

The Impact of the Financial Crisis on Residential Property Market of Greece

Stefanos GIANNOULAKIS, Nikolaos KARANIKOLAS, Agapi XIFILIDOU, Linos PERCHANIDIS, Greece

Key words: Greek property market, residential properties, financial crisis, valuation, hedonic model

SUMMARY

This paper is part of an ongoing research concerning the build of a model in order to evaluate the impact of the financial crisis on residential property market with application to the residential sector of Thessaloniki's real estate market.

The Greek Economy continues in the dawn of 2016 the 9th year of recession due to credit crunch of 2008. Greece's social and economic crash reflects in its property slump. The Greek Real Estate Market (GREM) has long been a pillar of the Greek economy and as a result has been severely affected too. The GREM continues to be characterized by excess supply and falling purchase and rental values as well as by a limited number of transactions. According to Eurostat, the EU's statistics agency, the country had suffered the second steepest decline in house prices after Croatia, the bloc's newest member. The main key characteristics of this recession are the further decrease in household's disposable income, the contraction of investment activity, and the uncertainty regarding the tax environment as well as the rising unemployment.

In this research, a sample of over 5000 comparable sales and valuation reports of residential properties in the Metropolitan area of Thessaloniki have been gathered and integrated into a database for a time - period from 2006 till now. The database includes also a number of the characteristics for each individual property such as age, size, floor, and date of purchase/valuation. At the same time, other variables such as household income, unemployment rates, inflation and construction activity might be taken into consideration. The main tool of the empirical analysis is the hedonic model. The hedonic model, which is extensively used in the related literature, is the classic multiply linear regression, which regresses the house values with their particular characteristics providing a coefficient to each characteristic. The estimated coefficients constitute the marginal prices of property characteristics. The analysis of the empirical results provides significant information in order to assess the behavior of Thessaloniki's residential market and more importantly how the house values influenced by the economic crisis.

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1. INTRODUCTION

1.1 The Credit Crunch and the impact on the property market worldwide

Since the start of the credit crunch, both academics and real estate professionals have undertaken research to evaluate the impact of the financial crisis on both residential and commercial property markets.

The current global financial crisis is the result of inadequate regulation of real estate and financial markets. The collapse of the subprime residential mortgage market in the US was the catalyst for the financial crisis. The central element in the current financial crisis is the housing bubble which continues to be the epicenter of the financial crisis in the dawn of 2016 the 9th year of recession due to credit crunch of 2008.

In Europe the impact of the economic crisis to the residential property market becomes more and more conspicuous especially in the biggest metropolitan cities and it is shown below to Table 1:

Date	Country - City	Report
Q2 2015	Switzerland	Property prices inflated by as much as 70% in just 5 years in cities such as Geneva and Zurich. Prices fell 5% in the last two months.
Q2 2015	U.K. - London	Property prices in central London are falling faster than at any time since the financial crash, with family homes down as much as 10 per cent in just 8 weeks. In Britain overall, the volume of property transactions has completely collapsed, falling 40% since 2008.
Q2 2015	France	House prices in Metropolitan France fell for the ninth consecutive quarter, falling by 1.21% during the year to Q2 2014, according to the National Institute for Statistical and Economic Studies.
Q2 2015	Italy	Housing prices are now down by 27.7 percent in the south, and 15.5% in northern and central Italy.
Q2 2015	Ireland	According to the latest figures from the Central Statistics Office, property prices fell by 0.4% in the capital Dublin.

*Table 1: Impact of the financial crisis to European Real Estate property markets.
Source: The Knight Frank Global House Price Index Q2 2015*

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1.2 The credit crunch and the impact into Real Estate in Greece

The Greek Economy continues in the dawn of 2016 the 9th year of recession due to credit crunch of 2008. The main key characteristics of this recession are the further decrease in households' disposable income, the contraction of construction and investment activity, and the uncertainty regarding the tax environment as well as the rising unemployment. The performance of several leading indicators in Greece for the period of 2006-2015, such as Gross Domestic Product (GDP), Unemployment Rate, Construction activity (Building Permits), Consumer Price Index (CPI) and Income Index is represented below in Figure 1:

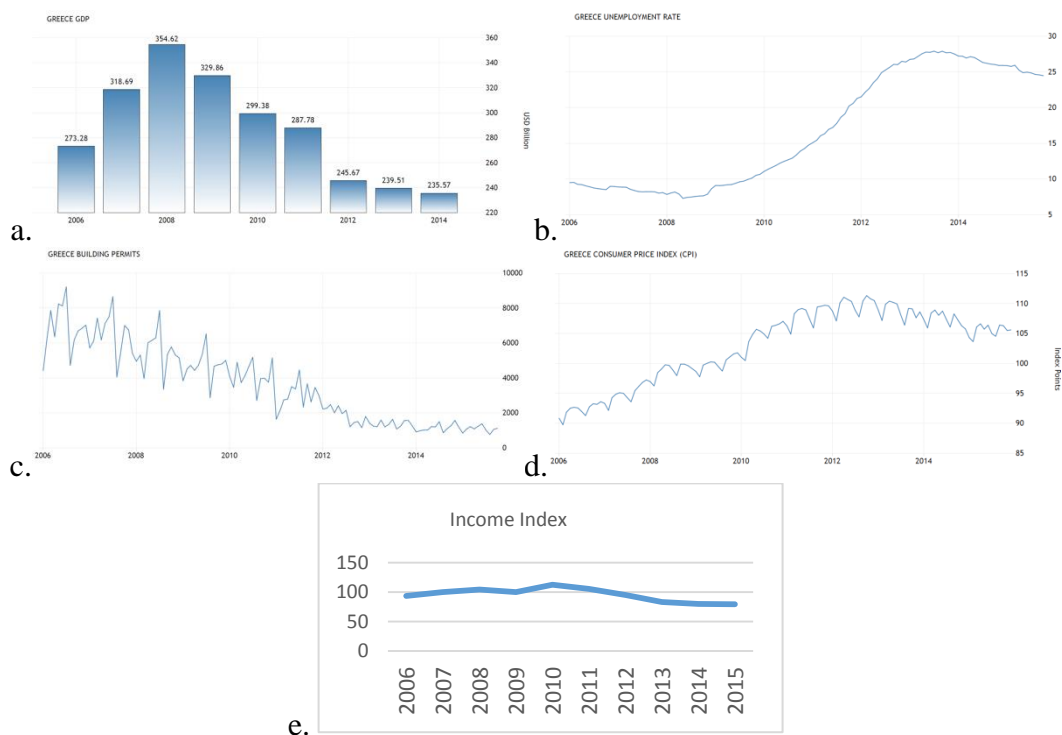


Figure 1: The performance of several leading indicators (a. GDP, b. Unemployment Rate, c. Construction activity, d. Consumer Price Index (CPI), e. Income Index for the period of 2006-2015. Source: Trading Economics, World Bank Group & Hellenic Statistical Authority

Greece's social and economic crash is reflected in its property slump. The Greek Real Estate Market (GREM) has long been a pillar of the Greek economy and as a result has been severely affected too. The increased uncertainty of the political landscape, which started near the end of 2014 as well as the capital controls imposed in July 2015 have increased the negative pressure on the real estate market.

The GREM continues to be characterized by excess supply and falling purchase and rental values as well as by a limited number of transactions. According to Eurostat, the EU's statistics agency, the

country had suffered the second steepest decline in house prices after Croatia, the bloc's newest member. Moreover, according to the Eurobank Property Service's Property Market Report (January - October 2015), residential property prices have experienced a cumulative decrease of approximately to 40% at a national level, 43% in Athens and 44.8% in Thessaloniki, the two biggest metropolitan cities of the Greece.

1.3 The scope of the research

This paper focuses on assessing the behaviour of Greece's residential property market during the crisis. It is an ongoing research concerning the build of a model in order to evaluate the impact of the financial crisis on residential property market with application to the residential sector of Thessaloniki's real estate market.

In this research, a sample of over 5000 comparable sales and valuation reports of residential properties in the Metropolitan area of Thessaloniki have been gathered and integrated into a database for a time period from 2006 to 2015. The database includes also a number of the characteristics for each individual property such as age, size, floor, and date of purchase/valuation. At the same time, other variables such as household income, unemployment rate, GDP, inflation and construction activity etc. might be taken into consideration.

In quantitative research the outcome is an objective reality which exists independently of the researcher's perception. Additionally, the goal of the quantitative research is to assess and determine associations between variables using an objective mathematical framework (Sale et al., 2002). The main tool of the empirical analysis is the hedonic model. Considering the related literature regarding housing studies, the hedonic pricing model represents this objective mathematical framework which is used extensively.

The hedonic model is the classic multiply linear regression which regresses the house values with their particular characteristics providing a coefficient to each characteristic. The estimated coefficients constitute the marginal prices of property characteristics. The analysis of the empirical results provides significant information in order to assess the behaviour of Thessaloniki's residential market and more importantly how the house values are influenced by the economic crisis.

2. LITERATURE REVIEW

2.1 Hedonic models

Hedonic models belong to the category of indirect methods of valuation, where valuation is conducted through market choices by individual consumers in specific cases. The environmental goods that are measured by indirect valuation methods are those with value of use. The valuation of an environmental good, which cannot be measured directly, is attempted indirectly through related markets in which values can be measured in a more direct manner. Hedonic models provide a useful tool towards this attempt.

Essentially, the first who applied hedonic models was Court (1939) in the automobile market. Colwell and Dilmore (1999) stated that Haas produced a hedonic study 15 years before Court implemented hedonic modelling in the automobile market (Colwell & Dilmore, 1999). Another reference was made by Lancaster during his analysis on the consumer theory (1966). However, Rosen is acknowledged to be the father of hedonic models due to their wide introduction in 1974. In his work entitled «Hedonic Prices and Implicit Markets», Rosen developed the theory that a good, whether its value can be measured directly or not, consists of a set of characteristics, which in combination define the good's value of use for every consumer, the consumer's desire to acquire it and, therefore, its value (Nclovic, 1995). It is important to mention that Lancaster's model is mostly used on consumer goods, whereas Rosen's model is most suitable for durable goods, such as real estate values. Moreover, Lancaster uses a linear relationship between the value and the characteristics of a good. On the contrary, Rosen postulates that and introduces a nonlinear value function implying that implicit value is not a constant (Chin & Chau, 2003). Due to the fact that hedonic models were mainly used for the calculation of the use value, many researchers felt reluctant for their utilization. Nevertheless, the method is widely accepted since it provides accurate results in many different case, it is efficient and no other method is able to predict the value of certain goods (Bartik, 1987; Hite, Chern, Hitzhusen, & Randall, 2001; Boes, Nüesch, & Wüthrich, 2015).

The method was named after a school of economics who argue that the aim of all economic activities is to achieve the greatest possible satisfaction and thus avoiding any damage. The word hedonic is derived from the Greek work "hedonikos", which means pleasure. So hedonic refers to the satisfaction of the utility someone feels and achieved from the consumption of a particular good. The hedonic method is used to estimate the value of every aspect or part that make up a product. In this case, the method will be applied for the recognition of the factors that influence real estate values in certain areas in the city of Thessaloniki, Greece. The method is based on the estimation of the usefulness of each element to the consumers and not on the estimation of the value of the property itself. Thus, values reflect the value of all the characteristics, including environmental, urban and other characteristics, which consumers consider important when buying an estate. For instance, the assessment of the impact of upgrading the quality of the urban environment by creating a green space on the value of real estate is measured effectively by hedonic models (Mohd Noor, Asmani, & Abdullah, 2015).

The fundamental equation of the hedonic model is set as follows:

$$P = f(N_1, N_2, N_3, \dots, N_i, L_1, L_2, L_3, \dots, L_i, H_1, H_2, H_3, \dots, H_i)$$

In the real estate case, the value of an estate results from various different components. In most studies, these components are classified into three main categories: construction - construction characteristics of the property (N_1, \dots, N_i), the characteristics of the area or the neighbourhood in which it is placed (L_1, \dots, L_i) and environmental characteristics (H_1, \dots, H_i). Additionally, the value of a property may be influenced by socio-economic data or even cultural data.

The equation can, also, be stated as follows:

$$P = \beta_0 + \sum \beta_{Ni} x_{Ni} + \sum \beta_{Lj} x_{Lj} + \sum \beta_{Hk} x_{Hk} + \varepsilon$$

where

x_{Ni}, x_{Lj}, x_{Hk} are the values of the explanatory variables for every characteristic N, L, H

β_0 is the constant coefficient

$\beta_{Ni}, \beta_{Lj}, \beta_{Hk}$ are the weight coefficients for every characteristic, L, H

and ε is the estimation error.

The expected value for each variable can be calculated through the derivation of the above equation. Furthermore, the partial derivatives of P for each variable produces the demand curve for each particular variable.

$$\frac{\partial P}{\partial x_{Hi}} = P_{Hi}$$

For the real estate sector, the ratio $\frac{\partial P}{\partial x_{Ki}}$ is the differential income and the measure of the marginal change in H_i variable. In other words, it measures the change in the value of a property due to the marginal change of the measured explanatory variable (characteristic of the property). Therefore, this ratio is important because it quantifies virtually any change of any attribute regardless of its characteristics (measurable or not). In an ideal free market, the consumer adjusts his choices and preferences depending on the differential income, ie to the point where the marginal value change of a particular attribute equals the marginal cost of this change (Latinopoulos, 2010).

2.2 The application of Hedonic models into assessing the impact of the credit crunch upon the property market

Since the beginning of the crisis, hedonic modelling has been applied in studies referring to the impact of the economic crash on the real estate market. The identification of the differences in the way crisis influences real estate values due to institutional factors relating to the housing system (Lux & Sunega , 2013) and the impact of general macroeconomic factors (Renigier-Bilozor & Wisniewski, 2012) are two very usual subjects of study. Additionally, hedonic modelling is used in countries where the economic crisis had different impact from the western societies, such as Taiwan and China (Kang & Liu, 2014). In general, the method is widely used in the real estate market analysis, offering the opportunity to identify and compare different findings before, during and after the economic crisis (Aizenman & Jinjark, 2014; Navarro-García & Madrid-Guijarro, 2015). Nowadays, in Greece, the method is widely used for the estimation of the factors that influence real estate values, their results and any kind of development prospects in the market both in its simple econometric and advanced spatial form (Xifilidou, Vagiona, & Karanikolas, 2013; Akantziliotou, Vlachostergiou , & Mitrakos, 2013; Perchanidis, 2015).

3. METHODOLOGY

3.1 The study area

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The study area is the city of Thessaloniki, which is located in the North of Greece. Thessaloniki is Greece's second major economic, industrial, commercial and political centre, and a major transportation hub for the rest of south-eastern Europe. According to the Hellenic Statistical Authority, the Thessaloniki Metropolitan Area (the prefecture of Thessaloniki) extends over an area of 1.455,62 km² and its population in 2011 reached a total of 1.104.460 inhabitants. One of the most interesting features of the city is its geomorphological appearance. Thessaloniki is situated between wooded hills to the North and the Thermaikos bay to the South, thereby comprising a complex urban space with intense spatial fluctuations (Lagarias, 2012). Consequently, because the city is bordered by two limiting physical features (hills and the sea) in two directions, the urban expansion is only possible to the West and East, a fact which is clearly observable from an amphitheatre view. Thessaloniki, and Greece in general, was experiencing a major development boom from 1997 to 2008, predominantly due to the availability of financial resources and low financing costs (Molson, 2007). The residential prices followed the intense development activity reaching their peak in 2007. In parallel, the residential property was the main investment activity, representing 25% of total investments in the country (Gallagher & Buchanan, 2012). However, after 2008 and the credit crunch, followed by the strict fiscal policy deployed and the adoption of the European memorandum by the Greek government, the situation has changed dramatically and there is continuous fall in residential property prices. For this reason, in the research due to the great differentiation in house prices, a sample of over 5000 house transactions and valuation reports is being analysed for the time - period from 2006 to 2015.

3.2 Real Estate data

The data refer to the residential market of Thessaloniki. More analytically, 5.448 flat transactions and valuations reports are being considered, from 2006 to 2015 covering the metropolitan area of the city. This database has been provided by Bank of Greece for the purposes of the present study. It should be noted that the same database is used by the bank to produce the housing price indices. The database includes for each residential property the following characteristics:

- Address and postcode
- Transaction date/date of valuation
- Sale price in €/market value
- Construction year
- Level of floor
- Size in square meters
- Quality of construction
- View

The use of this particular database is considered as important because is one of the most reliable databases it could be provided considering that there are no data available in public in the Greek real estate market.

3.3 Financial indicators

Furthermore, in this research, the performance of several leading financial indicators in Greece for the period of 2006 to 2015 is being considered. The data are being provided by the Hellenic Statistical Authority and are the following:

- Income index

- Unemployment Rate
- Gross Domestic Product (GDP)
- Consumer Price Index (CPI) (as a meter of inflation)
- Construction activity (Building Permits)

3.4 Variables

According to the above database and determinants of housing prices which are presented in the literature review, 15 variables were created regarding the residential market of Thessaloniki: ten time factors indicating the year of transaction/appraisal of each property, five structure factors and five economic indicators. Variables are presented in detail, below in Table 2:

Category	Variables	Measures
Time factors	Y2006	Dummy var with 1 indicating that properties were sold/valued in 2006, otherwise 0
	Y2007	Dummy var with 1 indicating that properties were sold/valued in 2007, otherwise 0
	Y2008	Dummy var with 1 indicating that properties were sold/valued in 2008, otherwise 0
	Y2009	Dummy var with 1 indicating that properties were sold/valued in 2009, otherwise 0
	Y2010	Dummy var with 1 indicating that properties were sold/valued in 2010, otherwise 0
	Y2011	Dummy var with 1 indicating that properties were sold/valued in 2011, otherwise 0
	Y2012	Dummy var with 1 indicating that properties were sold/valued in 2012, otherwise 0
	Y2013	Dummy var with 1 indicating that properties were sold/valued in 2013, otherwise 0
	Y2014	Dummy var with 1 indicating that properties were sold/valued in 2014, otherwise 0
	Y2015	Dummy var with 1 indicating that properties were sold/valued in 2015, otherwise 0
Structure factors	Age	The age of properties in years
	Floor	The level of floor of each property which varies from -1 indicating a basement apartment to 9.
	Size	The size of properties in sq. meters
	Quality of construction	Dummy variable with 1 indicating that properties have high quality construction, otherwise 0

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	View	Dummy variable with 1 indicating that properties factors have sea or forest view, otherwise 0
Economic factors	Income index	A quarterly index indicating the income in Greece from 2006 to 2015
	Unemployment Rate	A monthly percentage indicating the unemployment in Greece from 2006 to 2015
	GDP	The Gross Domestic Product per year in billion Euros.
	Consumer Price Index (CPI)	A quarterly index indicating the consumer price fluctuations for 2006 to 2015
	Construction activity	A quarterly index indicating the buildings construction activity from 2006 to 2015

Table 2: The variables that were created regarding the residential market of Thessaloniki and included in the hedonic analysis.

Building the model and hedonic simulation

In order to interpret the housing prices in Thessaloniki and how they are influenced by the economic crisis we consider two log-linear models with dependent variable the price per square meter in both case. The first model regresses the dependent variable with the time factors and the structure factors. The second model regresses the dependent variable with the structure factors and the financial factors. The reason we employ two separate models is that when a model with all the above independent variables is considered the results are insufficient for interpreting the housing prices in Thessaloniki. The most important drawback for employing one model was the fact that time variables appear as insignificant. The two models solve the problems providing significant outcomes for the housing price evolution during the economic crisis and the influence of both structure and financial variables on housing prices as well.

Additionally, pure econometric hedonic models are considered ignoring for the spatial dependence in housing prices. In the related literature spatial hedonic models receive credits for their real estate price prediction in contrast to the econometric hedonic form. It is strongly argued that ignoring for the spatial effects (spatial dependence and spatial autocorrelation) results biased coefficients and reduce the model predictability (Orford, 2002; Orford, 2000; Liu, 2012; Can, 1990; Bourassa et al., 2007; Case et al., 2004). On the other hand, the present survey attempts mostly to interpret how the economic crisis has influenced the housing prices and an econometric model is considered as sufficient tool to extract the necessary results. Finally, a spatial model requires further research and deep understanding of the housing submarkets, issues which are beyond the interests of the present research paper.

Finally, it is important to mention that a sample size of 5448 flat transactions in Thessaloniki is considered. This sample derives from a large database with more than 16000 house transactions from 2006 to 2015. We reduce the database and construct a solid sample by extracting the

peripheral areas of Thessaloniki and the outliers in order to avoid the abnormalities in housing prices and in consequence the abnormalities in the results.

4. RESULTS AND DISCUSSION

4.1 The Time – Structure model

The *first model* aims at highlighting the impact of certain structural characteristics of each property on its value and the impact of the economic crisis through a time scale of 10 years. The reference year is 2010, when the economic crisis started influencing real estate at a great scale. It must be mentioned that these years refer to both pre-crisis and recession years. The model is based on 5.448 real estate data throughout the city of Thessaloniki. The results of the first model are shown in Table 3.

R^2	Adjusted R^2	Residual standard error	df	F-statistic	Durbin-Watson statistic
0.667	0.6661	0.3351	5433	777.3	1.847
Dependent variable: Log (Price)					
Independent variable: 14					

Table 3: Summary of the linear model.

The R^2 indicates that more than half of the variation of the dependent variable can be explained by the variations of the independent variables. A percentage of 66.7% of the real estate values can be predicted by the model. The Adjusted R^2 suggests that the predict power of the model is highly satisfactory. Considering the heterogeneous character of the market and the unprecedented Greek economic reality, the percentages are satisfactory. The F-statistic is 777.3 with a p-value almost 0, which means that the linear model provides significantly better property value prediction comparing to the mean value (**Field, Miles, & Field, 2012**).

Table 4 presents the results of the model referring to each independent variable's impact on values. All the variables are statistically significant in 5% level of significance.

Variables	Unstandardized Coefficients		Standardised Coefficients	t-value	p-value	Collinearity Statistics
	B	Std. Error	Beta			VIF
Intercept	10.81554	0.0207051		522.363	< 2e-16	
Time factors						
X2006	0.200	0.022	0.084	9.258	< 2e-16	1.354
X2007	0.197	0.016	0.13	12.146	< 2e-16	1.859
X2008	0.180	0.016	0.115	10.931	< 2e-16	1.802
X2009	0.095	0.016	0.061	5.838	5.60E-09	1.758
X2011	-0.150	0.020	-0.069	-7.479	8.71E-14	1.406
X2012	-0.273	0.021	-0.117	-12.869	< 2e-16	1.351
X2013	-0.334	0.020	-0.152	-16.474	< 2e-16	1.397
X2014	-0.464	0.023	-0.175	-19.761	< 2e-16	1.281
X2015	-0.459	0.043	-0.086	-10.686	< 2e-16	1.069
Structure factors						
Age	-0.009	0.000	-0.253	-31.271	< 2e-16	1.064
Floor	0.048	0.003	0.15	18.756	< 2e-16	1.046
QofC	0.092	0.025	0.03	3.626	0.000291	1.103
View	0.078	0.031	0.02	2.534	0.011308	1.051
Size	0.013	0.000	0.681	85.117	< 2e-16	1.043
R²	0.667					
Sample size	5448					

Table 4: Linear regression results.

The B coefficient indicates the change of value if one of the independent variables change by a unit, assuming that all other variables remain stable.

As far as Time factors are concerned, they are all coded as dummy variables showing the change in values between 2010 and the year they are referred to. When economic crisis hit Greece in 2008, real estate values started dropping after two years. Real estate values had been increasing for almost a decade creating a housing bubble. Due to the fact that properties are inflation hedge equities and that they were the basic form of investment in Greece, they started experiencing a drop after 2010. This finding is validated by the results of the model. The years before 2010 have a positive sign, indicating an active real estate market. On the contrary, negative signs are observed in the years 2011-2015. The X2011 variable indicated that real estate values dropped by 15% compared to 2010, keeping all other variable constant. This drop continued and intensified, leading to percentages of 27.3%, 33.4%, 46.4% and 45.9% in 2012,2013,2014 and 2015, all compared to 2010. The results of the model give the opportunity to identify any value changes through the years in Greece.

Structure factors provide very interesting results as well. Surprisingly, the most influential variable is the quality of construction (QofC). If a property is constructed well with good quality materials and layout, it is valued 9.2% higher than others with lower quality of construction. Potential buyers are willing to pay more for a high quality construction house. Furthermore, traditionally, high quality houses are located in high quality areas attracting the interest of high household income buyers.

The floor level of the properties is the second most influential factor. The results indicate that by increasing the floor level by one, values increase by 4.8%. Higher floor levels appear to be more attractive to buyers or tenants, a result which is closely related to the importance of the location factor of the view, which will be analyzed afterwards.

The size of the property, also, plays an important role in the determination of its value. It is very interesting that if the size of the property increases by a unit, then the value increases by 1.3%. This finding highlights the importance of the size of the property to its value and to the buyers' preferences.

The age of the building appears to have negative effect on the value. In other words, each year of age decreases the value by 0.9%. The result is logically interpreted, as older buildings require more maintenance expenditures than relatively new buildings and in most cases have lower quality.

Lastly, the view variable indicates the difference in housing prices between properties which enjoy a sea, forest or any other view with those which have not. The results show that houses with view have 7.8% higher prices than houses which have no view. The importance of this locational factor in Thessaloniki is clearly shown by the results. This importance is explained by the special landscape between the sea and forest of the city. But, apart from any characteristics of the city, the sunny weather in Greece and the fact that the most of the buildings have balconies as a necessary structural attribute, reinforces the general perspective that a house with view has a very important and valuable benefit.

It is crucial to verify the appropriateness of certain hypothesis on which the hedonic model is based on.

4.1.1 Validation of the model

Independence test

Durbin-Watson indicator identifies if there is any kind of correlation (positive, negative) between the variables. If the indicator is within the limits of 1.5-2.5, then variables are independent (Harrell, 2002). In this case, Durbin-Watson indicator equals 1.847, and, therefore, no problem is observed.

Residuals' normality test

Outliers can have a very negative effect on hedonic results. Moreover, the residuals should approximately reach normality. Figures 2 and 3, which include the standardized residuals, are very satisfactory and prove that there is no problem in the stability or accuracy of the model.

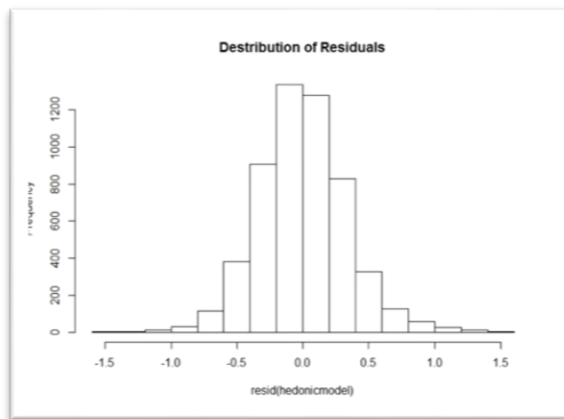


Figure 2: Histogram of Residuals.

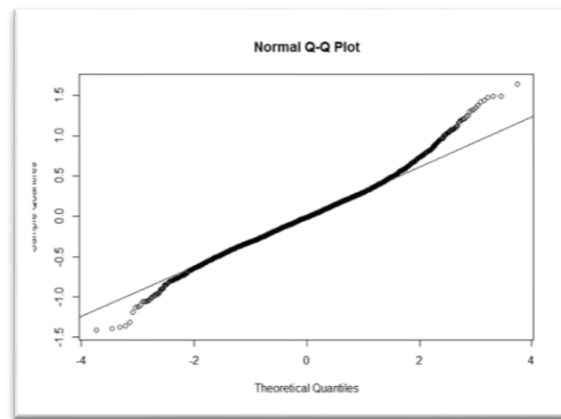


Figure 3: Q-Q plot.

Linearity test

Both charts are sufficient for the validation of the linearity test. No problem is observed.

Collinearity test

Collinearity is tested through the VIF factor and the Tolerance factor. After checking the Tolerance factor which is below 1 for all variables, the VIF factor validates that no problem of collinearity is observed. VIF must not exceed the value of 10 for any variable (Luchters & Chakrabarty, 2006). In this case, no problem of collinearity or multicollinearity is documented.

4.2 The Economic – Structure model

The *second model* includes economic variables and some structural variables of the property. The economic variables are the income, the unemployment, the GDP, the inflation and the construction activity. Economic crisis has massively influenced all these variables, which, in turn, place a major impact on the real estate values. This is the main reason for which those variables are chosen. These variables date to both pre-crisis (2006-2008) and recession years (2009-2015), so that the impact of the crisis can be clearly highlighted. The model is based on 5.448 real estate data throughout the city of Thessaloniki. The results of the model are shown below in Table 5:

R^2	Adjusted R^2	Residual standard error	df	F-statistic	Durbin-Watson statistic
0.6651	0.6645	0.336	5439	1350	1.859

Dependent variable: Log (Price)
Independent variables: 8

Table 5: Summary of the linear model.

All coefficients are proven very satisfactory for the model. More specifically, the R^2 proves that more than 66% of real estate values can be interpreted by the model. Additionally, the Adjusted R^2 indicates that the predictive power of the model is 66.45%. This percentage is highly satisfactory for specific reasons. Apart from the heterogeneity of the market, Greece is facing a very difficult and uncertain economic reality. This special uncertainty of the economy creates an unstable background with the economic indicators being changed very often. The F-statistic is 1.080 with a p-value almost 0, which means that the linear model is preferred for its accuracy for the prediction of property values compared to the mean value.

Table 6 describes the results of the model and the variables that entered and remained in the model for the prediction of property values. The level of significance equals 5% for all variables.

Variables	Unstandardized Coefficients		Standardised Coefficients	t-value	p-value	Collinearity Statistics
	B	Std. Error	Beta			VIF
Intercept	11.398	0.183		62.397	< 2e-16	
Structure factors						
Age	-0.009	0.000	-0.251	-31.033	< 2e-16	1.06
Floor	0.047	0.003	0.149	18.653	< 2e-16	1.034
QofC	0.096	0.025	0.031	3.807	0.000	1.1
View	0.083	0.031	0.021	2.679	0.007	1.049
Size	0.013	0.000	0.677	84.714	< 2e-16	1.038
Financial factors						
Unemployment	-0.021	0.001	-0.254	-14.524	< 2e-16	4.973
CPI	-0.004	0.002	-0.0356	-2.190	0.029	4.288
Construction activity	0.001	0.000	0.084	4.157	0.000	6.62
R²	0.664					
Sample size	5448.000					

Table 6: Linear regression results.

The B coefficient indicates the change of value if one of the independent variables change by a unit, assuming that all other variables remain stable.

As mentioned before, Economic factors provide a clear insight on how the economic crisis influences the real estate market. Starting with the most influential factor, unemployment has influenced values at the greater scale. Unfortunately, unemployment is the major problem of Greece, as more than 25% of Greeks are unemployed, a percentage that is much higher for the young ages. This fact has led to byers' inability to acquire a property, minimizing the demand and, in consequence, decreasing values. In the model, as unemployment rises, values drop by 2.1%.

Inflation plays an important role in the determination of values, as well. As inflation rises, real estate values drop by 0.483%. A rise in inflation leads to a rise in prices of all goods. In combination with the decrease in the income, the purchasing power of Greeks decreases even more.

Afterwards, this decrease leads to a decrease in demand and ability to buy, which, lastly, influenced real estate values negatively.

As far as the construction activity is concerned, it is expected that values increase as the construction activity increases. In this case, its effect on values is very small (0.0599%). The construction activity continued to be intense even in the first years of recession. The great drop started after 2012 resulting in a total inactivity after 2015.

Taking all factors into account, it is clear that the real estate market has entered a vicious circle which can only be altered by a long and stable economic growth, a fact that unfortunately is a not existing scenario for the present economic situation of Greece.

It must be noted that from the five financial variables mentioned above the three are finally entered into the model. The reason is that the model with all the financial factors indicating strong multicollinearity among the variables. This fact stems from the economic crisis and the nature of the variables. To be more specific, inside the years of the economic crisis the GDP, the income and the construction activity fall. On the other hand, the unemployment rate rises. These movements are analogical indicating high negative or positive correlation reaching 95%. For that reason the appearance of multicollinearity is inevitable a fact which invalidates the initial model. Consequently, the GDP and the income index variable are excluded from the model.

All structural factors appear to have the same behavior as the previous model. Therefore, they will not be analyzed thoroughly again.

As in the previous model, certain tests must be checked in order to verify the stability and suitability of the model.

4.2.1 Validation of the model

Independence test

The key in identifying whether there is any kind of correlation between variable is Durbin-Watson indicator. In the second model, the indicator reaches 1.859, a value that is within the safety limits. Therefore, the model passes the independence test successfully.

Residuals' normality test

After checking for outliers, the residuals must approximately be close to normality. This is verified by Figures 4 and 5, which include the standardized residuals. They are both very satisfactory and prove that there is no problem in the stability or accuracy of the model, due to residuals' normality issues.

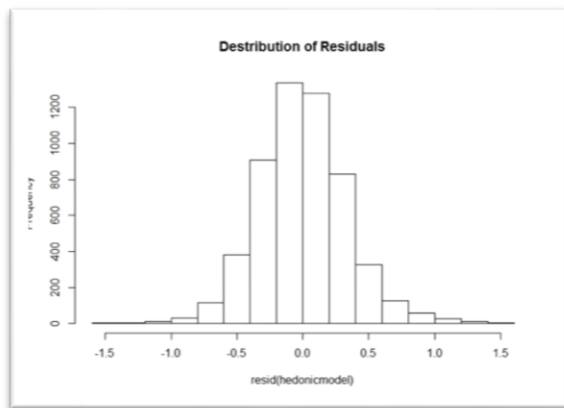


Figure 4: Histogram of Residuals.

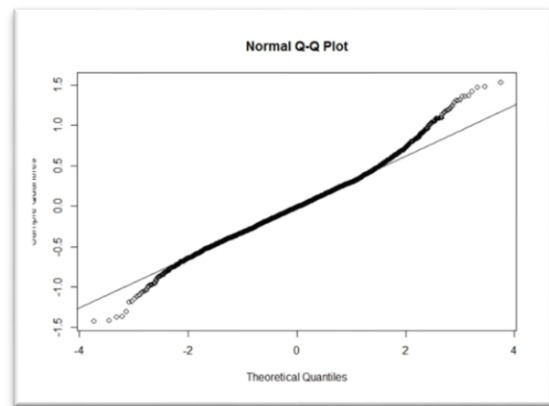


Figure 5: Q-Q plot.

Linearity test

Both charts are sufficient for the validation of the linearity test. In this model, no problem of linearity is documented.

Collinearity test

VIF factor and Tolerance factor are the main indicators that are used for the identification of collinearity. After checking the Tolerance factor which is below 1 for all variables, the VIF factor validates that no problem of collinearity is observed. Also, all VIF factors for all the independent variables are lower than 10. Therefore, to sum up the results of both factors, there is no problem of collinearity or multicollinearity in the second model as well.

5. Conclusion and future work

The present research paper attempts to investigate the behavior and the determinants of housing prices of Thessaloniki inside the economic crisis which has severely influenced the Real Estate market. The results provide us with significant outcomes about the movement of the housing prices inside the economic crisis and the influence of several structure and financial factors on them. For the purpose of the research two hedonic models are constructed: one with time and structure factors in order to indicate the housing price movement and one with structure and financial factors in order to indicate the influence of the subject variables in housing prices.

The results of the first model indicate that before 2009, the housing prices in Thessaloniki show a moderate stability. The global economic crisis is apparent but the dramatic drop in the housing prices started from the 2010 which is the starting year of the Greek debt crisis. The housing prices have lost almost half of their values from 2010 to 2015 and the latest forecasts show that they will keep dropping. Additionally, structure factors as age, size, floor, quality of construction and view appear as significant and influential for the housing price.

The second model confirms the significance of the structure factors and proves that financial factors as unemployment, construction activity and CPI are important as well. The most important outcome of the second model is that the Greek debt crisis created a chaotic Real estate environment. The

financial factors are, in some cases, almost perfect linear, a fact which makes them inappropriate for interpretation using a hedonic model. For that reason factors such as unemployment, income and GDP are impossible to be explained together.

The above results indicate that inside the economic crisis the Real Estate market presents abnormalities and it should be treated accordingly. Consequently, further research is required and a more sophisticated model should be employed in order to deal with the housing prices inside an economic crisis and their particular financial determinants.

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