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RESEARCH ARTICLE

The "urban sprawl" effect on out-of-town real estate market

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Abstract

This paper examines the "urban sprawl" effect on out-of-town real estate market. There are many factors leading to urban sprawl and modulating exurban real estate market. In order to identify these factors, a survey conducted in the Larisa city fringes. Demand, which is a formulation of a number of variables, was determined using two different methods: a) the interview survey which is a descriptive method of identifying the characteristics that affect the property market and b) statistical analysis which is a quantitative assessment of suburban property demand, based on the stochastic method of hedonic regression. According to the questionnaire survey, land value is dependent on adjacency to road infrastructure, distance of the property from the city centre urban land use concentration and physical features of the property which are view adjacent to the road, shape and size of lot. The outcome that land value is dependent on the existence of important economic activity in the property's locality is consistent with the hedonic regression result, according to which there is a strong and statistically significant correlation between land sale price and distance from a major central use. Hence, the role of theses land uses is documented reflecting the impact of urban sprawl on land market. This correlation is negative, statistical significant and follows a different function for each axis of development. The function depends on type and cycle of development of each area which have a different distribution and type of land uses. That is to say, each function expresses the different way that emerging land uses and urban morphology affect the land market. This outcome is important because allows us to assess the effect of a future spatial planning project of activities in the tertiary sector, on out-of-town real estate market.

Keywords: Urban sprawl, Larissa, Fringes, Property price, Real estate market, Hedonic, Planning

Introduction

Standard policy, according to Greek reality, is that planning follows current trends without assessing the impact of the projects provisions on local land market. The central objective of this research is to evaluate the impact of exurban central uses in terms of property value, which basically reflects the impact of urban sprawl on land market. This can be used to assess the effect of a future spatial planning project of tertiary sector land uses on real estate market.

In the context of the study of urban sprawl process, an important issue arises: how and to what extent the emerging urban landscape in terms of land use patterns and urban morphology affect land market? The conditions (factors) under which urban sprawl progresses and real estate market results, are the general objective of the paper. Local, commercial real estate market conditions are reflected in the out-of-town area through analysis of commercial real estate. Selected factors were derived from Greek and foreign documentary research [Tsampaniotis, Ghardouvelis, 2012].

As mentioned above, the main issue under consideration is to evaluate the effect of a major out-of-town land use on property values. Hence, the role of these land uses as emerging "epicentres"28 of postmodern exurban landscape [Gospodini, 2006] will be documented. The above issues are examined through the example of the Larissa fringes which follow the linear development pattern.

The documentation for out-of-town real estate refers to geographic locations situated outside the country [Johnston et al., 2002]. The Greek, exurban real estate market is an almost unexplored field of research, given the lack of available data in this area. The only official studies in existence are those by the Bank of Greece [Bank of Greece, 2008] and certain authors [Symigiannis, Chondrogiannis, 2009]. However, these studies concern mainly housing market analyses on a national level or analyse property prices in the capital region of Athens. Therefore, the study of the real estate market in the fringes of a medium-sized Greek city such as Larissa is rare and necessary in Greek documentary, as it combines the real estate market with the out-of-town urban diffusion process.

On a methodological level, the official research carried out on Greek properties is based on traditional econometric models using external variables related to real estate demand (interest rates, income, inflation, etc.). However, Discounted Cash Flow Models are complex and require further financial data which is not easily available. In this approach, the possibility of an alternative method is given. A descriptive interview survey together with a hedonic pricing model were used, in order to obtain the greatest possible range of features constituting the demand for out-of-town properties, given the lack of available data for certain variables in the hedonic model.

Among these variables there are included land uses of the tertiary sector developing in the exurban space. Correlation between land sale price and distance from such a use is statistical significant according to hedonic method and thereby, these land uses plays an important role as emerging epicentres of the postmodern landscape. This enables us to evaluate the impact of a future spatial plan of a clearly defined epicentre, on the out of town real estate market.

Methodology

There is a wide range of qualitative / quantitative variables that contribute to the formation of supply and demand in the real estate market, and they are connected with the attractiveness of a property as a location for the establishment of business. The real estate market research focuses on factor groups, such as: a) economic factors related to the general economic situation and financing, b) spatial features of the region i.e. the tertiary sector activity development, the existence of infrastructure etc. c) exurban real estate market features (land availability, low land market values) d) structural (surface area, shape etc.) and location features (distance from existing networks, other markets, shopping centres etc.) and e) urban planning factors, which concern urban planning regulations (existing building ratio, permitted land uses, etc.) or other regulatory constraints (environmental impact assessments, requirements in terms of connections with road networks etc.).

Demand, which is a formulation of a number of features, was determined using two different methods: a) The interview survey which is a descriptive method of identifying the features that affect the property market and b) statistical analysis of land prices enabling the valuation of the impact of variables involved in suburban property demand. In consideration of the lack of available data for certain variables in statistical models, it became necessary to apply a combination of quantitative method with the interview survey. In the questionnaire, such variables (referred to as factors) as are considered most important in the view of commercial real estate tenants and owners are analysed. The quantitative assessment of suburban property demand is based on the stochastic method of hedonic regression [Monson, 2009]. The Hedonic pricing method was formulated to evaluate the statistical correlation between a major activity of the tertiary sector in the suburbs and real estate price increases; i.e. the increase in demand for such uses.

Data Collection– Sampling

For the purposes of the survey a non-random sampling method based on spatial criteria was used. In fact, a predefined general group was sought. The commercial real estates and the enterprises of tertiary sector located along the Larissa fringes as shown in Figure 1. These are the two main roads in the southern suburb of the city, the road to Farsala (Farsalon) and the old highway to Athens, the old highway to Volos (Volou) in the east, the old highway to Thessaloniki to the north and the roads to Karditsa (Karditsis) and Trikala (Trikalon) in the south-western and western suburbs of the city.

The illustration of the current situation of commercial real estates and enterprises was based on primary data, collected from the on-site documenting which took place during periods May-June of the academic year 2011-2012, November-December of the academic year 2012-2013 and March of the academic year 2013-2014. For the mapping of land uses, geospatial data by satellite geodatabases (Google Earth, Imagery, Open Street Map, and Topographic) and the aerial library of the Rural Area Laboratory of the Department of Planning and Regional Development (DPRD) were also used.

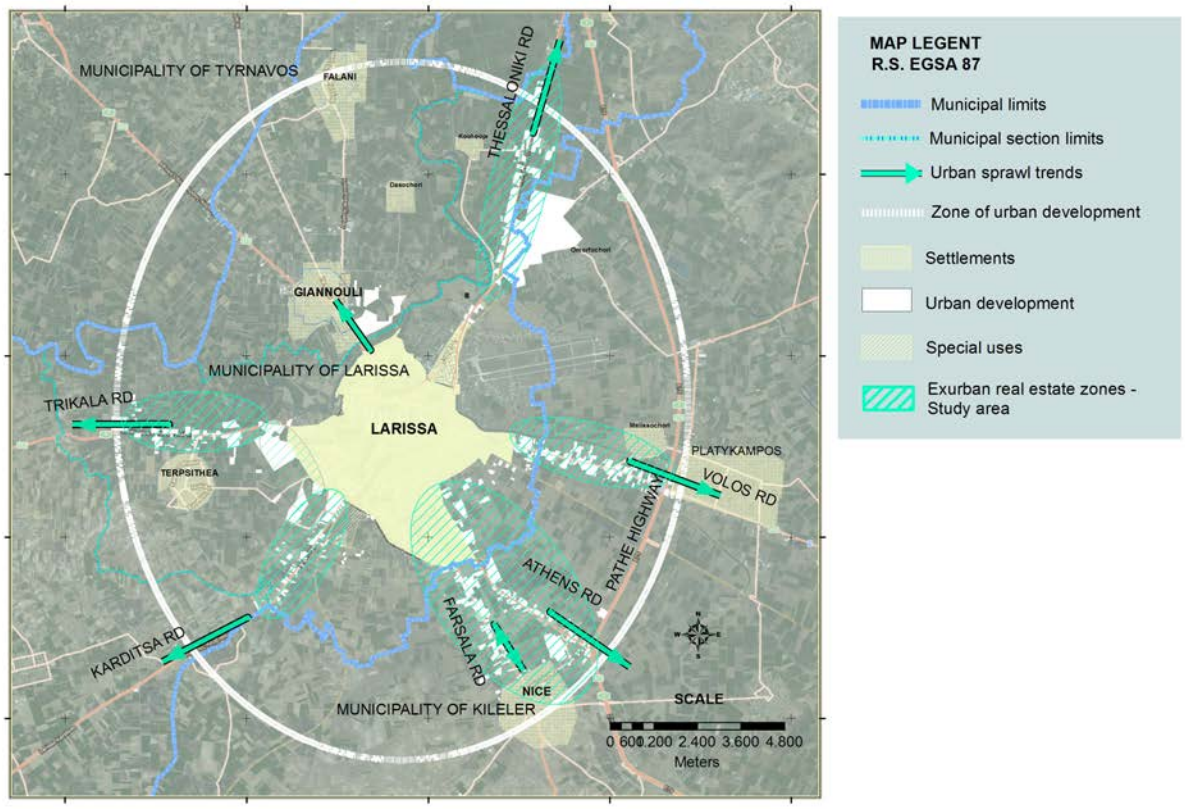

Fig 1. Study area

Participants for interview were sampled from enterprises of all sizes (large, small and medium-sized enterprises) collected from the on-site documenting, located in the city suburbs along the above mentioned road areas, operating in all professional activities of the tertiary sector; To carry out the research two types of questionnaires were created, one addressed to entrepreneurs and one to the owners of commercial properties located to the above listed roads areas. In particular, 258 business owners were recorded of which, 143 participated in the questionnaire. Approximately 250 commercial properties were identified of which 211 were being used for tertiary sector activities. Of those owners, 108 participated in the relevant survey.

To implement statistical technique, a spatial database of 245 unstructured parcels adjacent to the above mentioned roads and in proximity of a major suburban activity was initially established. Parcel mapping is based on data from satellite geodatabases, on National Land Registry [Larissa cadastral office, 2013] and OPEKEPE [Payment and Control Agency for Guidance and Guarantee Community Aid] archives using Geographic Information Systems (GIS). Supplementary data was given by owners (final size, topographic mapping) or came from secondary material (Local street plans).

The sale price observations were based on real estate market price data of 2007. According to market characteristics, it is estimated that property prices in the region until 2007 continued to depend on pre-crisis economic fundamentals. For these purposes the suitable reference point of 2007 was selected, in order for the applicable model to be used in an ordinary future post-crisis period. Market values were obtained from a real estate agency database in tabular form with

spatial reference [S2 Appendix]. The data referred to actual (market) prices of transactions carried out in 2007 and to real estate experts' estimations. This (unpublished) data was released at the responsibility of real estate agents and in the absence of any further appropriate information from other official sources (e.g. National Cadastre). Sale price observations together with locational and environmental features of properties analysed using IBM SPSS Statistics computer package.

Application of the hedonic model to the research area

The theory of the polycentric model is the hypothesis on which is based the hedonic pricing method applied in the suburb under research. This theory refers to the progress of rent on land in relation to central land uses, as shown in Figure 2 [Skouras, 2007]. The independent variable 'Market Value' (which refers to land sale price), increases as approaching the centre of an urban area via which the road in question passes and it decreases as moving away from it.

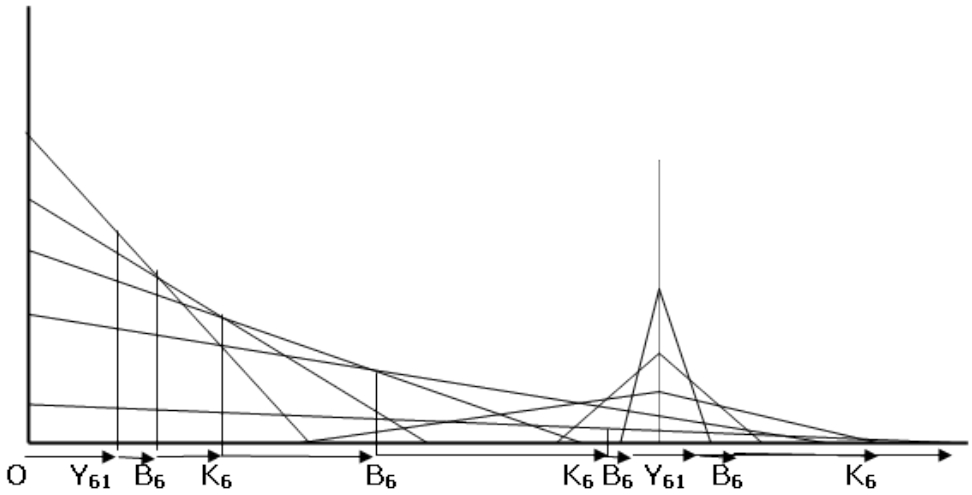

Fig 2. Creation of a Polycentric City [Skouras, 2007]

At the same time, a new 'demand curve' forms for central land uses in another centre of the urban area or the exurban zone, in this case the suburb under study which, as approaching or moving away from it (or major services of the suburb such as the shopping centre, university etc.), it increases or decreases respectively. Therefore, the correlation coefficient of these variables expressed as distance from the city centre or a central land use is expected to be negative.

The data used to implement the regression model is real estate sale prices as the dependent variable and property features as the independent variables. Of the features concerning the location of the plots (locational features), the distance of the property from the centre in kilometres was chosen. The role of the shopping centre and other major high-range central uses (e.g. Retail Park, clinic) in the configuration of the real estate market were also evaluated. To quantify this variable, distances were calculated (in km) from the centre of the area of use (shopping centre, care unit) to the centroid of each plot.

Urban planning status of the area is depicted by an indicator connected with building, expressing maximum build ability, based on the planning status in

place current in 2007. This variable was defined as Average Building Ratio or ABR, expressing the average building ratio per section of axis of development. The congestion ratio clearly constitutes an environmental variable, is expressed in 1000 m^2 of undeveloped area within a radius of 150m from the centroid of each property and is described by the OSPACE (Open space) variable. Correlatively, the land use ratio expresses the coverage of current land use within a radius of 150m from the property's centroid described by the LUSES (Land uses) variable with a focus on evaluating the effect of land use coverage on land value. More particularly, the explanatory variables of Table 1 initially participated in the model.

Table 1. Variable Definitions

Variable	**Definition**	**Development Axis**	**Units**
DC	Distance from Centre	All	(Km)
DP	Distance from Retail Park	Athens–Farsala rds	(Km)
DA	Distance from Care Unit Animus	Karditsa – Trikala rds	(Km)
DTEI	Distance from Technological Educational	Karditsa – Trikala rds	(Km)
DH	Distance from Hospital	Volos rd	(Km)
DCUSE	Distance from Central Use zone	Volos rd	(Km)
ABR	Average Building Ratio	All	%
AREA	Area	All	1000 m^2
OSPACE	Open Space	All	1000 m^2
LUSES	Land Uses	All	1000 m^2

These features were applied for the implementation of the Regression Model as k independent variables xi_1, xi_2,...,x_{ik}, in the form of:

$$Y_i = b_0 + b_1 x_{i1} + b_2 x_{i2} + ...+ b_k x_{ik} + u_i \ (i = 1,2,...n) \qquad (1)$$

Coefficients were calculated via the Ordinary Least Squares (OLS) Method. Subsequently, it was examined to what extent the resulting regression line makes for a sufficient approach of the observation values. Special statistical techniques were used for this examination, which include both the determination of the distribution attributes as well as the error terms between actual and theoretical values. These are the tests of Linearity, Independence, Normality, Multicollinearity, and Homoscedasticity. For the linearization of the correlation between X and Y and to satisfy the conditions above, relative transformations to X and/or Y were carried out.

Following the conversions of the explanatory variables and 'Y' we regressed via the stepwise regression method for the implementation of the best linear model. The model selected in which the Adjusted R2 achieves its greatest value while it carries the lowest value in the Akaike Information Criterion (AIC), Amemiya's Prediction Criterion (APC), Mallow's Prediction Criterion (Cp) and Schwartz's Bayesian Criterion (SBC). Further to that, tests were applied to distributions and error terms between actual and theoretical values.

Result and Discussion

Questionnaire research results

The commercial real estate market under research shows particular characteristics such as a high rate of owner-occupancy at 63% and a low bank borrowing ratio. Also, the majority of local enterprises are small, autonomous entities of local origin, few of which constitute large investment groups and banks active in financial markets and land titles. According to all of the above, it is estimated that land prices of the area and until 2007 still rested on fundamental and pre-crisis levels.

Investments, many of which coincide with out-the-town land sales (1955 to 2010) and according to the survey, did not significantly depend on bank borrowing and government grants, factors which, according to the sample, are given a low grading with the exception of some local zones adjacent to roads (Trikalon rd). Naturally, there is a post-2007 stagnation of road areas development, i.e. the northwest Kozani road region and Pantheon Plaza region near the southern city limits. In the remainder of the regions land supply and its development, with the creation of central land uses, continues to 2012 though simultaneously there is a significant number (38) of properties vacant.

In the entrepreneurs' assessment shown in Figure 3, out-of-town development axes concentration of tertiary sector use is, for the majority of those asked, connected with land availability, low land value and existence of suitable transport infrastructure in the proximity of the real estate in question. This infrastructure is the road network providing transport for the businesses in question and assures access to markets. Location of the property with regard to the city of Larissa plays a significantly major role in the establishment of businesses in the area. A large number of enterprises also consider the general pre-crisis economic situation to be a decisive factor, despite the significant standard deviation of answers (44% consider the economic situation an important factor and 39% not). The abovementioned factors are considered as most important (with a rating of <5 on a scale of 1-10 in descending order) by all enterprises categories, very small and medium sized enterprises, with the latter placing greater emphasis on the property's relevant location with regard to the city and major roads.

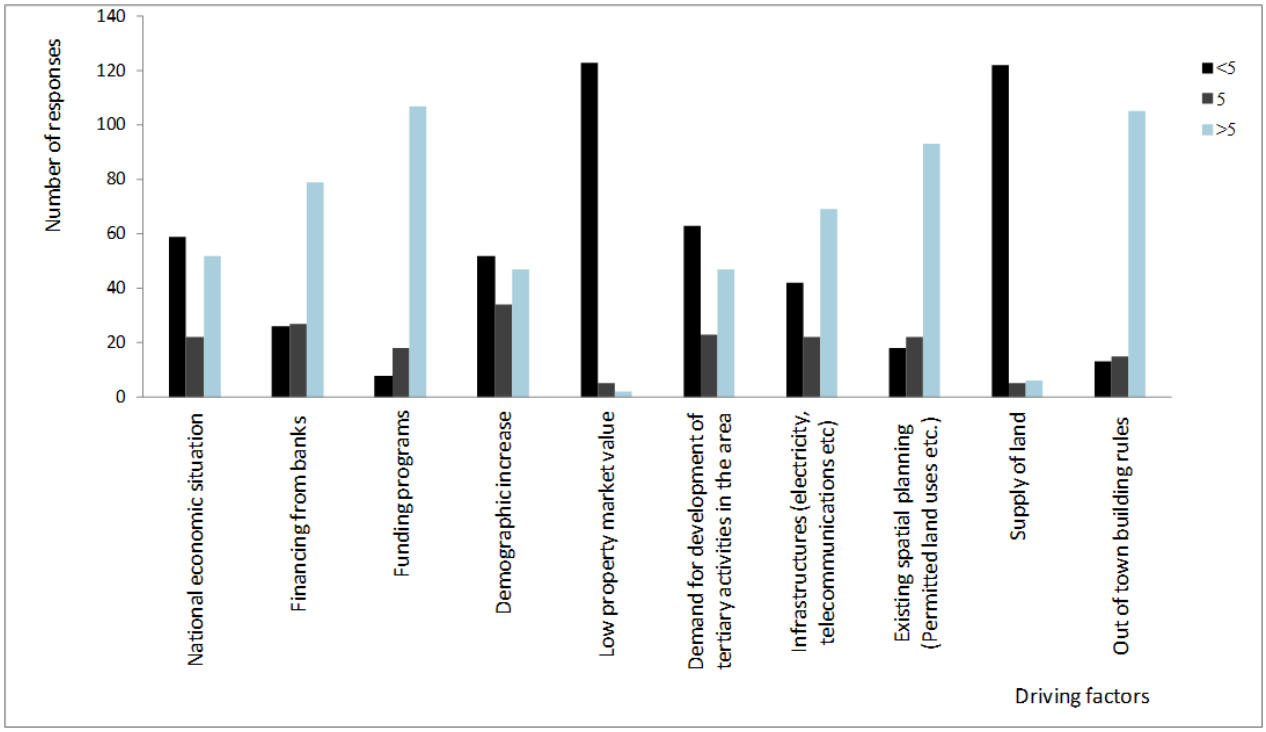

Fig 3. Evaluation of factors leading to the development of tertiary sector uses

According to the evaluation of factors leading to land prices increase, shown in Figure 4, view adjacent to the road, shape and size of lot play the most important role. With regard to services in the property's locality, it is noted that the existence of activities in the tertiary sector constitutes a significant factor, since it is rated at an average of 2.21 on a scale of 1-4 in descending order.

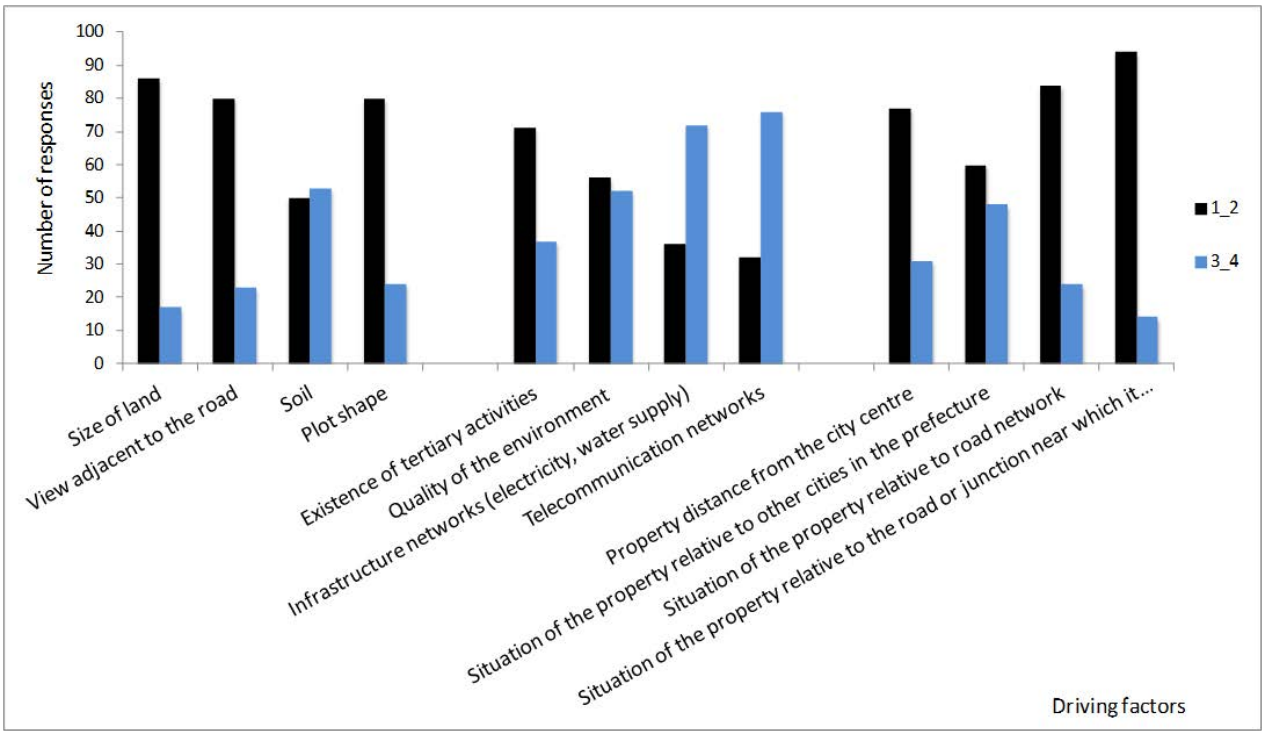

Fig 4. Evaluation of factors leading to land prices increase

Location of the property in relation to the city plays a major role and yet the most important role is played by the situation of the property relative to the road or intersection near which it lies. Aside from the low average, the latter factor shows a minor standard deviation, since 70% of those questioned rated it 1. Location of the property in relation to the region's road axes network received the subsequent rating.

Market analysis results

Sample trends in the development axes were analysed using "Geostatistical Analyst" extension of ArcMap application (in ArcGIS) as shown in Figure 5. In the case of the development axes of Athens, Farsala, Karditsa and Trikala roads, between sale price and distance from the city centre there is a tendency expressed with a 3rd degree polynomial in the form of the equation (1). In the case of the Thessaloniki road area, there is a tendency in real estate market value expressed with a multiplicative model:

$$Y = \gamma_0 X^{\gamma_1} \cdot \varepsilon \quad (2)$$

or an inverse exponential function of X (distance) in the case of the Volos road area:

$$Y = \gamma_0 e^{-\gamma_1 x \cdot \varepsilon} \quad (3)$$

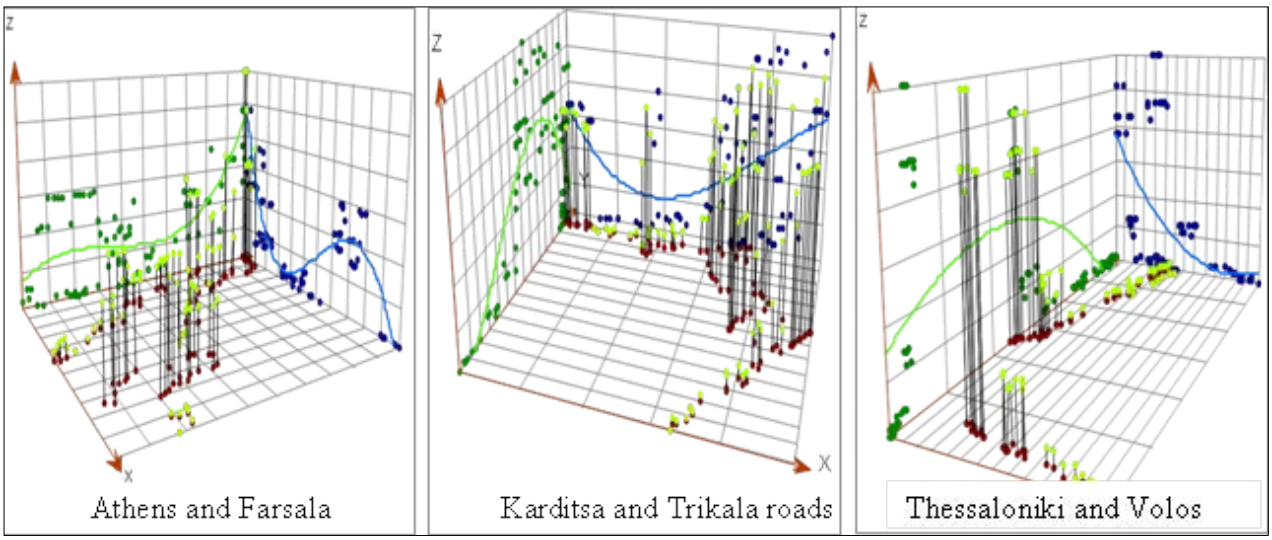

Fig 5. Analysis of the sample trend in the development axes (Processing in Geostatistical Analyst-GIS)

In three-dimensional trend diagram, the green and blue points are vertical projections of the observations (sale prices) at the surfaces formed by the Z-Y and Z-X axes, respectively. In the case of the development axes of Athens and Farsala, blue line in the diagram, starting with high values, decreases as it moves toward the middle of the X-axis and then again increases. Similarly, the bright green line, takes high values as it moves north and low when it moves to the center of the Y axis. This shows that the data exhibit a strong trend on the ends of the spatial sample, where high values are observed. In the beginning values are high due to the proximity to the city center and the existence of the shopping center of Pantheon Plaza, and then observing falling prices with increasing distance from the city center, and as decreasing distance from the

Larissa Retail Park begin again to rise and then reduce as moving away from the commercial activity.

In the case of the development axes of Karditsa and Trikala roads, blue line in the 3D trend diagram starts with high values, reduces as it moves toward the middle of the X-axis and then again takes high values. The light green line, starts at low prices and as it moves to the center of the Y-axis (Trikalon ring road) gets high prices (existence of important central uses). This indicates that the data exhibit a strong trend across the spatial sample in one direction (east-west), where high values observed in the city suburban perimeter and as moving west reduce until they start to rise again in 5th km of the road to Trikala (where the care unit is located). As moving from south to north, values form inverted shape U in the middle of the ring road area.

In the development axes of Thessaloniki and Volos roads values, reduces as getting away from the city center. Figures 6, 7 and 8 illustrate the land market configuration in relation to urban development along the Athens, Farsala, Karditsa, Trikala, Thessaloniki and Volos roads.

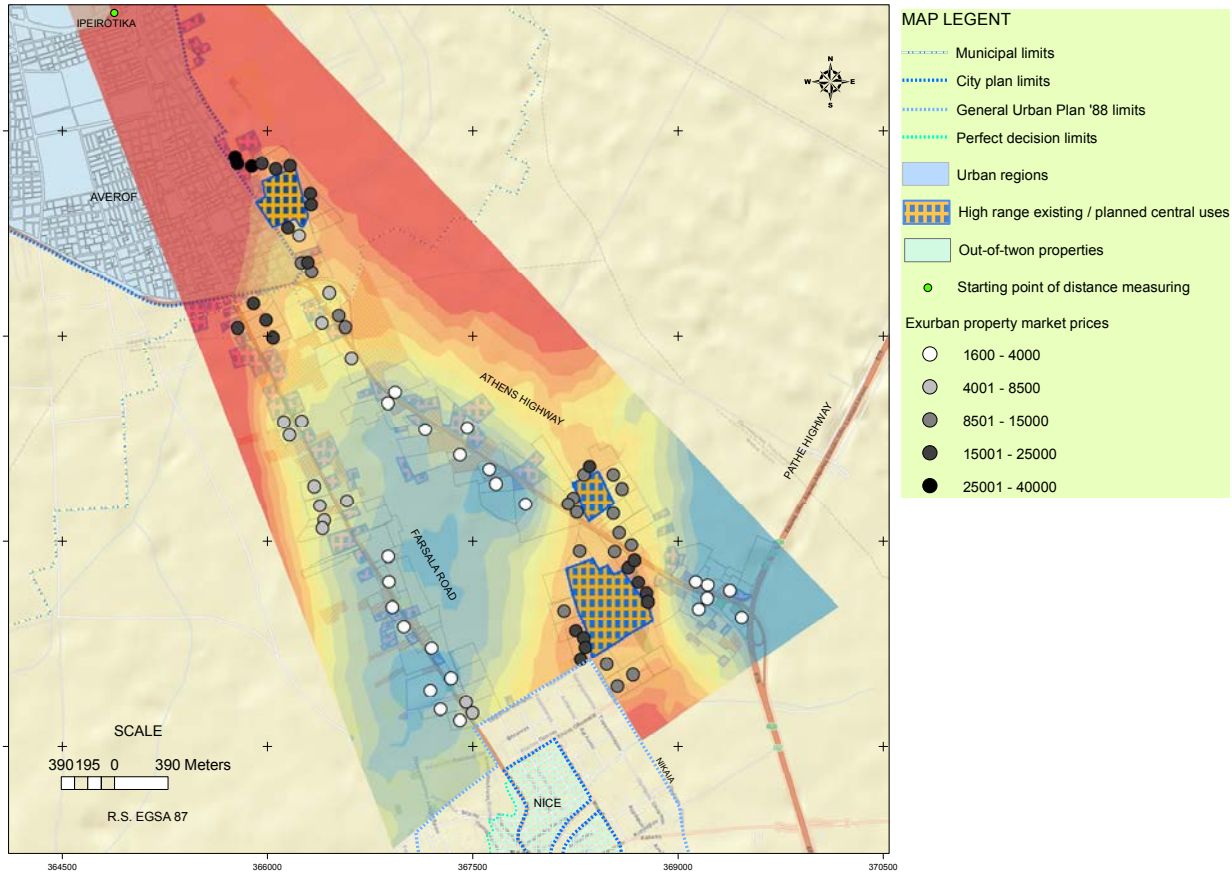

Fig 6. Real estate market along the Athens and Farsala roads

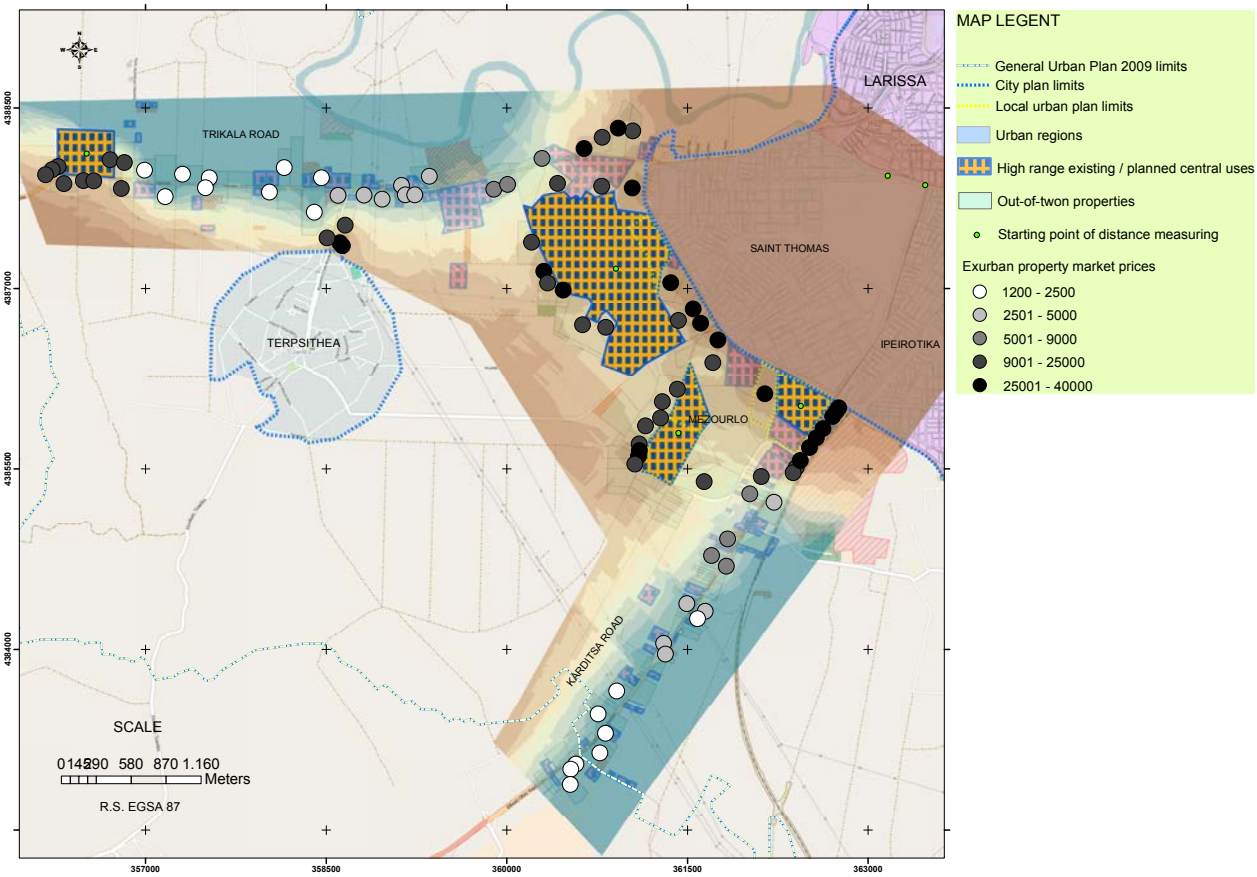

Fig 7. Real estate market along the Karditsa and Trikala roads

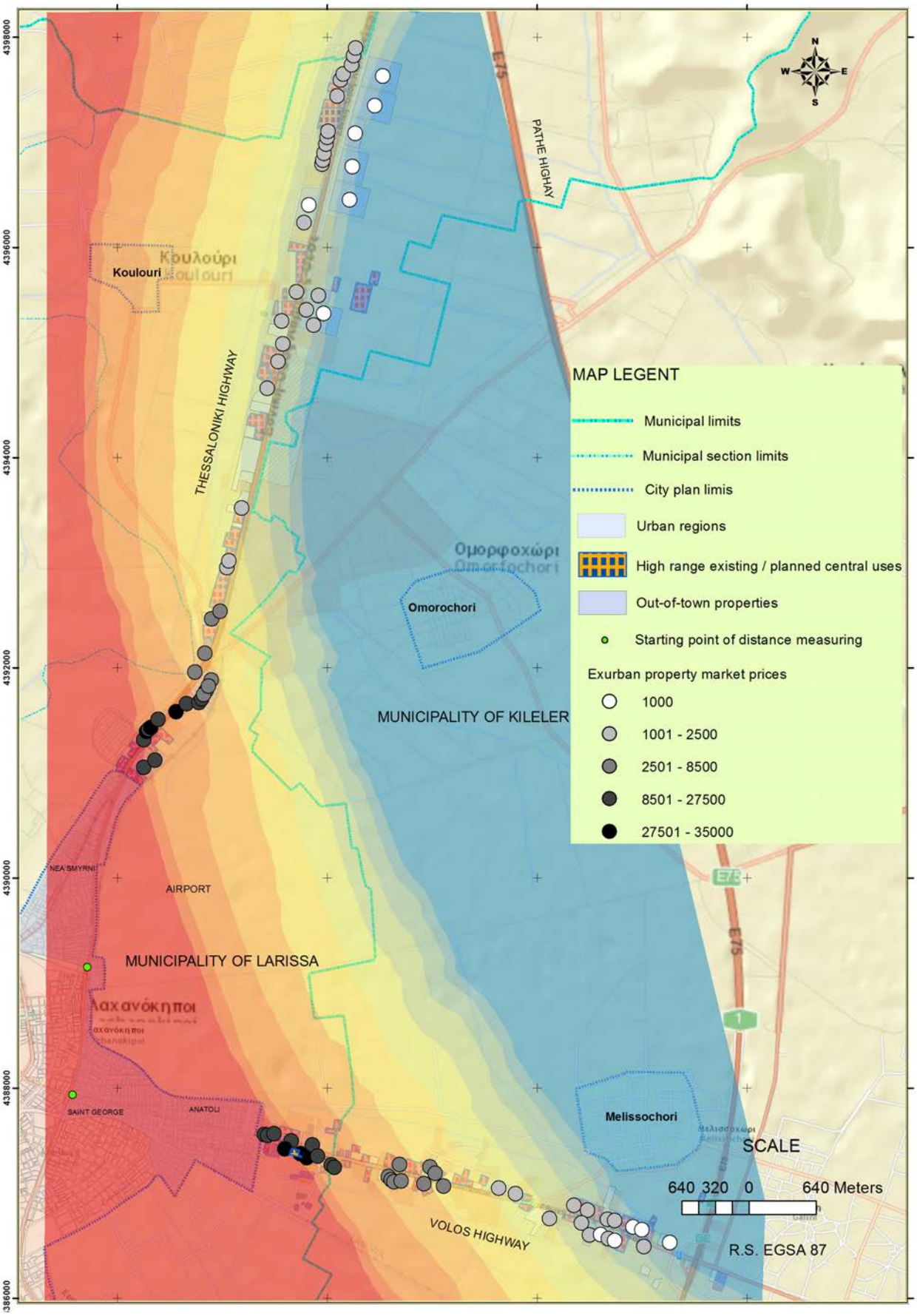

Fig 8. Real estate market along the Thessaloniki and Volos roads

Hedonic model results

Model Summary is shown in Table 2. This table notices that Adjusted R2 in the final model of each development axis indicates that the independent variable is responsible for over 80% of the value variability of the dependent variable or in other terms, more than 80% of the actual variability is explained in the model.

Table 2. Model Summary

Statistics	**Development Axes**				
	Athens-Fars. rds	**Kard.-Trikala rds**	**Thess/ki rd**	**Volos rd 1**	**Volos rd 2**
N	77	78	42	36	48
R^2	0.870	0.810	0.981	0.980	0.824
Adj. R^2	0.863	0.797	0.979	0.978	0.816

The angle of the coefficients of distance from the city centre and central land uses differs right from point zero bearing statistical significance ($p \leq 0{,}001$), according to Table 3, meaning a significant prediction of the dependent variable from these independent variables. According to standardized coefficients Beta, they came first the coefficients of the distance parameters from the city centre followed by coefficients of distances from central land uses.

Table 3. Coefficients

Variables / axes	Coefficients	Beta	t	Sig.	VIF
Athens – Farsala rds					
(Constant)	-18939.298		-6.385	.000	
OPDC	48090.183	1.041	20.943	.000	1.366
OPDP	5228.933	.605	11.076	.000	1.647
LNLUSES	-456.684	-.181	-3.565	.001	1.419
LNOSPACE	2713.326	.165	3.457	.001	1.266
Karditsa – Trikala rds					
(Constant)	-19853.413		-7.270	.000	
OPDC	99848.220	.869	13.121	.000	1.662
OPDA	8083.696	.584	9.683	.000	1.378
ABR	12974.750	.223	3.625	.001	1.429
LNAREA	-2530.760	-.214	-3.846	.000	1.174
OPDT	4340.467	.176	2.533	.013	1.823
Thessaloniki rd					
(Constant)	11.119		17.131	.000	
LNDC	-1.549	-.647	-21.082	.000	1.807
LNABR	2.000	.390	13.227	.000	1.672
LNAREA	-.247	-.223	-7.966	.000	1.504
LNOSPACE	.396	.068	2.372	.023	1.601
Volos rd: Model 1[29]					
(Constant)	9.727		37.014	.000	
DH	-.849	-.817	-20.231	.000	2.594
AREA	-.033	-.136	-4.210	.000	1.663
ABR	1.058	.109	3.010	.005	2.066
Volos rd: Model 2					

(Constant)	-25567.651		-5.049	.000	
OPDCUSE	8250.493	.354	3.232	.002	3.072
OPDC	109285.103	1.176	10.731	.000	3.072

Due to the fact that in the Volos road region there is no central land use development beyond the 2 kilometre distance from the Larissa city limits, since the wholesaler's centre where the hospital is situated simply makes for an extension of the city centre, an alternative scenario was chosen. According to the new model, we assumed the creation of a new central uses zone, named as DCUSE converted to $OPDCUSE = \frac{1}{DCUSE}$ variable, 5 kilometres from the city centre which would have the same effect on the value of real estate to that of Retail Park Larissa on Athens road axis whereas the value of land would follow a respective polynomial. By this admission and the relevant conversions, the regression equation which applies these values was recalculated producing Model 2. This way, we produced two models for the Volos road area: Model 1 which represents the current situation and Model 2 referring to a scenario for the creation of a new central uses zone away from the city centre. In order to residuals be controlled in all models, we carried out regression of y on $\hat{Y}$, so the final function of the Y prediction results according to the Table 4:

Table 4. Hedonic Method Summary

Development Axes	**Hedonic Model**	
Athens-Fars. rds	$\hat{Y}$(MVALUE)=-18939,298+48090,183*OPDC+5228,933*OPDP-456,684*LNLUSES+2713,326*LNOSPACE	(4)
Kard.-Trikala rds	$\hat{Y}$(MVALUE)=-19853,413+99848,220*OPDC+8083,696*OPDA +12974,750*ABR-2530,760* LNAREA+4340,467*OPDT	(5)
Thess. rd	$\hat{Y}(MVALUE) = e^{10.868 - 1.544 * LNDC + 1.921 * LNABR - 0.248 * LNAREA + 0.439 * LNOSPACE}$	(6)
Volos rd: Model 1	$\hat{Y}(MVALUE) = 0.9968 \cdot e^{(9.727 - 0.849 * DH + 1.058 * ABR - 0.033 * AREA)^{1.0003}}$	(7)
Volos rd: Model 2	$\hat{Y}$=-25370,7801+108443,6077·OPDC+8186,9642· OPDCUSE+122,67	(8)

Conclusions and Recommendations

In Greece, commerce and leisure uses has been left to economic activities of private sector without planning [Gospodini 2007]. Current planning includes building derogations and regulations which essentially favour linear urban diffusion [Portokalidis, Zygouri, 2012]. Spatial planning in the area under research, comprising out of town building development regulations (derogations concerning surface area of a buildable lot, building ratio etc.), seems to have an effect on the exurban real estate market. This effect refers to the physical characteristics of the local real estate i.e. dominance of small properties along

roads and to land sale price which seem to be affected by the current Building Ratio of the area according to the hedonic pricing method.

Assessment of the impact on of central land uses in terms of property value can be used to evaluate any impact the establishment of a master plan in order to control exurban tertiary sector land uses would have on land prices. Standard policy, according to Greek reality, is that planning follows current trends without the simultaneous evaluation of the effect of various projects provisions and regulations on the local land market. In this dissertation the appropriate out of town spatial planning model, is proposed, in order to control land uses and to evaluate its effect on out-of-town land prices.

Calculation of the final area of zones designed to receive central land uses depended on the development tendencies of the local population. Taking into account the fact that the exurban region of Larissa shows radial expansion tendencies, an external elliptical zone of approximately 7-9 kilometres radius (distance from the city centre) was created as shown in Figure 9. This zone was divided into an eastern arc (ellipse section) encompassing the region of the Thessaloniki, Volos, Athens, Farsala roads and the western arc (ellipse section) encompassing the Giannoulis, Trikala and Karditsa roads region.

For the evaluation of the required surface area of zones designed to receive the new land uses, future population growth tendencies of the two arcs were calculated. The population of the western arc was calculated by adding the population of Terpsithea, Giannouli [Hellenic Statistical Authority, 2001, 2011] and western district of the Larissa conurbation [Tsakiris, Lalenis, 2006]. The population of the eastern arc was calculated by adding the population of Nice, Platykampos, Koulourion [Hellenic Statistical Authority, 2001, 2011] and eastern districts of the Larissa conurbation [Tsakiris, Lalenis, 2006].

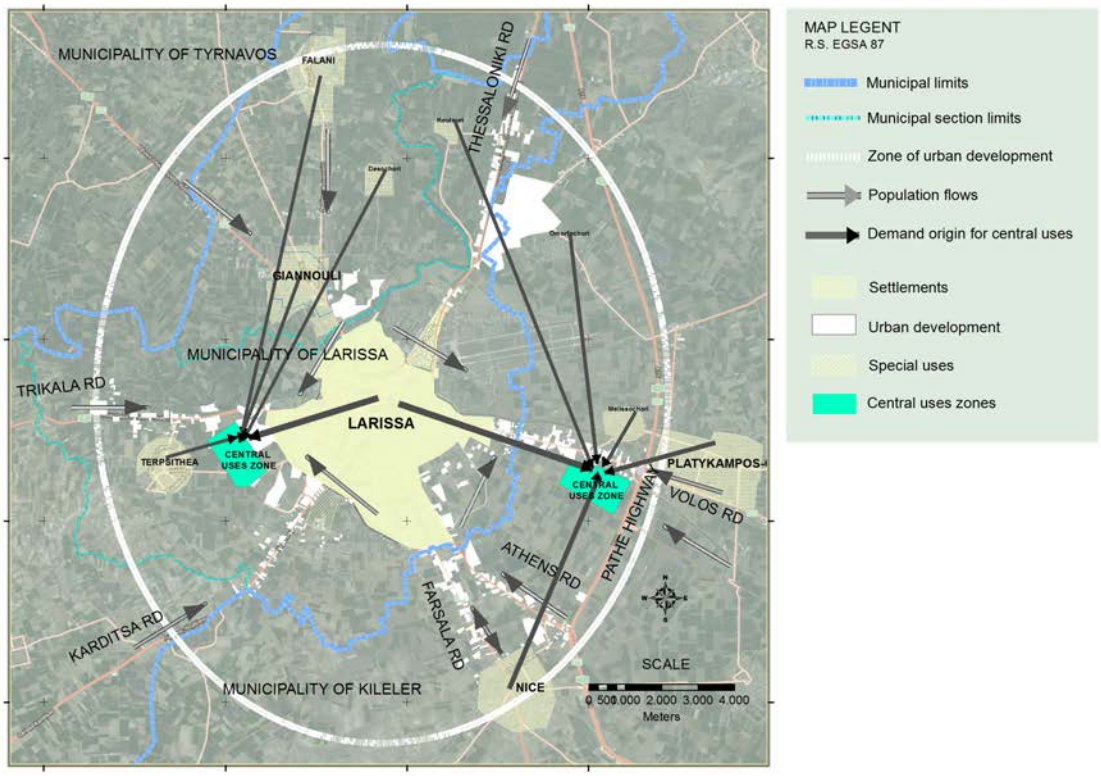

Fig 9. Central land uses zones in the Larissa exurban region

Thereafter the population change for the period 2011-2025 was calculated. The extra population means extra demand for more space for construction, according to current urban planning standards per person [Ministry of the Environment, Physical Planning and Public Works, 2004], as shown in Tables 4 and 5.

Table 4. Assessment of the construction demand in the western arc zone according to urban planning standards

Land Use	**Demand population**		**Land standards**	**Construction demand (sq.m)**	
	2001-2011	**2011-2025**	**Sq.m/ inhabitat**	**2011**	**2025**
Public services	11512	10.698	0,5	5756	5349
Sports - Leisure	11512	10.698	5,5	63318	58840
Culture-Leisure	11512	10.698	0,2	2302	2140
Educational-sports complexes	3000	3000	30	90000	90000
Retail park, wholesale	14714	13.937	2,5	36786	34842
Retail	14714	13.937	1,4	20600	19512
Total				218763	210683

Table 5. Assessment of the construction demand in the eastern arc zone according to urban planning standards

Land Use	Demand population		Land standards	Construction demand (sq.m)	
	2001-2011	2011-2025	Sq.m/ inhabitat	2011	2025
Public services	13510	8014	0,5	6755	4007
Sports - Leisure	13510	8014	5,5	74303	44077
Culture-Leisure	13510	8014	0,2	2702	1603
Educational-sports complexes	1500	1500	30	45000	45000
Retail park, wholesale	16712	11253	2,5	41779	28132
Retail	16712	11253	1,4	23396	15754
Total				193935	138572

Urban planning standards have been adjusted to the region particularities. The type of standard was selected in accordance with the type of use proposed to be located in each zone. In the case of the western arc area, educational-sports complexes standards were used, since the region is intended to receive educational uses. This type of use involves educational-cultural-sports complexes with minimal surface per user 20 to 30 m^2. and at least two units (1500 users per unit viable volume, i.e. 3000 users for 2011 and 2025, since there is no increase in the population).Also, because of that commercial uses are considered as a commercial-leisure park, urban planning standard provided for wholesale facilities, technology centres and business parks, was used.

To meet local needs for urban space, the index value, for agglomerations over 25,000 inhabitants, defined from 0.7 to 2.5 m^2 / inhabitant. Since the surface area shows significant wholesale ratio due to its commercial character and because these are uses of regional level, at least, a 2.5 m^2 / inhabitant standard was selected. The change of the population in Tables 4 and 5 includes local population change and prefecture population change. For retail, shopping center area per person was used, i.e. 1.4 m^2 / person according to the building code, since it is considered the most appropriate for the case of a commercial suburban center.

This demand should be absorbed by suitable space with a high ratio of public spaces, free open spaces and networks of up to 50%, a low average building ratio (0.2) and saturation ratio of λ = 0,55-0,6. Also, due to that the eastern zone being intended for the establishment of transport companies and freight terminal, building demand multiplied with a coefficient of 0.5 (1/2) as opposed to a demand of 1/3 for the western zone. On a soil suitability level (gullies, subsoil, etc), a suitability coefficient of 0.8 was considered proper due to the fact that in general terms the region, as well as based on interview survey and autopsy, does not offer unsuitable soil. By these assumptions required land area is estimated to be:

$211/3^* 0.5^*0.2^*0.6^*0.8$=1,463,000 m^2 land area for the western arc zone (9)

$139/2^*0.5^*0.2^*0.55^*0.8$=1,575,000$m^2$ land area for the eastern arc zone (10)

The necessary land areas for central activities are estimated with an outlook until 2025 equivalent to 3,038,000 m^2.

The hedonic model considered for the area under research previously, may be used for valuation of land prices within the receiving areas for new uses. This way, land prices in the western arc zone for a 4000m^2 properties located three kilometres from the centre, 500m from the Technological Educational Institution and four kilometres from the care unit Animus, having a building ratio of 0.8 results according to the equation (11). Respectively, land value in the eastern arc zone for a property that is located 5 kilometres from the centre and 330 m from the central uses zone rises according to the equation (12).

$$\hat{Y}(MVALUE)=19853.413+99848.220*OPDC+8083.696*OPDA+12974.750*ABR-2530.760*LNAREA+4340.467*OPDT= € 31003 /1000m^2. \quad (11)$$

$$\hat{Y}(MVALUE)= -25370,7801+108443,6077\cdot OPDC+8186,9642\cdot OPDCUSE + 122,67= € 21250 /1000m^2. \quad (12)$$

There are many factors leading to urban sprawl and modulation of exurban real estate. According to the research questionnaire carried out in exurban real estate of Larissa, land value is directly dependent on adjacency to road infrastructure following the diffusion process which remain associated with major main roads, as in the case of USA and North Europe initially and southern Mediterranean European cities thereafter [Gospodini, 2006]. Linear development pattern along motorways reflects new developments in the enterprises location criteria, i.e. Thessaloniki, Athens [Gospodini, 2006], Milan [Foot, 2000] and also in medium sized Greek cities – Volos, Larissa, Kavala, Comotini [see Gounaris and Digridakis, 2005].

According to the questionnaire survey, land value is dependent on the existence of important economic activity in the property's locality. This is consistent with the hedonic regression outcome, according to which there is a strong and statistically significant correlation between land sale price and distance from a major central use. Studies made for Athens [Emmanouil, 1999] and Larissa [Maloutas, 1999] showed that a large concentration of stores and services (or basic employment in services sector) in the suburb attract the upper middle classes of households and in the case of Athens, there was a more than doubling of market housing values (Bank of Greece published data) and office rental [Triantaphyllopoulos, 2005].

Furthermore, in the research area, location of the property with regard to the city of Larissa plays a significantly major role in the establishment of businesses and the formation of land value. This outcome verifies land use allocation theory and it is consistent with the literature for Greek cities, according to which land value is presented as a variable depending on the distance from one or more centers [Skouras, 2007] and households follow the same pattern.

In the questionnaire survey also found that land value is dependent on physical features of the property. According to the evaluation of factors leading to land prices increase, view adjacent to the road, shape and size of lot play the most important role. Most studies show that the size of the structure [Monson, 2009], that is the building itself, has a positive impact on the sale price since the potential economic exploitation of the property increases. The same applies to

the lot size, constituting initially a positive structural feature, though one which is directly related to the surface area of a buildable lot according to out-of-town building regulations. This way, from some point on (usually on land over 10000 m2), according to land market research, the value (€ per1000 m2) reduces, as the lot in conjunction with its shape and view adjacent to the road, cannot be exploited (built) further.

Demand is also connected to land availability and its initially low acquisition price as the shift of activities is led by the desire for greater profit yields, to control markets [Arseniou, 2009] and to avoid congestion, which has been a topic of studies for many a scholar [Kumar, 1990]. According to the example of the Thessaloniki metropolitan region, trade development and especially of "out-of-town" supermarkets and shopping centres is linked to the major main road axes and availability of land to build (buildings and land) [Giannakou, Kafkalas, 1999].

On an urban level, the development of the city of Larissa would be said to be broadly approaching the radial model comparing with the Sector Model of Hoyt [Bourne, 1971] but in conjunction with the polycentric model expressed by theory of multiple nuclei model of Harris and Ullman [Tsouderos, 2002] or the Urban Realms Model of J. E. Vance [Kron, 2014].

Hedonic pricing method applied in the suburb under research is based on the theory of the polycentric model. According to this theory, demand curves are as many as the 'epi(centers)' created in the suburb and / or in the downtown. These 'demand curves' increase as approaching from a center and decrease as moving away from it. Therefore, the correlation coefficient between land value and distance from the city centre or a central land use is expected to be negative.

However, correlation between land property prices and distance from a central land use not always negative. Regression model applied to the exurban land market of the Washington County portion of the Portland, Oregon, metropolitan area [Nelson, 1993], following a dispersed rural – residential pattern, gave a land-value gradient different from the demand curve of figure 2. 'Edge cities' developing in the city's suburbs are considered by households sources of congestion, pollution, noise, so that the price of exurban land increases as moving away from these areas to the exurban space rather than decreasing.

According to the hedonic pricing method implemented in the research area, factors that mainly define the real estate market are distance from the centre, vicinity to major tertiary sector activities and building which is expressed through the average building ratio of the area. Correlation between land property prices and distance from a central land use is negative, statistical significant and follows a different function for each axis of development. The function depends on type and cycle of development of each area which have a different distribution and type of land uses. That is to say, each function expresses the different way that emerging land uses and urban morphology affect the land market. In literature [Skouras, 2007] pricing method is based on an exponential function of land value in relation to the city center (or centers).

Therefore, in a linear development pattern of the exurban space, if there are two centers, the city center and some major central use at the end of the axis (rds to Athens - Farsala) or on the perimeter of the city (rds to Karditsas -

Trikala), the function between land price and land attributes can be expressed better with a linear model. If the city center or a major central use is located at the beginning of the development axis (rds to Thessaloniki, Volos), then the function between land price and land attributes can be expressed better with an exponential model. Subsequently, the prediction models of the hedonic method are summarized:

Table 6. Out-of-town Land prices models

Central uses layout	**Land price function**
City center & central uses on the perimeter - end of the axis	Linear model
City center – central use located at the beginning of the development axis	Exponential model

According to the literature and case study results, found that there are (spatial-temporal) levels and variations of the urbanization / urban diffusion process from the monocentric to the polycentric, the dispersal or the linear scheme. Land prices are differently affected depending on the scale of urbanization, the specific characteristics of each urban area and the criteria by which these characteristics (eg urban center, edge city, mall) are assessed by the social classes, investors and generally those involved in the process of reproduction of the built space.

Finally, it was concluded that the role of emerging epicentres of the postmodern exurban landscape on land prices is significant and hereby the role of theses land uses is documented reflecting the impact of urban sprawl on land market. Furthermore, valuating the impact of central uses in terms of property value can be used to assess the effect of a clearly defined epicentre in the exurban space.

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"New centralities of diffused urbanity" (Gospodini, 2006), are the type of "clearly defined epicentres" which refers to the phenomenon of dispersed built in urban fringe belts, including commerce and leisure uses, shopping centres, theme parks and amusement parks.

In the case of the model one of Volos road area, between DC and DH variables a choice had to be made given the absence of observations within the city plan (the sample distribution begins from the city edge) and because the hospital located near the city edge makes for an extension of the city centre. If both variables (DC and DH) were to be chosen as independent variables, multicollinearity problems and overestimation of the coefficients would result. Finally, DH was selected as an independent variable rather than DC, since DC shows heteroskedasticity and less clear test on autocorrelation. Also with DH we have better implementation of Rsq.

Supporting information captions

S1 Appendix: Questionnaire research results
S2 Appendix: Property research results
S3 Appendix: Regression results