TÉCNICO LISBOA

EXTENDED ABSTRACT

# Influence of energy certification on house prices in Greater Lisbon

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# 1 Introduction

Energy, in all its forms, is key to the economic and social growth of a population, which, inevitably, uses it at high levels to meet its needs. In order to reduce those needs, we must develop into a more sustainable society, aware of the need for energetic efficiency and preservation of the natural environment, thus actively contributing to the rationalization of energy use.

Energetic efficiency can be understood as the optimization of energy uses through the implementation of strategies which allow us to reduce water wastage. In order to achieve this aim, it is necessary to make use of innovative building methods and materials with high thermal performance, more efficient equipment, central and /or local management energy systems based on renewable forms of energy, as well as new and improved methods of conversion, transport and storage of said energy.

Energetic rehabilitation consists on the minimizing of energy consumption and improving of thermic comfort in existing buildings, by improving both walls and windows, thermal systems (air conditioning units, lighting and appliances) and by implementing, as far as possible, renewable energy production systems. Opting for more efficient systems doesn't necessarily mean consumption levels will be lower, but as said, levels may be caused by their inappropriate or incorrect use. Therefore, the population must be educated and made aware of the importance of energy rationalization, thus allowing it to become more sustainable.

Oil, coal, gas and other traditional sources of energy still meet the growing global energy needs. However, the burning of such fuels causes the release of gases which are harmful to the environment namely those which cause the greenhouse effect) and which are partly responsible for the climatic changes we have been witnessing. Moreover, these energy sources are finite. Energy consumption in Portugal can be divided into five economic areas, in which transportation, in 2015, used the highest amount of energy nationwide, 41%, industry used 21%, and private residences used 16% (INE, 2017). Buildings (industry + private housing + services) amount to 56% of total energy consumption.

The Energy Performance Certificate is quite relevant in making people aware of the release of gases which contribute to climate change and green house effects. It is also essential to inform the final consumer about the thermal performance of their houses, allowing them to assess its global performance and be aware of how it influences the costs of energy consumption, which might interest them in seeking more effective solutions. (Macedo, 2009). Consequently, in 2013, Decree n.118/2013 of 20 August, has made it mandatory that the energetic classification of houses for sale of rent must be publicly divulged.

The energetic classification in buildings is similar to the classification for appliances, ranging from A+ (best performance) to G (worst performance) (ADENE, 2008; 2017b). Because of the imposed requirements of the Energy Performance Certificate in Buildings, new buildings or those subject to major remodelling will never be rated lower than B-, whereas older buildings may fall into any energetic class. It is expected that buildings which perform better will have a higher market valuation, contrary to the devaluation of buildings that fall into a lower rate, thus encouraging investments in the improvement of thermal performance in buildings (ADENE, 2017b).

Knowing that price quotations for apartments is fundamental information for realtors, buyers and analysts, real estate adverts may be considered the first stage of buying/selling a house (Robertson & Doig, 2010; Semeraro & Fregonara, 2013). When a building goes up for sale, real estate agencies make public information which they consider relevant to potential sellers, meaning to emphasize certain characteristics and omit others (Fregonara et al., 2014).

There have been some studies on the impact of energy efficiency on the price of sale and /or rental of buildings. Laquatra, et al. (2002) carried out a meta-analysis and found a set of limitations in those studies, namely the fact that the study sample was too small or too specific. Nevertheless, they identified a positive relationship between energy efficiency (or *proxies* towards energy efficiency) and house sale prices.

Despite the results, it is clear that there is a lack and/or insufficiency of articles on this subject in publications related to the area of study (Fuerst et al., 2013). Most studies on the effects of energy certification on real estate prices have been made in business offices in the USA. One of the first studies to look into the effect of the price of mandatory energy certification on real estate prices was carried out by the *Australian Bureau of Statistics* (2008). Using a database on residential sales in the Australian capital area in 2005 (counting 2.385 transactions) and 2006 (2.719 transactions) and through standard procedures, the effect of energy performance certification on real estate prices was estimated. Through the study and the total sample relative to the year of 2005, a premium of about 1% was estimated per 0,5 increase in the classification rate, ranging from 0 to 5 points (Fuerst at al., 2013).

A different study carried out in England (Fuerst et al., 2015) showed a statistically significant increase in value of 5% and 1,8% in prices of rea estate rated A/B and C respectively, when compared with buildings rated D. In addition, there was a decrease in value of 0,7% and 0,9% in buildings rated E and F. Another study carried out in Whales (Fuerst et al., 2016) showed an increase in value of 11,3% and 2,1% in the prices of real estate rated A/B and C, and decrease in value of 2,15, 4,7% and 7,2% in buildings rated E, F and G. These two studies suggest that the selling prices in Whales are much more dependent on energy certification than in England. This difference is justified by the fact that buildings in Whales are older (it is noticeable that the year of construction has an effect on energy classification) and also that in many of them more modern materials and appliances have been used, namely in kitchens and bathrooms, which, in the end, increases the value of the real estate.

Similarly, Santos et al. (2016) have carried out a study with eight EU countries (Austria, France, Germany, Italy, Norway, Poland, Romania and Spain) with the objective of analysing the professional opinion of real estate agents as to the main factors taken into account by families when they intended to buy or rent a house. The participants did not see an association between energy certification and higher prices in real estate. In Poland and Spain, the association between these two variables was significantly less frequent and only 27% of participants identified the relationship between energy certification and higher prices of sale/ rental. The Germans grasped this dependency relationship more frequently (46%).

In fact, the appreciation of certain characteristics on a building can be done using specific methodology, being that the most common theoretical model used to analyse real estate market prices is the hedonic model (Catalão, 2010; Nesheim, 2006). This model is used to infer on the implicit price of goods with multiple characteristics. Thus, according to Nesheim (2006) a hedonic price function reflects the relationship between the economically relevant characteristics of a product or service and its price. It is therefore a model rooted in microeconomy which is widely used in real estate economics.

The hedonic approach looks at a building as a group of individual components, each of them having an implicit price. Therefore, the market price of any house or apartment results on the sum of the prices of its individual components. The hedonic model for real estate, assumes that buyers will use (in the economic sense of the word) each of the characteristic of the building, and builders will strive to build in a way that reflect the buyers' sense of taste maximizing its use (Pozo, 2007).

Globally, according to Millington (2000), the main factors taken into account in a real estate valuation are location, the condition the building is in, its design, the total area and quality of flooring, urban equipment and services, adaptability to different tenants, requisites and accessibility. Fregonara et al. (2013) draws attention to the fact that location, finishings and how old the building is, are still the most important factors which determine prices in the moment of buying a house.

As a matter of fact, factors associated to sustainability and energy efficiency are not always taken into account in the valuation process, and have only recently been included in the guidelines for real-estate agents, who should now consider them when surveying a house (Royal Institution of Chartered Surveyor – RICS, 2009).

According to Fuerst et al. (2013), many factors can interfere in the association between the energetic performance of a building and its economic value. First, the fact that the classification in a certificate merely indicates the inherent energetic performance of the building based on its conception and equipment, might make the buyers feel uncertain as to the potential savings when using the building, leading them to attribute less importance to the information contained in the certificate. Second, any flaw or omission in an energy performance certificate, will misinform and mislead the buyer, thus altering the buyer's behaviour. Additionally, even if the energetic rating shows precisely the project's savings potential, behavioural factors may effectively compensate the gains of higher energy efficiency, commonly known as the "Jevon Paradox".

Fragoso (cyted by Gonçalves, 2014) says that what differentiates a house rated A+ in terms of energy efficiency and one with a different rating are three essential aspects: first, the quality of the building, the walls, windows, thermal performance and insulation. Only the buildings erected in the last decade show care was taken in these three aspects. Second, having highly efficient and low energy consumption appliances. Third, how much renewable energies contribute to running the house.

Keeping these aspects in mind, the main goal of this study is to analyse the influence of energy certification in the market value of apartments in greater Lisbon, seeking to determine the existence of a "premium" in the value of real estate deriving from the energetic certification attributed to them.

## 2 Methodology

This study is retrospective, once the data was collected between January and December 2016, and quantitative, since it seeks to explain, predict and control specific phenomena, identifying their regularity and laws from measurable and quantifiable procedures. The data is presented in the time period from January to December 2016), and it was collected and analysed in one single moment, or in cross-sectional way.

Bearing in mind the goals of this research, and all the literature read in regards to this topic, the following variables have been considered: (a) Dependent variable (DV) – value of the real estate transaction per square metre, which stands as the continuous measurable variable, and (b) Independent Variable (IV) – type/number of rooms (discreet measurable variable); rates of energetic certification (ordinal categorical variable) and age of the building (continuous measurable variable).

In addition to these variables, two others were considered when characterizing the sample, namely the date when the building was erected (assumed both as continuous measurable variable and as ordinal categorical when grouped according to rating) and civil parishes / regions (nominal categorical variable) later turned into zones (nominal categorical variable).

The sample that supported preparing this dissertation was requested to and supplied by a leading Portuguese real estate agency. This company was requested to provide information about housing sold in the period of time afore mentioned in the greater Lisbon area. This information was stored in the agency's database after the sale of the property. In this database, some of the grounds that influence a price of a building for sale are mentioned: location, number of rooms, date of build, selling cost and other distinctive characteristics. As mandatory by law (Decree n. 118/2013 of 20 August) this database also includes the energetic classification rate attributed to the properties that were sold.

315 properties have thus been identified (from within a universe of 4,170), later subdivided into seven groups of 45 observations, which make up the seven zones (seven different civil parishes) which were the basis for the results found.

The data was analysed with two types of statistics: descriptive and inferential analysis. The descriptive analysis (Guimarães & Cabral, 2010) is presented in absolute and relative frequencies, as well as measurements of central tendency (e.g., average, median, standard deviation, minimum and maximum values). The inferential analysis presents three different and independent procedures: (a) Test *F* by Anova *One Way* followed by *Turkey*

*Significant Difference (TSD),* in order to analyse the differences between averages; (b) Correlation coefficient of Pearson ® which allows us to analyse the degree of association or linear mutual relation between two ordinal, continuous or without normal distribution variables and (c) Hedonic regression analysis which allows us to analyse the way in which multiple attributes of economic goods reflect in their selling value (Borges, 2009; Fuerst et al., 2013), from Univariate Generalized Linear Models which allow us to shape the values of a dependent (measurable) variable, based on its relationship with predictive variables, either qualifiable (in categories) or quantitative. During the testing of hypothesis estimating the parameters, studies have been made through the Levene Test which analyses the homogeneity of residue variances and Kolmogorov-Smirnov (KS) Test to analyse the normalcy of the distribution of the residues.

The data was typed into Excel and moved to the programme *Statistical Package for the Social Sciences®* (IBM® SPSS), version 23.0 for *Windows*.

# 3 Results

## 3.1 Differences in Average in Energetic Certification

Table 1 shows that there are statistically significant differences in the global sample ($F$=3,754; $p$=0,01), suggesting that the sale value/m$^2$ is higher for the A/B energetic rating comparing to categories C and E/F; in zone 2 ($F$=9,469; $p$=0,00), the sale value /m$^2$ is higher for energetic rating A/B in comparison to ratings C, D e E/F; in zone 5 ($F$=4,751; $p$=0,00), the sale value/m$^2$ is higher for ratings A/B e C comparing to rating E/F and in zone 7 ($F$=4,492; $p$=0,00), the sale value/m$^2$ is higher for ratings A/B and C comparing to rating E/F. In zones 3 ($F$=2,507; $p$=0,06) and 6 ($F$=0,852; $p$=0,47) there is also a tendency for increased sale value/m$^2$ as energetic ratings get higher, but this tendency isn't statistically significant. In zones 1 ($F$=0,430; $p$=0,73) and 4 ($F$=1,912; $p$=0,14) we can note small differences in the sale value/m$^2$ due to energetic ratings, but these are not statistically relevant.

Table 1 – Descriptive statistics and ANOVA Tests: Relationship between sale value/m2 and energetic rating

| | | N | Average | Standard Deviation | *F* | *p* | *TSD* |
|---|---|---|---|---|---|---|---|
| Global Sample | A/B | 36 | 2161,2 | 1111,1 | 3,754 | 0,01** | A/B > C, E/F |
| | C | 120 | 1646,0 | 825,5 | | | |
| | D | 95 | 1740,5 | 816,4 | | | |
| | E/F | 64 | 1661,4 | 684,3 | | | |
| Zone 1 | A/B | 5 | 1064,0 | 250,8 | 0,430 | 0,73 | |
| | C | 21 | 1073,7 | 246,1 | | | |
| | D | 14 | 977,6 | 275,5 | | | |
| | E/F | 5 | 1023,5 | 199,6 | | | |
| Zone 2 | A/B | 8 | 1452,3 | 286,6 | 9,469 | 0,00** | A/B > C, D, E/F |
| | C | 12 | 915,4 | 292,6 | | | |
| | D | 16 | 1051,3 | 269,9 | | | |
| | E/F | 9 | 824,1 | 169,8 | | | |
| Zone 3 | A/B | 5 | 1932,0 | 334,3 | 2,507 | 0,06 | |
| | C | 20 | 1742,5 | 337,2 | | | |
| | D | 13 | 1584,8 | 275,4 | | | |
| | E/F | 7 | 1496,4 | 278,6 | | | |
| Zone 4 | A/B | 2 | 1448,3 | 25,9 | 1,912 | 0,14 | |
| | C | 34 | 1213,5 | 198,0 | | | |
| | D | 5 | 1368,9 | 286,2 | | | |
| | E/F | 4 | 1366,5 | 224,2 | | | |
| Zone 5 | A/B | 8 | 3510,7 | 1322,8 | 4,751 | 0,00** | A/B, C > E/F |
| | C | 10 | 3189,4 | 989,6 | | | |
| | D | 14 | 2669,0 | 947,1 | | | |
| | E/F | 13 | 2054,9 | 610,8 | | | |
| Zone 6 | A/B | 2 | 3025,2 | 141,2 | 0,852 | 0,47 | |
| | C | 13 | 2578,8 | 473,1 | | | |
| | D | 17 | 2435,4 | 680,3 | | | |
| | E/F | 13 | 2367,9 | 620,4 | | | |
| Zone 7 | A/B | 6 | 2362,2 | 638,7 | 4,492 | 0,00** | A/B, C > E/F |
| | C | 10 | 2246,5 | 776,3 | | | |
| | D | 16 | 1788,9 | 462,4 | | | |
| | E/F | 13 | 1565,9 | 397,4 | | | |

*p≤0,05; **p≤0,01

### 3.2 Correlation between the Variables

Correlations have been established between the sale value/m$^2$ of the properties and by zones, considering the independent variables. With the assistance of the Correlation Coefficient of Pearson, Table 2 shows us that, in what respects the seven zones, in Zone 1 there is only one negative relationship, which is statistically significant, between the sale value/m$^2$ and how old the apartment is ($r$=-0,477; $p$=0,00), meaning that the sale value/m$^2$ decreases significantly as the apartment gets older. In Zone 2, there is a negative relationship, which is statistically significant, in the sale value/m$^2$ and how old the apartment is ($r$=-0,665; $p$=0,00) and a positive relationship, statistically significant, between the sale value/m$^2$ and energetic rating ($r$=0,465; $p$=0,00), meaning that the sale value/m$^2$ increases significantly with the increase of energetic rating, whereas it decreases noticeably the older the apartment is. As for zone 3, there is a negative relationship, statistically significant, between sale value/m$^2$ and how old the apartment is ($r$=-0,463; $p$=0,00) and a positive relationship with the energetic rating ($r$=0,371; $p$=0,01), suggesting that the sale value/m$^2$ decreases significantly as the apartment gets older and increases visibly with a higher energetic rating. In the case of Zone 5, negative relationships, statistically significant, are noticeable, between sale value/m$^2$ and how old the apartment is (r=-0,534; $p$=0,00) and the number of rooms ($r$=-0,444; $p$=0,00) and a positive relationship which is statistically relevant with energetic rating, suggesting that the sale value/m$^2$ decreases significantly the higher the age of building, and number of rooms, whereas it significantly increases with energetic rating. In Zone 7 there are positive relationships, statistically significant, between the sale value/m$^2$ and energetic rating ($r$=0,511; $p$=0,00) suggesting that the sale value/m$^2$ increase significantly the higher the energetic rating. In the remaining study variables, statistically significant correlations could not be identified, which means that the impact of IV on DV could not be observed.

Table 2 - Pearson Correlation: Relationship between the sale value/m2 and age, type (number of rooms) and energetic rating

| | Total (N=315) | Zone 1 (N=45) | Zone 2 (N=45) | Zone 3 (N=45) | Zone 4 (N=45) | Zone 5 (N=45) | Zone 6 (N=45) | Zone 7 (N=45) |
|---|---|---|---|---|---|---|---|---|
| Age of Apartment | **0,210(**)**<br>0,00 | **-0,477(**)**<br>0,00 | **-0,665(**)**<br>0,00 | **-0,463(**)**<br>0,00 | -0,158<br>0,30 | **-0,534(**)**<br>0,00 | -0,249<br>0,10 | -0,158<br>0,29 |
| Number of rooms | **-0,163(**)**<br>0,00 | 0,178<br>0,24 | 0,264<br>0,08 | 0,128<br>0,40 | -0,131<br>0,39 | **-0,444(**)**<br>0,00 | 0,218<br>0,15 | -0,113<br>0,45 |
| Energetic Rating | 0,105<br>0,06 | 0,121<br>0,42 | **0,465(**)**<br>0,00 | **0,371(**)**<br>0,01 | -0,168<br>0,27 | **0,510(**)**<br>0,00 | 0,230<br>0,12 | **0,511(**)**<br>0,00 |

*p≤0,05; **p≤0,01

### 3.3 Hedonic Regression Model

Table 3 shows the coefficient of determination obtained for the respective models, not only for the seven zones separately, but also for the seven zones as a total (315 observations). Value $R^2$ is higher for Zone 5 (58,8%), Zone 4 (55,0%) and Zone 2 (50,7%), followed by Zone 1 (35,6%), Zone 7 (29,4%) and Zone 3 (29,3%), and lower for Zone 6 (25, 6%).These values show the percentage of the variation which occurs in the variable sale value/m$^2$ justified by the IVs which integrates each regression model.

Table 3 – Coefficient of Determination ($R^2$)

| | Total | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 | Zone 7 |
|---|---|---|---|---|---|---|---|---|
| $R^2$ | 0,113 | 0,356 | 0,507 | 0,293 | 0,550 | 0,588 | 0,256 | 0,294 |
| $R^2$ modified | 0,096 | 0,254 | 0,429 | 0,181 | 0,479 | 0,523 | 0,138 | 0,183 |

**p≤0,01

In Table 4, we can see the results of the model, namely the estimates of its parameters, as well as individually for the seven zones and for the total sample.

Table 4 – Estimates of the Model Parameters

| | Total | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 | Zone 7 |
|---|---|---|---|---|---|---|---|---|
| Interception | | | | | | | | |
| *B* | 7,603 | 7,258 | 7,366 | 7,668 | 7,678 | 8,571 | 8,068 | 7,996 |
| Standard Error | 0,113 | 0,227 | 0,241 | 0,147 | 0,118 | 0,134 | 0,207 | 0,274 |
| *t* | 67,268 | 32,035 | 30,597 | 52,122 | 64,825 | 63,878 | 38,990 | 29,147 |
| *p* | **0,00**** | **0,00**** | **0,00**** | **0,00**** | **0,00**** | **0,00**** | **0,00**** | **0,00**** |
| [CE=E/F] | | | | | | | | |
| *B* | -0,380 | 0,189 | -0,306 | -0,152 | -0,063 | -0,186 | -0,198 | -0,380 |
| Standard Error | 0,096 | 0,144 | 0,150 | 0,125 | 0,117 | 0,145 | 0,193 | 0,171 |
| *t* | -3,981 | 1,319 | -2,049 | -1,219 | -0,544 | -1,288 | -1,023 | -2,216 |
| *p* | **0,00**** | 0,195 | **0,04*** | 0,230 | 0,590 | 0,205 | 0,313 | **0,03*** |
| [CE=D] | | | | | | | | |
| *B* | -0,334 | -0,056 | -0,147 | -0,079 | -0,084 | 0,113 | -0,188 | -0,269 |
| Standard Error | 0,090 | 0,109 | 0,136 | 0,113 | 0,109 | 0,150 | 0,187 | 0,156 |
| *t* | -3,728 | -0,513 | -1,086 | -0,702 | -0,769 | 0,754 | -1,006 | -1,726 |
| *p* | **0,00**** | 0,611 | 0,284 | 0,487 | 0,447 | 0,456 | 0,321 | 0,092 |
| [CE=C] | | | | | | | | |
| *B* | -0,311 | 0,004 | -0,289 | -0,008 | -0,156 | 0,175 | -0,004 | -0,016 |
| Standard Error | 0,083 | 0,102 | 0,141 | 0,100 | 0,092 | 0,151 | 0,195 | 0,164 |
| *t* | -3,725 | 0,036 | -2,051 | -0,084 | -1,687 | 1,160 | -0,020 | -0,098 |
| *p* | **0,00**** | 0,971 | **0,04*** | 0,934 | 0,100 | 0,253 | 0,984 | 0,922 |
| [CE =A/B] | | | | | Reference | | | |
| Age | | | | | | | | |
| *B* | 0,005 | -0,012 | -0,009 | -0,006 | -0,009 | -0,009 | -0,003 | -0,004 |
| Standard Error | 0,001 | 0,003 | 0,004 | 0,002 | 0,003 | 0,002 | 0,002 | 0,002 |
| *t* | 4,475 | -4,086 | -2,377 | -2,703 | -3,127 | -4,330 | -1,539 | -1,513 |
| *p* | **0,00**** | **0,00**** | **0,02*** | **0,01**** | **0,00**** | **0,00**** | 0,132 | 0,139 |
| Number of Rooms | | | | | | | | |
| *B* | -0,037 | 0,101 | 0,040 | 0,010 | 0,100 | 0,006 | 0,162 | -0,072 |
| Standard Error | 0,039 | 0,075 | 0,101 | 0,048 | 0,033 | 0,047 | 0,063 | 0,082 |
| *t* | -0,961 | 1,347 | 0,398 | 0,208 | 3,019 | 0,125 | 2,572 | -0,881 |
| *p* | 0,337 | 0,186 | 0,693 | 0,836 | **0,00**** | 0,901 | **0,01**** | 0,384 |

*$p \leq 0,05$; **$p \leq 0,01$

Relatively to the model assumptions, the results (Table 5) do not allow for the rejection of the hypothesis of equality of variances within the groups for DV, which confirms the verification of the presupposition of homogeneity of variances for all the models developed.

Table 5 - Levene Test to the Homogeneity de variances

| | Total | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 | Zone 7 |
|---|---|---|---|---|---|---|---|---|
| *F* | 1,220 | 0,482 | 0,657 | 0,395 | 2,221 | 1,464 | 1,544 | 0,073 |
| *gl1* | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| *gl2* | 311 | 41 | 41 | 41 | 41 | 41 | 41 | 41 |
| *p* | 0,303 | 0,697 | 0,583 | 0,757 | 0,100 | 0,238 | 0,218 | 0,974 |

In Table 6, it is noticeable that there is a normalcy in the distribution of standardized residues, since the probative value is higher than 5%, so the null hypothesis cannot be rejected, with the exception of civil parish of Porto Salvo (Zone 4), but if we consider the reference value of 1%, we can also accept that the presupposition in this parish be verified.

Table 6 - KS Test to the normalcy of the distribution of the residues

| | Total | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 | Zone 7 |
|---|---|---|---|---|---|---|---|---|
| *Statistics* | 0,038 | 0,091 | 0,055 | 0,100 | 0,137 | 0,089 | 0,068 | 0,093 |
| *gl* | 315 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| *p* | > 0,200 | > 0,200 | > 0,200 | > 0,200 | *** 0,033** | > 0,200 | > 0,200 | > 0,200 |

Lastly, Table 7 shows the summary of the most relevant results, which allow to point out the statistically significant relationships previously mentioned.

Table 7 – Estimates of the model parameters(summarized)

| | Total | Zone 1 | Zone 2 | Zone 3 | Zone 4 | Zone 5 | Zone 6 | Zone 7 |
|---|---|---|---|---|---|---|---|---|
| [CE =E/F] | **-0,380**** | 0,189 | **-0,306*** | -0,152 | -0,063 | -0,186 | -0,198 | **-0,380*** |
| | (0,096) | (0,144) | (0,150) | (0,125) | (0,117) | (0,145) | (0,193) | (0,171) |
| [CE =D] | **-0,334**** | -0,056 | -0,147 | -0,079 | -0,084 | 0,113 | -0,188 | -0,269 |
| | (0,090) | (0,109) | (0,136) | (0,113) | (0,109) | (0,150) | (0,187) | (0,156) |
| [CE =C] | **-0,311**** | 0,004 | **-0,289*** | -0,008 | -0,156 | 0,175 | -0,004 | -0,016 |
| | (0,083) | (0,102) | (0,141) | (0,100) | (0,092) | (0,151) | (0,195) | (0,164) |
| [CE =A/B] | | | | Reference | | | | |
| Age | **0,005**** | **-0,012**** | **-0,009*** | **-0,006*** | **-0,009**** | **-0,009**** | -0,003 | -0,004 |
| | (0,00) | (0,00) | (0,02) | (0,01) | (0,00) | (0,00) | (0,00) | (0,00) |
| Number of Rooms | -0,037 | 0,101 | 0,040 | 0,010 | **0,100**** | 0,006 | **0,162*** | -0,072 |
| | (0,03) | (0,07) | (0,10) | (0,04) | (0,03) | (0,04) | (0,06) | (0,08) |
| Constant | **7,603**** | **7,258**** | **7,366**** | **7,668**** | **7,678**** | **8,571**** | **8,068**** | **7,996**** |
| | (0,113) | (0,227) | (0,241) | (0,147) | (0,118) | (0,134) | (0,207) | (0,274) |
| N | 315 | 45 | 45 | 45 | 45 | 45 | 45 | 45 |
| $R^2$ | 0,113 | 0,356 | 0,507 | 0,293 | 0,550 | 0,588 | 0,256 | 0,294 |
| $R^2$ modified | 0,096 | 0,254 | 0,429 | 0,181 | 0,479 | 0,523 | 0,138 | 0,183 |

**p*≤0,05; ***p*≤0,01

To sum up, this data allows us to conclude that, in most of the seven zones and for two zones (when analysed separately), the sale value/m2 is higher for energetic rating A/B and significantly lower for the rest. The difference between sale value/m2 is bigger the lower the energetic rating is (closer to rate F). There is therefore a statistically significant relationship between the decrease in sale value and a lower energetic rate (closer to F).

## 4 Conclusions

The main goal of this study is to analyse the main factors that determine the sale price of apartments in the real estate market within a sample which is representative of the greater Lisbon area, having given prominent value to their energetic rating. In this way, this study intends to look into the influence of energetic ratings on sale value of apartments in the greater Lisbon area.

The main differential results show that sale value/$m^2$ varies according to the energetic rating, being favourable to rate A/B within the global sample and in zone 2. In zones 5 and 7, however, sale value is more favourable to ratings A/B and C.

When it comes to correlational results, and when the individual zones were considered, there was noticeably a negative impact in sale value/$m^2$ depending on how old the house was in zones 1, 2, 3 and 5 and depending on type of house in zone 5. It was also perceptible that there was a positive impact in sale value/m2 of energetic rating in zones 2, 3, 5 and 7.

The results originated by the hedonic regression models showed that, when considering the totality of the seven zones, sale value/$m^2$ is significantly higher for energetic rating A/B and lower for the rest. When the seven zones are analysed individually, the results show a negative impact in sale value/$m^2$ for rating E/F throughout the sample, in zone 2 and zone 7. Energetic rating D impacted sale value/$m^2$ negatively throughout the sample. Rating C had a significant negative impact on sale value/$m^2$ throughout the sample and in zone 2. As for the impact of IVs, it was noticeable that: the age of the building has a significant negative impact in sale value/m2 in all the zones with the exception of zone 6 and zone 7 (which cannot be considered significant); the type of house had a significant positive impact in sale value/$m^2$ in zone 4, zone 5 and zone 6. Lastly, the type of house had a significant positive impact on sale value/$m^2$ in zone 4 and zone 6.

Globally, it is possible to say that the energetic rating is an influencing variable, albeit not the only one, on the sale value of real estate. These data are in accordance with several studies (national and international) which draw attention to the fact that real estate properties which have a higher energetic rating sell for higher prices, although other factors are also taken into account at the moment of purchase.

In spite of the fact that these data are considered important indicators of the relationship between price of houses and their energetic rating, it is also deemed necessary to further studies within the country, which might consolidate the results presented here. In fact, there are few studies based on empirical data within the Portuguese real estate world. This study means to start filling that void, and presents itself as the first of many.

Further investigations should also be carried out at a local and national level, with a view to overcoming the above-mentioned limitations in order to determine the existence of any "bonus" imbuing the immovable property resulting from the energy classification attributed to them.

Hence, this study should not be looked upon as a final result, but rather as a starting point for new studies and new ways of thinking. Quoting Einstein, "*The mind that opens up to a new idea never returns to its original size.*"

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