

The Effect of Energy Classifications on Housing Prices

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***Abstract.** Previous researches have provided contradictory results on the effect of energy classifications. It seems that the effects are limited only to the highest energy classifications (A & B) while the lowest classifications seem to have little or no effect, suggesting that the housing prices are consisted of completely different factors than this. The methods for this study are literature review in addition to a regression analysis using available open data. Our regression model supported the previous results but also indicated the need to perform further research on the topic and develop the existing model by all odds, e.g. increasing the amount of variables or changing the current ones.*

***Keywords:** energy classification, housing prices, open data, regression analysis*

1 Introduction

1.1 Background

According to the previous studies, there has been a lot of debate of whether energy classifications have any effect on the housing prices. The primary goal of energy certifications is to compare the energy consumption between buildings based on their physical qualities. Not only does it grade the building on a scale from A to G, where A is the highest and best, but is also gives suggestions on how to improve the building's energy efficiency. (Motiva Oy.) Energy certificates have been used in Finland since 2008 but now according to the Finnish Act on Energy Certification of Buildings (50/2013) they are not only recommendable but also compulsory to get. Since it is likely that in the future the possibly higher energy costs will affect the housing prices, this topic will remain hot (Finnish Government Institute for Economic Research, 2006). There is open data available along with the selling and renting declarations, which arouses the question of whether the information on the energy classifications affects the price that people are ready to pay for their houses.

1.2 Objectives, Research Questions and Limitations of the Research

This paper will review the effect of energy classifications on housing prices through answering these research questions:

1. Where is open data used and what are its benefits?
2. What is the effect of energy classification of buildings on housing prices?
3. Would the openness of data on the energy classification levels of buildings benefit the housing market?

This study focuses on the usage of open data in order to find out how energy classifications affect the housing prices of apartment buildings in Helsinki, Finland. This study does not cover the so-called high-

class areas of Helsinki, including Kruunuhaka, Eira, Töölö and Ullanlinna, in order to get statistically significant results. The focus of this study is on the single-room, two-room and three-room apartments of Helsinki located in all other locations than the above-mentioned high-class areas.

1.3 Motivation

This paper is made for the course Game in Urban Planning and Development at Aalto University. One of the courses themes was open data and how it can be used. The authors decided on the topic of energy certifications because they are widely discussed at the moment. Furthermore there is available open data of transaction prices with information about energy certifications which can easily be exploited in an empirical study.

1.4 Research Methods and Structure

The research methods are literature review and regression analysis. Firstly the study focuses on the theory of open data and its possibilities and limitations. Secondly the study gives a literature review on the energy certifications of buildings in Finland and the European Union followed by housing price formation and finally the impact of energy classifications on housing prices. The literature review is formed using various articles and data available online. After this, the authors present their regression model, which reveals whether the energy classifications have effects on the selling price per square meter in high-rise apartments. Finally the authors present their conclusions of this study and discuss the further possibilities in this field.

2 Open Data

In everyday life the word data is mixed up with the words information and knowledge, or even wisdom. When speaking about open data, it usually means raw data, which is in digital form. This data is only symbols with no significance before it is interpreted. Open data needs to be free for use, reuse, and redistribution. Data can be collected from all fields such as environment, transport and culture. (Poikola, 2010.) Usually the discussion about open data revolves around public organizations and the data they collect or should collect. Lots of pressure is being placed on them to release their raw data. (Janssen et al., 2012.)

Data provides evidence, which is the foundation for all scientific progress (Molloy, 2011). Unfortunately, only a small part of the collected data is usable or even accessible. The goal of open data thinking is that this small part of data will grow wider. (Reichman et al., 2011.) There are many benefits for open data, yet there are also barriers. There are technological and sociological challenges that have limited open access to data. (Janssen, 2012.)

Benefits of open data can be divided into three categories: political and social, economic, and operational and technical. Political and social benefits can be e.g. equal access to data and improvement of citizen services and satisfaction. Economic benefits of open data are for instance economic growth, stimulation of innovation and development of new products and services. Finally there are the operational and technical benefits, which are e.g. sustainability of data (no data loss), no re-collection of the same data and counteracting unnecessary duplication and associated costs. (Janssen, 2012.)

There are also various barriers concerning open data. They can be categorized into institutional level, the task complexity of handling the data, the use of open data and participation in the open data process, legislation, and information quality at the technical level. Examples of these barriers can be that the revenue system of the organization is based on creating income from the data, lack of ability to discover the appropriate data, registration required before being able to download the data, privacy violations, incomplete information and difficult data formats. (Janssen, 2012.)

There is an obvious need to solve the technological and sociological challenges that have limited open access to data. Usually organizations share interpretations of data (presentations and publications) rather than provide direct access to it. (Reichman et al., 2011.)

The availability of open data has grown significantly in Finland, but there is a lack of open data in housing prices and even more concerning energy classifications. A service called asuntojenhintatiedot.fi collects data from housing transactions. The data also includes information on the energy classification of different housing options. However, the information is not always complete and the service gets data only from a handful of realtors. Thus, a thorough evaluation of validity of the open data is needed.

3 Literature Review

3.1 Energy Certifications of Buildings in Finland and European Union

Buildings account for 40% of total energy consumption in the area of European Union. The European Council has emphasized the need for increasing energy efficiency and thereby set a goal to achieve a 20% reduction in the total energy consumption in the area of European Union by 2020. Also, the overall greenhouse gas emissions should be reduced by at least 20% below 1990 levels until 2020. (European Union 2010.) European Union has prepared several regulations as the outcome of its energy politics in order to reach the targets, including the Union wide regulations of energy classifications. According to the 11th article of the directive on the energy performance of buildings

“Member States shall lay down the necessary measures to establish a system of certification of the energy performance of buildings. The energy performance certificate shall include the energy performance of a building and reference values such as minimum energy performance requirements in order to make it possible for owners or tenants of the building or building unit to compare and assess its energy performance.” (European Union, 2010.)

The directive requires implementing the regulations in the national laws in 28 EU member states, and also Finland has adopted the regulations in its own legislation. Finnish Act on Energy Certification of Buildings (“Laki rakennuksen energiatodistuksesta”) came into force in 2013 replacing the previous act from 2007. The purpose of the act is to provide possibilities for comparing buildings based on their energy efficiency when renting or selling properties and to promote renewable energy. (Finnish Act on Energy Certification of Buildings.)

The main goal of energy certifications is, as said, to facilitate comparisons between buildings as the certificate relates the calculated energy consumption based on the building’s physical qualities. Therefore, an energy certificate only implies the consumption that is not dependent on the building users and their energy consumption customs. The energy efficiency class is calculated based on e.g. lighting, building structures and elements, ventilation and heating as well as the energy form used as renewable energy sources are preferred. The energy efficiency class is then presented on a scale from A to G where A is the highest score. A certificate also includes suggestions on how to improve the building’s energy efficiency given by professionals if the building in question is not new construction and improvement opportunities can be detected. (Motiva Oy.)

The energy certification system is adopted gradually, and energy certificates have been used in Finland already since 2008 in new constructions and since 2009 also when selling or renting out large properties or new small residential properties. In the housing market the certificate is required and compulsory for all new buildings, all blocks of flats, all row houses, and one family houses that have been built after 1980. From July 2017 the certificate will be required for all one family houses, despite the year of construction. (Ministry of the Environment, 2013.) Still, some residential buildings, for example buildings with area smaller than 50 sq. m. and summerhouses, have been excluded from the regulations. Also some commercial properties, such as industrial and storage buildings, do not need energy certificates. Energy certifications are valid for ten years from the completion of the certificate after which a re-certification is required. (Finnish Act on Energy Certification of Buildings.)

Andaloro et al. (2010) have studied to what extent European countries have adopted energy certifications for buildings. According to their results, in 2010 Finland was one of the best-performing countries along with the Czech Republic, Portugal and Slovakia when measuring the progress achieved in terms of comparability. Still, it was still very far from the top when identifying the absolute leaders in energy certification reaching only the grade 1 out of 6. Among the best in class countries were for example Denmark and Germany scoring 4 out of 6 points. (Andaloro et al., 2010)

3.2. Housing Price Formation

Apartment buildings in Finland are sold as shares of apartment house companies. The law of demand and supply also applies also for price formation of these shares. The law of supply and demand defines the effect that the availability of a an apartment and the demand for that apartment has on price. Generally, if there is a low supply and a high demand, the price will be high. In contrast, the greater the supply and the lower the demand, the lower the price will be. Therefore the buyers in the market are willing to pay a certain amount of money at the certain time based on their income, expectations and the price of other goods (Wallenius, 2015).

However, the price formation of these shares of apartment house companies depends on many other features. On a study Pennanen (2014) concludes, as shown in figure 1, that the apartment price is formed between a willing buyer and seller in a market, where the price is a combination of market factors and value factors. Market factors are for instance the availability of apartments, financial market situation and the general economic situation (Pennanen, 2014) as well as regional reasons like education level and employment in the specific area (Kasso, 2005). Value factors can be divided into general, locational and apartment-specific factors. General factors include real estate market situation that will have direct impact on market values. (Pennanen, 2014.) Locational factors influence housing prices only locally. According to Oikarinen (2007) homes locating in the same urban area can be considered as close substitutes to each other. As a result, the housing market is meaningful to analyze in the regional level, for example, in a continuous urban area. Apartment-specific elements include the condition of the apartment house company, amount of rooms, shape of the apartment, location in the building, condition of the apartment and the level of equipment (Pennanen, 2014; Kasso, 2005).

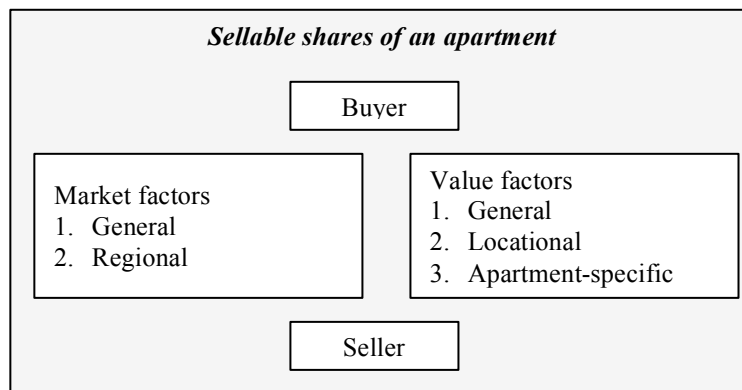


Figure 1. Features Affecting on the Selling Price of Shares of an Apartment (Pennanen, 2014)

Laakso and Loikkanen (2004) complete this by saying that there are several factors that affect on the features buyers are looking for when buying an apartment, these either raise or lower the apartment prices. The features are the apartment size, age of the building, living environment and the quality of the neighborhood, available services in the area, socioeconomic status of the area, and location, i.e. accessibility.

The apartment prices can be valued by several different ways. As there are typically sufficient amount of open sales data of apartments available, the sales comparison approach can be conducted by using statistical regression analysis. Regression analysis estimates the relationship between housing price and different variables as described above.

As a conclusion, energy classification can be seen as an apartment-specific factor. Therefore, according to the basic theory of supply and demand, if energy certifications would have an impact on housing prices, good energy classes would result in higher demand and higher apartment prices, whereas poor energy classes would result in lower demand and lower apartment prices.

3.3. The Impact of Energy Certificates on Housing Prices

When considering apartment buildings, the effect of energy certificates on housing prices has raised diverse results amongst researchers. According to Tuomi (2010), the impact of energy certificates on housing prices can be considered rather irrelevant in today's housing market as the energy consumption's part in the selling price or rent is not specified in the maintenance charges. Therefore a potential buyer cannot fully compare apartments based on the energy class of the building. However, it is possible in the future that potentially higher cost of energy can affect the housing prices and become an important factor when choosing properties. Also the Finnish Government Institute for Economic Research (2006) claims in their report that as energy efficiency becomes increasingly important, the impact of energy certificates on housing costs and thereby price levels is very likely.

On the other hand, a recent study concluded by Laitala (2014) suggests that there is a possible correlation between the energy class and the housing prices at least in the higher energy classes A-C, whereas it would appear that in the lower classes there is only slight effect. Nevertheless, Laitala (2014) discusses whether the price model and the results can be fully trusted as the causality could also depend on other reasons besides the energy class. Same kind of results arose in a recent master's thesis by Pennanen

(2015). According to her research, energy classes A-C would add 4,1 % to the property value compared with the classes D-E, whereas the lower classes F-G are so called proxy variables and the real reasons behind the apartment's market value cannot be estimated. However, the results of these studies do show that it is worthwhile to investigate the effect of the energy certificates further.

The Finnish Government Institute for Economic Research (2006) presents in their report that it is possible that ignoring the improvement suggestions given in the energy certificate may have an impact on the potential selling prices depending on the energy class of the building in question. So far realization of the suggestions has been voluntary for the property owner. It is possible though that the improvement potential would stay undiscovered if an energy certificate had not been drafted. Realizing the improvements could have a positive effect on the energy efficiency of the building and thereby mean lower costs for the owner. In a research conducted by Lassila & Tikanoja (2011) it is stated that increasing energy efficiency can add up even 7 percent to the property value. This is based on the upgraded technical condition of the building and improved user satisfaction, as up to 40 % of maintenance costs are generated by heating, electricity, and water consumption.

According to the Finnish Broadcasting Company (YLE) the impact of energy certificates remains unclear among the consumers. In a questionnaire made for the owners of detached houses (Omakotiliitto) by YLE's television program Kuningaskuluttaja in 2014, it is implied that it is possible that the housing prices are not affected merely by the energy certificates but the underlying impact is based on the house's qualities and structures, which are taken into consideration when making an energy certificate. This is in line with the research conducted by both Laitala (2014) and Pennanen (2015). Therefore it can be questioned if the actual energy certificate plays a large if any role in the process of buying a property or if the added value is created by other factors.

The impact of energy efficiency and energy certificates on purchase decisions or the property values has not been proved impeccably and so far the process has not become a significant part of real estate evaluation. The real impact of energy certifications might perhaps be solely the added discrepancy and changing the consumers' attitudes towards more energy efficient buildings in the future. (Andelin, 2011.) Research done by Nordström and Rehn (2009) argues that there is no clear connection between energy classification and housing prices. The crucial factors in the decision making process when purchasing a dwelling is highly subjective. Buyers who have the knowledge about energy classifications are also the ones who appreciate the buildings with higher energy classification. They understand the effects of energy classification for example on future repairs and costs results by energy consumption. We might say that the energy classifications benefit the buyers who are already aware of the effects on energy classifications. (Nordström & Rehn, 2009.)

4 Regression Analysis

The aim in this regression analysis is to find out if energy classification has an effect on the selling price per square meter in block-of-flats apartments. This analysis was conducted due to the interest towards Laitala's article in 2014 on the same subject by using the available open transaction data. This regression model is created to represent the price model that explains the connection between housing prices and energy classification. Therefore, with this model we are able to explain the price per square meter in apartments based on its individual attributes. This model is created by using STATA.

4.1 Data Collection and Analysis

The data needed for the model is collected from asuntojen.hintatiedot.fi-service, maintained by the Ministry of Environment of Finland. The data includes apartments in block-of-flats transacted during the last 12 months in Helsinki area. The data was collected on May 2015, thus the data covers time from May 2014 to May 2015. The apartments where the number of rooms was not reported were excluded from the dataset which after that includes 2,435 transactions. Data from the areas Kruununuhaka, Eira, Töölö and Ullanlinna was excluded in order to produce more explanatory power for the model. The aforementioned areas can be considered as high value areas with old buildings creating distortion in both apartment prices as well as increased heterogeneity of the apartments. Hereby it is assumed that energy class is not a significant factor in the sale price as location could be considered as one of the dominating factors. The final dataset includes 2,280 transactions. Below are the tables for the distributions of variables age, logarithm for price per square meter and logarithm for floor area (Figures 2, 3 and 4).

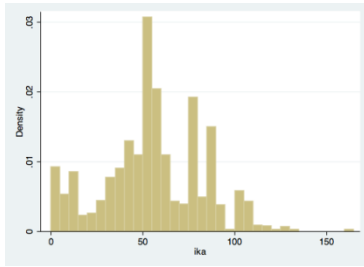


Figure 2. Distribution of Variable Age

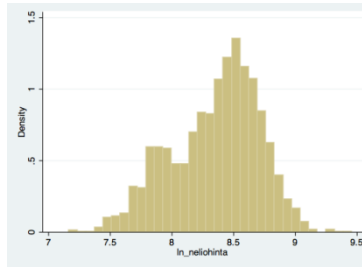


Figure 3. Distribution of Variable Logarithm for Price per Square Meter

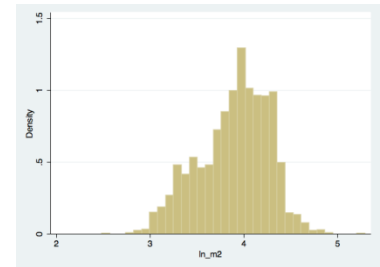


Figure 4. Distribution of Variable Logarithm for Floor Area

4.2 Regression Model

The regression model is conducted and then tested by using mathematical statistical software, and then the dependent transaction price is calculated with price factor regression coefficients (β_i). Formulating the regression model is a combination of both earlier research articles' results as well as trial and error. For computing the initial regression model, the earlier studies described in our literature review, are used in order to choose correct variables and find the equation that best fits the current data. Then the collected open-source data was edited in order to construct a viable regression model applying the ordinary least squares method (OLS-method). The analysis included transforming variables into dummies. Dummy variable is an independent variable (which is qualitative in nature) that is turned into a numerical value, which takes the value 0 or 1 to indicate the absence or presence of some categorical effect that may be expected to shift the outcome (e.g. elevator). In addition to the variable of price per square meter, also floor area was transformed to logarithmic scale to gain more explaining power.

The natural logarithm of price per square meter was set as the dependent variable in the model. The tested independent variables in this model are (see Figure 6): floor area, sauna dummy, floor number, dummies for apartment condition, dummies for categories of construction year (1910, 1911—1930, ..., 1991—2005, and 2006—2016) and energy class dummies (A - G). The highest class is A and the lowest is G. The number of apartments varies in each energy class in our data. In classes A and B there were only 6 and 8 apartments, which is viewed as quite a weak representative sample. In comparison to the other classes the amount of apartments varies from 41 to 343. Unfortunately as Laitala (2014) stated in his article, the energy classification from different years are not entirely comparable with each other and not all energy classifications are reported in the data, hence there could be a lot more information out of our reach. However these errors in the data are expected to be normally distributed and thus not affect the data to be particularly skewed as shown in the distribution histograms in the previous chapter. Below in the figure 5 is shown the relationship between natural logarithm of price per square meter and natural logarithm of floor area.

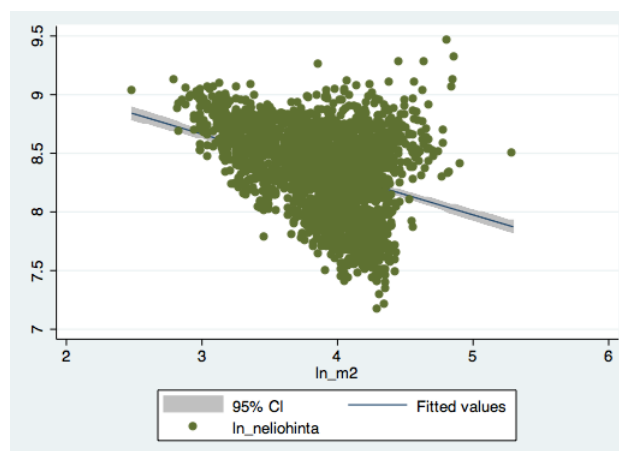


Figure 5. The Relationship between Natural Logarithm of Price per Square Meter and Natural Logarithm of Floor Area

The final equation for regression analysis:

$$\text{square price} = X0 - X1(\ln_m2) + X2(sauna) + X3(floor) + X4(satisfactory\ condition) + X5(good\ condition) + X6(construction\ year:\ 1910) + X7(construction\ year:\ 1911-1930) + X8(1931-1950) + X9(1951-1960) + X10(1961-1970) + X11(1971-1980) + X12(1981-1990) + X13(1991-2005) + X14(2006-2016) + X15(energy\ class\ A) + X16(energy\ class\ B) + X17(energy\ class\ C) + X18(energy\ class\ D) + X19(energy\ class\ E) + X20(energy\ class\ F) + X21(energy\ class\ G)$$

Dummies for elevator and poor condition were excluded from the model since the poor condition seemed to increase the price. Also elevator was excluded from the dataset because people living in different floors benefit from the elevator in different ways. For instance, a person who is living in the first floor may not appreciate an elevator as much than a person living in the sixth floor. Hence, the dummy for elevator could end up having skewed results. The final model is shown below in Figure 6.

	Normal standard errors	
Constant	9.6224***	(0.7046)
Log floor area in sqm	-0.3483***	(0.0140)
Dummy for sauna in the apartment	0.1348***	(0.0111)
Floor number	0.1277***	(0.0029)
Dummy for good condition	0.0091	(0.0235)
Dummy for satisfactory condition	-0.0785***	(0.0103)
Dummy for building year before 1910	0.3750***	(0.0568)
Dummy for building year between 1911 - 1930	0.1510***	(0.0492)
Dummy for building year between 1931 - 1950	0.1244**	(0.0487)
Dummy for building year between 1951 - 1960	-0.0475	(0.0486)
Dummy for building year between 1961 - 1970	-0.2926***	(0.0482)
Dummy for building year between 1971 - 1980	-0.3107***	(0.0490)
Dummy for building year between 1981 - 1990	-0.2027***	(0.0505)
Dummy for building year between 1991 - 2005	-0.1210***	(0.0259)
Dummy for building year after 2006	0.0776*	(0.0442)
Dummy for energy class A	0.2525***	(0.0919)
Dummy for energy class B	0.1334	(0.0844)
Dummy for energy class C	0.1032***	(0.0339)
Dummy for energy class D	0.0261	(0.0164)
Dummy for energy class E	0.0795	(0.0137)
Dummy for energy class F	0.0679***	(0.0241)
Dummy for energy class G	0.404	(0.0367)
R-Squared	0.593	
Number of observations	2281	
White's test for heteroskedasticity		
Chi-squared value	539.5***	
P-value	0.000	

Standard errors are expressed in parentheses. *, ** and *** indicate statistical significance at the 90%, 95, and 99% levels respectively.

Figure 6. Regression Model

The final equation with the coefficients from the regression model, after running the statistical analysis, from where can be seen the coefficients' values and effect to the square price:

$$\text{square price} = 9.6642437 - 0.3482994 (\ln_m2) + 0.1348336 (sauna) + 0.0127706 (floor) - 0.0784517 (satisfactory\ condition) + 0.0091156 (good\ condition) + 0.3749682 (construction\ year:\ 1910) + 0.1509817 (construction\ year:\ 1911-1930) + 0.1244225 (1931-1950) - 0.0474805 (1951-1960) - 0.2926872 (1961-1970) - 0.310718 (1971-1980) - 0.2027017 (1981-1990) - 0.120145 (1991-2005) + 0.077622 (2006-2016) + 0.2525324 (energy\ class\ A) + 0.1333931 (energy\ class\ B) + 0.1031623 (energy\ class\ C) + 0.0260778 (energy\ class\ D) + 0.0079468 (energy\ class\ E) + 0.0678799 (energy\ class\ F) + 0.040292 (energy\ class\ G)$$

4.3 Evaluation of the Model

The model succeeded in having satisfactory explanation power as the R-squared coefficient is 0.59, which means that this model could explain 59 per cent of the variance of the housing prices in this sample. White's test for the model produced a Chi-squared value that reflected high heteroscedasticity. This is important to knowledge and it could be reduced for example by transforming the variables or by using robust standard errors. With a time series data the model would have resulted in more accurate results. However, the model is significant enough for the purpose of this analysis and unfortunately time series data would be difficult to obtain from open sources.

Some energy classes seem to have statistical significance and the trend seems to be to the intuitively right direction: Energy class A seems to have the highest coefficient with a p-value of $p=0.006$, showing statistical significance at 1% level and the magnitude of the coefficients seem to decrease logically as the level of energy classification decreases. In dummy variables for energy classes F and G the coefficient is rather high but this may be due to the fact that having an energy class of F or G can be considered almost the same in the housing market as not having an energy class at all. However, the variables for sauna dummy and floor area have the highest coefficients hence they affect the selling price per square meter more than the energy class. These variables also have p-values of $p=0.000$ hence they have statistical significance at 1% level.

The variable for level of condition is statistically insignificant for apartments in good condition; the beta coefficient for apartments in satisfactory condition seems illogical since the beta coefficient should be based on comparison to apartments in poor condition. The variable itself is determined by the view of brokers and therefore can be seen as highly subjective.

Below in the figure 7 is clarified the statistical significances of all variables. After using robust standard errors the model did not change dramatically. Dummy for building year after 2006 lost its statistical significance whereas dummy for energy class D gained statistical significance at 10% level when using the robust standard errors.

	(1) Normal standard errors		(2) Robust standard errors	
Constant	9.6224***	(0.7046)	9.6224***	(0.7615)
Log floor area in sqm	-0.3483***	(0.0140)	-0.3483***	(0.0148)
Dummy for sauna in the apartment	0.1348***	(0.0111)	0.1348***	(0.0111)
Floor number	0.1277***	(0.0029)	0.1277***	(0.0031)
Dummy for good condition	0.0091	(0.0235)	0.0091	(0.0206)
Dummy for satisfactory condition	-0.0785***	(0.0103)	-0.0785***	(0.0104)
Dummy for building year before 1910	0.3750***	(0.0568)	0.3750***	(0.0599)
Dummy for building year between 1911 - 1930	0.1510***	(0.0492)	0.1510***	(0.0515)
Dummy for building year between 1931 - 1950	0.1244**	(0.0487)	0.1244**	(0.0509)
Dummy for building year between 1951 - 1960	-0.0475	(0.0486)	-0.0475	(0.0513)
Dummy for building year between 1961 - 1970	-0.2926***	(0.0482)	-0.2926***	(0.0517)
Dummy for building year between 1971 - 1980	-0.3107***	(0.0490)	-0.3107***	(0.0523)
Dummy for building year between 1981 - 1990	-0.2027***	(0.0505)	-0.2027***	(0.0537)
Dummy for building year between 1991 - 2005	-0.1210***	(0.0259)	-0.1210***	(0.0249)
Dummy for building year after 2006	0.0776*	(0.0442)	0.0776	(0.0482)
Dummy for energy class A	0.2525***	(0.0919)	0.2525***	(0.1669)
Dummy for energy class B	0.1334	(0.0844)	0.1334	(0.1306)
Dummy for energy class C	0.1032***	(0.0339)	0.1032***	(0.0277)
Dummy for energy class D	0.0261	(0.0164)	0.0261*	(0.0155)
Dummy for energy class E	0.0795	(0.0137)	0.0795	(0.0139)
Dummy for energy class F	0.0679***	(0.0241)	0.0679***	(0.0252)
Dummy for energy class G	0.404	(0.0367)	0.404	(0.0431)
R-Squared	0.593			
Number of observations	2281			
White's test for heteroskedasticity				
Chi-squared value	539.5***			
P-value	0.000			

Standard errors are expressed in parentheses. *, ** and *** indicate statistical significance at the 90%, 95, and 99% levels respectively.

Figure 7. Statistical Significances of Variables and Robust Standard Errors

In addition to the physical attributes of an apartment, there are a lot of other factors that influence the selling price. These factors are the kind of factors that cannot be valued today, such as future renovations, repair debt or whether the building is located on freehold or leasehold land. (Laitala, 2014.) In Helsinki area there is also differences in housing prices between different submarkets. Micro-location is not included in this model even though it is possible to make separate regression analyses considering smaller areas in Helsinki. In that case, the problem is to have enough transactions from specific and rather small areas.

The results from this model are reasonable and logical as there are many variables that affect the selling price per square meter. Usually energy classification is not the most significant factor. However the results support the fact that energy classification should not be left out when the selling price is formed and sellers and buyers seem to take it into account when buying an apartment. All in all this study supports the statement that there is a connection between energy classification and selling price per square meter in apartments as Laitala (2014) stated as well in his study.

5 Conclusions and Discussion

Findings from this literature review analysis show that the requirements for energy certifications are well-implemented in the legislation of European Union countries. The energy certification's main goal is to compare buildings' physical qualities with each other, meaning that the concrete energy usage of consumers is not taken into account. The energy certifications are graded on a scale from A to G, where A is the highest and best. In Finland these certifications have been used since 2008 in new constructions and since 2009 additionally in selling and renting occasions. Nowadays, it is required to have an energy certificate completed in the housing market, which makes its effect on housing prices even more relevant.

According to the literature it seems that the energy efficiency is clearly seen to have an effect on the value of the building, but the effect of energy certificates still seem to remain unclear at least to some extent. Energy certificates are apartment-specific factors that according to a basic theories and literature could have an affect on the price, since the quality varies between apartments. We agree with the Finnish research done by YLE that people are still generally too unaware of the meaning of energy certificates, which for one's part increases the need to make researches about them even more easily available. However, it is commonly known that the physical qualities of the buildings already have a significant effect on the housing prices, which leaves the question of 'whether the energy certifications have a separate effect on them' hanging. Accordingly, the problems for future studies should be finding the keys for sharing information on the benefits of energy certificates for the consumers more efficiently.

However, our regression analysis supports the primary researches' findings: there is a slight increasing effect on the housing prices within the highest energy classifications (A & B) but the lower ones do not show any significant changes. Due to this we can assume that the housing prices in these cases are composed from completely other factors (e.g. location, physical elements). The lowest energy certifications (F & G) seem to have so non-existent effects on the housing prices so that these buildings can be considered to have no such certification at all. Nonetheless, our results seem consistent with the existing literature and although the effect of energy certificates on housing prices is not magnificent, it still exists and should not be left out.

In the end, it seems that there is no clear relationship between the housing prices and energy classifications. The appreciated housing details are always individual. In our case this probably appears in such way that people who are aware of the energy classifications and their meaning are more prone to appreciate buildings that have been classified with higher energy classes. After all, people who have prior knowledge on the energy classifications understand the positive sides of a good classification while at the same time recognize the possible repair and other costs that worse classification could cause in the future. Due to this we do not feel that the openness of data on energy classifications would radically benefit the general housing market. However, it does offer a better chance for the people already interested in the topic to discover more detailed information and consequently to compare houses. It is still rather unclear how the information on energy classifications reaches a regular consumer who is not generally interested in energy classes and due to this does not realize to find or ask for it.

Since our data in the regression analysis was partially incomplete, mostly concerning the highest energy classification classes, our findings are not the most significant. For future studies we suggest using bigger data sample and including the time frame into it in order to find out any time-related effects (if there are any). In order to use this kind of a regression model in the future it must be developed by all

odds, e.g. increase the amount of variables or modify the existing ones by some means. In addition, instead of asking how the openness of data on energy classifications benefit the housing market, the further researches should concentrate on how to make this data interesting and needed for the consumers and that way actually have an effect on people's conscious decision-making in housing transactions. Also an interesting research question in the future would be if the energy class really has an effect on selling prices and the capital values of the buildings as they use less energy and natural resources.

References

- Andaloro, A.P.F., Salomone, R., Ioppolo, G., & Andaloro, L. 2010. Energy certification of buildings: A comparative analysis of progress towards implementation in European countries. *Energy Policy*. Vol. 38 (10). 5840 – 5866.
- Andelin, A. 2011. Energiatohokkuusluokka asunnon arvotekijänä. Aalto University School of Engineering. Bachelor's thesis. Available at: <https://aaltodoc.aalto.fi/handle/123456789/9800>.
- European Union. 2010. Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings. Available at: <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32010L0031>.
- Finnish Act on Energy Certification of Buildings. 50/2013.
- Government Institute for Economic Research. 2006. Government Institute for Economic Research. Energiatodistusten taloudelliset vaikutukset. Helsinki. [Referred on 10.5.2015.] Available at: http://www.vatt.fi/file/vatt_publication_pdf/m75.pdf.
- Janssen, M., Charalabidis, Y. & Zuiderwijk, A. 2012. Benefits, Adoption Barriers and Myths of Open Data and Open Government. *Information Systems Management*. Vol. 29 (4). 258 – 268.
- Kasso, M. 2005. Asunto- ja kiinteistökauppa. Jyväskylä: Gummerus Kirjapaino Oy. ISBN 952-14-0964-9
- Laakso, S. & Loikkanen, H. 2004. Kaupunkitalous: johdatus kaupungistumiseen, kaupunkien maankäyttöön sekä yritysten ja kotitalouksien sijoittumiseen. Helsinki: Gaudeamus Kirja. ISBN 951-662-893-1
- Laitala, A. 2014. Onko asuntojen energiatohokkuudella arvoa? *Maankäyttö* 4/2014. 31–34.
- Lassila & Tikanoja. Energiatohokkuus kasvattaa kiinteistön arvoa. 2011. Press release 2.11.2011. [Referred on 11.5.2015.] Available at: <http://www.lassila-tikanoja.fi/tiedotteet/Sivut/Energiatohokkuuskasvattaaakiinteist%C3%B6narvoa.aspx>.
- Luukkonen, P. 2011. Asuntojen hintojen muodostuminen ja kotitalouksien velkaantumisen rooli - Onko pääkaupunkiseudulla asuntokupla? Aalto University School of Economics. Pro-gradu. Available at: https://aaltodoc.aalto.fi/bitstream/handle/123456789/655/hse_ethesis_12523.pdf?sequence=1
- Ministry of the Environment. 2013. Energy certificate for buildings. [Referred on 7.5.2015.] Available at: http://www.ymparisto.fi/en-US/Building/Ecoefficiency_and_energy_consumption_in_buildings/Energy_certificate_for_buildings.
- Molloy, J. 2011. The Open Knowledge Foundation: Open Data Means Better Science. *PLoS Biol* 9 (12): e1001195. DOI: 10.1371/journal.pbio.1001195.
- Motiva Oy. [Referred on 10.5.2015.] Available at: <http://energiatodistus.motiva.fi>.
- Nordström T. & Rehn L. 2009. Energideklarationens påverkan på fastighetens värde. Fastighetsekonometriprogrammet C-uppsats. Karlstads Universitet. Available at: <http://www.diva-portal.org/smash/get/diva2:224025/FULLTEXT01.pdf>
- Pennanen, T. 2015. Energialuokan vaikutus asunto-osakkeen markkina-arvoon. Aalto University of Engineering. Degree programme in Real Estate Economics. Master's thesis.
- Poikola, A., Kola, P. & Hintikka, K. 2010. Julkinen Data- ja Johdatustietovarantojen Avaamiseen. Liikenne- ja viestintäministeriö. Helsinki. ISBN 978-952-243-146-2.
- Reichman, O., Jones, M. & Schildhauer, M. 2011. Challenges and Opportunities of Open Data in Ecology. *Science*. Vol. 331. 703 – 705.

Tuomi, M. 2010. Asunnon hinnan muodostuminen – toteutuvaan kauppahintaan vaikuttavat asiat, kiinteistönvälittäjän näkökulma. Turun ammattikorkeakoulu. Thesis.

YLE. 16.10.2014. Energiatodistuksen Merkitys Jäänyt Kuluttajalle Hämäräksi. [Referred on 10.5.2015.] Available at: <http://yle.fi/aihe/artikkeli/2014/10/16/energiatodistuksen-merkitys-jaanyt-kuluttajalle-hamaraksi>