Estimating the HARA land-use model for housing planning based on hedonic price analysis

Authors

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1. Problem background and objectives

Problem background

Cities are facing problems like heat stress, rainfall flooding, air pollution and so on.

The potential of urban-green strategies for creating climate adapted and healthy cities has been proved.

Now, many cities are looking at the green strategies to make the cities become more climate adaptive .

Possible conflicts between green strategies and other planning objectives are limited urban space and relatively high land costs

1. Problem background and objectives

Objectives

(1) Build a model system and apply the model system:

- Considering a full range of green measures (green land, green roof, green facades)
- Considering the demands for other land-uses and scarce space

(2) Apply the model system as an experimental tool to evaluate urban greening strategies:

- Net values
- Climate benefits (Cooling effect)
- Trade off between net value and climate benefits

1. Problem background and objectives

We Developed HARA as a tool for urban green development investigation tool

The objective of this paper is to estimate the value function for the HARA based on the hedonic price analysis.

Contributions

Looking into the different quality of green environment value for urban facilities (housing)

Derive the value function In the context of HARA model

2. HARA model development for urban green scenarios

- HARA is a state-of-the-art land-use allocation model that developed by Arentze et al. (2010)
- Net-value functions are incorporated, and can be monetarized and estimated empirically
- HARA uses a search algorithm to find the optimal spatial allocation of new housing demands in an urban plan area
- The solution generated by HARA represents an optimum as well as a market equilibrium (maximum net value for developers).
- Analyze the impact of different incentive schemes on land-use allocation decisions

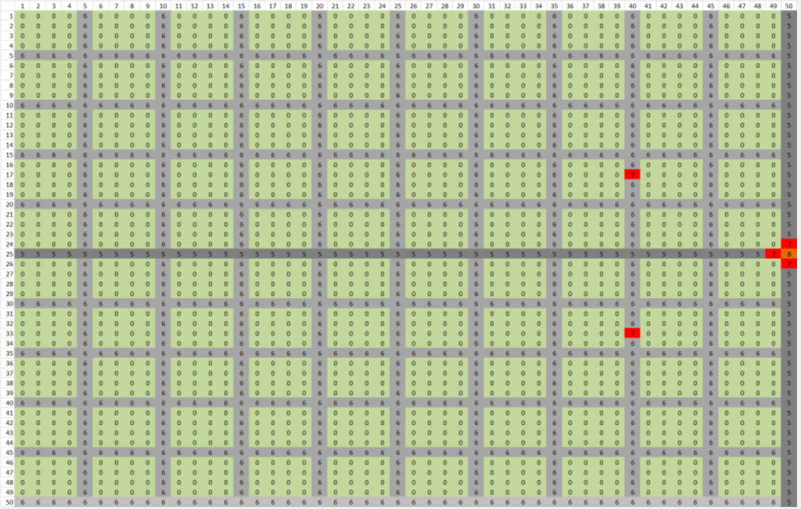
2. HARA model development for urban green scenarios

HARA land-use model for housing planning

The plan area is represented as a regular grid of cells where each cell corresponds to a piece of land that has a particular land-use.

On the main level, HARA distinguishes the following land-use categories:

Nature (unbuilt land); Task land-uses (Ktask types) and Fixed land-uses (Kfix types).



HARA initial land-use map

2. HARA model development for urban green scenarios

Algorithm

represent net value for developer

$$S_{ij} = \sum_{k} X_{ik}^{j} + \sum_{j'} D_{ij'}^{j} + \sum_{j'} A_{ij'}^{j}$$

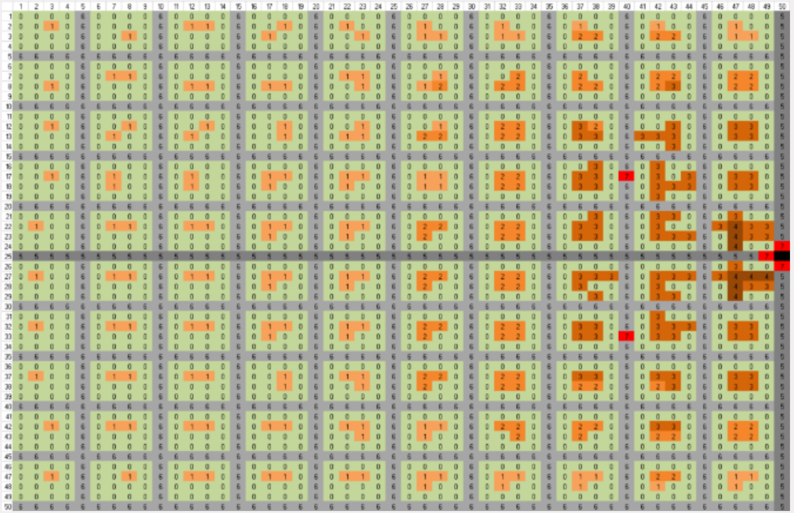
Parameters and input

Housing demand

Housing type percentage

(stand-alone, semidetached, row houses and apartments)

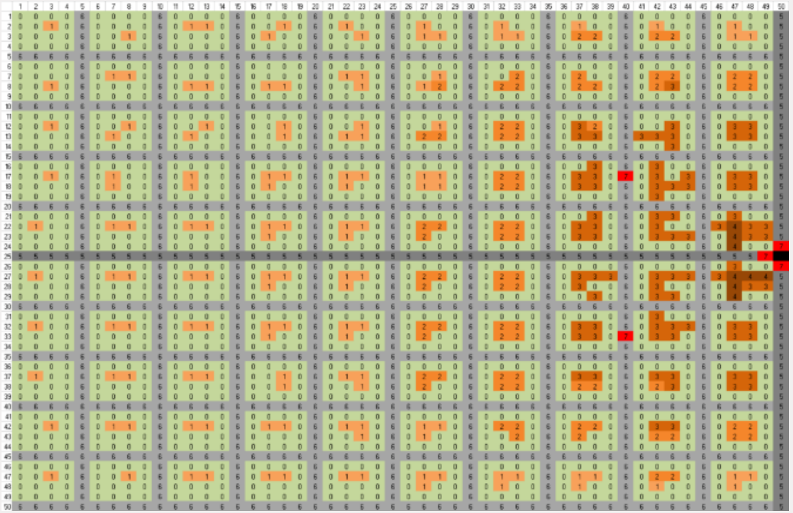
Construction cost; Land cost



HARA land-use output

2. HARA model development for urban green scenarios

Nature	0 (green color)
Housing of type 1 – stand-alone	1 (yellow)
Housing of type 2 – semi-detached	2 (orange)
Housing of type 3 - row	3 (dark orange)
Housing of type 4 - apartments	4 (brown)
Main road	5 (dark grey)
Secondary road	6 (light grey)
Shopping area	7 (red)
CBD	8 (black)



HARA land-use output

2. HARA model development for urban green scenarios

The value-function is specified that it accurately represent buyers' willingness-to-pay for dwelling and location characteristics in the housing market.

The trade-off between living in a green environment (owners) and market value (for the developer).

Using the model as an experimentation tool, we consider what the impacts of changes in the trade-off will be for the spatial planning of housing.

3. Methodology

DATA

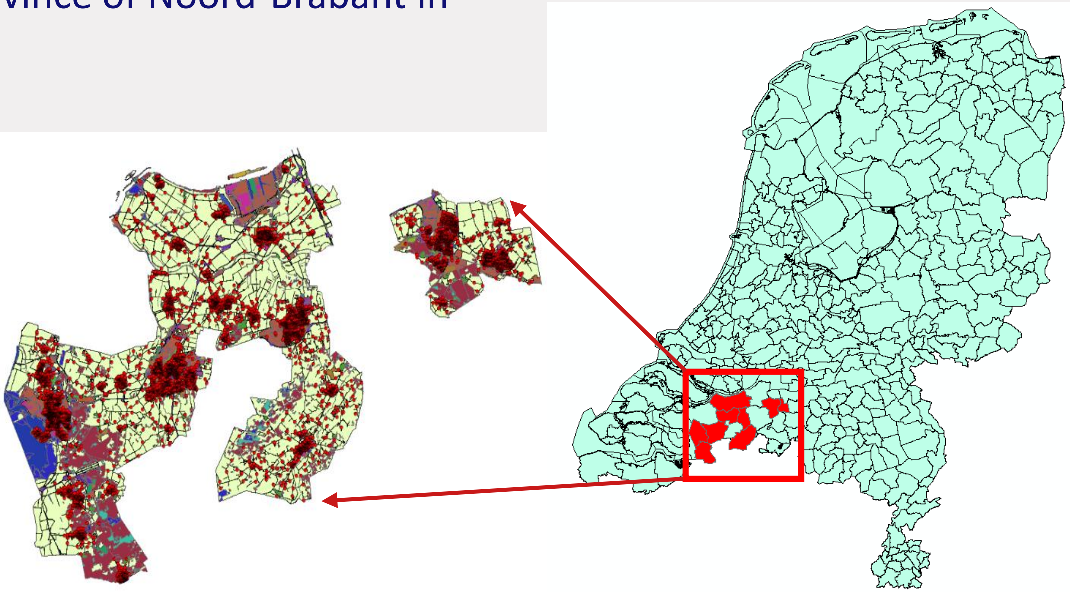
Nine municipalities in the west of the province of Noord-Brabant in the Netherlands

Housing transaction data:

Municipality data

more than 23,000 transaction cases

Spatial land-use data: CBS
(Central Bureau of Statistics) data



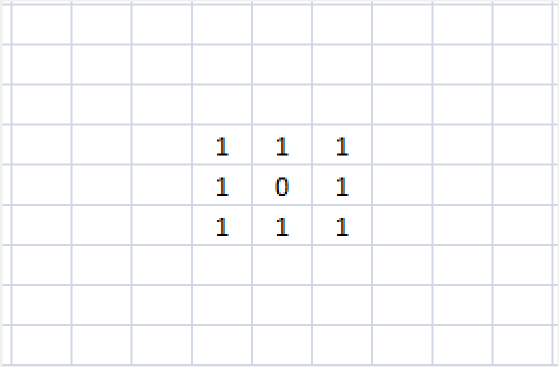
3. Methodology

ArcGIS analysis

Based on the housing transaction data and the spatial data.

Each transaction case postcode are spatially located in the grid map.

The land-use characteristics of each cell's direct neighborhood (eight cells) can be calculated.



The neighborhood cells

3. Methodology

Hedonic price analysis

Decompose the housing price into different housing components that make contribution to the price.

Fixed effect regression

We use fixed effect regression to capture all the remaining spatial characteristics on the neighborhood code level based on the panel data (Create dummy variables of neighborhood code).

$$\ln P_{ij} = Green_i + d_j + S_i + \varepsilon$$

3. Methodology

Neighborhood Land-use characteristics ($Green_i$):

The Urban green space (UGS) land-use percentage in the direct neighborhood cells.

Housing characteristics (d_j):

Housing volume; lot size; construction year; maintenance condition; quality luxury; size of balcony, basement, garage and etc.

Fixed effect (S_i):

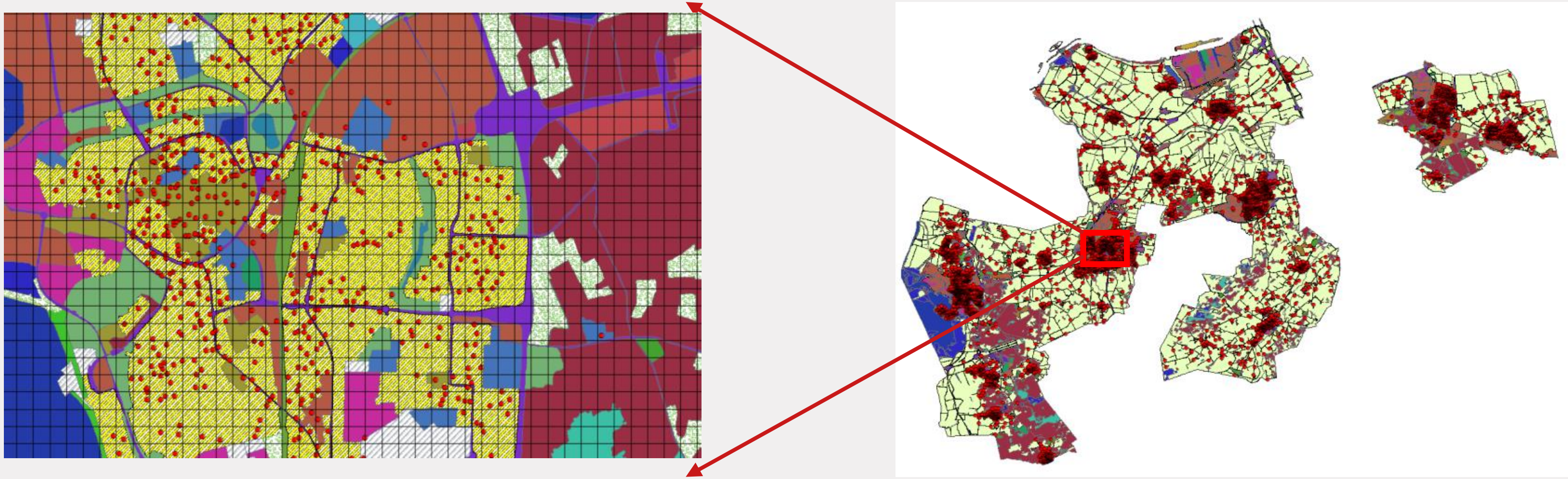
Fixed the effect based on the entities level

Create dummy variable based on the neighborhood code

4. Results

GIS analysis

Each postcode point cell's neighborhood (eight cells) land-use characteristics



4. Results

Fixed effect regression (hedonic model)

summary

Model Summary				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.909[a]	0.827	0.826	0.15610

4. Results

Fixed effect regression (hedonic model)

Coefficients of housing characteristics

Coefficientsa					
Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	4.745	0.009		542.605	0.000
Volume	0.001	0.000	0.439	108.522	0.000
Lot size	0.000	0.000	0.234	47.757	0.000
dweltype	-0.052	0.002	-0.172	-34.105	0.000
rowhouse	-0.085	0.003	-0.107	-29.868	0.000
apartment	0.056	0.006	0.049	10.060	0.000
Has garage	0.081	0.003	0.103	29.272	0.000
Has bay window	0.081	0.003	0.087	27.226	0.000
Has basement	0.075	0.009	0.026	8.555	0.000
Has balcony	0.042	0.005	0.029	8.800	0.000
Has dormer	0.028	0.003	0.033	10.546	0.000
Services	0.062	0.002	0.123	30.765	0.000
Maintenance condition	0.042	0.002	0.072	18.361	0.000
Location	0.073	0.003	0.070	22.277	0.000
Appearance	0.047	0.004	0.039	11.186	0.000
Quality luxury	0.048	0.003	0.062	16.496	0.000
Efficiency	0.031	0.005	0.023	6.860	0.000
byeark2	0.012	0.001	0.069	14.383	0.000
isyearo1930	0.060	0.016	0.012	3.760	0.000
isyear40_49	-0.035	0.009	-0.012	-4.013	0.000
isyear50_59	-0.028	0.005	-0.019	-5.745	0.000
isyear60_69	-0.048	0.004	-0.046	-12.269	0.000
isyear70_79	-0.014	0.004	-0.015	-3.711	0.000
isyear90_99	0.104	0.005	0.103	22.571	0.000
isyear00_09	0.138	0.006	0.095	22.309	0.000

4. Results

Fixed effect regression (hedonic model)

Neighborhood green environment characteristics

Preliminary result

Not finalize the estimation yet

Coefficientsa					
	Unstandardized Coefficients		Standardized Coefficients		
Model	B	Std. Error	Beta	t	Sig.
Park	0.064	0.016	0.014	4.021	0
Other agricultural land	-0.027	0.008	-0.013	-3.367	0.001
Other inland water	0.222	0.038	0.021	5.796	0

5. Conclusions

Conclusions

The HARA model system parameters can be derived by the hedonic price analysis. Indeed, the different types of UGS (urban green space) have different impact on the property transaction price and some of them are significant.

This Hara model system is a practical tool to investigate different scenarios

Discussions

Analyze the impact of different incentive schemes on land-use allocation decisions for future research.

Thanks