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DRIVING FACTORS AND EMPIRICAL ANALYSIS OF URBAN SPRAWL IN GREECE

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Abstract
This paper aims at describing urban sprawl driven land use changes during the last decades in Greece as well as analyzing the major regional and economic development implications. Particular attention is given to the analysis of possible driving forces with economic and social origin that contribute to the sprawl of urban forms in the suburbs and into the countryside. We employ an ordinal regression model in order to investigate the likely driving factors of urban sprawl across NUTS-III municipalities in Greece. Ordinal regression is a variation of ordinary regression which is used when the dependent variable is categorical and the explanatory variables are continuous or categorical ones. The results of the empirical analysis bring up some important issues relevant to the theoretical framework of the study. The degrees of influence of the individual factors as well as their level of significance vary considerably. Accessibility, informal housing practices, direct population potential and the existence of coastal natural resources seem to fuel urban sprawl. Overall, we think that this empirical research can provide decision-makers with important information concerning the major factors which influence urban sprawl. In the context of planning a sustainable regional development policy the major driving factors and the spatial patterns generated by urban phenomena such as urban sprawl and illegal housing are of crucial importance. Urban sprawl phenomenon has hardly been analyzed at the regional level in Greece. Most existing studies focus on the periphery of great metropolitan areas. Yet, an overview of urban sprawl patterns at a broader scale can give valuable information on the basic trends of the phenomenon across the country and uncover certain spatial differences in the magnitude of sprawl between locations.
Keywords: Urban Sprawl, Ordinal Regression, Land Use Change, Informal Housing.

1. INTRODUCTION

In recent year, the geographical boarders between urban space and the countryside are difficult to identify. Intense sprawl of urban forms in the periphery of cities and beyond is a reality raising several

concerns about the consequences of urban development on the environment (Burchell et al., 1998; Lopez and Hynes, 2003; De Ridder et al., 2008). Ex-urban areas are being transformed rapidly becoming places of sustaining various, very often conflicting uses (Burchell et al., 1998; EEA, 2006). The new patterns of urban expansion seem random and unintentional not matching to any of the well-known urban geometric models proposed at the first half of the 20th century. The aforementioned developments have brought about considerable changes in the relationship between urban and ex-urban areas. The volume of exchanges between urban and rural areas has escalated whereas the types of exchanges have been enriched (EEA, 2006).

Several scholars and planners argue that the boarders amongst urban areas and the countryside have already collapsed (Burchell et al., 1998). Urban sprawl is a phenomenon that affects sizable areas far beyond city suburbs (Theobald, 2001). In that respect, there is general consensus that urban sprawl holds some identifiable characteristics (Zhang, 2000):

- Vast special dispersion of urban activities and forms in the countryside, even in remote areas,
- Distinctive linear developments across road infrastructure,
- The emergence of large open areas with scattered urban forms, patches of urban activities and housing units of no particular pattern in space.

In most cases sprawl is a the process of urban change that leads to undesirable urban development patterns making space more homogenous and at the same time even more unstable. Moreover, the intensity of land use antagonism creates constantly new urban forms and also influences the social aspects of rural areas. Land fragmentation emerges as a side-effect, the established dynamic equilibrium amongst urban network, rural space and natural ecosystems gets disrupted and the local communities start changing their structure seeking an different role in the regional context (Burchell et al., 1998; Grimm et al., 2008). Therefore, urban sprawl affects not only existing land uses but also natural equilibriums and social institutions, norms and behaviors (Glaeser and Kahn, 2004; Fan et al., 2008; Grimm et al., 2008). To extend knowledge and understanding of the causes of observed variability and changes regarding urban expansion and to design effective urban planning policies presuppose thorough understanding of past and current urban sprawl trends. The mechanisms by which the observed expansion of the built-up area happens might be a crucial matter (Razin, 1998).

As regards the driving forces of the phenomenon, there is a need to identify and estimate the all major factors that influence not only the per capita consumption of land but also the factors that determine the special characteristics of that land. The relevant literature (Fujita, 1996; Burchell et al., 1998; Brueckner,

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2000; Theobald, 2001; Veldkamp and Lambin, 2001; Glaeser and Kahn, 2004; Foley et al., 2005; EEA, 2006; Fan et al., 2008) suggests that the level of experience in the filed urban planning in each region, transportation policy, preferences of individuals regarding the characteristics of their homes and the location decisions of certain economic activities, influence considerably the magnitude and patterns of urban sprawl.

In this article, we attempt to approach the new urban sprawl geography in Greece by mean of an empirical analysis. The particular goals of this paper are a) to identify and evaluate the spatial variations in the magnitude of urban sprawl and b) to examine the likely factors that explain this variability of sprawl as well as the relative importance of each factor. The aforementioned goals are pursuit by means of an empirical model that simulates and analyzes the interactions between urban sprawl and a range of economic, social, environmental and policy factors. In this way, we estimate the effect of the factors on the magnitude of urban sprawl across the districts of the country. Following introduction, the article comprises four main sections. The next section reviews selective theoretical perspectives as well as previous empirical research in the field of urban sprawl. The third section presents the study area and the spatiotemporal scale of analysis, the independent variables used data sources and finally, the methodology and the specific techniques employed. The fourth section deals with model calibration, data analysis and results interpretation. The last section comments on the wider implication of urban sprawl on regional development.

2. THE COMPLEXITY OF URBAN SPRAWL PATTERNS: REVIEW OF THEORETICAL AND EMPIRICAL ASPECTS.

It is widely accepted that in recent years the per capita consumption of land has been rising sharply (Burchell et al., 1998; Brueckner, 2000; Glaeser and Kahn, 2004). This tendency has resulted in extensive areas of low population densities. These territories share a relatively large area and a low urbanization level. This type of urban development is associated with a number of negative environmental and public health issues (Fujita, 1996; Glaeser and Kahn, 2004) causing considerable concern. Past and current theoretical and empirical research on the driving forces as well as the proximate and underline causes associated with the phenomenon has contributed in the formation of a significant body of theoretical schemata and conceptual frameworks on the topic (Burchell et al., 1998). This theoretical and empirical quest is complex and uses several elements coming from diverse theoretical traditions such as urban and regional economics, political economy and natural and social theories.

Amongst the post war schemata of interest referring to urban development is growth pole theory by Perroux and Boudeville (Priemus et al., 2004). The theory focuses on the influence of large industries on their surrounding area arguing that the developed core areas interacts with surrounding areas spreading prosperity from the core to the periphery. This spread of development and prosperity to the periphery changes rapidly land uses in the surrounding area creating extensive new urban patterns usually unplanned and formed under market forces. As regards the abovementioned process of development, Michael Lipton (1977) focusing on the relationship between urban and rural areas introduces the term of "urban bias" suggesting that due to political and economic superiority urban areas exploit rural ones. New development patterns emerging in rural areas are almost totally determined by decisions formed in urban areas leading some times to unsustainable situations in the countryside. Friedmann and Douglass (Douglass, 1998) however, state that this relationship need not be asymmetric. The decentralization of political power in the framework of an agropolitan approach could contribute to the establishment of a more balanced relation between urban and ex-urban areas.

A more microeconomics-based perspective coming from the urban economics theorization tradition was the one put forward by Alonso. His urban land market theory, building on von Thunen agricultural land use theory, suggests that urban land use, land rent, population and employment is a function of distance to the city central business district. Therefore, the ability of a household paying a certain land rent while maintaining a given level of utility plays a key role in determining urban land uses. In this respect, households need to consider several aspects such as commuting costs, the level of their income, other than housing necessary goods and services etc. In later years several researches tried to study in detail most of the issues raised by Alonso. The empirical models of Muth in 1969, Mills in 1972 and Wheaton in 1974 (Brueckner and Fansler, 1983), are some well-known examples of establishing associations between urban expansion on the one hand and changes in population, household income, distance from the city centre, commuting costs and land rent on the other hand. Recently, Glaeser and Kahn (2004) suggested that although urban sprawl phenomenon is complex issue, it is in fact the widespread use of automobiles in last decades that makes it happen. This dominance of using private vehicles has resulted in a massive decentralization of employment as well so that only a small fraction of jobs are still situated at the city centre.

The theoretical schema of desakota by McGee (2007; 2008), is a relatively recent perspective trying to put urban expansion in the broader context of globalization. The perspective attempts to integrate new economic developments, technological change and other higher level forces with lower level factors such as distance, availability of infrastructure and new business opportunities. Although the model has

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mostly been tested in Asian regions, it is believed to hold significant potential for western Europe as well (Xie et al., 2007).

Finally, the theoretical schemata concerning the structure and evolution of urban space include several perspective based on urban geography and political economy. Amongst other the theoretical steam of expanding city addresses the importance of current technological progress in the field of information technologies, the massive increase in the volume, flow speed and spatial extent of goods and services exchanged as well as the new social values and ways of living (Munoz, 2003; Zhang and Sasaki, 2005). According to Ingram (1998), the contemporary city is characterized by a strong tendency of sprawl of both people and employment (Thurston and Yezer, 1994).

Despite their diverse origins and spatiotemporal scales of employment, the presentation of theoretical perspectives of urban land use patterns formation made clear that they share some common features. It seems that thinks such as distance and accessibility have a significant influence on urban patterns. Moreover, technological changes in transportation and beyond play a key role in urban evolution. The new social ethics, behaviours, preferences and ways of living also influence considerably the structure of space. Population and demographics which are traditional forces of change need also be taken into account in the context of regional and urban development. In the sections following this discussion, we make an attempt to analyze urban sprawl phenomenon in Greece in light of the precedent theoretical discussion paying particular attention to the driving forces of the phenomenon.

3. A CONCEPTUAL FRAMEWORK OF THE EMPIRICAL ANALYSIS

The size and characteristics of urban sprawl are subject to a diverse range of factors (Brueckner and Fansler, 1983; Burchell et al., 1998; Brueckner, 2000; Lopez and Hynes, 2003). Following, we take a spatial approach and propose a conceptual framework concentrated on explaining the variation in intensity of urban sprawl amongst different regions. The research focuses on Greek NUTSIII regions (i.e. prefectures) and proposes 5 categories of driving factors relevant to urban sprawl. The categories are:

1. Urban planning policy and monitoring category comprising of factors relevant to the quality and adequacy of urban planning system and to the efficiency of control and regulation procedures.
2. Regional spatial accessibility category referring to factors relevant to the quality and adequacy of transportation infrastructure and to the dispersion of cities and town in space.
3. People's preferences category, made up of factors relevant to the household preferences regarding the characteristics of the particular location they chose to live.

4. Regional economic environment category, referring to factors pertinent to regional prosperity level, population skills and quality, structure of the local economy and level of economic activity.
5. Category of demographics, encompassing spatiotemporal population factors relevant to population size, to the level of concentration of people to urban areas etc.

Schematically, the conceptual framework is depicted in Figure 1.

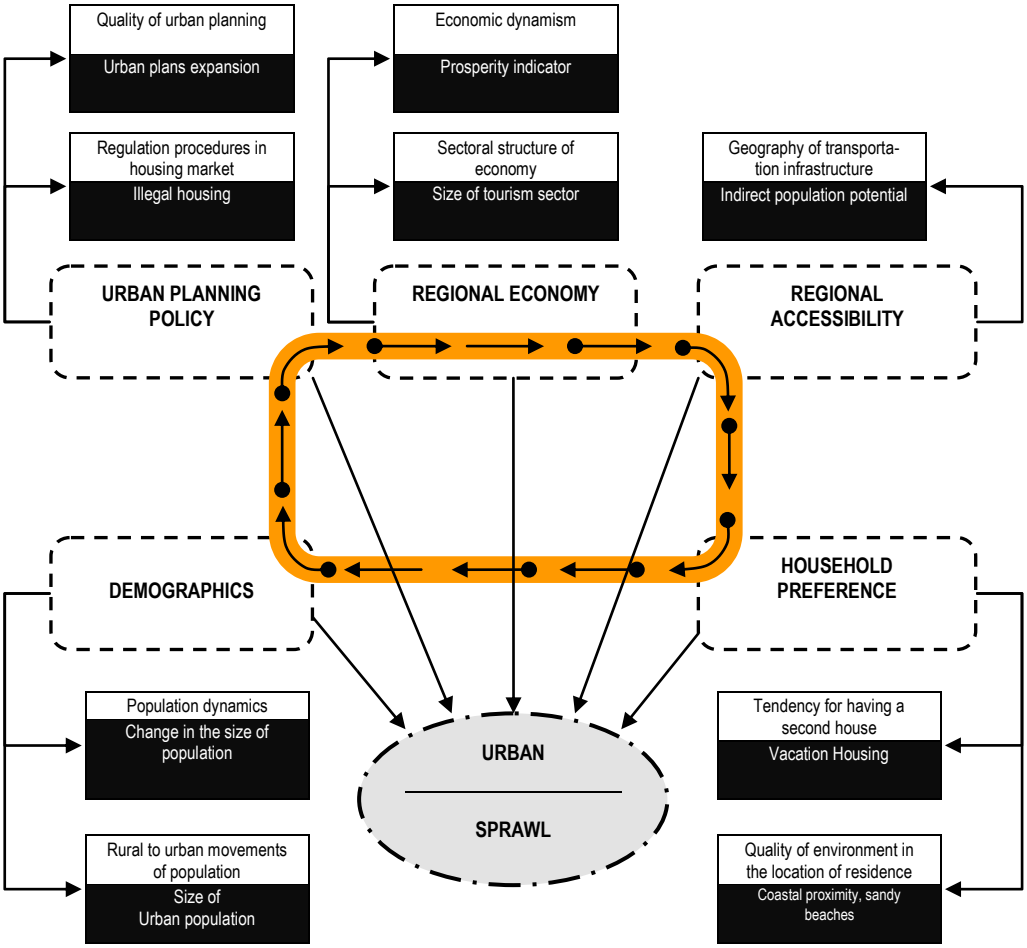

FIGURE 1 - CONCEPTUAL FRAMEWORK OF URBAN SPRAWL.

4. EMPIRICAL ANALYSIS

4.1. Variables

A total of 9 variables describing economic, social and physical characteristics were employed for the empirical analysis. The prefectural administrative level corresponding to NUTS III level of Eurostat was used in the analysis.

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This scale of analysis results in 51 observations. Both the dependent as well as the explanatory variables that were finally employed in the analysis of urban sprawl phenomenon in Greece for the period 1990-2000 are commented below.

Urban sprawl: The dependent variable:

The variable depicting the size of urban sprawl in each prefecture is an indicator calculated b using the following formula:

$$UrbSpw_i = \frac{B_{OUT\,i} \times 100}{B_{TOTALi}} \quad (1)$$

where,

$UrbSpw_i$ = The size of urban sprawl in spatial unit i.

$B_{OUT\,i}$ = The number of buildings constructed outside the approved boundaries of cities and towns in spatial unit i.

B_{TOTALi} = The number of buildings constructed in spatial unit i.

The initial continuous variable was transformed to an ordinal one taking into account the standard deviation of the mean of all observation. This has resulted in the formation of 4 categories of spatial units in relation to the magnitude of urban sprawl. Figure 2 and Table 1 present these categories.

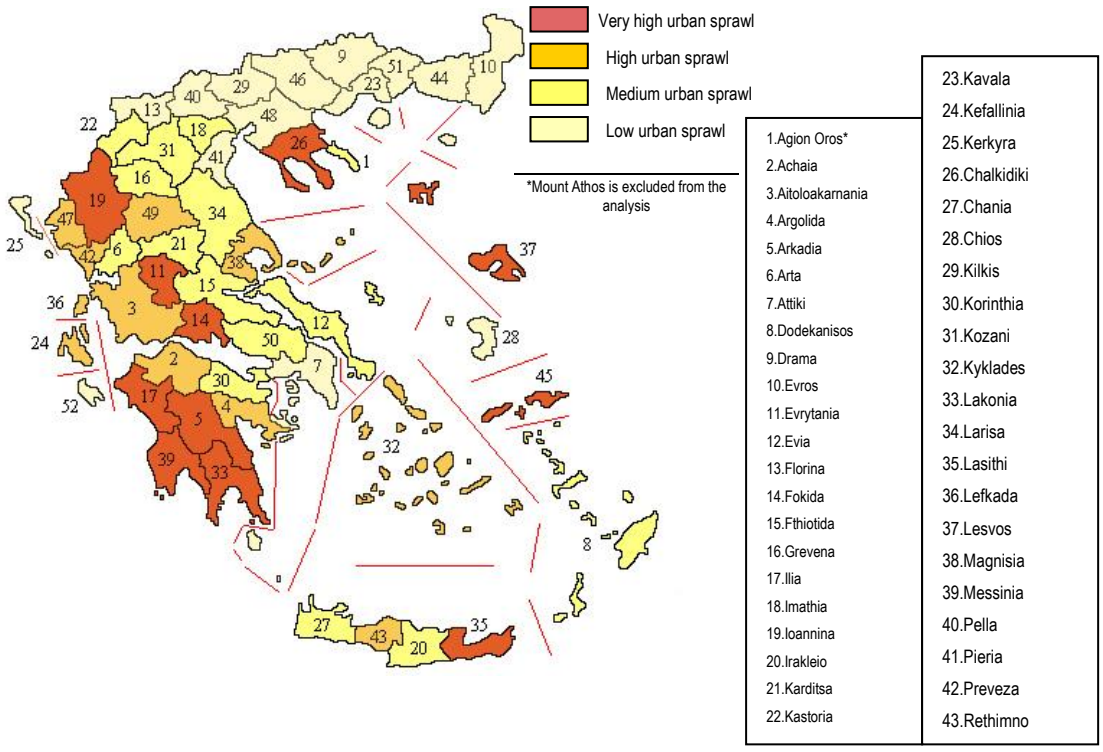

FIGURE 2 - THE SPATIAL PATTERNS OF URBAN SPRAWL IN GREECE FOR THE PERIOD 1990-2000.

TABLE 1: CATEGORIES OF URBAN SPRAWL

Category	Urban Sprawl	Interval in the value of $UrbSpw_i$
1→	Prefecture experiencing low urban sprawl	≤ 2,99
2→	Prefecture experiencing medium urban sprawl	3,00 - 4,99
3→	Prefecture experiencing high urban sprawl	5,00 - 6,99
4→	Prefecture experiencing very high urban sprawl	7,00+

- X1: Illegal housing: The term "informal housing" indicates a group of dwellings that have been created by their owners without, in some way, following the legal construction procedures defined in the state regulations. Informal housing in Greece constitutes a phenomenon with economic, social and political dimensions. It is tightly connected to the kind of management placed on urban and non-urban land uses by the state as well as the implemented housing policies. This situation tents to become an acute problem with serious economic, social and environmental implications (Leontidou, 1989; Leontidou et al., 2002; Potsiou and Ioannidis, 2006). The values of the variable represent the total number of informal housing units in each prefecture that entered into the legalisation process during the period from 1997 to 2006

- X2: Vacation housing: The scale of second and vacation homes has increased considerably in recent years. However, this type of development has not been planned adequately. As a result its influence on spatial patterns of urban development is unclear. It is believed that the current trends in the vacation home sector have placed significant pressure on natural environment especially on the costal zone (Coccossis and Parpairis, 2000; Potsiou and Ioannidis, 2006). We introduce into the analysis the net number of vacation building in each prefecture in an attempt to indentify likely associations with the magnitude of urban sprawl.

- X3: Sandy beaches: The total length of sandy beaches is a measure of the total length of the coastline and to some extent indicates the existence of suitable areas in each prefecture for situating vacation and holiday houses. The existence of extensive scenic coastal locations is a factor of attraction for locating vacation homes.

- X4: Regional Prosperity Indicator: The prosperity indicator has been estimated by using the official data for the Greek prefectures by Eurostat concerning the contribution of each prefecture to the GNP of Greece and to GNP per capita in €, as well as in Purchasing Power Standards (PPS). By using this variable we investigate whether the level of regional prosperity in each prefecture is connected to urban sprawl.

- X5: Indirect population potential: It shows the accessibility of each prefecture to the rest of the prefectures. We use this indicator because very often changes in the use of land in a location are

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generated by people who live and work away from that location. Residents of large urban concentrations may sometime choose to build houses or undertake other forms of land use transformation in adjacent prefectures. The indirect population potential can be estimated by using the following equation (Clark et al., 1969; Keeble et al., 1982):

$$IPP_i = \sum_{j=1}^{50} \frac{P_j}{D_{ij}^{\alpha}} \quad (2)$$

where:

IPP_i = The indirect population potential of region i.

P_j = The population of region j, where j=1,…,50 (fifty is the number of Greek prefectures minus one).

D_{ij} = A measure of the distances between regions i and j.

α = The superscript α is a measure of distance "friction".

- X6: Change in Population: The population variable was used in the model in order to assess the influence on urban sprawl of contemporary demographic processes. Bearing in mind that the past phenomenon of rural-urban migration has long ceased in Greece, we wanted to investigate the influence of the opposite process of rural rebound.

- X7: Size of urban population: This variable represents the total number of people living in urban areas. We introduce this variable into the model in order to indentify whether urbanization processes result in more compact cities and town or the relevant spatial units experience urban sprawl in the suburban areas of cities and beyond

- X8: Expansion of Urban plan boundaries: This variable represents the expansion of urban plans in each prefecture for the period 1995 to 2003. The area that was incorporated within the boundaries of towns and cities during that period was mainly for meeting the demand of for urban developable land.

- X9: Nights spent by foreign tourism: The nights spend by foreigner tourists in each prefecture (ftour) is a proxy variable that may capture tourist attractiveness of each prefecture as regards foreign tourism. In turns, this may affect the total demand for accommodation and relevant land for building tourism infrastructure.

4.2. Selection of the empirical model

The relationships between urban sprawl and its driving factors are evaluated by using ordinal regression. Ordinal regression can take into consideration and introduce into the calculations some of that extra information in the ordinal scale of the response variable (Norusis 2004). Therefore, the

methodology can be used to analyse the magnitude of a phenomenon (low, medium or high change) when it is not possible to capture this by a continuous variable or proxy. The magnitude of urban sprawl can be expressed as a function of the aforementioned independent variables having the following form:

$$\text{Urban Sprawl} = f\left(X_1, X_2, ..., X_n\right) \quad (3)$$

The specification of the empirical model with 'j' categories of dependent variable can be expressed as (Agresti, 1990; Norusis, 2004; SPSS, 2007a):

$$link\left(\gamma_{ij}\right) = \frac{\alpha_j - \left[\beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k\right]}{exp\left(\tau_1 Z_1 + \tau_2 Z_2 + ... + \tau_m Z_m\right)} \text{ and } \gamma_{ij} = Prob\left(Y \le j \mid x_i\right) = \sum_{l=1}^{j} \pi_{ij} \quad (4)$$

where,

$link\left(\gamma_{ij}\right)$ = The link function used. The index *j* refers to the magnitude of urban sprawl (e.g. low, medium, high, very high).

Y = The response variable, which takes integer values from 1 to *J*.

γ_{ij} = The cumulative response probability up to and including *Y=j* at subpopulation *i*.

X_k = The *k* predictor variables associated with the observed changes in the dependent variable.

α_j = The intercept of the regression equation or *threshold* for each cumulative probability. The index *j* refers to the magnitude of urban sprawl.

β_k = The coefficients of the predictor variables or the *locations* of the model. The threshold α_j and the regression coefficient β_k are unknown parameters to be estimated by means of the maximum likelihood algorithm.

π_{ij} = The cell probability corresponding to *Y=j* at subpopulation *i*.

There are five different link functions that can be used in the construction of an ordinal model depending on the distribution of values of the response variable cumulative probability (Norusis 2004; SPSS Inc 2006). We use the *Cauchit link* because the escalation the cumulative probability several increases rapidly, then slows down and finally accelerates again.

Having chosen the *Cauchit link* the general model is written as following:

$$\tan\left(\pi\left(\gamma_{ij} - 0.5\right)\right) = \alpha_j - \sum_{n=1}^{k} \beta_k X_k \quad (5)$$

Therefore the logits of the model can be expressed as following:

$$\omega_1 = tan\left[\pi\left[prob\left(urban\_sprawl \le low\right) - 0.5\right]\right] = \alpha_1 - \sum_{n=1}^{k} \beta_k X_k \quad (6)$$

$$\omega_2 = tan\left[\pi\left[prob\left(urban\_sprawl \le medium\right) - 0.5\right]\right] = \alpha_2 - \sum_{n=1}^{k} \beta_k X_k \quad (7)$$

$$\omega_3 = tan\left[\pi\left[prob\left(urban\_sprawl \le high\right)\right] - 0.5\right] = \alpha_3 - \sum_{n=1}^{k} \beta_k X_k \quad (8)$$

4.3. Model fitting information

As regards the Goodness-of-Fit Pearson and Deviance measures (table 2), we should not rely on them because the number of empty cells in the model is very large due to the use of several continues

dependent variables (there was a warning that 153 or 75.0% cells with zero frequencies). As regards the overall-model test, it yields a very low significance level. Therefore, the intercept-only model does not perform better than the model with the predictors. Finally, the pseudo-R2 measures indicating the success of the model in explaining the variations in the data are all satisfactory bearing in mind that their values in ordinal regression are almost always much smaller than the corresponding ones for a linear model (Norusis 2005).

TABLE 2 - MODEL FITTING INFORMATION(A)

Model	-2 Log Likelihood	X^2	Df.	Sig.
Constant Term Only	140,404	---	---	---
Final	79,979	60,424	14	0,000
				Pseudo R-Square
Cox and Snell				0,694
Nagelkerke				0,741
McFadden				0,430

(a) Link function: Cauchit.

Finally, the test of parallelism (table 3) namely the assumption that the regression coefficients are the same for all categories of urban sprawl cannot be rejected because the level of statistical significance for the general model is 0,731. Therefore, we sustain the null hypothesis that the location parameters are the same across the response categories.

TABLE 3 - TEST OF PARALLEL LINES(C)

Model	-2 Log Likelihood	Chi-Square	Df.	Sig.
Null Hypothesis	79,979			
General	56,945[a]	23,035[b]	28	0,731

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.
a. The log-likelihood value cannot be further increased after maximum number of step-halving.
b. The Chi-Square statistic is computed based on the log-likelihood value of the last iteration of the general model. Validity of the test is uncertain.
c. Link function: Cauchit.

4.3. Estimation Results and Discussion

The results of the estimation are presented in Table 4. As regards the variable of illegal housing, we can see that the regression coefficients of the two non-redundant categories have positive signs and they are also statistically significant. The positive signs imply that the areas with low and medium illegal housing activity are more likely to present high rates of urban sprawl compared to the areas with high illegal housing activity. However, we should take into account that the variable shares an interaction effect with prosperity level. Spatially speaking, this means that its relationship with urban sprawl varies

under the influence of prosperity level in each prefecture. Table 5 contains the estimators if we consider both simple and interaction effects using formula 8 (Jaccard, 2001; Bauer and Curran, 2005).

$$\frac{\partial Y}{\partial X_1} = \beta_1 + \gamma_2 * X_4 \quad (9)$$

TABLE 4 - PARAMETER ESTIMATES(A)

		Est.	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							L.B.	U.B.
Threshold								
ω_1	Urban Sprawl = [1]	13,765	15,105	0,830	1	0,362	-15,840	43,370
ω_2	Urban Sprawl = [2]	19,613	16,546	1,405	1	0,236	-12,816	52,042
ω_3	Urban Sprawl = [3]	24,980	17,426	2,055	1	0,152	-9,175	59,134
Location								
X_1	Illegal Housing = [1] Low	34,142	18,272	3,491	1	0,062	-1,671	69,956
--	Illegal Housing = [2] Low	35,627	17,295	4,243	1	0,039	1,729	69,525
--	Illegal Housing = [3] High	0(a)	.	.	0	.	.	.
X_2	Vacation Housing = [1] Low	-10,617	4,219	6,333	1	0,012	-18,886	-2,348
--	Vacation Housing = [2] Low	-8,512	3,515	5,866	1	0,015	-15,401	-1,624
--	Vacation Housing = [3] High	0(a)	.	.	0	.	.	.
X_3	Sandy Beaches	3,689	1,502	6,033	1	0,014	0,745	6,633
X_4	Prosperity Level	0,707	0,431	2,691	1	0,101	-0,138	1,551
X_5	Indirect Population Potential	0,164	0,071	5,296	1	0,021	0,024	0,303
X_6	Population Change 1991-2001	-6,490	11,768	0,304	1	0,581	-29,556	16,575
X_7	Size of Urban Population	-0,218	0,091	5,770	1	0,016	-0,397	-0,040
X_8	Expansion of Urban plan boundaries	1,489	0,642	5,387	1	0,020	0,232	2,746
X_9	Nights spent by foreign tourism	2,328	1,247	3,484	1	0,062	-0,116	4,772
2- Way-Interaction								
X_3*X_5	Sandy Beaches * Indirect Population Potential	-0,060	0,027	5,016	1	0,025	-0,113	-0,008
X_1*X_4	Illegal Housing = [1] * Prosperity Level	-1,020	0,538	3,589	1	0,058	-2,075	0,035
--	Illegal Housing = [2] * Prosperity Level	-1,064	0,511	4,343	1	0,037	-2,065	-0,063
--	Illegal Housing = [3] * Prosperity Level	0(a)	.	.	0	.	.	.

Link function: Cauchit

(a) This parameter is set to zero because it is redundant.

Bearing in mind the new regression coefficients, we can make the following remarks:

- Spatial units with low or medium informal housing activity and relatively low prosperity level are more likely to experience high urban sprawl compared to the prefectures of high informal housing and high prosperity level.
- Spatial units with low or medium informal housing activity and relatively high prosperity level are less likely to experience high urban sprawl compared to the prefectures of high informal housing and high prosperity level.

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TABLE 5 - ESTIMATION OF THE EFFECT OF ILLEGAL HOUSING ON URBAN SPRAWL UNDER THE INFLUENCE OF PROSPERITY LEVEL

Prefecture (example)	Total regression coefficient	Kind of relation	
A) X_1*X_4 = Illegal Housing [Low] * Prosperity Level		**Sign**	**Interval**
Evrytania, Fthiotida, Fokida, Messinia, Lakonia	$\beta_{1\text{-total}}=\beta_1+\gamma_2*X_4$= 34,142+(-1,020*11)= **+20,942**	(+)	$11<X_4<32$
Lefkada, Larisa, Pieria, Chios, Rethimno	$\beta_{1\text{-total}}=\beta_1+\gamma_2*X_4$= 34,142+(-1,020*33)= ≈ **0**	Turning point	$X_4 \rightarrow 33$
Attiki, Kefallinia, Zakinthos, Dodekanisos	$\beta_{1\text{-total}}=\beta_1+\gamma_2*X_4$= 34,142+(-1,020*41) = **-7,678**	(-)	$34<X_4<66$
B) X_1*X_4 = Illegal Housing [Medium] * Prosperity Level		**Sign**	**Interval**
Thesprotia, Aitoloakarnania, Arkadia, Trikala, Pella	$\beta_{1\text{-total}}=\beta_1+\gamma_2*X_4$= 35,627+(-1,064*19)= **+15,411**	(+)	$19<X_4<32$
Achaia, Ioannina	$\beta_{1\text{-total}}=\beta_1+\gamma_2*X_4$= 35,627+(-1,064*30)= ≈ **0**	Turning point	$X_4 \rightarrow 33$
Kerkyra, Kyklades, Chania	$\beta_{1\text{-total}}=\beta_1+\gamma_2*X_4$= 35,627+(-1,064*44) = **-11,189**	(-)	$34<X_4<66$

Therefore, a low or medium informal housing activity level is associated with high urban sprawl only when prosperity level is also low. A likely explanation regarding the abovementioned spatial pattern is that in the less developed areas with high urban sprawl and low informal housing, increased urban sprawl is due to a newly started developmental process that has been focused to the intensive exploitation of land through urban developments. In this initial stage of development through urban sprawl, informal housing phenomenon has not probably yet has a noticeable strength. However, the current empirical model implies that as development proceeds as well as prosperity level raises, informal housing activity is getting stronger.

Next, the variable that depicts the size of vacation housing sector in each spatial unit has two negative as well as statistically significant regression coefficients for the non-redundant categories. The negative signs indicate that the regions with high levels of vacation houses are more likely to present high urban sprawl too compared to the regions with low and medium levels of vacation houses. It seems that vacation housing activity has a positive association with urban sprawl. Property development dynamics through vacation housing activity produce significant pressure to ex-urban land uses creating spatial patterns of scattered urban land uses. It is therefore, questionable whether the present pattern of vacation housing sector contributes to sustainable development of rural space as well as to regional convergence. As long as the critical issue of developing and applying a coherent planning strategy for vacation housing sector is neglected, environmental degradation through habitat distraction and natural resources depletion will probably proceed.

The third variable which refers to the quality and abundance of coastal natural resources in each spatial unit has a positive regression coefficient with a p-value of 0.014. It seems that the regions with

extensive sandy beaches are associated with high levels of urban sprawl compared to the regions with a limited total stretch of sandy beaches. These results support view that the quality of environmental characteristics has a key role in individuals' location decisions regarding their homes. In this way, environmental quality seems to be a significant element in the configuration of the observed spatial differentiation in urban sprawl intensity. The pack of intangible environmental services in each location is being quantified in the real estate market of housing units. However, because this variable contributes to an interaction effect with indirect population potential (X5), the actual association between sandy beaches and urban sprawl should be estimated by using the following formula (Jaccard, 2001; Bauer and Curran, 2005):

$$\frac{\partial Y}{\partial X_3} = \beta_3 + \gamma_1 * X_5 \qquad (10)$$

Table 6 presents the results of the calculations. As we can see, the positive association between the length of sandy beaches and the magnitude of urban sprawl is valid only for the regions with a low or medium level of accessibility (i.e. an indirect population potential with a value up to 60). This is the case for most insular prefectures as well as the mainland prefectures which are in some substantial distance from major urban concentrations. In cases where the level of accessibility is relatively high or very high (i.e. more than 60), then the association between urban sprawl and the regional length of sandy beaches becomes negative. These results indicate that several prefectures situated in the vicinity of major urban concentrations (e.g. Korintia, Viotia, Evia, Pieria), although they sustain substantial coastal resources they seem to experience relatively low urban sprawl. A likely explanation of this pattern is that these areas are now less attractive to urban housing developments. Being in the vicinity of major cities, they have received extensive developmental pressures in previous decades resulting in environmental degradation.

TABLE 6 - ESTIMATION OF THE EFFECT OF SANDY BEACHES ON URBAN SPRAWL UNDER THE INFLUENCE OF "INDIRECT POPULATION POTENTIAL" (ACCESSIBILITY).

Prefecture (example)	**Total regression coefficient**	**Kind of relation**	
X_3*X_5 = Sandy Beaches* Indirect Population Potential		**Sign**	**Interval**
Kefallinia Irakleio, Lasithi, Zakynthos	$\beta_{3\text{-total}}=\beta_3+\gamma_1*X_5$= 3,689+(-0,060*14)= **+2,849**	(+)	$3<X_5<60$
Attiki, Kozani	$\beta_{3\text{-total}}=\beta_3+\gamma_1*X_5$= 3,689+(-0,060*30)= **+1,889**	(+)	$3<X_5<60$
Pieria	$\beta_{3\text{-total}}=\beta_3+\gamma_1*X_5$= 3,689+(-0,060*61)≈ **0**	Turning point	$X_5 \rightarrow 61$
Korintia, Viotia, Evia	$\beta_{3\text{-total}}=\beta_3+\gamma_1*X_5$= 3,689+(-0,060*85)= **-1,411**	(-)	$62<X_5<107$

Concerning the next variable which depicts regional prosperity level (X4), the relevant regression coefficient has a positive sign and it can marginally be considered statistically significant at the level of 0.1. The positive sign indicates that the prefectures with high prosperity levels are more likely to present increased urban sprawl. Therefore, high prosperity levels do not seem to relate to more sustainable property development dynamics. However, an interaction term was included in the ordinal regression model between prosperity level and informal housing activity. Taking this into account, the actual influence of prosperity level on urban sprawl rate should be estimated by using the following mathematical equation (Jaccard, 2001; Bauer and Curran, 2005):

$$\frac{\partial Y}{\partial X_4} = \beta_4 + \gamma_2 * X_1 \qquad (11)$$

Evaluating the results of the relevant calculation in Table 7, it can be claimed that the specific interaction term indicates that the effect of prosperity indicator varies with the intensity of the phenomenon of illegal housing of each region. From the results of Table 7 it is also evident that the sign of regression coefficient which measures the effect of prosperity indicator to urban sprawl varies according to the value of illegal housing.

TABLE 7 - ESTIMATION OF THE ACTUAL EFFECT OF PROSPERITY INDICATOR ON URBAN SPRAWL UNDER THE INFLUENCE OF THE PHENOMENON OF ILLEGAL HOUSING

Prefecture	Estimation of actual effect of prosperity indicator on urban sprawl under the influence of the phenomenon of illegal housing	Kind of relation	
X_4*X_1 = Prosperity Level * Informal Housing = [1] and [2]		Sign	Interval
Fthiotida, Fokida, Ilia, Drama, Grevena, Kozani, Kastoria	$\beta_{4\text{-total}} = \beta_4+\gamma_2*X_1 = +0,707+(-1,020*1) =$ **-0,313**	(-)	$X_1 \rightarrow 1$
Trikala, Ioannina, Thesprotia, Pella, Kyklades	$\beta_{4\text{-total}} = \beta_4+\gamma_2*X_1 = +0,707+(-1,064*2) =$ **-1,421**	(-)	$X_1 \rightarrow 2$

A further analysis of the results leads to the following key points:

- When "informal housing" is low and takes the value (1), the effect of prosperity level on urban sprawl is also low. This means that in regions where the level of informal housing is low, the high prosperity level indicator does not entail higher urban sprawl. The four possible scenarios for these regions are the following. Firstly, despite the high values of prosperity level indicator, it is possible that the phenomenon of informal housing is confronted in a satisfactory level and urban sprawl is limited. When this scenario is fulfilled the pattern of urban expansion can be characterized as highly sustainable. Secondly, these regions might face a reduction of building activities which automatically means reduced levels of informal housing and urban sprawl. These regions may face an increase of the levels of informal housing in the future. Thirdly, high

levels of prosperity level in these regions might not be based on the building activity but on the increased activity of other economic sectors. Finally, the high prosperity levels might lead to investments' export, resulting to increased urban sprawl in adjacent prefectures.

- The same scenarios occur into the regions with medium levels of informal housing. The indicator of prosperity level seems to be related with lower urban sprawl levels in these regions, as well. On the contrary, the regions that are characterized by high levels of informal housing and the prosperity level indicator is high, seem to present high urban sprawl.

The spatial pattern that is shaped seems to describe a situation where high prosperity levels combined with high levels of informal housing, lead to high levels of urban sprawl. In contrast, high prosperity level seems to lead to lower urban sprawl when informal housing in the region is low. The specific spatial pattern is depicted in Figure 3. In this figure we can notice that the majority of prefectures that are characterized by the first relation lay under the influence of two major urban centers of the country. A significant percentage of prosperity of these prefectures is a consequence of their proximity to large urban concentrations. Therefore, we can observe that in the above prefectures, any actions to improve their prosperity coexist with a powerful blend of high illegal housing and high urban sprawl. This finding raises concerns about the nature of their relationship with the major urban centers and the sustainability degree of their development model.

In this figure, it is also obvious that the majority of island prefectures bear similar characteristics when the relationship among illegal housing, prosperity indicator and urban sprawl level is analyzed.

The prosperity level indicator has a value over 30 for the island prefectures, while these areas are characterized by low or medium levels of informal housing and high levels of urban sprawl. These prefectures may face a situation where the phenomena of illegal housing and urban sprawl occur with a time elapse.

Thus, it should be stressed that these prefectures may face an upsurge of the phenomena of illegal housing in a subsequent period.

The indicator of Indirect Population Potential has a positive sign and it is statistically significant at the (0,05) level. The positive sign of the estimation implies that the increase of indirect population potential simultaneously increases the likelihood of higher levels of urban sprawl occurring in the specific prefectures.

As it has already been noted, this result is reasonable since approaching the area of interest is easier for more people due to the improved spatial accessibility which also increases the potential of

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investments in the industrial, tourist and building sectors. It seems that the high quality of road infrastructures and the proximity to large urban areas strengthen the phenomenon of urban sprawl.

As it was noted before, this fact raises questions about the kind of influence of large urban centers to adjacent prefectures.

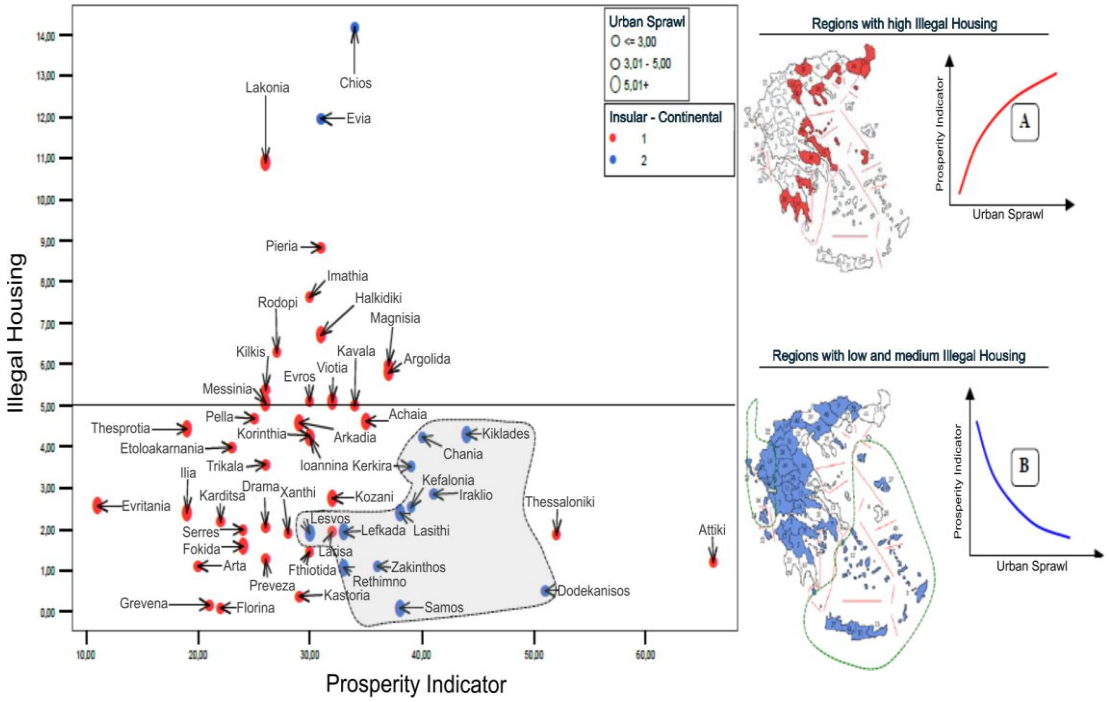

FIGURE 3 - THE RELATIONSHIP AMONG ILLEGAL HOUSING, PROSPERITY INDICATOR AND URBAN SPRAWL LEVEL.

Additionally, concerning the effect of indirect population potential, it should be noted that a statistically significant interaction term is shaped by the indirect population potential and the indicator of sandy beaches. Taking this into account, it is interesting to examine the net effect of indirect population potential on urban sprawl, under the prism of this interaction.

The relevant estimation results are presented in Table 8 (Jaccard, 2001; Bauer and Curran, 2005). The estimation is based on mathematical equation (12).

$$\frac{\partial Y}{\partial X_5} = \beta_5 + \gamma_1 * X_3 \qquad (12)$$

As can be seen from the results, in prefectures which are characterized by low or medium values of sandy beaches indicator (0,79 to 2,73), the indirect population potential seems to have a positive relation with urban sprawl.

On the contrary, a significant number of prefectures with expansive sandy beaches are characterized by a negative relationship between indirect population potential and urban sprawl. The prefectures of the second category are presented in Figure 4.

TABLE 8 - ESTIMATION OF THE EFFECT OF INDIRECT POPULATION POTENTIAL ON URBAN SPRAWL, UNDER THE INFLUENCE OF SANDY BEACHES INDICATOR

Prefecture	Estimation of the effect of indirect population potential on urban sprawl under the influence of sandy beaches	Kind of relation	
X_3*X_5 = Sandy Beaches* Indirect Population Potential		Sign	Interval
Arkadia, Fokida, Xanthi	$\beta_{5\text{-total}}=\beta_5+\gamma_1*X_3$= 0,164+(-0,060*0,79)= **+0,1166**	(+)	In Interval 0,79<X_3<2,72
Chios, Samos Rethimno, Pieria, Laconia, Korinthia	$\beta_{5\text{-total}}=\beta_5+\gamma_1*X_3$= 0,164+(-0,060*1,58)= **+0,0014**	(+)	In Interval 0,79<X_3<2,72
Achaia, Preveza	$\beta_{5\text{-total}}=\beta_5+\gamma_1*X_3$= 0,164+(-0,060*2,73)≈ **0**	Turning Point	$X_3 \rightarrow$2,73
Thesaloniki, Kerkira, Iraklio, Lesvos, Kavala	$\beta_{5\text{-total}}=\beta_5+\gamma_1*X_3$= 0,164+(-0,060*4,14)= **-0,0844**	(-)	2,74<X_5<6,70
Attica, Dodekanisa, Messinia, Ilia, Halkidiki	$\beta_{5\text{-total}}=\beta_5+\gamma_1*X_3$= 0,164+(-0,060*6,70)= **-0,238**	(-)	2,74<X_5<6,70

These results denote the existence of three different categories of prefectures according to the reasons presenting negative relationship between the indirect population potential and urban sprawl.

The first category includes highly concentrated urbanized prefectures, as Attica, Thessaloniki, Achaia and Iraklio. In these areas urban sprawl is quite low, despite the fact that these prefectures present a medium to high indirect population potential and high values of the sandy beach indicator.

These prefectures may have faced high levels of urban sprawl in an earlier period, particularly in the decades 1970 and 1980.

Additionally, the power of phenomenon may have declined after these periods, due to the extensive inclusions of built-up space in urban plans. In conclusion, the two factors under analysis may have pushed urban sprawl in earlier periods.

A similar interpretation can be made for the case of the second group of prefectures which are characterized by the strong and early development of tourism (Corfu, Dodekanisos, Chalkidiki and Chania). These prefectures present lower indirect population potential than the prefectures of the first category and therefore, the low urban sprawl levels can be characterized as reasonable. In addition, it must be noted that in correspondence with the prefectures of the first category, prefectures of the second category may have faced high levels of urban sprawl in an earlier period, as well. Finally, for

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several of the remaining prefectures of the third category with high sandy beaches, including Ilia, Messinia and Lasithi, it should be noted that the influence of indirect population dynamic to the direction of increasing urban sprawl had not begun yet, at least during the period under study. Nevertheless, taking into account that urban sprawl is present in these areas; one possible explanation that could be given is that urban sprawl is expanded spatially. The phenomenon is now intense in prefectures with lower indirect population potential and better environmental conditions, while in the past urban sprawl was mainly observed in urbanized prefectures and in prefectures with higher indirect population potential.

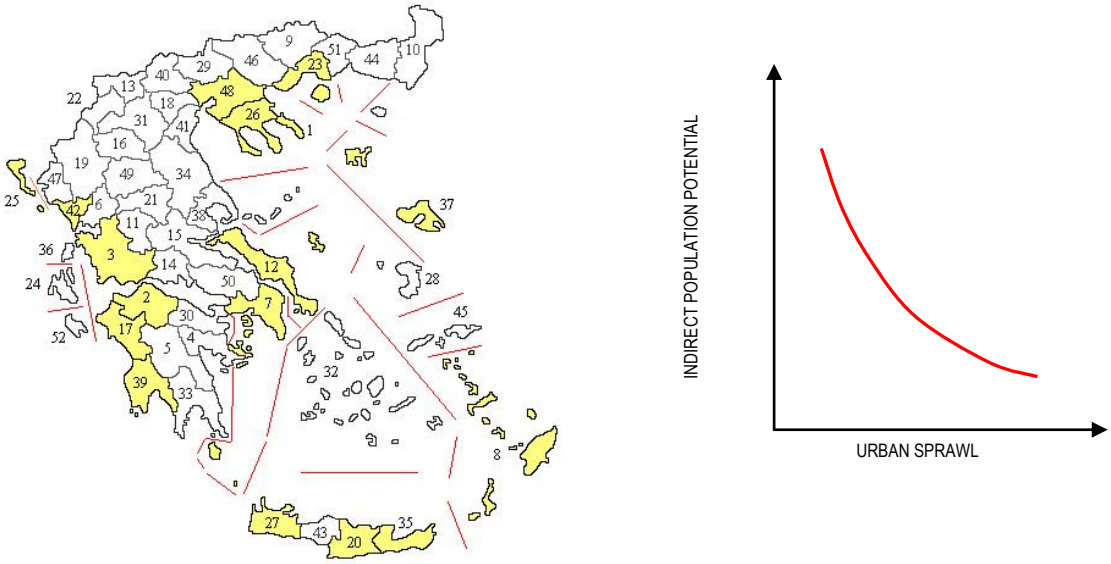

FIGURE 4 - REGIONS WITH HIGH VALUES OF SANDY BEACH INDICATOR AND NEGATIVE RELATIONSHIP BETWEEN INDIRECT POPULATION POTENTIAL AND URBAN SPRAWL. THIS TYPE OF RELATIONSHIP CONSTITUTES A REMARK THAT URBAN SPRAWL IS LED TO MORE REMOTE AREAS WITH BETTER ENVIRONMENTAL QUALITY.

The coefficient of variable depicting the variation of prefectures' population has a negative sign but its statistical significance is not satisfactory. The negative sign indicates that the major positive changes in the population of a prefecture do not necessarily imply an increase of the likelihood of presenting a high urban sprawl. Nevertheless, the absence of statistical significance of the estimation cannot lead to reliable conclusions. Therefore, the results of the model adapted in this study lead to the conclusion that the variation of population does not appear to be related with the intensity of the phenomenon of urban sprawl in the period under study.

Furthermore, the estimation of the coefficient of prefectures' urban population is statistically significant at the level of 0,05 and has a negative sign. This result suggests that as the urban population of a prefecture increases, the likelihood of this prefecture displaying high levels of urban sprawl reduces. The prefectures with large urban populations are less likely to develop high urban sprawl and the

adjacent prefectures that are less urbanized are more prone to urban sprawl. This result raises a question about whether the standards of urban development at suburban areas of less urbanized prefectures is the result of processes that occur within these prefectures or a result of forces arising from large urban concentrations of the state.

The regression coefficient of the variable 'expansion of urban plan boundaries' has a positive sign and is statistically significant at the 0,05 level. The positive sign indicates that areas with extensive integrations into the urban plans of cities and settlements are more likely to develop high urban sprawl. Thus, the supply of new urban land through the planning process does not seem to have any beneficial effect towards the objective of limiting the phenomenon of 'outside city plans' building. A possible explanation of this phenomenon is that urban plans in most regions of the country, are not based on the demand for urban land, but are designed to improve, already formulated conditions usually with a long delay. Therefore, the harmful and unplanned urban sprawl continues and urban planning is following rather preceding the formation of urban space.

Finally, the coefficient of the variable 'Nights spent by foreign tourism' has a positive sign and is statistically significant at the 0,1 level (sig. 0,062). This result implies that as the number of nights spent by foreign tourism increases in a prefecture, the likelihood of this prefecture presenting urban sprawl is increasing, as well. Therefore, the popular tourism destinations present a high probability of facing the phenomena of urban sprawl. This means that the main tourist regions whose development is based on the attraction of domestic tourism create pockets of tourist activities in areas out of the city's plans. This pattern of tourism development seems to strengthen the selective urban sprawl in the non urban space.

5. CONCLUSIONS

The phenomenon of urban sprawl continues to constitute a major threat for the natural environment and sustainable rural development in many regions worldwide. The increasing decentralization of population, economic activity and employment, leads to the conclusion that at this stage, one of the main forms that the urban growth takes, is the diffusion of urban sprawl in the suburban and the wider regional space of cities. Some researchers argue that as the private car remains the dominant means of transport, urban sprawl is likely to continue remaining the main form of urban growth.

The present study focused on the determination of forces behind urban sprawl in the Greek regional system. The results of the empirical model and its evaluation lead to some critical conclusions and also highlight some important aspects of the phenomenon, requiring further research. Bearing the theoretical basis of the empirical model in mind, a number of important observations can be made.

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Firstly, it is obvious that the current urban development policy, as expressed through the relevant regulatory framework, the procedures of spatial design and designs' application, has failed to intervene decisively in the direction of a sustainable urban development of space. The analysis showed that the provision of new building land does not help to curb the phenomenon of urban sprawl. Cities' and villages' expansion plans policy presents a significant time lag in relation to the manifested demand for building land. In this era, the role of the State can be characterized as more passive than active, as State is confined only in the integration or legalization of already built-up areas.

Furthermore, it is extremely doubtful whether the existing urban and housing policy has emerged after consideration of the fact that people's preferences about the characteristics of their home have changed significantly over the last decade. The characteristics of the area which is expected to receive the first and second homes are important and almost always reflected in land values. Empirical analysis showed that the presence of valuable natural resources in a spatial entity, such as sandy beaches, is associated with increased levels of urban sprawl. However, the organized supply of building land, whose characteristics will meet to a considerable degree the current preferences of the demand side, is a fundamental object of design.

On the other hand, it is obvious that major weaknesses of the State to improve and coordinate existing mechanisms for control of urban development, are present. The revenue associated with the use of land through non urban land use, exerts enormous pressure, even in areas where construction is under certain restrictions or even prohibited. The phenomenon of illegal housing appears to be involved in the transformation of non urban space, possibly presenting different characteristics depending on the economic, social and political conditions. Therefore, a form of geographical diffusion appears, as illegal housing seems no longer to be a sole feature of the suburban areas of urbanized prefectures, but a phenomenon of new and more distant spatial units, as well.

Undoubtedly, spatial accessibility is a prerequisite for the phenomena of urban sprawl and illegal housing. The improvement of transport infrastructure altered significantly the accessibility of many regions. Most remote prefectures of the state develop their economic and social transactions with other prefectures, with improved conditions in terms of accessibility. Improved accessibility means quick transportation between areas and increased investment opportunities in industry, tourism and residential sector. As a consequence, phenomena that once characterized the urban areas now occur with a relatively high intensity in "regional" units with a low level of prosperity, as well.

In this sense, economic dynamics in a number of prefectures is not required to continue to manifest itself with the investments within the limits of these prefectures or in prefectures near them. In current

conditions, the mobility of capital has increased and it is now easier to exploit economic opportunities in alternative spatial units. Therefore, it is also possible that the new emerging patterns of land use in several spatial units can be the result of exogenous forces or rather the result of a combination of exogenous and endogenous forces. A typical example is tourism, at least for these prefectures whose economic base is depended on it. The spatial formations that dominate the non urban space are complex and enforced largely by the development of tourism activities.

Finally, the influence of demographic trends seems not to follow the traditional model, which requires that population growth causes growing demand for building land. Given that country's population growth rates are very low, the explanation of the disproportionate increase in demand for building land should be found in the theory of the "demographic transition". This is a trend which is also observed in most developed countries, where even when population growth rates are negative, the demand for building land and changes in land use in non-urban space, accelerate.

In conclusion, it can be stated that as the critical issue of organized urban development remains unresolved at the planning and implementation level, the phenomenon of urban sprawl will continue to be intensified, showing possible temporal variations and spatial selectivity. However, stocks of natural resources of non-urban space will continue to be threatened by degradation and the rural development pattern will present unsustainable characteristics.

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