Spatial analysis of differences in variation of building activity in Greece

Serafeim Polyzos, Dionysios Minetos
University of Thessaly, School of Engineering, Department of Planning and Regional Development, Volos, Greece
spolyzos@prd.uth.gr, dminetos@prd.uth.gr

Abstract
The building and construction industry is a significant driver of both economic growth and land use change in Greece. Given the importance of the sector, a reliable and consistent pool of evidence on the evolution and state of regional building activity trends within the broader context of the country can contribute considerably to the improvement of strategic policy design and implementation. The spatial dimension of building activity variance is very important because it is possible to better understand the principal dynamic of both the increased spatial dependency and the increased regional divergence. This empirical research investigates the spatial differences in variations of building activity for the whole country. The unit of analysis is at the prefectural level (NUT III) and the key building variation drivers relates to ample social, economic, infrastructure and institutional forces. Data on building activity variations cover the period from 1990 to 2000 and the employed statistical procedure for the analysis is multinomial logistic regression. Logistic regression treats the distribution in a probabilistic manner, and expresses each dimension of the issue under investigation in terms of probability. The results indicate that that the size of variance is highly influenced by the size of economic activity, fluctuations in the tourism sector, the level of regional prosperity and the developmental incentives provided by the state.

Keywords: Building activity, Regional development, Incentives, Variance, Multinomial logistic regression.

Introduction

The building and housing sector is an important contributor to the development of the national economy as well as the regional economies in Greece. The actual mean contribution of the sector for the past 5 years to the gross domestic of the country was around 10 percent whereas at the regional level the contribution ranged considerably between the prefectures (for example 5% in the prefecture of Arkadia, and Drama, 16% in the prefecture of Viotia). The sector is also a major driver of land use change and therefore its role in achieving long-term sustainable development patterns is great. Due to the fact that the building industry produces lasting assets that remain in good and usable condition for a long period of time, the industry products are perceived as a form of investment. This form of investment is diverse and comprises several types of residential buildings such as houses and bocks of apartments as well as special types of non residential buildings like industrial units, shops and offices and all sorts of public buildings.

In terms of employment, the sector contributes to the national economy with 350.000 jobs involving several building professionals, technicians, property managers and material suppliers. Building activity levels have a direct effect on regional prosperity level, consumers spending level and employment opportunities. During the past few decades the national economy has grown relatively quickly along with the building activity sector. However, there is evidence that building activity is more changeable than the rest of the economy tending to vary often or widely in space and time. Spatial variations in building activity as the regional economies experience periods of economic growth and decline are great even within a particular region from year to year. This instability in building patterns puts significant pressure on certain aspects of the regional economies and raises a number of questions. Falling, stagnant or highly fluctuated building activity patterns revile a poorly performing sector that can be a significant obstacle in improving regional development levels. Because the condition associated with poor performance makes it difficult to make progress or to achieve certain quality objectives, it is important to understand the underlying cause of building activity variance.

A reliable and consistent pool of evidence on the evolution and state of regional building activity trends within the broader context of the country can contribute considerably to the improvement of strategic policy design and implementation. This is important if we bear in mind that present urban land use patterns are the outcome of multiple socioeconomic spatial processes that, some times, have caused irreversible damage to land and water ecosystems. The concern about the adverse consequences of building activity is rising. Most of the impacts are well-documented in the literature addressing the processes such as informal housing and urban sprawl and the associated damages to the environment. Biodiversity treats, forest land reduction, land erosion, aquifer and surface water utilisation, loss of heritage agricultural landscapes (Boatman *et al.*, 1999; Tilman *et al.*, 2001; Rahman, 2005; Butler *et al.*, 2007) are only a few. Certain European Union (EU) policies as well as initiatives at the national level have tried to influence the direction of developments in the rural areas.

Given these considerations, the paper is organized into five main sections. Following the introduction, section 2 describes the spatial dimension and the characteristics of building activity in Greece. The study area with regards to the spatial unit of analysis is also presented. Section 3 provides a thorough description of the explanatory variables, which are used in the empirical model. The fourth section presents and evaluates the multinomial logistic regression methodology employed in the empirical analysis, describes the available data as well as the spatial configuration of the variance of building activity across the Greek prefectures. It also attempts to interpret the parameters estimates yielded by the analysis. The focus here is on approaching the underlying causes of variance during the study period. The paper ends by commenting on the wide implications of the phenomenon.

Explaining regional differences in building activity variance

Understanding volatility in the building and construction sector can provide useful insights regarding the behavior of regional real estate markets and of the trajectories of change of regional land use system. The spatial dimension of building activity variance is very important because it is possible to better understand the principal dynamic of both the increased spatial dependency and the increased regional divergence. Economic underperformance of some region in relation to some other is an indicator of the effectiveness of the applied regional policy.

Housing and building activity levels are significant within the economy, with a direct effect on the consumer price index and interest rates. Building and housing patterns also influence directly or indirectly the environment through various paths. Complex processes such as urban sprawl, material consumption and public infrastructure requirements alter the natural environment as well as the regional economies creating a new environment for societies. The way in which the building and construction sector is connected to economic, natural and social environment haw attracted much attention within the scientific community. The debate over the role of building investment in economic growth and other aspects of the regional environment has been theorised in several studies drawing on certain concepts of endogenous growth theory and economic cycles perspective. According to endogenous growth theory firms opt to maximize profits. In this process the production of new technologies and human capital are very important Constant return to scale production function can generate growth in the building activity sector. Policy measures can have an impact on the long-run growth rate of the building sector. Therefore, subdivides on development can increase the growth rate of the building sector influencing the overall level of the activity. According to the theory, additional factors such as new technologies and human capital can influence significantly the stability in the building and construction sector.

With the relative stability of the building and construction sector deals the concept of real estate market cycles. Long or short cycles in building activity are associated with an array of factors such as supply of and demand for new buildings, urban development rates, structural changes in the economy, population dynamics and technological advances. In a typical cycle, a low development period is followed by an increase in business activity as well as expansion. At this point, the available supply of property in not sufficient to meet demand. As the demand increases the restricted supply influences rents and capital values. In turns, this increases the profitability of the building sector and generates the necessary conditions for increasing investments in new constructions. However, there is a lag between economic development and building boom because the buildings usually require long time for completion. As the economy moves to the stage of recession, the supply of new buildings is high causing a decrease in rents affecting the profitability of the sector. Eventually, decreasing profitability lowers the pace of building activity. The cyclical process described above can be influenced by several factors in its stage. These factor may be economic, social, demographic or of a complex nature. The influences generated can affect differently the regional economies and give raise to diverse spatial patterns.

The conceptual framework in figure 2 provides an overview of the process of building activity variance. We identify three generic categories of influential forces, which could have an important effect in shaping the observed patterns of patterns in building activity. In particular, the three generic categories are: (a) the local resources, (b) demography and (c) the regional economic environment. Certain combinations of these subgroups of factors can exercise significant effects on the stability of building activity. As local resources we consider important aspects and characteristic of the local environmental such as coastal proximity, sandy beaches length, special protection areas and wildlife reserves. Socio-demographic characteristics are related to people's movements, educational level and preferences on where to live and work (e.g. in urban or ex-urban areas. Finally, the regional economic environment as it is shaped by the State spatial policies; prosperity level and sector structure of the regional economy may be influence the performance and strength of the building sector. Following, we specify in more detail the underlying factors of building activity variance and construct an empirical model in order to evaluate their influence on the performance of the sector.

[INSERT FIGURE 1 ABOUT HERE]

The driving factors of regional differences in building activity variance

Study area

Greece covers a total area οf 131.957,4 km^2. The mainland part of the country marks the end of the Balkan Peninsula whereas the insular part (about 3.000 both habited and inhabited islands situated in the Aegean Sea as well as the Ionian Sea) borders with Asia and Africa continents. Coastline stretches for approximately 15,021 kilometers. According to the National Statistics Services of Greece (NSSG, 2001b) the country's population is approximately 10.9 million people with 72.8% staying in urban areas and the remaining 27.2% being rural population. In mountainous areas lives 9.2% of the population, whereas in semi-mountainous and urban areas the figures are 21,8% and 69.0% respectively. Finally, agriculture and pastoral uses cover 49.5% of country's surface, forests, shrub and bare land cover 47.2%, inland water 1.3% and urban and other artificial surfaces cover 2.0% (NSSG, 2001b).

Geomorphologically speaking, most of the mainland territory consists of mountains. Just a few major agricultural plains exist the largest of which is placed in central Greece in the administrative boundaries of the Thessaly region. The country consists of 13 administrative regions, which are further subdivided into 51 prefectures (Fig.3). The 51 prefectures are also subdivided into 1,035 municipalities and communities.

Methodology

The spatial phenomenon of the observed differences in building activity variance can be described by a categorical variable that assigns spatial units to a limited number of categories in relation to the magnitude of variance. In this way, we can reduce the dimensions of the issue under investigation and sustain only the major trends in variance. Considering the majors dimensions of the phenomenon in the analysis is useful for better understanding spatial dissimilarities. Reducing or filtering out such phenomena results in some practical dimensions that are less sensitive to numerical or data collection noise. For the purpose of the present analysis, we employ a multiple logistic regression model with four dimensions of the building activity variance issue.

Logistic regression treats the distribution in a probabilistic manner, and expresses each dimension of the issue under investigation in terms of probability. Logistic regression is part of a category of statistical models called generalized linear models. The *multinomial logistic regression* technique is an extension of the binomial logistic model to the cases where the response variable has more than two categories (Norusis, 2005a) (e.g., low variance, *medium* variance, *high variance* etc). In this case, the response variable of interest exhibits a multinomial distribution and not a binomial as in a simple logistic model. This type of regression does not assume that the relationships between the explanatory variables and the dependent variable are linear. Furthermore, it does not assume that the response variable and the error terms are distributed normally. In our model we set the «very high variance» category as the reference category and we form three non-redundant logits. Using the general formula of logistic regression (eqns 1 and 2) we construct logit A (eqn 3), logit B (eqn 4) and logit C (eqn 5):

$$prob(Y = j) = \exp(a_{0j} + \beta_{1j} X_1 + ... + \beta_{nj} X_n) \Big/ \sum_{i=1}^{m} \exp(a + \beta_{1i} X_1 + ... + \beta_{nj} X_n) \quad (1)$$

$$\ln\left[\frac{prob_{(i-category)}}{prob_{(j-category)}}\right] = \alpha_{0i} + \beta_{1i} X_1 + \beta_{2i} X_2 + ... + \beta_{ni} X_n + \varepsilon_i \quad (2)$$

Where,

$prob_{(i-category)}$	=	The likelihood the dependent variable being in the *i* category, *i=1,…m* the number of categories.
$prob_{(j-category)}$	=	The likelihood the dependent variable being in the *j* category (the baseline category).
X_n	=	The explanatory variables *1,…n*, employed by the empirical model.
α_{0i}	=	The intercept for *logit i.*
β_{ni}	=	The regression coefficients of the *n* variables for *logit i.*
ε_i	=	The residuals for *logit i.*

In the case of observed differences in building activity variance the logits which we create have the following form:

$$LOGIT\_A = \ln\left[\frac{prob\,(Low \to \sigma^2)}{prob\,(Very\_high \to \sigma^2)}\right] = $$

$$= b_{0A} + b_{1A} X_1 + b_{2A} X_2 + ... + b_{nA} X_n + \varepsilon_{iA} \quad (3)$$

$$LOGIT\_B = \ln\left[\frac{prob\ (Medium \rightarrow \sigma^2)}{prob\ (Very\_high \rightarrow \sigma^2)}\right] = $$

$$= b_{0B} + b_{1B}X_1 + b_{2B}X_2 + ... + b_{nB}X_N + \varepsilon_{iB} \quad (4)$$

$$LOGIT\_C = \ln\left[\frac{prob\ (High \rightarrow \sigma^2)}{prob\ (Very\_high \rightarrow \sigma^2)}\right] = $$

$$= b_{0C} + b_{1C}X_1 + b_{2C}X_2 + ... + b_{nC}X_N + \varepsilon_{iC} \quad (5)$$

Logit A shows the log of the odds of the probability that a prefecture is in the «low building activity variance» category than in the very high category, Logit B depicts the log of the odds of the probability of being in the «medium building activity variance» category compared to the very high variance category and finally, Logit C shows the log of the odds of the probability that a prefecture is in the «high building activity variance» category than in the very high category.

The dependent variable

Data for estimating the regional variances in building activity were derived from the National Statistical Service of Greece. The values of the latent dependent variable represent the variance (σ^2) in building activity for the period from 1990 to 2000 in each prefecture (NUTS III level). These original values of variances were transformed in order to construct broad variance categories of building activity and subsequently to investigate the relative performance of the building sector against a diverse group of continues and categorical variables which we considered as the major driving factors of building activity fluctuations. Hence, the prefectures were classified into 4 categories according to the magnitude of variance that they presented during the study period. The categories were:

- Category 1: Prefectures with low variance in building activity ($0 \le \sigma^2 \le 0,79$)
- Category 2: Prefectures with medium variance in building activity ($0,80 \le \sigma^2 \le 2,00$)
- Category 3: Prefectures with high variance in building activity ($2,01 \le \sigma^2 \le 5,00$)
- Category 4: Prefectures with very high variance in building activity ($5,01 \le \sigma^2$

The construction of the categories was based on the distribution of the values of the continue dependent variable as well as some statistical characteristics such as skewness and kirtosis. Figure 2 presents the histogram, boxplot and stem-and-leaf plot of the dependent variable. As we can the distribution of the values does not follows the normal distribution. There is a very long tail to the right with several outliers and extreme values. There are also many cases with low values of variance driving the median, which is a measure of centrality, (see boxplot) to the left.

[INSERT FIGURE 2 ABOUT HERE]

The patterns and spatial distribution of variance measures are shown in figure 3. As we can observe, there are distinctive spatial differentiations amongst the units of analysis.

[INSERT FIGURE 3 ABOUT HERE]

We can see that a great number of insular and coastal prefectures present high or very high fluctuations in their building activity during the study period. This observed spatial distribution of variance raises a number of issues relevant to the regional economies. It generates high unemployment rates and employment instability (Stretton, 1981) during certain periods. The unstable nature of employment has several direct and indirect effects on the stability of the regional economies itself. It considerably affects the prices in the real estate market, sometimes leading to phenomena of land speculation. Regional income distribution, interest rates and other aspects of the local economies might be affected to some degree impacting productivity as well as regional economic performance as a whole. Considering the importance of building and construction activity sector, any future revision of the housing policy may need to address these issues.

Independent variables and research hypotheses

In this section we present the predictor variables of the empirical model as well as the research hypotheses assigned to each variable. In total, we consider nine explanatory variables related to economic, social as well as environmental regional characteristics.

- *Size of Urban Population*: The urban population variable represents the size of urban population in each prefecture for the year 2001. Data come from the NSSG (NSSG, 2001a). The size of urban population is a measure of urbanisation. The relationship between the size of urban population and building activity is a complex one. Bearing in mind the concept of cycles in real estate markets, we try to find out whether the prefectures with large urban concentrations are associated with more stable patterns of building activity.
- L*ength of Coastline:* The total length of coastline in each prefecture indicates the existence of suitable areas in each prefecture for situating vacation and holiday houses as well as tourism infrastructure. We assume that this factor depicts better the potential in each prefecture for tourism development. The existence of extensive scenic coastal locations is a factor of attraction for tourism investment because of the economic benefits traditionally associated with tourism. Data for this variable come from the NSSG (2004). We
- *The prosperity level* of residents in each prefecture. We investigate whether or not there is a positive influence of the prosperity level on the variance of building activity. Prosperity level is an indicator of the level of economic development in each prefecture. Therefore, we assume that it also depicts the capability of the local economy in the construction sector. 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). Due to the fact that the per

capita GNP cannot give a safe estimation of the prosperity in the NUT II & III levels, they have also been incorporated into the variable additional financial and development indicators concerning the levels of consumption and civil infrastructure in the prefectures. The data concerning this variable come from a previous study by Petrakos and Polyzos (2005).

- *Size of agricultural sector:* This variable represents the share of the agricultural sector to the gross domestic (GDP) of each prefecture for the period of 1990 to 2000. The ratio is calculated by using the following formula:

$$\frac{MeanGDP_{i\_agr}}{TotalGDP_{i}} \quad (6)$$

where,

$MeanGDP_{i\_agr}$ = is the mean GDP in agriculture for the years 1990 to 2000 in the prefecture i
$TotalGDP_{\_i}$ = is the mean total GDP for the years 1990 to 2000 in the prefecture i

Data for this variable come from the NSSG. We expect that the growth of gross domestic product in agricultural sector decreases the likelihood of agricultural land being abandoned.

- *Total Population*: Increasing local populations create new requirements for housing and therefore have an influence on both housing and construction activity in each prefecture. For the purpose of the present research the statistical data regarding population changes in each prefecture for the study period derive from the NSSG (NSSG, 2004).
- *The variance of the nights spent by foreigner tourists for the period 1990-2000*: This is a variable that represents the effect of tourist demand in the magnitude of building activity. Large fluctuations of tourism demand may affect building activity at least in the regions that their economy is tourism-orientated. Data for this variable come from the NSSG (NSSG, 2002).
- *Informal Housing Activity:* Recently, the informal housing phenomenon has attracted much attention and has also been approached through the concept of “Syndromes of Global Change”. It is considered as a major proximate cause of land use change and has been named as the “Favela Syndrome”. However, “Favela Syndrome” refers mainly to uncontrolled and unsustainable urbanization processes in developing countries. Informal settlements in Greece form a complex issue. These groups of housing units are associated with a diverse population of a wide variety of social and economic backgrounds. The phenomenon is taking up large areas of both marginal and productive agricultural land as well as forest land. Spatially speaking, we expect that if there is an association between variance of building activity and informal housing activity will be negative because of the antagonism for land between the two processes. Data for this variable come from the relevant annual building activity tables published by NSSG (2005).
- *Size of legal housing per capita 1990-2000:* Legal housing per capita is a measure of the housing activity in each prefecture. By employing this variable we want to investigate whether the variance in building activity has an analogous relationship with the size of

the activity or they are uncorrelated. The data for this variable are taken by the NSSG (2005).

- *Developmental Incentives or Motives (MOT)*
  In a lot of developed and most developing countries, economic activities are allured to locate or move by government regional policy through subsidies. In fact, this is a long pursued strategy for reducing regional inequalities and for enhancing employment opportunities and income (Begg and McDowal, 1986; Moore *et al.*, 1991; Filippaios and Kottaridi, 2004; Lambrecht and Pirnay, 2005; Bertolini and Giovannetti, 2006). This type of financial assistance usually varies in geographical space and includes low interest loans for qualifying firms, subsidies to a business for capital investment project, tax abatements, grants, procurement and export assistance. Regional development incentives that were provided by the Greek state during the study period formed 5 geographical categories. These were zones A, B, C, D and Thrace. Through zones A to D the percentage of subsidy escalated from 0% to 55% of the total cost of each particular project. Zone D had very strong incentives, while Thrace was a special zone with higher incentives than even Zone D. As far as the relevant regional incentive legislation is concerned, the subsidies were given under the provisions of Act 1892/1990 as the Act 2234/1994 later amended it. For the purpose of the present study we have classified the Greek prefectures into four categories according to the percentage of subsidy to private investments that the aforementioned act provided. These categories are: (1) Low, (2) Medium, (3) High and (4) Very incentives zones.

Results and discussion

Model fitting information

Table 1 is a summary presentation of the ordinal dependent variable coding scheme as well as the categorical independent variable depicting the magnitude of developmental law incentives. In table 2 we present the model fitting information.

[INSERT TABLE 1 ABOUT HERE]

The Likelihood-Ratio tests the hypothesis that all coefficients in the logistic model are 0. Because the observed significance level is small (0.0003), the null hypothesis that all coefficients for the independent variables are 0 can be rejected. Therefore, we can conclude that the final model is significantly better than the intercept-only model. The null hypothesis that the model adequately fits the data can be examined by the Pearson and Deviance tests in the Goodness-of-Fit table 3. However, because of the large number of covariant in the model, there are a lot of cells in the cross-tabulation have zero frequencies. Therefore, we cannot relay on these tests.

[INSERT TABLE 2 ABOUT HERE]
[INSERT TABLE 3 ABOUT HERE]

The pseudo r-square statistics can provide an indication of explained variation similar to the R^2 of multiple linear regression models (table 4). Larger pseudo r-square statistics indicate that the model explains more of the variation. The Cox and Snell R^2 and the Negelkerke R^2 are large enough. All associated percentages are satisfactory as the values of logistic regression measures are almost always much smaller than the corresponding ones for a linear model (Norusis, 2005b).

[INSERT TABLE 4 ABOUT HERE]

The Likelihood Ratio Tests presented in table 5 evaluates the contribution of each effect to the model. It is a test for the individual coefficient and tests the hypothesis that the coefficients are 0. This measure. For each effect, the -2 log-likelihood is computed for the reduced model; that is, a model without the effect. If the significance of the test is small (less than 0.05 or 0,10) then the effect contributes to the model. This test can be used instead of Wald test presented in the parameter estimates tables.

[INSERT TABLE 5 ABOUT HERE]

The classification matrix (table 6) shows that the model does very well in identifying the prefectures that experience very high variance in their building activity. About 80% of them are classified correctly. In addition, the model classifies very well the prefectures with high variance in their building activity (84,6%) and relatively well the prefectures in the low category (68,8%). are correctly assigned. The model does relatively poorly in identifying prefectures in the medium category.

[INSERT TABLE 6 ABOUT HERE]

Parameter estimates

The results for the first logit (table 7) indicate that the variables which significantly contribute to the separation of the low variance category in relation to the very high variance category of building activity are the length of coastline, prosperity level, variance of tourist stays, size of building activity and the zone of incentives coded 2. For the second and third logits (tables 8 and 9 respectively) the results are similar with minor differences. Specifically, evaluating the predictor variable it can be said that the size of urban population has a positive sign indicating that the prefectures with large urban concentrations are less likely to experience high levels of variance in their building activity. However, the level of statistical significance is not is not satisfactory for this variables for the first and the third logits whereas it is satisfactory for the second logit (p=0,048). Therefore, the association between the variables is statistically significant for the second logit meaning that as the size of urban population increases so does the probability of a prefecture to be assigned in the medium category of variance in respect to the probability of being in the very high variance category.

The variable representing the total length of coastline appears positively associated with the depended variable as well as statistically significant for all logits. This means that as the length of coastline increases, the probability of a prefecture being in the very high category of variance decreases. However, if we take into account the variable «variance of tourist stays», we will see that the relationship is negative and statistically significant meaning that the fluctuations in tourism demand increase the variance of building activity. Therefore, although the length of coastline is associated with lower variance in building activity, in the spatial units where the fluctuation of tourism activity is large, this conclusion might not be the case. From diagram 3, we can see that most of the insular prefectures have high or very high values of variance in their building activity.

As regards prosperity level, the sign of the regression coefficients are negative for all logits and the coefficients are statistically significant for the first and the third logit. The negative sign implies that as the prosperity level increases, the likelihood for a prefecture to have high variance – and therefore a highly unstable building activity sector – increases. This possibly means that the economic development during the study period, was positively connected with the size of the variance of the building activity. This conclusion is also related to the regression results regarding the variable of the «the size of building activity». For this variable, the coefficient is negative and statistically significant for all three logits meaning that the size of building activity is positively associated with its variance. Similarly, the size of informal housing activity is positively associated with the size of the variance in building activity. Therefore, it could be argued that the last three variables discussed, form an indicator of the size of economic activity in each prefecture. Hence, the overall conclusion is that the economic activity in each prefecture is positively connected to the variance of building activity sector.

The variable representing the share of agricultural sector to the GDP in each prefecture is positively related to the dependent variable but it is only statistically significant for the third logit. This means that as the share of agricultural sector to the local economy increases so does the likelihood of a prefecture being in the high variance category with respect to the very high variance category. These means that the prefectures with developed agricultural sector, which usually are the poorest prefectures, can frequently exhibit high variance in their building activity but not very high.

The variable representing the total population in each prefecture, does not seem to be very useful in separating variance categories and therefore it does not contribute to the model. Finally, the regression coefficient of the categorical variable «zone of incentives» is statistically significant only for logits A and B and only for its second category coded 2. This means that the prefectures that receive relatively medium state financial support for establishing economic activities are more likely to present low of medium variance in building activity than very high variance in relation to the prefectures that receive very high state support.

[INSERT TABLE 7 ABOUT HERE]
[INSERT TABLE 8 ABOUT HERE]
[INSERT TABLE 9 ABOUT HERE]

Conclusions

The above empirical analysis haw indicated which factors influence the relative stability of economic activity in the building and construction sector in Greece. It appears that the size of variance is highly influenced by the size of economic activity, fluctuations in the tourism sector, the level of regional prosperity and the developmental incentives provided by the state. These results can be useful to planners of real estate and land use policy. The results could:

- Extend knowledge and understanding of the causes of observed variability and change.
- Give early insights of proximate and underlying cause as well as go deeper into the clusters of elements that give rise to certain patterns of building activity.
- Reduce scientific uncertainties regarding the proximate and underlying causes of fluctuations in the building and construction sector.
- Look into the structure of underlying causes and improve policy decision capabilities to serve regional planning needs.
- Improve quantification of the forces bringing about land use changes and thus reduce uncertainty in projections of how the land surface may change in the future.
- Prepare scientific syntheses and assessments to support informed discussions on urban land use variability issues by decision-makers.

References

Begg, H. and McDowal, S. (1986) The effect of Regional Investment Incentives on Company decisions. *Regional Studies,* 21(5), pp. 459-470.

Bertolini, P. and Giovannetti, E. (2006) Industrial districts and internationalization: the case of the agri-food industry in Modena, Italy. *Entrepreneurship & Regional Development,* 18(4), pp. 279 - 304.

Boatman, N., Stoate, C., Cooch, R., Rio Carvalho, C., Borrelho, R., de Snoo, G. and Eden, P. (1999) The enivironmental impacts of arable crop production in the European Union: PEctical option for improvement. in E. Commission (Ed.).

Butler, S. J., Vickery, J. A. and Norris, K. (2007) Farmland Biodiversity and the Footprint of Agriculture. *Science,* 315(5810), pp. 381-384.

Filippaios, F. and Kottaridi, C. (2004) Investment Patterns and the Competitiveness of Greek Regions. *The Applied Regional Science Conference (ARSC) /RURDS,* 16(2), pp. 93-112.

Lambrecht, J. and Pirnay, F. (2005) An evaluation of public support measures for private external consultancies to SMEs in the Walloon Region of Belgium. *Entrepreneurship & Regional Development,* 17(2), pp. 89 - 108.

Moore, B., Tyler, P. and Elliott, D. (1991) The Influence of Regional Development Incentives and Infrastructure on the Location of Small and Medium Sized Companies in Europe. *Urban Studies,* 28(6), pp. 1001-1026.

Norusis, M. (2005a) *SPSS 14.0 Statistical procedures companion,* (New Jersey: Prentice Hall Inc).

Norusis, M. (2005b) *SPSS 14.0 Statistical Procedures Companion,* (New Jersey, USA: Prentice Hall).

NSSG (2001a) *Population cencus,* (Pireas: Hellenic Republic).

NSSG (2001b) *Statistical Yearbook of Greece,* (Athens: Hellenic Republic).

NSSG (2004) *Statistical Yearbook of Greece,* (Athens: Hellenic Republic).

NSSG (2005) *Yearly Data on Construction Activity in Greece,* (Pireas: Hellenic Republic).

Petrakos, G. and Polyzos, S. (2005) Regional Inequalities in Greece: Literature Review and Estimations of Inequalities. in M. Chletsos, C. Kollias and H. Naxakis (eds) *Studies in Greek Economy.* (Athens: Patakis), pp. 185-216.
Rahman, S. (2005) Environmental impacts of technological change in Bangladesh agriculture: farmers' perceptions, determinants, and effects on resource allocation decisions. *Agricultural Economics,* 33(1), pp. 107-116.
Stretton, A. W. (1981) The Building Industry and Urbanization in Third World Countries: A Philippine Case Study. *Economic Development and Cultural Change,* 29(2), pp. 325-339.
Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A., Howarth, R., Schindler, D., Schlesinger, W. H., Simberloff, D. and Swackhamer, D. (2001) Forecasting Agriculturally Driven Global Environmental Change. *Science,* 292(5515), pp. 281-284.

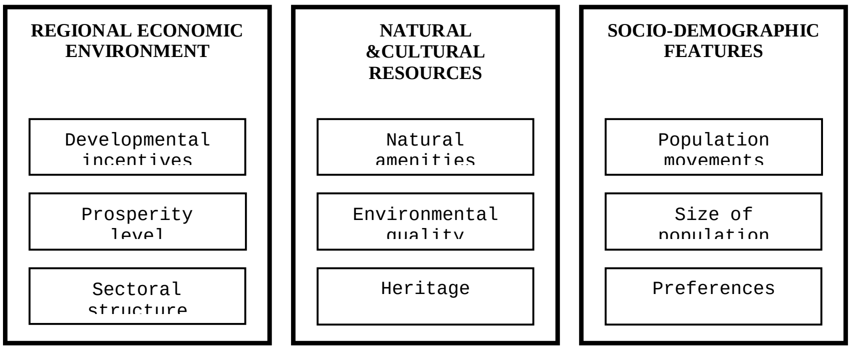

Figure 1: Conceptual framework

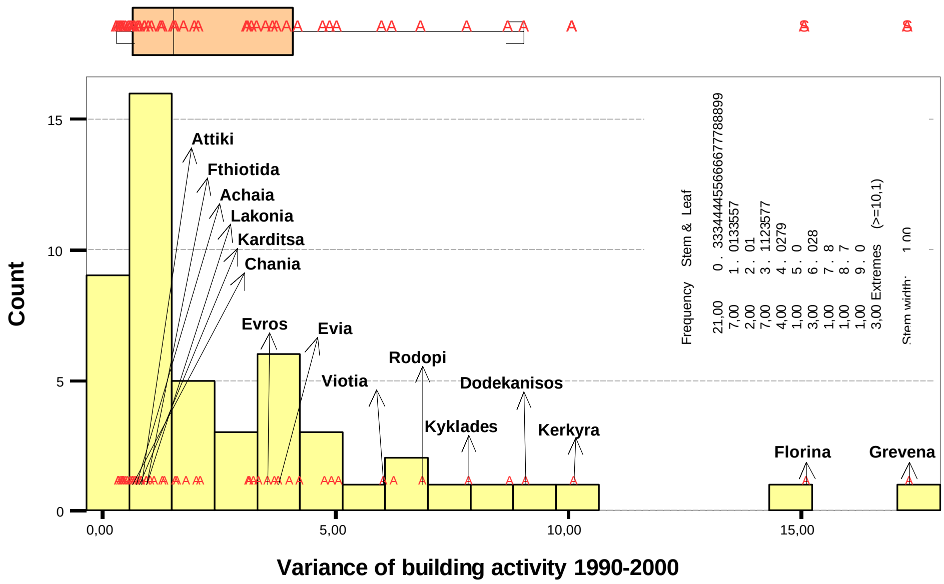

Figure 2: Stem and leaf plot, normal probability Q-Q plot, histogram and box-plot of the dependent variable.

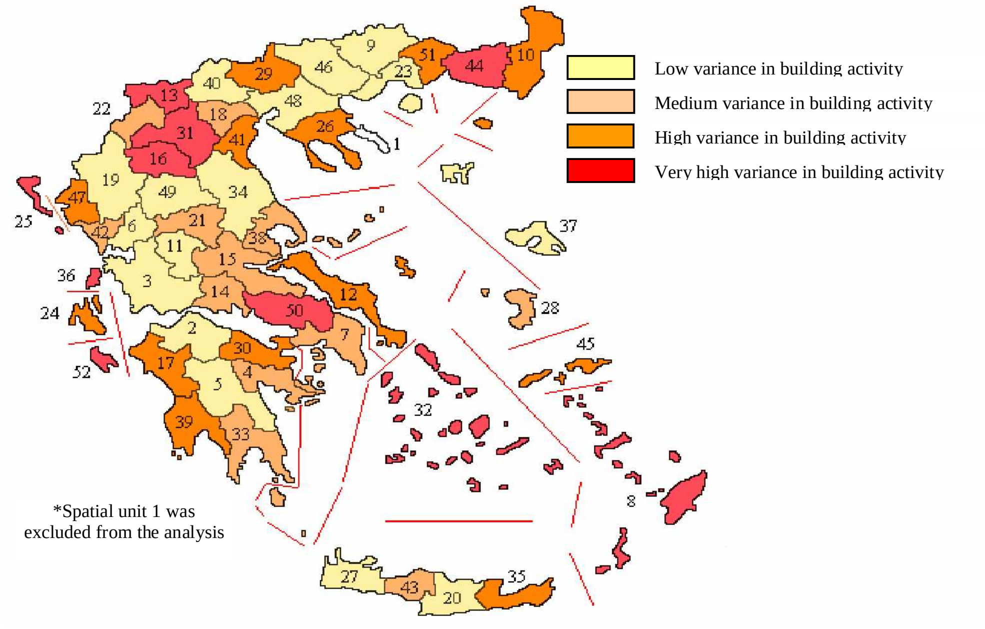

Figure 3: Spatial distribution of building activity variance (σ^2) in Greece for the period 1990-2000.

Table 1: Case Processing Summary

Variables Coding Scheme		N	Marginal Percentage
Variance of building activity 1990-1996 (Binned)	<= ,79	16	31,4%
	,80 - 2,00	12	23,5%
	2,01 - 5,00	13	25,5%
	5,01+	10	19,6%
Zone of Incentives (Banded-4 Categories)	1	8	15,7%
	2	23	45,1%
	3	13	25,5%
	4	7	13,7%
Valid		51	100,0%
Missing		0	
Total		51	
Subpopulation		51(a)	

(a) The dependent variable has only one value observed in 51 (100,0%) subpopulations.

Table 2: Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	139,945			
Final	72,730	67,216	33	0,0003

Table 3: Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	533,219	117	0,000
Deviance	72,730	117	1,000

Table 4: Pseudo R-Square

Pseudo R-Square	Value
Cox and Snell	0,732
Nagelkerke	0,783
McFadden	0,480

Table 5: Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	72,730(a)	0,000	0	.
Urban population of the year 2001	86,742	14,013	3	0,003
Length of coastline	84,537	11,808	3	0,008
Prosperity level	77,841	5,111	3	0,164
Size of agricultural sector	80,205	7,476	3	0,058
Population of 2001	79,272	6,543	3	0,088
Standard deviation of tourist stays	84,192	11,462	3	0,009
Informal housing activity	74,262	1,532	3	0,675
Size of building activity	94,148	21,418	3	0,000
Zone of incentives	85,470	12,740	9	0,175

The chi-square statistic is the difference in -2 log-likelihoods between the final model and a reduced model. The reduced model is formed by omitting an effect from the final model. The null hypothesis is that all parameters of that effect are 0. a This reduced model is equivalent to the final model because omitting the effect does not increase the degrees of freedom.

Table 6: Classification matrix

Observed	Predicted				
	<= ,79	,80 - 2,00	2,01 - 5,00	5,01+	Percent Correct
<= ,79	11	2	3	0	68,8%
,80 - 2,00	2	8	0	2	66,7%
2,01 - 5,00	1	1	11	0	84,6%
5,01+	0	1	1	8	80,0%
Overall Percentage	27,5%	23,5%	29,4%	19,6%	74,5%

Table 7: Parameter Estimates for Logits

Variance of building activity 1990-1996 (Binned)(a)	B	Std. Error	Wald	Sig.	Exp(B)	B	Std. Error	Wald	Sig.	Exp(B)	B	Std. Error	Wald	Sig.	Exp(B)
Variables	**Logit A Function**					**Logit B Function**					**Logit C Function**				
Intercept	3,351	6,394	0,275	0,600		0,302	6,667	0,002	0,964		-0,602	5,831	0,011	0,918	
Urban population of the year 2001	0,204	0,132	2,392	0,122	1,226	0,260	0,131	3,927	0,048	1,297	0,091	0,115	0,636	0,425	1,096
Length of coastline	3,868	1,895	4,168	0,041	47,86	4,146	1,893	4,797	0,029	63,19	4,552	1,985	5,262	0,022	94,85
Prosperity level	-0,395	0,236	2,813	0,093	0,674	-0,321	0,240	1,794	0,180	0,725	-0,375	0,234	2,572	0,109	0,687
Size of agricultural sector	0,032	0,090	0,124	0,725	1,032	0,095	0,096	0,981	0,322	1,100	0,186	0,100	3,456	0,063	1,205
Population of year 2001	0,0001	7,9e-005	1,715	0,190	1,0001	6,9e-005	7,9e-005	0,761	0,383	1,00006	-9,5e-006	7,4e-005	0,016	0,899	0,99999045
Standard Deviation of tourists stays	-0,094	0,047	3,927	0,048	0,910	-0,122	0,082	2,235	0,135	0,885	-0,133	0,059	5,080	0,024	0,876
Informal housing activity	-0,312	0,305	1,049	0,306	0,732	-0,140	0,288	0,234	0,628	0,870	-0,215	0,302	0,507	0,476	0,807
Size of building activity	-3,1e-005	1,2e-005	6,042	0,014	0.999	-3,6e-005	1,3e-005	7,350	0,007	0,99996	1,6e-006	9,1e-006	0,033	0,855	1,00000166
Zone of incentives=[1]	-2,043	5,037	0,165	0,685	0,130	-0,395	5,274	0,006	0,940	0,674	-5,007	5,015	0,997	0,318	0,007
Zone of incentives=[2]	5,811	3,205	3,287	0,070	334,1	7,820	3,381	5,349	0,021	2490	3,022	2,696	1,256	0,262	20,52
Zone of incentives=[3]	2,350	2,798	0,705	0,401	10,49	3,939	3,135	1,579	0,209	51,39	1,691	2,272	0,554	0,457	5,426
Zone of incentives=[4]	0(b)	.	.	.	.	0(b)	.	.	.	.	0(b)	.	.	.	.

a The reference category is: 5,01+.
b This parameter is set to zero because it is redundant.