Estimating the effect of sustainability factors on apartment prices: The case of Athens greater area

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ERES 2014, Bucharest

Outline

- Scope and aims
- Limitations
- Environmental factors affecting residential prices – from literature
- Determining the impact of sustainability and environmental design factors using hedonic models
  - ✓ Data compilation and data management
  - ✓ The hedonic price model
  - ✓ Testing
- Conclusions
- Fields for further research

Scope and aims

- **Scope:**
  - ✓ Identify the potential of applying a hedonic model for estimating the impact of environmental and sustainability factors on housing prices.
- **Aims:**
  - ✓ Identification and presentation of the environmental factors affecting property prices through existing literature
  - ✓ Synthetic research, identification and recording of all environmental and sustainability factors – variables with a possible effect on the housing prices
  - ✓ Determination of the appropriate analysis methodology
  - ✓ Final choice and testing of the model
- **Application using data from Bank of Greece valuations database, for Northern and Southern Athens sectors**

Limitations

- Limited accessible data, incomplete, out of date or obsolete databases
- Bank of Greece residential property prices database comprises valuations from credit institutions. Good coverage, quality, timeliness etc., but not actual transaction data
- Parameter generalization (i.e. population density, average building factor etc.)
- Subjectivity in quantification of qualitative parameters
- Time factor

Environmental factors affecting house prices (i)

A/A	Environmental factor	Description
1	**Country planning**	Environmental design with emphasis in the distribution and compatibility of uses, as well as protection and enhancement of local resources
2	**Urban planning**	Quality of urban plan (free spaces, green land, building density, construction terms etc.) and the degree of compliance
3	**Forests**	Proximity to significant forest areas
4	**Water front**	Proximity or front to sea, lakes or rivers
5	**Climate**	Special climate traits such as humidity, drought etc.
6	**Infrastructure**	Existence and quality of infrastructure at the level of town or neighborhood
7	**Services**	Services at the neighborhood level, such as public transport. community transport system, heath services, education etc.

Environmental factors affecting house prices (ii)

A/A	Environmental factor	Description
8	**Metrorail or Subway system**	Existence and proximity to the Metrorail, Subway, Suburban rail etc. networks
9	**Security**	At town and neighborhood level. Technical features (lighting, accessibly etc.) and social characteristics of the areas.
10	**Air pollution**	From heavy traffic, proximity to manufacturing or other air polluting plants etc.
11	**Noise**	Especially by aircrafts and heavy traffic
12	**Soil pollution**	Toxic waste
13	**Proximity to special uses**	Proximity to cemeteries, shopping malls etc.
14	**Building characteristics**	Orientation of windows, level, view etc.

Synopsis of all factors affecting housing prices at city and neighborhood level

- **Urban plan and development**
  - ✓ Development pattern
  - ✓ Intensity of development,
  - ✓ Population density, local demographics
  - ✓ Infrastructure and transport systems
  - ✓ Road and traffic network design and efficiency
  - ✓ Social services
  - ✓ Interaction with other cities or other subareas within the city
  - ✓ Inflows and outflows of human and material resources
  - ✓ Investments
- **Quality of natural environment**
  - ✓ Landscape
  - ✓ View
  - ✓ Proximity or front to forests, groves, rivers, streams, lakes and the sea
  - ✓ Characteristics of the micro-climate
- **Quality of built environment**
  - ✓ Urban Planning
  - ✓ Intensity and terms of development
  - ✓ Compatibility of uses
  - ✓ Open space network (both private and public)
  - ✓ Green areas
  - ✓ Building's architecture and aesthetics
  - ✓ Pollution and noise
- **Security**
- **Physical hazards**

Determination of the effect of environmental factors in house prices using econometric analysis (i)

Data sources:

- Bank of Greece residential property prices database
- Hellenic Statistical Authority
- Ministry of Finance
- Internet
- Interviews with local residents
- Real estate agents

Determination of the effect of environmental factors in house prices using econometric analysis (ii)

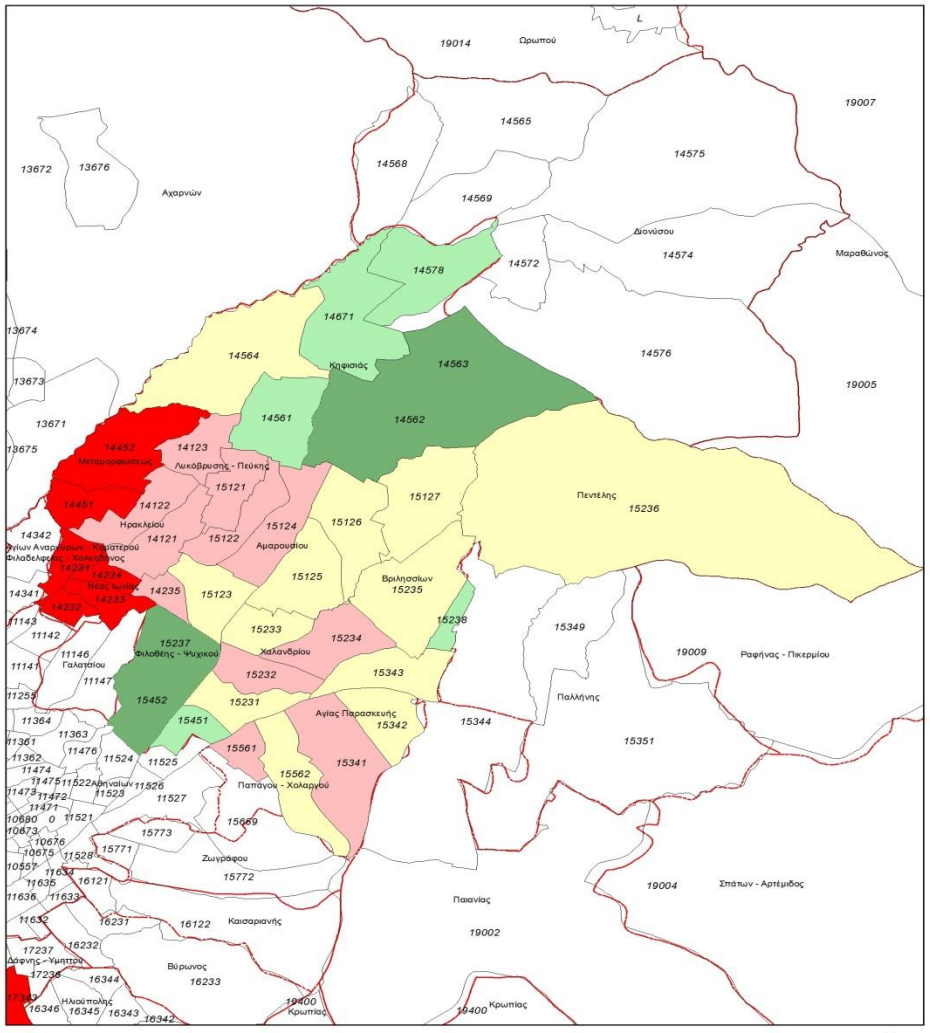
Data sample:

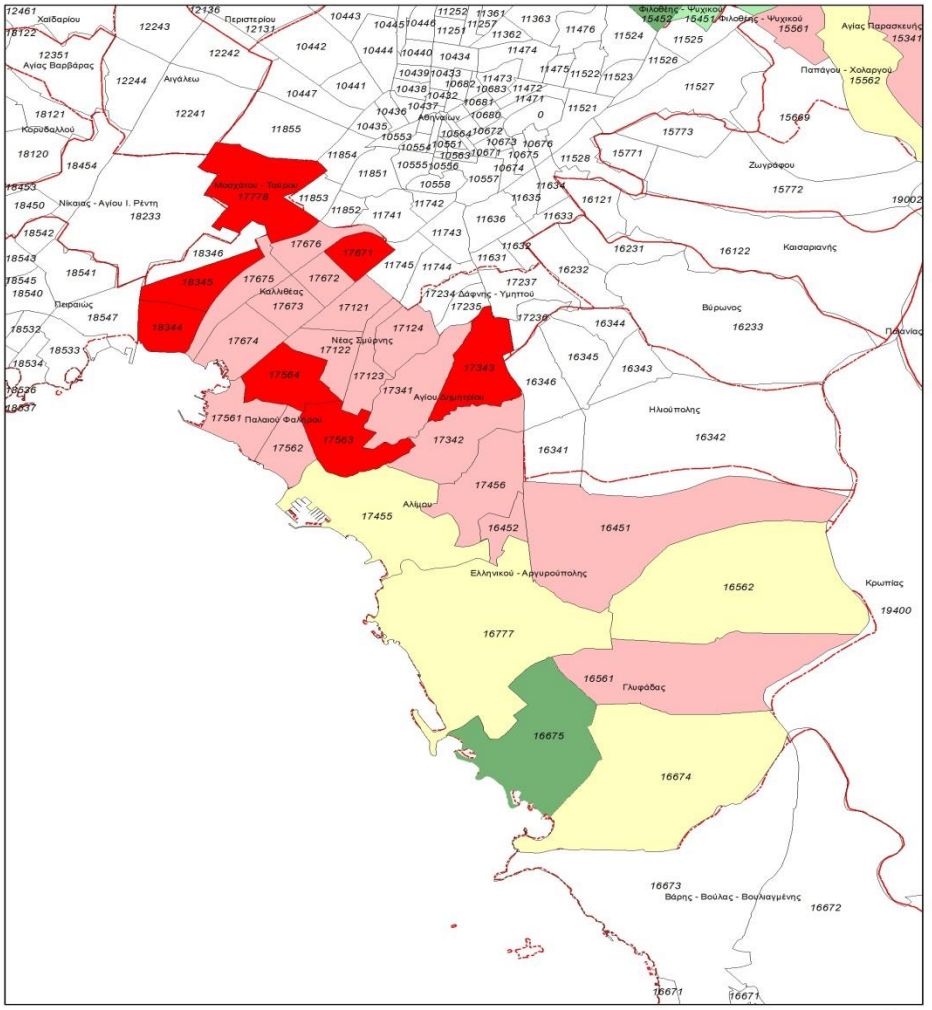
- Reference period: Jan. 2012 – Feb. 2014
- Initial sample of 3875 observations
- Coverage: municipalities of the Northern and Southern Sectors of Athens

Data processing:

- Filtering – selection of apartments (mezonettes and houses excluded)
- Values adjustment for floor level
- Values adjustment for age
- Calculation of Mean Adjusted Value for each of the 68 Postal Codes included in the area of interest

Distribution of Mean Apartment Values within greater Athens area





Determination of the effect of environmental factors in house prices using econometric analysis (iii)

Description of model variables

Dependent variable	ln(y)	ln of Adjusted Mean Value within each Postal Code area, as €/sqm
Independent variables	SD	Mean Building Factor within the Postal Code area
	DEN	Population density within the municipality, as residents per sqkm
	BUILT	Quality of built environment (values: 1=poor to 5=excellent)
	NAT	Quality of natural environment (values: 1=poor to 5=excellent)
	INFRA	Proximity to public transport (values: 1=poor to 5=excellent)
	USES	Compatibility of uses (values: 1=poor to 5=excellent)

Determination of the effect of environmental factors in house prices using econometric analysis (iv)

Descriptive statistics of variables

Variable	Mean	Std. Dev.	N
Ln(y)	7.788	0.208	68
SD	1.283	0.630	68
DEN	9,529.041	6,170.802	68
BUILT	3.235	0.896	68
NAT	3.176	1.116	68
INFRA	3.654	0.654	68
USES	3.015	0.946	68

Correlation Matrix of independent variables

	SD	DEN	BUILT	NAT	INFRA	USES
SD	1	0.867	-0.616	-0.333	0.033	-0.489
DEN	0.867	1	-0.732	-0.434	0.024	-0.475
BUILT	-0.616	-0.732	1	0.503	-0.063	0.744
NAT	-0.333	-0.434	0.503	1	-0.284	0.386
INFRA	0.033	0.024	-0.063	-0.284	1	-0.161
USES	-0.489	-0.475	0.744	0.386	-0.161	1

Hedonic model summary results

Hedonic model beta-coefficients

	β	Std. Error	t	Sig.
(Constant)	**7.2414**	0.1422	50.9310	0.0000
BUILT	**0.3359**	0.0843	3.9824	0.0002
USES	**0.0651**	0.0651	0.9990	0.3217
INFRA	**-0.0150**	0.0846	-0.1777	0.8595
NAT	**0.1188**	0.0479	2.4777	0.0160
SD	**-0.0912**	0.0423	-2.1577	0.0348

Regression Statistics

Adj.R^2	**0.6697**	**Std. Error**	0.1195
F	**28.1644**	**Sig. F**	0.0000

Hedonic model testing

Implementation of the model in "Agioi Anargiroi" area, in the Western sector of Athens

$\Delta y = y - y' = €1,896.62 - €1,816.98 =$ **€79,64/sqm**

y= actual value

y'= fitted value

Or

+ 4,3% deviation from actual value

Conclusions

- Identification and cluster representation, of the most significant sustainability and environmental factors, into six initial independent variables.
- Explanatory variables selected on the basis of both their environmental effect and the accessibility of data
- Hedonic pricing model assessing, with an explanatory power of approximately 67%, the relative differences between the mean apartment prices levels among the various Postal Codes within greater Athens area.
- Built environment quality identified as the most significant environmental variable
- Natural environment quality and building factor also significant (statistically and arithmetically)
- Compatibility of uses not significant
- Proximity to transport appears non- significant and with a marginal negative effect, within the greater metropolitan area
- A percentage of 33% of the values remains not explained by selected independent variables

Proposals for future research

- Alternative models, through examination of additional variables or analysis of current variables into their components
- Collection of data at the level of neighborhood, special location and property
- Insertion of macroeconomic variables in order to identify further interrelations and new balances among the variables and their effect on the values
- Investigation of the potential of using hedonic model pricing to determine the effect of environmental and sustainability factors at the a district and country level

Thank you very much!

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