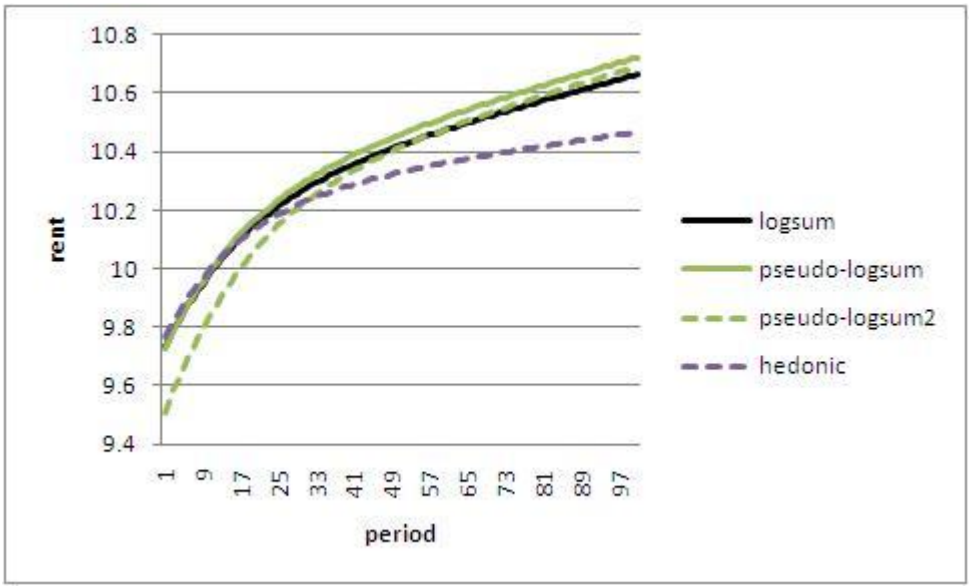


  - "Small" (type 3)

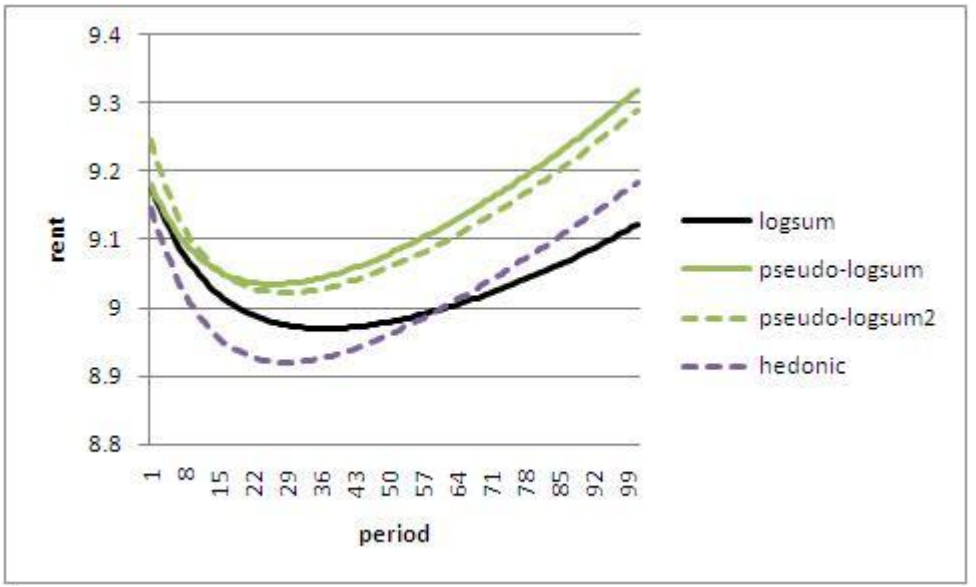


Simulation results (b)

- Rents by zone
- High income (zone 5)



Low income (zone 1)



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Conclusions / Discussion

- Maximum bid and hedonic approaches generate different results
- Maximum bid approach naturally captures heterogeneity in households preferences
- It is hard to reproduce maximum bids using hedonic rent models
- Hedonic models are insensitive to changes in general market conditions (like income distribution)

Conclusions / Discussion

- Adjustment of the willingness to pay (b_h) is not explicitly modeled in most models, however, any assumption of location of all households requires some adjustment in the prices.
- Is it possible to directly replace a hedonic rent model by the expected maximum bid (logsum)?
- Further work:
  - Analysis with real data
  - Combination of logsum with hedonic approach