DEVELOPING AN AUTOMATED VALUATION MODEL (AVM) FOR RESIDENTIAL PROPERTIES IN GREECE

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Taxation of Real Estate in Greece (1/2)

Taxation on income from real estate (leasehold income, stamp duties, solidarity contribution, inferable income etc.)

Taxation of property value (Annual and Periodical taxation, Taxation on transfer / change of ownership (sale, parental benefit, donation, heritage etc.)

Tax = Taxable Value × Coefficient of taxation

Taxable Value = Objective Value or Contract Value (in cases $V_{obj} < V_{con}$).

System of Real Estate Values Objective Calculation: 4 subsystems for the whole Greek territory. The Objective Value of a typical property category:

$$V_{obj} = V_{zone} \cdot x_{ij} \cdot \text{Area}$$ where x_{ij} = tabulated factors

March 2007: Last Adjustment of system.

Taxation of Real Estate in Greece (2/2)

Weakness of Real Estate Taxation & System of Real Estate Values Objective Calculation

- Adjustment at random time intervals → weakness to approach market values, creation of «time opportunities» on property transfer.
- Due to economical crisis V_{obj} > Market Value→ imposition of high taxation that corresponds to fictitious property and unfair distribution of tax burdens.
- High taxation on property ownership due to the significant reduction of residential and commercial property transactions during the period of 2009-2015.
- High taxation & frequent tax law changes → unsettle the real estate market.
- Imposition of new taxation with strictly cash targets on properties → increase of tax evasion.

Currents needs: Constant and Fair Real Estate Taxation System.

Data of Market Values in Greece?

National Cadastre

- Property and ownership data.
- There is not information about the value of property.

Property sales data is not public.

✓ The sale price is a secret between the seller & the buyer.
✓ If a Real Estate Agent is involved: probably knows too.
✓ If a Bank is financing the loan: knows only the valuation.

There is not an official collection of sales data.

The only try to collect and analyze the real estate data is from the **Bank of Greece**, through collection of valuations of financial institutions for market values of properties from financing or guaranteeing loans.

AVMs and CAMA systems (1/3)

Mass Appraisal

Mass Appraisal is the systematic appraisal of groups of properties as of a given date using standardized procedures and statistical testing *(Eckert, 1990)*.

Single vs Mass Appraisal

1. Scale.
2. Scope.
3. Quality Control.
4. Human Resources.

The need for uniformity and consistency in appraisals for a fair tax system and the need for revaluations in several properties → **Development of Automated Valuation Models (AVMs) and Computer Assisted Mass Appraisal (CAMA) systems.**

AVMs and CAMA systems (2/3)

Computer Assisted Mass Appraisal (CAMA) systems

A Computer Assisted Mass Appraisal system is an automated system for maintaining property data, valuing property, notifying owners and ensuring tax equity through uniform valuations, also designed to operate independently as part of an automated network. *(Zentelis, 2001)*.

The necessity of developing a CAMA System

- ✓ Taxation of Real Estate.
- ✓ Expropriations.
- ✓ Urban Planning.
- ✓ Proper management of state –owned land.
- ✓ Mortgage portfolio management
- ✓ Investments.

Subsystems of a CAMA system

- ✓ Data Management subsystem
- ✓ Sales Analysis subsystem
- ✓ Valuation subsystem
- ✓ Administrative subsystem

AVMs and CAMA systems (3/3)

Mass appraisal techniques

- ✓ **Regression Analysis (statistical method)**
- Multiple Regression Analysis
- Geographically Weighted Regression Models, Spatial Autoregressive Models.
- ✓ **Artificial Intelligence (computer systems on imitation of human behavior)**
- Expert Systems.
- Artificial Neural Networks.
- Case Based Reasoning.

The selection depends on the purpose of the automated appraisal system (taxation, portfolio management, expropriations) and expertise in each country.

Some countries that have developed and used CAMA systems are: Australia, Canada, Denmark, Egypt, Finland, Latvia, Lithuania, Mauritius, Netherlands, Russia, South Africa, Sweden, United Kingdom, Northern Ireland, United State, Slovenia, Moldova, Hong Kong, Thailand, Brazil and Columbia.

Integration of GIS & CAMA systems

The value of a property depends on three factors "location, location, location"

A GIS system can support a CAMA system with the following main functions:

- ✓ **Spatial Analysis** (Spatial Variables, Spatial Autocorrelation, Queries in database).
- ✓ **Spatial Database** (Supports vector and raster data (ortho-images, digital elevation model, photographic documentation of the property, polygons of plots, buildings, land uses, axis of roads, points of interest), Geocoding).
- ✓ **Thematic Maps** (of assessed values, sales prices, neighborhoods, visualization of common attributes of properties like age, quality of construction etc.).
- ✓ **Web-based GIS applications** (public access to cadastral data and data of the real estate → transparency to the system and sense of justice to the citizens – taxpayers).

AVM for Residential Properties
Study Area: Municipality of Chalandri (1/7)

Study Area: Municipality of Chalandri

- ✓ Total area 10,18 km² and population 74.192 (census 2011).
- ✓ Residential/commercial region.
- ✓ 5 metro stations and 2 stations of suburban Railway, busses and trolley.

Data

- ✓ Properties Data
- Bank of Greece: xls with valuations of financial institutions for market values 693 apartments of Municipality of Chalandri for the period 2009 to 2011 and the 2Q of 2012, Properties Characteristics and Assessed Values.
- ✓ Geographic data (in Greek Geodetic Reference System 1987)
- National Cadastre and Mapping Agency S.A.: Ortho-images scale 1:500 and vector data of polygons of plots and of the boundary of Chalandri.
- Hellenic Statistical Authority: vector data of polygons of blocks and of roads axes, scale 1:5000.
- Points of interest from TeleAtlas (metro & suburban railway stations, schools, parks, hospitals, sports areas, Attiki Odos junctions entrance- exit).

AVM for Residential Properties
Study Area: Municipality of Chalandri (2/7)

Multiple Linear Regression Analysis

SPPS Statistical Software IBM 23.0

The general equation of a linear regression model is:

$$Y = b_o + b_1 X_1 + b_2 X_2 + \cdots + b_n X_n + e$$

- Y: Dependent variable (assessed value)
- X: Independent variables (property characteristics & spatial variables).
- e: error of regression model.

✓ Coefficients $b_o, b_1 \ldots . b_n$ were determined by Ordinary Least Squares method .

✓ Stepwise method of multiple regression was used because this method distinguishes independent variables which were statistically significant.

Separation of Study Area

✓ Heterogeneity of study area - complex land-uses and market values.

✓ A unique model was not be able to represent successfully and accurately the real estate overall the region of Chalandri.→ building of 3 linear regression models.

AVM for Residential Properties
Study Area: Municipality of Chalandri (3/7)

Dependent Variable

- ✓ **Market Value.** Assessed value of apartment (€).

Independent Variables - Property characteristics

- ✓ **Living Area.** Continuous Quantitative
- ✓ **Floor.** Interval Discrete Quantitative
- ✓ **Age.** Year of Valuation - Year of Construction. Continuous Quantitative
- ✓ **Number of parking spaces and stores.** Ratio Discrete Quantitative
- ✓ **Prime Quality.** If the apartment value had increased due to excellent quality of construction. Dummy Variable (1= apartment with increased value due to excellent construction, 0= otherwise)
- ✓ **Prime location/view.** If the apartment had increased value due to a privileged location, view or neighborhood (eg two facades, with view, close to a park or metro station) than the other apartments located in the area of the municipality. Dummy Variable (1= apartment with increased value due to prime location/view, 0= otherwise)

AVM for Residential Properties
Study Area: Municipality of Chalandri (4/7)

Spatial Analysis of Properties

ArcGIS 10.3 software of ESRI

- ✓ **Proximity to metro station & suburban railway station:** "service areas" ArcGIS Online service, Zones 0-3, 3-6, 6-9 minutes (walk time 5km/h). 4 dummy variables.
- ✓ **Proximity to "Attiki Odos" junctions:** Generate service areas ArcGIS Online, Zones 0-250, 250-500, 500-750 meters. 4 dummy variables
- ✓ **Proximity to "Attiki Odos":** zone 50 meters.
- ✓ **Proximity to parks:** zones 0-250, 250-500 meters.
- ✓ **Proximity to schools:** zones 0-250, 250-500 meters.
- ✓ **Proximity to hospitals:** zone 0-750 meters.
- ✓ **Proximity to sports areas:** zone 750 meters.
- ✓ **Proximity to the stream Penteli – Chalandri:** zone 100 meters.

Buffer tool

AVM for Residential Properties
Study Area: Municipality of Chalandri (5/7)

A first regression was run to the sample of each zone and the regression models were tested for multiple regression analysis assumptions. Specifically, the models were tested for:

- ✓ Normally distributed errors (Statistic test Kolmogorov – Smirnov, Histogram, Stem and Leaf plots, Normal Q-Q plot and Box plot of Studentized Deleted Residuals).
- ✓ Independence of errors (Durbin – Watson, Scatter plot of Studentized Residuals).
- ✓ Homoscedasticity errors (Scatter plot Standardized Residuals - Standardized Predicted Value, Scatter plot Standardized Predicted Value – Dependent Value).
- ✓ Multi-collinearity of independent variables (Collinearity statistics: Tolerance and VIF).
- ✓ Check for outliers and influential observations (Leverage Values, Cook's Distance, Standardized DfBetas of regression model's coefficients and Standardized DfFits).

After having removed outliers, the three final linear regression models were built and calibrated.

AVM for Residential Properties
Study Area: Municipality of Chalandri (6/7)

Regression Model of Patima Area of Chalandri

*Value = 45197,112 + 2434,437*primearea – 5239,301*age + 15165,651*floor*

Regression Model of Centre of Chalandri

*Value = 73056,623 + 2033 *primearea – 2659,177*age*

Regression Model of Rest Area of Chalandri

*Value= 54796,241 + 2133,402 *primearea – 2524,218*age + 5508,549*floor + 9662,706*stasy_3_6*

*stasy_3_6: the apartments in the zone of walk time 3-6 minutes around of metro & suburban railway stations

- ✓ Increasing the area of the property 1 sq.m. leads to different increase to residential and commercial area.
- ✓ Increasing one year of age leads to different reduction to each zone of Municipality of Chalandri.

AVM for Residential Properties
Study Area: Municipality of Chalandri (7/7)

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- ✓ Variable "Floor" is not statistically significant in the regression model of Centre of Chalandri.
- ✓ Statistically significant the spatial variable "zone of 3-6 minutes from the stations".

Web Application (1/2)

Application aims to

- ✓ to provide an approach of market values of Chalandri Municipality to the general public.
- ✓ to provide transparency on the residential real estate market.

Users

- ✓ Owners of residential properties in Municipality of Chalandri.
- ✓ Interested buyers of residential real estate in Municipality of Chalandri.
- ✓ Real Estate Agents.

The **basic components** of the application divided as follows:

- ✓ **Map:** based on the programming languages Javascript, Html and CSS with the help of code samples provided by Google site. In addition, the kml file subregions-zones, the autocomplete search box and the map legend were added to Google Map.
- ✓ **Content Management System:** WordPress platform was used to host the application on web.

Web Application (2/2)

- ✓ **Input of the parameters of the property:** completed by the user based on automated valuation models. In each of the three regression models required only to complete the statistical significant variables in the form.
- ✓ **Estimation of Market Value:** using the linear equation of the regression models for each subregion. Note that the regression models were built and calibrated for residential property based on the valuations of 693 properties in the period 2009-2012, therefore relate to the most recent levels (Q4 2015) with the help of the Index of Residential Properties Prices of the Bank of Greece.

Conclusions

- ✓ Necessity of an Official Database of Sales Prices of properties.
- ✓ CAMA system for government and taxation purposes based on National Cadastre.
- ✓ The proposed process for automated valuation of residential properties operates in local government level and based on the development of linear regression models using GIS technologies for spatial analysis.
- ✓ Due to the quality of residential data statistical analysis, only some of the independent variables were found statistically significant, as the living area, floor, age and proximity to metro and suburban railway stations.
- ✓ Regression models can be improved by incorporating recent sale prices of properties as the independent variable and correct spatial dimension of properties.
- ✓ Web application approaches easily, quickly and without cost the level of the market value of the residential properties, without providing a formal and detailed valuation.

Thank you for your attention!!

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