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Hedonic housing price formation in Helsinki and Espoo

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ABSTRACT:

Though influence of the housing market for the economic is significant, academic research about housing price formation, especially in Finland, has been severely lacking. The reason might be partly due to challenges put forward by the research framework, limited research methods and the complexity of the housing price formation. This study assesses the hedonic housing price formation in Helsinki and Espoo, particularly focusing on dwelling's physical features and the distance to the center of Helsinki. The data has been gathered from Hintaseurantapalvelu through a cooperation agreement and it contains apartments' realized debt-free prices and the information from dwelling's individual attributes. Moreover, the study utilizes a location variable which measures the distance to the center of Helsinki. In total, the material covered includes 5495 observations from the time period of 1.1.2018 – 31.06.2018. I conduct the research with linear regression model and estimate the result based on the least squares method. As a result, the most significant connection for the debt-free price is own plot that equals price of 57 383,06 euros when other relevant factors are considered. Additionally, the research concludes that the second greatest connection for the debt-free price is apartment's distance to the centrum: one-kilometer increase in the distance to the center decreases the debt-free price by 19 043,09 euros. The findings drawn from the data and presented here after are statistically significant.

KEYWORDS: housing price formation, hedonic price model, housing markets

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TIIVISTELMÄ:

Asuntomarkkinoiden vaikutus talouteen on merkittävä, mutta akateemisesti etenkin asuntojen hintojen muodostumisesta on tehty Suomen tasolla vähäisesti tutkimuksia. Osasyynä voi olla tutkimisen haastavuus, mikä voi johtua rajoittuneista tutkimusmenetelmistä ja asunnon hinnan muodostumisen monialaisuudesta. Tutkin asuntojen hintojen muodostumista Helsingissä ja Espoossa, minkä pääfokuksena on ottaa huomioon asunnon fyysisiä ominaisuuksia sekä etäisyyttä keskustaan. Asuntokauppadatan sain yhteistyösopimuksella Hintaseurantapalvelusta, josta löytyy toteutuneet velattomat kauppahinnat sekä asuntojen yksilökohtaisia ominaisuustietoja. Tämän lisäksi loin sijaintimuuttujan, joka mittaa etäisyyttä Helsingin keskustaan. Helsingin ja Espoon asuntokauppa-aineisto sisältää 5495 havaintoa aikaväliltä 1.1.2018 - 31.06.2018. Toteutan tutkimuksen lineaarisella regressiomallilla ja estimoin tulokset pienimmän neliösumman menetelmällä. Tutkimuksen tuloksena Helsingin ja Espoon materiaalissa suurin yhteys asunnon velattomaan hintaan on oma tontti, mikä tuo asunnon hintaan 57 383,06 euroa, kun muut relevantit tekijät on huomioitu. Tämän lisäksi toiseksi suurin yhteys asunnon hintaan on asunnon sijainti, missä yhden kilometrin lisäys keskustaan laskee asunnon hintaa 19 043,09 euroa. Kyseiset tulokset ovat tilastollisesti merkitseviä.

AVAINSANAT: asunnon hinnan muodostuminen, hedonistinen hintamalli, asuntomarkkinat

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1 INTRODUCTION

1.1 Research background

In the Finnish housing markets, the trends during the last decades have been remarkable both in positive and negative terms. There are many reasons behind the varying development e.g. legislation changes in financial markets, Finland's accession to the European Union and financial crises, of which most recent took place in 2008 in the aftermath of the bankruptcy of U.S investment bank, triggering a worldwide crisis.

However, the greatest trend of recent years in Finnish housing market has been polarization. Housing markets are divided roughly into two categories: *growth centers* and *migration loss areas*. The most remarkable housing clusters in Finland are between Turku, Tampere and Helsinki metropolitan area. The reason behind this development has been urbanization. Corporate offices and common public services such as health care and schools are constantly focused on bigger growth centers, which has contributed to work-related emigration. This has been one of the major reasons for increasing housing prices, especially in the Helsinki metropolitan area, where growing housing demand has not been matched with sufficient increase in the housing supply. Housing supply is an inelastic phenomenon in a short term because building a new rising house and decisions about the zoning areas take time (Oikarinen, 2007:15). Therefore, the respond for a sudden increase in housing demand is challenging.

1.2 Research approach

The research is conducted by using quantitative data collection technique. The first data includes 5495 observations from the time period from 1.1.2018 to 31.06.2018 and the second data has 230 observations from equal time frame. Realized housing prices are collected from the Hintaseurantapalvelu (HSP), where most of the real estate companies and largest construction companies notify price information of sold apartments as well as the features of dwellings. Moreover, I created two location variables to measure distance to the Helsinki centrum and metro station. For the outcome, I utilized linear regression model on the statistical program SPSS and estimated the parameters by using the ordinary least squares method (OLS).

1.3 Research questions and objectives

The goal of this survey is to figure out, which dwelling's physical features create apartment's debt-free price in Helsinki and Espoo. Moreover, the second part of the survey examines the area of Lauttasaari by analyzing how distance to the metro station connects to the debt-free price.

Housing price formation is a local phenomenon. Different housing regionals are not substituted for each other and therefore many previous studies have investigated housing price formation locally. Regarding earlier studies, housing markets are relatively little investigated, especially in Finland (Oikarinen, 2007). Foreign studies investigate different countries' housing markets, and therefore, there is no possibility to compare the results straight to Finnish housing markets. However, especially in Nordic countries, housing markets have some similarities which suggests points of interest for further investigation.

The research is a positivistic study using quantitative methods. This kind of research contains certain assumptions concerning nature of reality as well as the assumptions of acceptable knowledge is mainly numerical. A researcher has an objective stance to research (Saunders, Lewis, Thornhill & Bristow, 2019). This type of approach is typical for a quantitative research (Ha-Vikström, 2018).

There are two detailed research questions for the research:

1. Which attributes have the most remarkable connection to the apartment's debt-free price?

2. To what extent the distance to metro station has a connection for the debt-free price in Lauttasaari?

1.4 Structure of the thesis

The structure of the thesis is following: Section 1 introduces the thesis. Section 2 presents the literature review that describes special features of housing, housing as an investment and the history of Finnish housing markets. Further, Section 2 introduces housing price formation from an economic perspective, and different pricing models for dwellings.

Section 3 presents previous studies of both Finnish and international housing markets. Regarding the data, the studies analyzed have collected apartment's hedonic attributes, which I have implemented into this thesis as well. The target is to indicate, how apartment's hedonic features have been investigated in the history of housing markets research. Section 4 introduces the method and limitations to it in the context of present study. Section 5 presents an overview of the material collected for the survey. Section 6 introduces correlation tables and the results from the VIF tests.

Section 7 assesses the results from the empirical research. Section 8 consists of a discussion and analysis about the most significant results derived from the data. Finally, the Section 9 presents the conclusion that unites the outcome of the thesis' and introduces the possible future research opportunities of the presented topic.

I chose this topic because the demand for dwellings especially in the Helsinki metropolitan area is extraordinarily strong, and therefore I wanted to investigate, which attributes have the most remarkable connection for the price. Moreover, housing market's extensive influence on different industries was an intriguing starting point for the topic.

2 LITERATURE REVIEW

Figure 1 below shows the prices of old dwellings from the year 2015 to 2019. There are three different curves to demonstrate Finland's housing price development; the one curve indicates the Helsinki, second Helsinki metropolitan area and the third rest of the country. Figure 1 demonstrates that in Helsinki and Helsinki metropolitan area old dwelling prices have increased from the starting year of 2015, where the nominal level of index is 100. In June 2019, level of the index has grown between the 110 and 115 on both curves. However, the third curve that demonstrates the rest of the country, the nominal level index has decreased on the same period for a little above the nominal level of 95. Even though this figure is a generalization about Finland's housing price development across the country, it indicates housing price changes between the regions, and especially how the Helsinki and Helsinki metropolitan area housing prices have increased significantly in recent years.

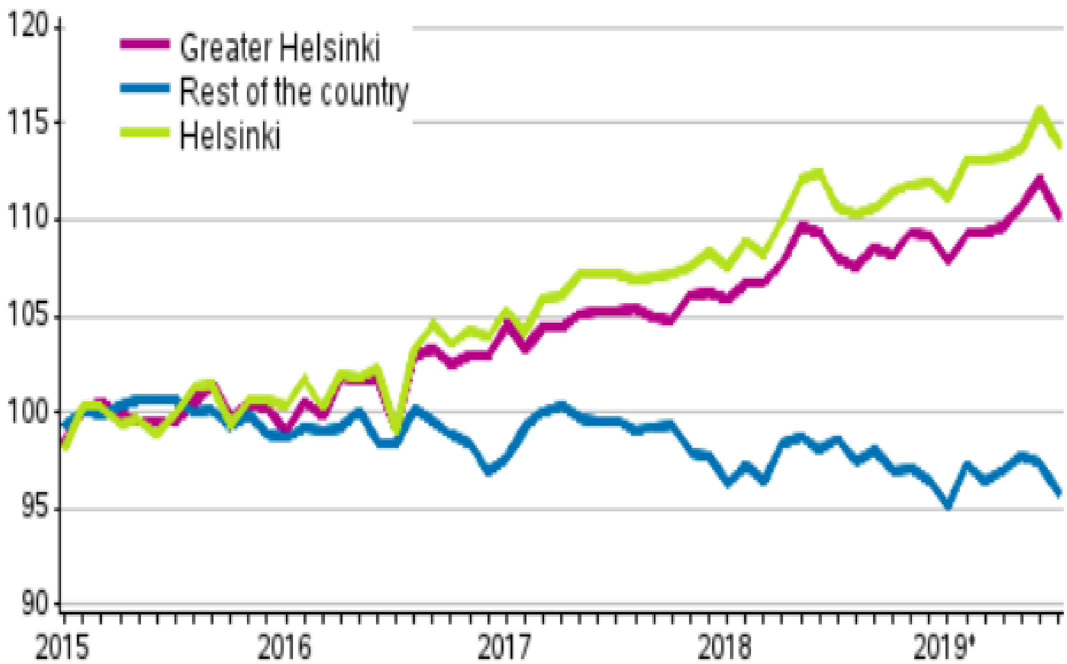

Figure 1. Development of prices of old dwellings in housing companies by month, index 2015=100 (Statistics Finland, 2019).

2.1 Special features in housing market

Housing market differs from other commodities markets; dwellings and the housing market overall have some special features that make it different in comparison to other markets. It is common to see some similarities to other commodity markets but not a combination of all attributes that consist the housing market as such (Laakso & Loikkanen, 2004).

From the economic perspective, housing is the similar type of consumer product than food or clothes. Households are using houses for living, which is the way the dwellings are consumed. It can be argued that housing is a necessary commodity because every person has to live somewhere. The unique peculiarities regarding dwellings is that their location is mostly fixed, excluding some special situations where a transfer could be possible (transferable mobile homes in the US). In addition, the dwelling is not easy to modify. There is a possibility to improve apartments or property's condition by doing renovations, but the actual modification is harder; there is no possibility to change the size or the amount of the maintenance fee because they are fixed to apartment itself (Laakso & Loikkanen, 2004).

Moreover, dwelling is an expensive commodity. According to Laakso and Loikkanen (2004), the average cost of an apartment is four times greater than the average yearly income of households. Because of that, most households are in charge of one dwelling at the time. Therefore, it is an expensive commodity and for many households the greatest investment during the lifetime (Laakso, 2000b).

In addition, dwelling is not a homogeneous commodity. The apartment consists of structural, quantitative and qualitative attributes that make dwellings heterogeneous commodity (Laakso & Loikkanen, 2004). Every apartment is a unique individual. Even though two apartments would have the same characters such as size, price, floor, and shape, there is always one different attribute – *location*. Primarily for this reason housing is seen as a heterogeneous commodity because the location cannot be the exact same between two dwellings (Oikarinen, 2007).

As mentioned earlier, housing markets are local phenomena. The supply is based on the location because apartments are not mobile. However, the demand for the local housing markets occurs across the regions and even nations because of migration. Still, national and international economies affect the local housing markets too via financial markets (Laakso, 2000b).

Another significant part of the housing is high transaction costs. Transaction costs occurs when a household moves to another owner-occupied apartment. These costs are exploration, moving, brokerage and taxes (Laakso & Loikkanen, 2004). Because of the high transaction costs, households move rarely. Also, the typical character of the housing market is asymmetric information, further investigated in the next chapter.

In addition, a dwelling is an exceptional long-term commodity. The share of new apartments that come to the market is only 1-3% of the entire existing housing stock and it takes at least two years from planning to completed property. Therefore, the major supply potential comes from existing apartments where both buyers and sellers are actual households (Laakso & Loikkanen, 2004).

For individuals, dwellings are either consumption or investment goods. In Finland, almost everyone can own or rent an apartment. That is for the most part made possible by Finland's unemployment support system, that provides the people without a job financial support from the government. That leads to a point where living in a dwelling can be seen as a necessity or a possibility in Finland (Laakso & Loikkanen, 2004).

Housing markets are very sensitive to cyclical fluctuations. The main reason is that the housing market supply is inelastic in the short term and therefore the market is unable to respond to rapidly changing demand, which reflects strongly to housing prices

(Laakso, 2000a). Other markets have the same kind of attributes as well but combining all these special features makes housing market special in comparison with any other market (Laakso, 2000b).

2.2 Dwelling as an investment

Housing is often defined as having a home where you can undertake ordinary activities such as sleep or cook food. On the other hand, many people are using dwellings as an investment. Comparing to other financial assets, the dwellings are heterogeneous which means that every single apartment is unique. That entails both challenges and possibilities for investors.

Housing investment is seen as an attractive investment option in short- medium- and long-term. Typically housing investment is considered as a long-term investment because transaction costs are high on the date of acquisition (Berges, 2004). Moreover, purchasing an apartment is valuable and therefore, investing in dwellings requires a large amount of capital comparing to other financial assets (Oikarinen, 2007). Therefore, housing investment is often conducted by utilizing debt money. The debt money enables to grow return of equity by increasing the leverage (Kahr & Thomsett, 2005). However, investors who are using large leverage are especially sensitive to the rising interest rate, which cuts down the profit (Huber, Messick & Privar, 2004).

Comparing residential investment to commercial one, residential investments are easier to remodel, if there comes a new demand shock for a different style of apartments. Regarding commercial investment, technology at the property is a crucial factor and it can vary in time. Additionally, it is extremely costly to renew property’s technology. Even though residentials require more time-consuming service and operating, these aspects can often be priced into the rent (Gabrielli, 2018).

According to Oikarinen (2007), a typical characteristic in the real estate market is informational asymmetry. There is no public real estate marketplace where all the information is gathered and shared, whereas in the financial market, everyone sees all the price and transaction details. Informational asymmetry might induce poor investment decision in the housing investment sector because buyer and seller have different details about the investment.

İçellioğlu (2015) states that demographical factors such as gender, education, monthly income, age and occupation influence the investment decisions. Lower-income people consider housing investment as a long-term investment whereas higher-paid people maximize the profit in the short-term by trading dwellings. As stated earlier, transaction costs in housing purchase are significant, and therefore short-term investment horizon is not always the most optimal solution when maximizing return.

House investment includes various expenses. Maintenance fee that covers basic refurbishment in the property is paid monthly. The cost is often based on the apartment’s square meters and therefore bigger apartments pay relatively bigger amount of maintenance fee. Moreover, upcoming renovation costs in the property are divided applying the same method and based on square meters. Another used method to calculate your share of maintenance fee or renovation cost is to determine it by the amount of shares your apartment is responsible for, but this is a rare standard in Finnish housing markets. Also, bigger apartments are responsible for larger share of the costs in this model as well.

The real estate tax is always paid in time of purchase. It is 2% of the dwelling’s debt-free price, excluding your first apartment that is free from the real estate tax if you have lived in the apartment continuously 2 years. Also, if you do have not lived continuously for 2 years in the dwelling you have purchased, you are required to pay capital tax from the share of profit. The amount of capital tax is 30% up to 30 000€’s from the profit and 34%

from the exceeding part (Vero, 2019). To conclude, financial assets have often smaller cost comparing to house investment (Oikarinen, 2007).

2.3 Housing market in Finland

In general, urbanization inside Finland has been an enormous trend that has influenced housing markets as well. Especially work-related emigration has been strong because many jobs are focused on growth centers. As demonstrated on figure 2, around 60 percentages of the Finnish population lived in a rural area in 1950. Coming to 2019, over 80 percentages of the population stay in the urban area: in 69 years 40 percent of all populations have moved from rural areas to urban areas. By 2050, estimated share for the population living in urban areas internationally is 90 percentage (United Nation). In June 2019, the population of Finland was a little bit over 5,5 million, of which Helsinki metropolitan area covers just below 1,2 million people (Tilastokeskus, 2018).

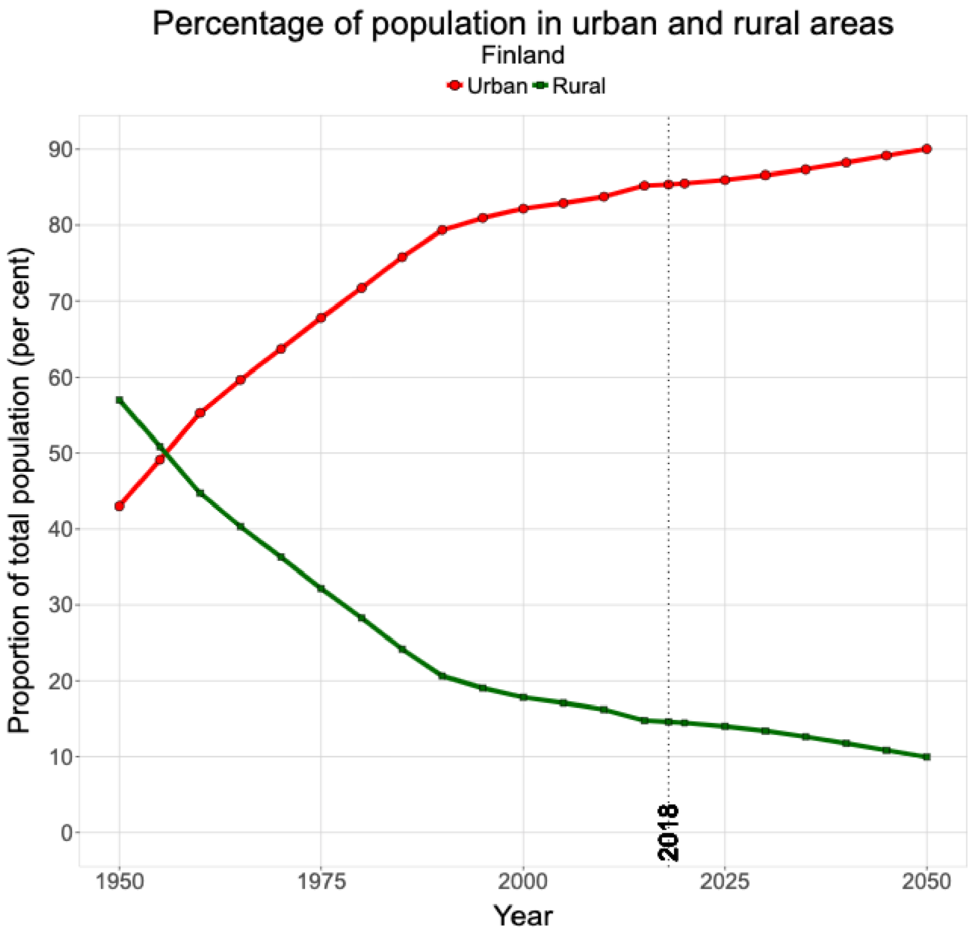

Figure 2. Percentage of population in urban and rural areas (United Nations, 2018).

2.4 Finnish housing market history

In this chapter, we will look at the basic structure and history of Finnish housing markets. This chapter is focused on the most critical turning points which have had the biggest influences for the housing market development. Overall, the importance of housing markets cannot be overstated. The capital spent to the housing market is greater than any another financial asset (Oikarinen, 2007).

The housing market in Finland is separated into two different sectors: privately financed sector and publicly regulated sector (Oikarinen, 2007). In a privately financed housing sector, selling and buying are not limited, and therefore privately financed housing sector does not distort the housing market because supply and demand have no restrictions. However, in the publicly regulated sector, there are limits of buying and selling the apartments and they are often realized under the market price. Publicly regulated owner-occupied apartments are called HITAS-apartments. Moreover, the city of Helsinki's rental apartments are normally under the market rent and therefore these restrictions have a connection to the whole housing market.

At the beginning of 2005, Finland had nearly 2.6 million apartments, of which 60% were owner-occupied housing. About 1% of the dwellings were "right of occupancy" which has characters of both owner-occupancy and rental apartment. The remaining share are rental dwellings. Institutional investors and the public sector hold approximately half of the rental apartments (Oikarinen, 2007). Therefore, the connection of the public sector in the Finnish housing market can be seen as prominent.

Speaking of Finnish financial market, which is highly correlated to housing markets, the government has played a huge role and the level of interest rate regulation has fluctuated in course of history. The first remarkable increase in housing prices occurred in the early of 1970s when Finland's economy was nearly recovered after the downturn. In the spring of 1972, the bank of Finland required Monetary Financial Institution (MFI) to give credit for both housing production based investments and housing construction. At the same time, commercial banks' central bank credit rate was decreased. Consequentially, the lightening monetary policy and the increase of overall demand resulted in the overheated housing market. Therefore, the interest rate was fixed up in 1973 to prevent the continuation of overheating ("Brisk activity in housing loan," 2018).

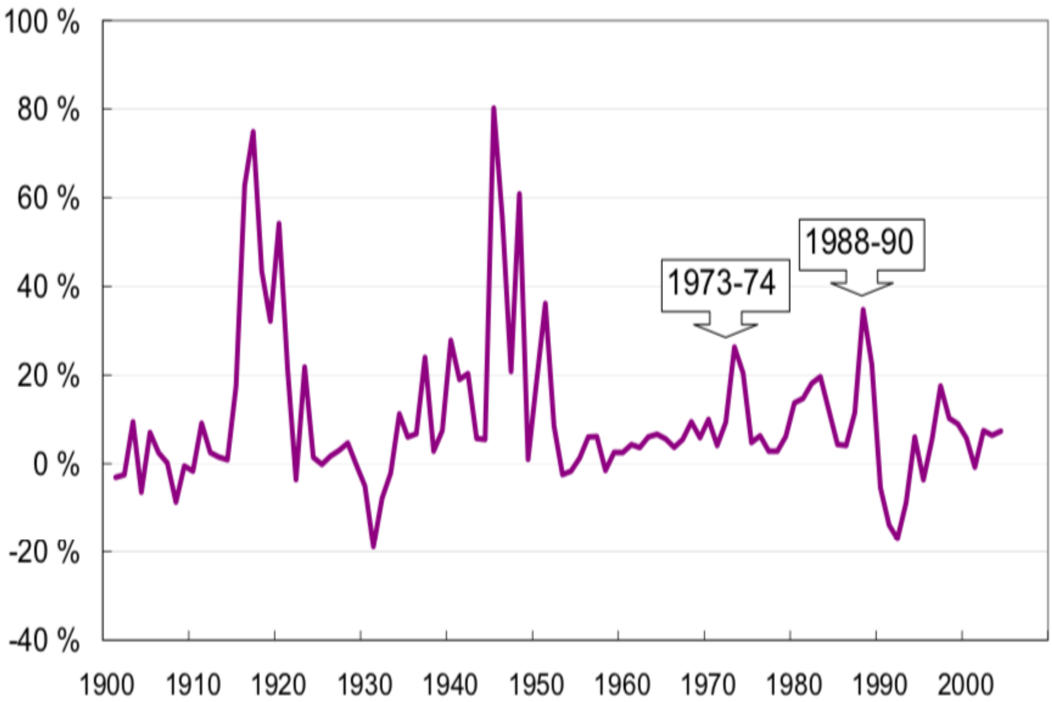

Figure 3. Annual change of dwellings' nominal prices in Finland 1901-2004 (Suomen pankki, 2019).

The major parts of the interest rates were regulated administratively from the beginning of the 1980s (Koskela ym. 1992). The typical private loan maturity at the beginning of 1980s was 8-10 years and the required down payment was 20-30% (Koskela ym. 1992). Banks wanted to minimize the risks and therefore the loan maturity was placed to a low level and the down payment ratio was at a high level. In February 2018, the average loan maturity was 20 years, which embodies the major change of Finnish financial markets structure during past decades (Suomen Pankki, 2019).

The critical turning point in the Finnish financial market occurred in 1986 when interest rate regulation was loosened, leading to housing market boom (Koskela ym. 1992). After the release, private lenders were able to get housing loans easier, and therefore the demand for the housing loans and owner-occupied dwellings increased. This change was especially reflected to housing prices that went extremely high. Moreover, an administrative change led to aggressive competition between the banks (Laakso, 2000: 33).

The housing market boom continued from 1986Q4 to 1989Q1 when the real housing market index increased by 58% in Finland (Oikarinen, 2007). The period after the housing market boom turned the dwelling prices for another direction. From 1989Q1 to 1992Q4 housing prices decreased 50% and therefore in 1993 housing prices were lower level than in 1886 before the change of interest rate regulation (Oikarinen, 2007).

There were two reasons why the dwelling prices dropped between the years 1989 and 1992. First, housing prices increased above their fundamental level after the interest rate regulation change. Second, Finland suffered deep recession in the early 1990s that led to remarkable mortgage rate increase (Oikarinen 2007).

The number of rental apartments was decreased from the 1950s to 1990s. The major reason was the public sector that had settled the rent regulation. However, during the time from 1992-1995 the rent regulation was fully removed. After the abolishment, the amount of rent dwellings were increased in a short-term but in the late 1990s the amount of owner-occupied dwellings became more popular (Oikarinen, 2007). The reason behind this development was loosened regulation in mortgage loans in 1986. After the 1990s recession, people started to think more about their future and therefore owner-occupied dwellings started to increase in the late 1990s.

In Finland, financial markets were released at the end of 1980s. The impact of financial market release had a massive influence on Finnish housing market. Before the release, lenders required a major amount of savings in order to get a housing loan. After the release, loaning became easier which increased the competition between the banks (Laakso, 2000).

2.5 Housing price determination

Dwellings are assets and dwelling’s price and the amount of construction is determined in the capital markets (Laakso & Loikkanen, 2004). The housing market is stable when supply and demand are balanced. The price formulation is a result of how much house investors are willing to pay from the apartment and how much is the actual supply in the owner-occupied housing market sector (Laakso & Loikkanen, 2004).

As stated earlier, new housing production is inelastic in the short term, and therefore the supply cannot adapt to changing demand. This change in demand will rise the area’s housing prices. The scenario motivates construction enterprises to build more apartments for the area with higher demand and when new dwellings are ready and increased demand is satisfied, the price point will revert to the cost of production level. The cost of production level includes all the construction company’s production costs and the profit margin (Laakso & Loikkanen, 2004).

The growing change in demand may occur if area’s migration or income level increases. If supposed that all the area’s dwellings are rental apartments, and the owners are investors, the change in demand will increase the level of rental income. The increase of rental income will raise the owner-occupied demand and therefore it will reflect the area’s growing housing prices (Laakso & Loikkanen, 2004).

The demand for the ownership of space and demand for the tenants of space have a connection. Moreover, rents and prices of dwellings are closely linked. These four elements in turn describe the effect in the housing market when there comes a change in supply or demand. The idea is to figure out how the price is formed in the long run and which are the key factors that change prices (DiPasquale & Wheaton, 1996). In this chapter, the idea is to describe macro-economic factors that influence housing prices. According to Abraham & Hendershott 1996, the rising construction costs, income growth and changes in interest rates explain approximately half of the housing price fluctuations.

According to DiPasquale and Wheaton article in 1992, the housing price formation in the long run is separated into four different markets. DiPasquale and Wheaton created four quadrant model to describe how the changing supply and demand in different factors connect. The four quadrants are housing production, defining housing prices, defining the amount of rent and housing. The model itself tries to determine the effect in the long term. This model is widely used in different housing market studies and the model uses macroeconomic attributes in these four different scenarios. The four-quadrant model is illustrated in Figure 4 below. The two right-hand quadrants show the property market that represents all the users of space i.e. tenants. Moreover, two left-hand quadrants represent the asset market consisting of the owner-occupied property market (DiPasquale & Wheaton, 1992).

The first market in the four-quadrant model is the price determination in the owner-occupied market. The quadrant in the upper left corner describes the scenario of how the amount of the rent and dwelling's price create the property's price in the long run. The vertical axis presents the dwelling's rent level $\$/m^2$ and the horizontal axis describes the price level $\$/m^2$. A line from the origin to the upper left describe the ratio between the rents and prices. Hence the ratio presents how much the risk-free net rental should be that house investors will possess price point *P* square priced dwellings. There is a connection between the dwelling's square price and the net rental level. Square price is formed when the upcoming net rentals are discounted to the present value. In figure 4, the interest rate level *i* presents the alternative investment profit in a given year (DiPasquale & Wheaton, 1992).

$$P = \frac{R}{i}, \quad (3)$$

Whereas *R* is formed from the gross rent, reducing running costs and taxes and by dividing it by the interest rate *i*.

From this point of view, attributes which affect to dwelling's square price are long-term interest rate level *i* (alternative investment profit) and changes in net rental level, which can be unexpected change in gross rental level, the risk change of upcoming rent profits or the change of tax treatment of rental income or property investment.

The higher the property investor's expected investment profit *i*, the steeper the $\frac{R}{i}$ line. If the investor's rate of return increases, the curve moves to the clockwise right. Respectively, the lower the rate of return, the less steep the curve (DiPasquale & Wheaton, 1992).

Expectations of increasing rental levels in the future lower the investor's rate of return which will in turn increase the price of dwellings. However, if the expectations are the opposite, i.e. rental level is expected to decrease in the future, investor's rate of return increases which will reflect rising housing prices. The riskier the market, the higher is the investor's rate of return *i.* In addition, investors will add a risk premium to the expected rate of return *i*. If the house investment becomes riskier increasing the risk premium, in the long term, the connection is perceived in lowered housing prices (DiPasquale & Wheaton, 1992).

To conclude, macro-economic factors control house investor's decision-making process in the long term. If unexpected change in macro-economic factors occurs, possibly having crucial connection for the investors i.e. tax treatment of rental income, the result might be a process in which investors are changing house investments for another investment product. In figure 4, the balanced price point is seen in the curve's $\frac{R}{i}$ intersection. Hence, the rental level defines dwellings price level (DiPasquale & Wheaton, 1992).

2.6 Housing production

In the down left corner of Figure 4, the quadrant describes the new housing production. The curve f(C), which slopes down left, contains the unit cost of housing purchase. The production cost curve describes the unit cost of new housing purchase, which includes building costs, land acquisition costs and construction company's normal profit (DiPasquale & Wheaton, 1992). The unit cost of new housing production is assumed to correlate with the amount of construction. The buoyancy of construction is assumed to have a connection for the price of the land, the price of the building material and the salaries of the construction industry (DiPasquale & Wheaton, 1992).

When construction companies are densely building new dwellings, the demand for the land, building material and employees is increased and therefore the price for these inputs are growing. The supply for land, building material and employees cannot adapt to the sudden increase in demand which would balance the rising prices. In the Figure 4 upper down left quadrant, the point of intersection between the production cost curve and price axis describes the minimum price level, where new housing production is realized. If there would not be any correlation between the amount of construction and new housing unit costs, production cost curve will be almost vertical. Another way around, the more vulnerable inputs are to amount of construction, the less steep is production cost curve's slope (DiPasquale & Wheaton, 1992).

The balance of new housing construction is a combination of the housing prices and production cost curve. New housing production is in balance when housing prices equal with overall production costs, so P = f(C). As stated earlier, overall production costs include construction company's profit margin (DiPasquale & Wheaton, 1992).

2.7 Housing stock

At the bottom right of Figure 4, the annual flow of housing production is transforming into long-term housing stock. The change in housing stock at a certain time is equal to new housing production minus wastage. At the bottom right quadrant, the wastage is standardized, and its standard share is q from whole housing. From the origin to downright passing line is wasting curve, that describes the ratio between housing stock and housing production. The optimal amount of housing stock is when new housing production is equal to wasting. This scenario would keep the housing stock constant. This optimal balanced amount of housing stock assumes that the number of households and income level do not change (DiPasquale & Wheaton, 1992).

To conclude from the whole four-quadrant model, the rental level in a short-term is formed between the demand and supply. Moreover, the rents determine housing prices in the asset market. In the short term, housing is standard because the new housing construction takes time. In addition, housing prices define the new housing construction. The combination of the asset market and property market within the housing market is balanced when the size of housing is equal from the start and end point (DiPasquale & Wheaton, 1992).

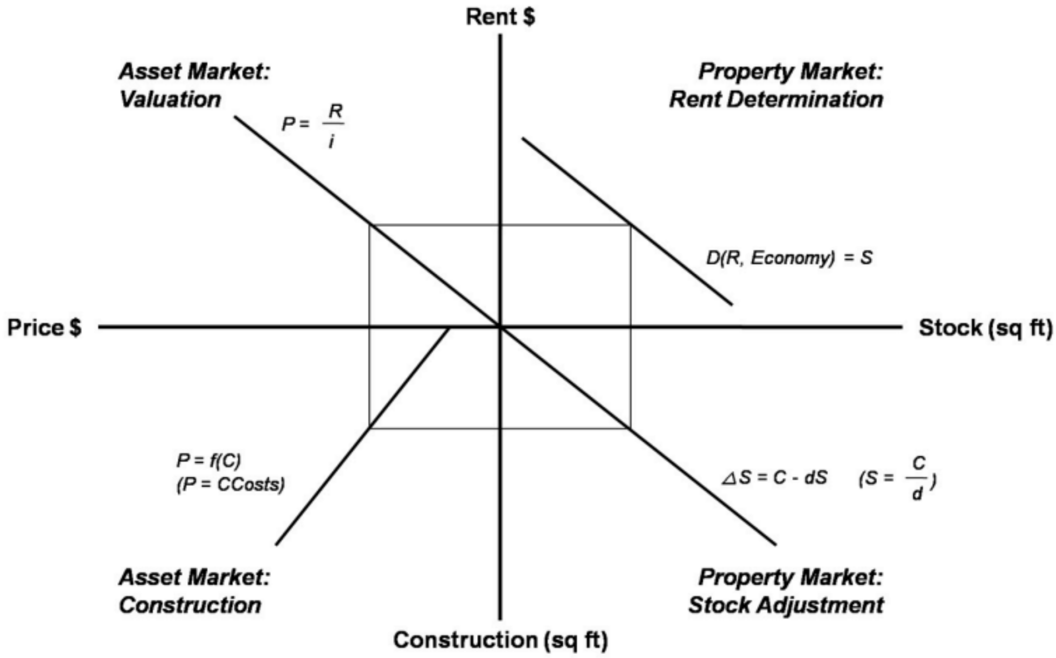

Figure 4. Housing markets price formation in a long term (DiPasquale & Wheaton 1992: 191).

2.8 Pricing models

According to Kasso (2011), there are three different pricing models to create a dwelling's valuation. In the housing market, markets determine the price at the end, and therefore the right pricing in the beginning is crucial. If the private seller or real estate agent has overpriced the dwelling's value, it will lead for a longer selling time which adds costs to the seller. The owner is required to pay a maintenance fee every month and that will not decrease the owner's possible housing loan.

Moreover, in case of a dwelling that has been a long time in the market because of the overpricing, the eventual price drop can be greater than the real value. Different pricing models are convenient for different types of properties. However, in some valuation cases, two pricing models are used in the same property (Kasso, 2011).

Dwellings differ from each other because there are no two exactly similar apartments by characteristics even though dwellings are located in the same property. The exact location within the property has influence and may even be the distinguishing factor. For example, another apartment locates down the street which brings disturbing noise to the apartment, whereas another dwelling is facing on the quiet courtyard side.

2.8.1 Transaction value method

The transaction value method is the most common valuation system in the housing market. The main target is to compare parallel realized real estate transactions and make the actual valuation based on realized debt-free prices (Kasso, 2011). Matching dwellings could be categorized, for instance based on the postal code or street name.

Substantive variability exists even within the same postal code area and therefore by studying only the same street, real estate transactions enables a more reliable interpretation of the dwelling's value. However, according to Kasso (2011), the transaction value method could be considered as an appropriate model if there is a sufficient amount of comparable home sales. The common practice in Finland is to investigate realized real estate transactions within the postal code because in the many areas, there are not sufficient amount of parallel real estate transactions within the same street.

According to Kasso (2011), the advantage of the transaction value method is that the model is based on realized purchase prices. This system is not taking into account asking prices which may vary enormously from the realized price. However, problems in the transaction value method may occur if too few home sales have been made in a given area, the lack of data decreases its reliability. In addition, realized housing transactions are based on the past occurrences, and therefore rapid changes in the market do not appear in the latest housing data (Kanerva, Palmu & Ridell, 1991).

Kanerva, Palmu & Ridell (1991) state that the central problem in the transaction value method is the suitability of comparative real estate transactions. In the same area, there might be two dwellings of similar size, but one is a row house and the other is an apartment. These two real estates are not comparable to each other because of the different housing types.

To conclude, the transaction value method is the most popular way of evaluating dwelling prices. Though acknowledging the problematic limitations of the method, the transaction value method is yet an efficient tool to evaluate dwellings based on the factual prices paid for similar type of dwellings in the same market area. In addition, the data of this master's thesis is collected by using transaction value method.

2.8.2 Profit value method

Profit value method calculates the value based on the net rental income. Real estate professionals prefer to use this model in retails and office spaces (Kasso, 2011). Conducting the net rental income, it is crucial to figure out the lease agreement's period of validity. If the supposed retail has an indefinite lease agreement, the high net rental would be justified as the indefinite retail has greater risk compared to retail limited to ten-year leasing agreement.

Moreover, the lease agreement should reflect the general market level to ensure the rent is on the level with market rent. In addition, the quality of the tenant is a crucial factor. Having a reliable tenant will lower the risk level of unpaid rents (Kasso, 2011).

In the profit valuation process the transaction value method or cost value method is used to tighten the valuation reliability. Price development is remarkable for its valuation. Therefore, adding transaction value method and searching the realized retail or office space purchase prices enhances validity (Kasso, 2011). In this scenario, profit can mean either gross profit or net profit. In case of gross profit, there are no deduction on property expenses, whereas in the net profit, all the expenses are deducted. If we suppose that yearly net income is 9 600 euros per year and the rate of return is 8 %, then the return value is 120 000 euros (9600/0,08) (Kasso, 2011). This is an example of how potential investors could calculate the value of retail.

The rate of return is determined by the investor. The risk level of the retail impacts the amount of rate of return. The riskier an investor sees the retail, the greater is the rate of return, which lowers the amount the investor is willing to pay for the retail. Other factors that influence the value are rental income, maintenance fee and financial expenses (Kasso, 2011).

2.8.3 The cost value method

The cost value method is the simplest valuation method because the cost value corresponds to the cost of the property. There is no connection to the return value or the market value. For example, increasing construction costs do not necessarily reflect on real estate price development.

Calculating the value, the cost value method takes into account building's condition and the age. Especially, the technical age of structures is an essential factor in creating a cost value. The cost value method is most suitable for quite new properties if new construction is an option. The biggest weaknesses are that the cost value does not take into account profit, future appreciation, realized housing prices or the current market situation. Therefore, the only reason to use this method is when the transaction value method does not have enough comparable real estate transactions or the market rent profit is unknown (Kanerva, Palmu & Ridell, 1991).

2.9 Former studies

In this chapter, I will introduce previous studies concerning housing markets and especially the housing price formation. I selected studies that focus on hedonic price models because my empirical research exploits hedonic price formation as well. Previous studies are both from domestic and international researches. Laakso (1992), Rantala (1998) and Vainio (1995) have investigated Finnish housing markets from different perspectives and implemented the hedonic model as part of their study. In international studies, Linneman (1980), Bowen (2001) and Adair, Berry & Mcglear (1996) have utilized a hedonic price model in the international housing markets. As becomes evident further sections, hedonic variables vary in different markets due to dissimilar levels of respect in housing characteristics.

Laakso (1992) investigated housing price formation in urban areas and the affection of public investments to dwelling's value. The data is collected from the Helsinki area and has been utilized to evaluate the impact of the Helsinki metro. In the empirical research part, Laakso investigates apartment's price function and dwelling's physical features by using hedonic price theory. The results are estimated in econometric methods. In the demand function, features that are taken into account are; *area of the dwelling, traffic center distance, area greenery, the share of top quarter income in the area, the share of city rental housing* (Laakso, 1992).

Laakso's results suggest that according to the estimated price equation, the price of the dwelling increases when the quality and size of a dwelling increase and the plot is spaciousness. Moreover, proximity to downtown, seaside and/or public transportation increases the price. The area's level of services has a mild effect on the price. In addition, the greenery and looseness of the area raise the price of a dwelling. If the share of high-income people is large, dwellings are expensive as well. Hence, city rental apartments in the same area decrease mildly prices comparing to the owner-occupied houses (Laakso, 1992).

Rantala's (1998) research expanded the use of hedonic price model method to the whole Finnish housing market area. The research was based on 1995 consuming survey data and targeted to investigate housing consuming and living space interaction between the household's purchasing power, age structure, family size, house location, and area's demographical factors. In addition, research deals with hedonic price formation and the choice of housing. Rantala (1998) conducted the research by using the shape of a log-linear regression model and estimated the results with least squares method. In the study, there are 12 variables, which define the dwelling's size, age, housing type, and heating method. What makes the research special is that it takes into account both owner-occupied houses and rental houses (Rantala, 1998).

In his dissertation, Vainio (1995) investigates externality's impact on people. The meaning of externality is that persons' manufacturing processes or consumption generate positive or negative external effects on other's wellbeing. In this study, Vainio examines negative externality from the perspective of traffic, as traffic produces pollution and noise cons. Research focuses on Helsinki's housing markets, and the results have been tested via multiple econometric methods. Vainio (1995) utilized hedonic price model to compare two exactly similar dwellings, where one locates in a peaceful area and another in a heavy traffic neighborhood. Therefore, information about the dwelling's hedonic attributes is crucial for overall implementation of the research.

The results of the study suggest that households are paying 1800 marks per every decibel which goes above the noise threshold. Noise threshold is limited to 55 decibels which are approximately equivalent to a thousand cars a year. The amount of the affection response was 0,5 percent of the apartment's value.

Moving to assess international studies, Linneman (1980) researched United States housing markets and implemented the hedonic price model at the national level from ten areas of land, located in 34 largest metropolitan areas. Moreover, research focused on single level cities; Chicago and Los Angeles.

Sample data is collected from the year 1973 housing prices and rental levels. Hedonic variables considered are *building's age, number of floors in the building* and also dummy-variables such as *neighborhood streetlights* and *abandoned buildings* (Linneman, 1980). External variables are extremely detailed and therefore specific value determination for these variables might be difficult. Linneman (1980) conducts the research using the Box and Cox function on outlined variables those being annual rent, property value, and annualized housing expenditures. As the outcome, Linneman (1980) found out that neighborhood-related variables explained 15 to 50 % of dwelling's value.

Bowen (2001) investigated housing price formation in Cuyahoga County, Ohio, using hedonic price models. Cuyahoga River separates the county into two areas; east and west. The main target is to investigate housing price differences between these areas. The sample data included 1387 observations from the east side and 1054 from the west side.

For the model, there were three different categories to determine price formation. The first category included dwelling's physical attributes such as *sales price, age of the structure* and *number of the bedrooms*. In the second category, all the city services were taken into account, and in addition, both cities have their own school district, which was also taken into consideration. In the third category, the surrounding environment is analyzed. This category contains variables from the *percentage of owner-occupied housing units*, *the median age of persons* and the *median income of households* (Bowen, 2001).

Empirical findings suggest that sold apartments from the east were more expensive, larger, older and with smaller lots. Moreover, comparing to demographical factors, the east was more densely populated, and more college educated. However, there was enormous difference in household income levels between these markets (Bowen, 2001).

Adair, Berry & McGreal (1996) conducted research that investigated Belfast housing markets. Moreover, the hypothesis was that the structure of the housing price can be implemented to define and differentiate housing submarkets. Research utilizes multiple different regression models to identify the outcome. The data is collected from the year 1992 and the sample size is 1080, and excluding new dwellings from the data, the investigated sample was 999.

Variables were divided into three different categories; property characteristics, environmental and population. Hedonic dwelling features taken into account contained typical variables such as *sales price, location*, and *age of the property*. In the second category, environmental aspects were describing the area's *attractiveness, privacy*, and *environmental quality*. In the third category, the population was taken into consideration in order to define the area's *demographic structure*, *employment, home-ownership level* and *religion* (Adair, Berry & Mcgreal, 1996).

The outcome from the survey was that the most remarkable attributes which affect housing purchase decision were property factors, price of the property and environmental factors. Moreover, a notable finding was that the level of the explanation R^2 increased slightly when moving from the macro to micro-scale. Hence, the general assumption predicted that the movement would have been more radical when the sample becomes more homogeneous. In addition, Adair, Berry & Mcglear (1996) argued that housing markets can be defined at the macro-level and do not necessarily take into account spatial effects.

3 METHODS

The chapter contains all the methods utilized in thesis's empirical research. Firstly, hedonic price theory is introduced and followed by the selected model. The rest of the section introduces the VIF test, which enables to investigate possible multicollinearity between the explanatory variables. Moreover, this paragraph discusses the possible limitations of chosen model.

One of the major investigators of the hedonic price model is Rosen (1974), who later utilized the hedonic price model to investigate housing price formation. Housing can be valued based on different attributes. Moreover, hedonic prices are determined to valuate separate characters of the product that form the overall price (Rosen, 1974).

According to Malpezzi (2002), the most important explanatory variables are; *the amount of the rooms*, *area*, *type of the property*, *age of the apartment*, *area's socio-economic factors*, *distance to centrum*, *workplaces* and *schools*, the *timing of collecting the data* and *characters of the possible tenant*. Malpezzi (2002) states that there are hundreds of other attributes that may affect the apartment's price in the hedonic model.

Prices are estimated by using regression analysis whereas the product's price is regressed on characteristics. Moreover, the hedonic price model supports the method used, and therefore the outcome will point all desired parameters.

In the hedonic price theory, the dwelling's attributes are separated into structural, locational and neighborhood factors. There is no possibility to purchase one separate attribute of the apartment because the dwelling is sold as an entity including all the physical factors involved. However, the hedonic price model enables to calculate the value for all of the individual attributes e.g. how much *sauna* has a connection for the dwelling's value (Rosen, 1974).

Every product has a market price *p* which can be described in the price function *p (z) = p*($z_1, z_2 \dots z_n$)*,* where *z* determines individual attribute and its value. Therefore, this function is called hedonic price regression: every collected price of the attribute describes the minimum price on the market. If two suppliers produce the same product at a different price, the consumer is ready to purchase in the perfect competition market only the cheaper product. This model does not assume asymmetric information between the suppliers and consumer and regards the consumer indifferent when choosing the supplier (Rosen, 1974).

3.1 Model

For the empirical research part, I selected multiple regression models to draw the results out of the sample data. The multiple regression model enables to investigate the effect of the dependent variable Y_i when changing one variable and keeping other regressors constant (Stock & Watson, 2003). The linear regression model is the easiest and clearest way to interpret the results. Moreover, a linear regression model is legitimate choice to investigate certain variable's connection to explained factor when taking into account other relevant variables.

The multiple linear regression presents the variable's connection to debt-free price in euros which indicates the outcome in a more concrete form. People get paid in absolute money, and therefore, it is easier for the readers to detect the connection. Moreover, when the connection is presented in euros, the information might help people to decide which apartment they will buy if the purpose is to optimize the dwelling from the valuation perspective. This is valuable information, especially for house investors.

The formula of the multiple regression model;

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots + \beta_k X_{ki} + u_i, i = 1, \dots, n, \quad (1)$$

Where the explained variable Y_i is i^{th} observation on the dependent variable. Variables $X_{1i}, X_{2i}, \dots, X_{ki}$ are the i^{th} observations from each *k* regressors and u_i is the error term (Stock & Watson, 2003). The error term u_i describes the deviation between the observed results and results of the model (Stock & Watson, 2003).

Moreover, coefficients of the multiple regression model are estimated by using ordinary least squares (OLS). The target of the OLS estimators is to minimize the sum of squared prediction mistakes (Stock and Watson, 2003).

3.2 VIF test

VIF test describes how the variance of an estimator is reflected by the multicollinearity between the variables (Gujarati, 1995). Large VIF values denotes the high amount of multicollinearity (Hair, Anderson, Tatham, Black & Babin: 2006). If all the variables are independent relative to each other, the VIF value gets the value 1. However, because this thesis is investigating characters that have connection to dwelling's value, the existence of multicollinearity is justified. The VIF value is presented in the equation below. R_i^2 presents coefficient of the determination (Hair, et al., 2006).

$$VIF = \frac{1}{(1-R_i^2)}. \qquad (2)$$

According to Gujarati (1995), the general rule of multicollinearity is that if the VIF value goes over 10, there is high multicollinearity between the variables. However, according to Hair, Anderson, Tatham, and Black (2008), the recommended VIF value is lower than 5. Researchers are justified to determine the VIF level for the research because recommended threshold values contain remarkable amount of multicollinearity (Hair, et al., 2006). Therefore, for this research, specified threshold is below 5, which is the lowest threshold between these two resources.

3.3 Problems in using chosen method

Using linear regression as a method, there is a chance that even though results are presented as a linear straight, in reality the results might not be distributed in a linear line. For example, in a small flat, the amount of square meter has a greater connection to the price than in case of larger apartments. This can entail uncertainties on the accuracy of the results.

Moreover, the model consists of omitted variable bias. If the regression has correlated with the variable that was left out from the regression and it defines the explained variable, the ordinary least square estimator has omitted variable bias (Stock & Watson, 2003). Research is not taking into account characteristics of its surrounding environments e.g. if the area has a high crime rate or the level of air pollution. In addition, social-economic factors, including the area's general salary or educational level are omitted from the regression.

In addition, multicollinearity affects in a way that it decreases single variable's predictive power that is linked to other independent variables. To maximize the actual prediction, it requires to focus on variables which have slight multicollinearity with another independent variables (Hair, et al., 2006). Therefore, VIF test is utilized in the research to look for the multicollinearity situation further.

However, there is never a situation whereas the model could explain clearly explained factor. The study is focusing on determining the debt-free price by the characteristics of the property itself and previously mentioned missing attributes create omitted variable bias for the least square estimator.

3.4 Material

Empirical research consists of two different parts. The first one investigates the area of Helsinki and Espoo housing price formation and the second part focuses on the area of Lauttasaari. The housing data was acquired from the Hintaseurantapalvelu (HSP), which is owned by the central union of real estate. Over 80 percent of all the Finnish real estate enterprises are collaborating with HSP. Therefore, there is no price information of all sold apartments and the service does not include private seller's home sales that are carried out without a real estate agent. To conclude, the housing data is partly inadequate which decreases the reliability. However, HSP has the most comprehensive price information of sold apartments in Finland and therefore it is the best housing price service available to conduct the research.

Most importantly HSP's service contains realized sales prices. The debt-free prices are a crucial factor overall and therefore realized debt-free prices increase the credibility of the research. Speaking of credibility, all the information is filled in by professional real estate agents, and therefore the correctness of the information is at a high level, perhaps excluding the dummy-variable *good condition,* which is real estate agent's subjective opinion of the dwelling's superficial condition.

I collected the housing data the time frame from 1.1.2018 to 30.6.2018. Overall, all of the housing data in HSP is collected from the year 1998, and therefore, there are high potential and possibility to analyze Finnish housing market development in the long term. However, to analyze housing price developments in a longer period would require taking into consideration macro-economic factors e.g. *change in interest rates* and *inflation*. The reason to choose a relatively narrow time frame is because my model does not take into account time or macro-economic factors, which is considered to be challenging expansion to the model. The research investigates only hedonic attributes, which are divided by the characteristics of the apartment and location attributes.

The first part of the research investigates Helsinki and Espoo areas' housing price development. I chose to focus on these cities because these areas can be considered substitutive, which enables comparability between these regions. On a national level, urbanization has led to separation between different areas in Finland and therefore the reason to investigate two similar areas next to each other is justified. In the first empirical research, housing data includes 5495 real estate transactions which can be considered as a convenient sample size to investigate housing price development further. Moreover, the second empirical study contains 230 realized housing transactions inside Lauttasaari. The sample size is small and therefore the result can be interpreted only at a general level.

3.5 Helsinki's and Espoo's empirical research material

In the first part of the empirical research, variables are; *town*, *distance to kamppi*, *size of the apartment*, *maintenance fee*, *age of the property*, *sales time* and dummy-variables *own plot*, *sauna*, *balcony*, *good condition*, and *top floor*. Also, empirical data is filtered so that it includes only rising houses, excluding al the office spaces, retails, row houses, partially owned properties and garages.

distance to kamppi; The variable measures the distance from the dwelling's postal code area to Kamppi citycenter. Kamppi citycenter can be considered as one of the Helsinki centrum's pinpoints and therefore it was chosen to be the location variable's target location. The distance was received by using Google Maps platform that calculated walking distance from the postal code are to the Kamppi city center. Distance is shown in kilometers.

size of the apartment: Variable describes the dwelling's size in square meters. For the size is only taken into account dwelling's living space.

maintenance fee: Maintenance fee describes how much dwelling is required to pay every month from property's basic maintenance. Basic maintenance costs are whole property's heating costs, common area's maintenance and waste disposal. In Finland, the maintenance fee is usually calculated based on apartment's living space square meters. Also, in this data, all of the maintenance fees are calculated based on the square meters.

age of the property: Variable is done by taking into account the data collecting year 2018 and reduced property's construction year which will result in the property's actual age.

sales time in days: The variable measures apartment's selling time in days.

own plot: Dummy-variable *own plot* defines whether the property locates in its own plot or is the property situated on the rental plot. As all of the dummy-variables, if the variable is true, the variable gets number 1 and if false, the value is 0. I transformed the plot information from the data into the numeric format which enabled to run it in the statistical program.

sauna: According to this variable, in HSP, there was existing information about apartments which has the sauna. However, information was for some parts inadequate. In the data set, the dummy-variable *sauna* had an own column whether there is a sauna or not, but this information was not filled up properly. In some cases, apartment description showed that dwelling has a sauna, but real estate professionals haven't marked up the information to *sauna* variable column. Therefore, I added the information from the apartment description to the column to improve the accuracy.

balcony: With this variable, I conducted the same procedure than with the dummy-variable *sauna* and transformed the information from the apartment description to the own column. Moreover, there were two columns, a glazed balcony, and a balcony without glass. For this variable, I combined these two into one – *balcony*. The reason to combine these two was that in the description of the apartment did not show whether the balcony was glazed or not. I wanted to minimize the risk of false information, and therefore combined these two variables.

top floor: I implemented this variable from the raw data where the information of the floor was shown only in which floor apartment locates. According to this variable, comparability of apartments from different properties was difficult because properties have a different number of floors. Based on this fact, I created a new dummy-variable *top floor*, which points only the information if the apartment locates in the property's top floor or not. I wanted to gain more information from top floor's connection because it is always considered as the most valuable floor of the property.

3.6 Lauttasaari material

On the second part of the empirical research, the main purpose is visualizing one neighborhood by using sample data, and especially figure out how the distance from the apartment to the metro station contributes to dwelling's debt-free price. The target is to investigate the area of Lauttasaari which is a neighborhood in Helsinki. Lauttasaari is an island that is connected through the bridge to the mainland of Helsinki. Earlier, public bus transportation was the only way of using public transportation on and off Lauttasaari, but in November 2017, the western metro was launched which opened another transportation option to central Helsinki and Espoo.

In the empirical research, four variables are utilized; *distance to lauttasaari metro station*, *size of the apartment*, dummy-variable *by the seaside* and *age of the property*. Lauttasaari received two metro stations; another metro station is called "Koivusaaren metro station". Koivusaari is an adjacent island from Lauttasaari, but the metro station is located in Lauttasaari and has Lauttasaari's postal code.

Variables *size of the apartment* and *age of the property* are implemented in a same way than in the Helsinki and Espoo empirical research but the data for these variables are collected only from Lauttasaari's sold dwellings. However, another two variables *distance to lauttasaari metro station* and dummy-variable *by the seaside* are implemented for this matter, and they are explained further below.

distance to lauttasaari metro station: This variable is conducted by using Google Maps platform and calculated the distance from the apartment to the nearest metro station. In the HSP sample data, there are exact home addresses and therefore it was possible to investigate precise distance. Lauttasaari has two metro stations, so the distance was calculated to the nearest metro station. I created a new variable and checked manually the distance from the home address to the nearest metro station. I implemented Google Maps platform's walking distance parameter. Moreover, the distance which was obtained is informed by kilometers.

by the seaside: As stated earlier, Lauttasaari is an island which signifies that the part of dwellings is located by the sea. As a pre-default, the connection of the sea for the apartment's debt-free price is significant. Taking this into consideration, the variable was conducted for empirical research. Because the information of the exact location for the apartment is in HSP data, I implemented the variable using Google Maps service. First, I located the apartment on Google Maps and checked if the apartment is locating by the sea or not. I took into consideration that the apartment is by the sea only if it had an unobstructed sea view. For example, those apartments which were situated near the sea but other properties were blocking the sea view, was not calculated.

4 RESULTS

This chapter introduces results of the survey. The paragraph includes correlation tables, VIF tests and linear regression models both Helsinki's and Espoo's and also Lauttasaari's material. Every variable's connection for the debt-free price is presented to perceive the overall picture from the survey.

4.1 Correlation table from Helsinki and Espoo

Table 1 presents correlation between the variables. Because all of the variables are hedonic features from dwellings, presumption is that correlations are at a high level. The highest correlation is with *debt-free price* and *size of the apartment*. This correlation is logical because especially in many areas of Helsinki and Espoo, an increase of the size lifts the apartment's prize. Moreover, the correlation between *debt-free price* and *distance to kamppi* is negative. When the distance is increased to the Helsinki centrum, the price is correlated negatively. This correlation result is accurate because the location in centrum is considered more valuable than further from the center. Both of these correlative findings are statistically significant at the level of 0,001. Otherwise, level of correlations to debt-free price is relatively small and therefore they are not analyzed further.

Table 1. Correlation between the variables from Helsinki and Espoo (Kiinteistönvälitysalan Keskusliitto ry, KVKL HSP- hintaseurantapalvelu).

CORRELATION	Debt-free price	Distance to Kamppi	Size of the apartment	Maintenance fee per square	The age of the property in years	Own plot	Sauna	Balcony	Good condition	Top floor	Sales time in days
Debt-free price	1	-,405**	,697**	-,125**	,089**	,160**	,253**	-,042**	,039**	0,004	,042**
Distance to Kamppi	-,405**	1	0,008	-,121**	-450**	-,144	,150**	,227**	-,009	,059**	,113**
Size of the apartment	,697**	0,008	1	-190**	-,005	0,005	,323**	,148**	,073**	,050**	,072**
Maintenance fee per square	-,125**	-,121**	-,190**	1	,113**	-,218**	- ,110**	-,100**	-,013	0,003	0,018
Age of the property	,089**	-,450**	-,005	,113**	1	,216**	- ,464**	-,263**	,241**	,054**	-,281**
Own plot	,160**	-,144**	0,005	-218**	,216**	1	- ,053**	-,090**	,076**	0,436	-,154**
Sauna	,253**	,150**	,323**	-,110**	-,464**	-,053**	1	,159**	-,016	0,013	,133**
Balcony	-,042**	,227**	,148**	-,100**	-,263**	-,090**	,159**	1	,056**	,064**	-,052**
Good condition	,039**	-,009	,073**	-,013	,241**	,076**	-016	,056**	1	,057**	-,195**
Top floor	0,004	,059**	,050**	0,003	,054**	-,011	0,013	,064**	,057**	1	-,047**
Sales time	,042**	,113**	,072**	0,018	-,281**	-,154**	,133**	-,052**	-,195**	-,047**	1

4.2 VIF test from Helsinki and Espoo

Moreover, I run a VIF test to check the multicollinearity of the variables. The idea is to investigate, whether there is a major multicollinearity between the variables. If the multicollinearity is high, variables are correlated strongly together which may cause reliability problems for the results. All the variables have a connection to dwelling's debt-free price and therefore, multicollinearity between the variables is justified.

The target is that levels of multicollinearity stays above the value of 5, which was earlier determined. As we can see from the table 2 below, all the VIF values are between 1,013 and 2,101 so the level of multicollinearity does not affect the reliability of the results.

Table 2. VIF test in Helsinki and Espoo (Kiinteistönvälitysalan Keskusliitto ry, KVKL HSP-hintaseurantapalvelu).

EXPLANATORY VARIABLE	VIF value
Distance to Kamppi	1,358
Size of the apartment	1,219
Maintenance fee	1,14
Age of the property	2,101
Own plot	1,136
Sauna	1,512
Balcony	1,275
Good condition	1,068
Top Floor	1,013
Sales time	1,108

4.3 Correlation table from Lauttasaari

Table 3 presents the correlation levels in Lauttasaari. The highest correlation is between the *debt-free price* and *size of the apartment*. Correlation is 0,867 and from this value, it can be said that correlation is strong. The correlation value is logical because Lauttasaari locates near Helsinki centrum and therefore the correlation level between dwelling's size and debt-free price is at a high level.

Moreover, the correlation between *debt-free price* and *by the seaside* is 0,533. This correlation level reflects the correlation between these variables. Dwellings, which are locating by the sea, are positively correlating to the price. From this can assume that location near the sea is more visible in the price than distance to metro station. Other results are in relative low level so there cannot conduct any further observations.

Table 3. Correlation table from Lauttasaari (Kiinteistönvälitysalan Keskusliitto ry, KVKL HSP-hintaseurantapalvelu).

CORRELATION	Debt-free price	Distance to Lauttasaari metro	Size of the apartment	By the seaside	The age of the property in years
Debt-free price	1	,182**	,867**	,533**	-,287**
Distance to Lauttasaari metro	,182**	1	,180**	,260**	-,419**
Size of the apartment	,867**	,180**	1	,325**	-,146*
By the seaside	,533**	,260**	,325**	1	-,125
Age of the property	-,287**	-,419**	-,146*	-,125	1

4.4 VIF test from Lauttasaaari

In table 4, VIF test in Lauttasaari's regression are performed. There is a small multicollinearity between the variables. However, the level of multicollinearity stays above the level of 5 and therefore there is no issue of the result's accuracy. All the four values are between the 1,137 and 1,286. Results are smaller than expected which confirms the fact that the level of multicollinearity is acceptable.

Table 4 VIF test from Lauttasaari (Kiinteistönvälitysalan Keskusliitto ry, KVKL HSP-hintaseurantapalvelu).

EXPLANATORY VARIABLE	VIF value
Distance to Lauttasaari metro	1,286
Size of the apartment	1,137
By the seaside	1,173
Age of the property	1,22

4.5 Results from Helsinki and Espoo

On the table 5 below, the results from the Helsinki and Espoo dataset are presented. In the regression model, the dependent variable is *debt-free price*. Debt-free price consists of apartment's selling price and the possible housing loan. The importance of using debt-free prices in the data cannot be overstated because many apartments have a major share of housing loans, and therefore it is crucial to take selling price and the remaining loan share into consideration.

On Table 5, there are 10 explanatory variables to describe the dwelling's price formation. The upper number in the cell describes the unstandardized beta coefficient which indicates the connection in euros. Lower figure in brackets is coefficients standard error. The closer the number is to zero, the more accurate is the estimate of the coefficient.

The stars after the coefficient standard error describe the statistical significance level. One star indicates the significance level of 5%, two stars 1% and three stars 0,1%. The three-star significance level can be said to be statistically remarkable significant if $p \leq 0,001$. Moreover, in the two-star statistically very significant level is if $0,001 < p \leq 0,01$ an in one star, the level is described statistically significant level if $0,01 < p \leq 0,05$. As we can see from the table 5, variables *distance to kamppi, size of the apartment*, *age of the property*, *own plot*, *sauna*, and *balcony* are statistically very significant in every column which describes that in these variables, probability of chance is 0,1% or lower.

The first notice from the results is that the variable *top floor* in columns 9 and 10 is not statistically significant, and therefore there is no certainty to make any further conclusions about the top floor. The reason why the standard error in *top floor* variable might be so high and closer to coefficient is that different properties have different number of floors and therefore the connection of the top floor varies between the properties. Moreover, there was no data whether the property has an elevator. As a pre-default, *top floor* was considered as a factor that increases the apartment's debt-free price. However, having a top floor apartment in a property that has no elevator can have a negative connection for the price because the movement to the highest floor without an elevator may be restricted for some population groups.

In the table 5, the first remarkable observation is that variable's *own plot* connection for the price varies between the 50 182,97 euros and 57 383,06 euros in columns 5 to 10. When new apartments are constructed, especially in Helsinki and Espoo, properties are often landed in hire plots which are owned by the city or private land fund. Hire plot increases property's costs which is reflected to higher maintenance fee per square for the homeowners, comparing to the property which locates in its own plot. This variable's connection for the debt-free price is the highest in Helsinki and Espoo data set.

Construction companies want to decrease economical risk and they sell property's land area to an external operator and focus mainly on their core competence. Moreover, especially in central of Helsinki, there is no space to build new high-rises or areas are not zoned for residential use. Therefore, lack of properties with own plots might contribute to high connection for the price.

In table 5, *distance to kamppi* has been taken into account in every column. All the results are remarkable significant at the level of 0,01. Location, especially in the metropolitan area, is often seen as the major influencer for the price. However, as analyzed earlier, the highest connection became between the dwelling's *debt-free price* and the variable *own plot*.

Variable's *distance to kamppi* unstandardized coefficients varies in columns from -16 974,43 euros to -19 043,09 euros so the debt-free price decreases when to distance to Kamppi increases, which was an expected result. Variability of variable's connection in every column is relatively small. The biggest unstandardized coefficient is in column 4, whereas one kilometer add to distance will decrease the debt-free price -19 043,09 euros. However, we are interested in the last column's result because in that column, all variables are controlled. The result in column 10 is -18 742,75 euros.

In table 5, columns 7, 8, 9 and 10 present the connection of the dummy-variable *balcony* for the debt-free price. The highest point of the negative connection to the debt-free price is -33 184,83 euros in column 9 and the lowest point is -25 643,73 euros in column 10. All the results are statistically remarkable at the level of 0,001.

The connection for the debt-free price is at a relatively high level, which is valid because balcony's square meters do not count for the apartment's overall square meters and the size has been controlled in these columns as well. However, the outcome of the negative connection is exceptional because in generally, the existence of the balcony in the apartment could be seen as a positive influence. One argument on behalf of negative connection is that balcony itself increases costs for the homeowner if there comes balcony renovation. However, the cost of this renovation is relatively small comparing the negative connection to the debt-free price so this do not explain entirely the high negative connection.

In table 5, the dummy-variable *sauna* is performed in columns 7 to 10. Overall, the size of the sauna is included to dwelling's square meters. According to this variable, results are stable in every column. In table 5 column 10, the connection for the debt-free price is 31012,62 euros and the result is statistically remarkable at the level of 0,001. This dummy-variable is created from the apartment description, where the existence of sauna is informed. Analyzing the result, there is a possibility that the size of the connection is greater than the factual one. Finnish people appreciate apartment-specific sauna but in this model, the connection for the debt-free price is much greater than the one-kilometer distance increase to centrum, which can be considered unreal result, and therefore statistical bias is a reasonable assumption.

According to the results, variable *age of the property* coefficient is low. In the table 5, the unstandardized beta coefficients in columns from 4 to 10 are between -858, 96 euros and -671,35 euros. The outcome shows that when one year is added to the property's age, it has quite nonexistent effect for the debt-free price. The reason for this might be that for the late 19th and early 20th century dwellings, plumbing renovation may have been carried out already once or twice and therefore the general structural condition of the property can be in a good level, even though the dwellings are older. In comparison, the 1970s apartments are becoming into an age to execute plumbing renovation, which is normally the most expensive renovation for the owner.

In addition, especially in the Helsinki central area, late of the 19th and beginning of the 20th properties have implemented architecturally appreciated solutions that are valuable in today's residential markets. Comparing to properties that are built-in the 1960's and 1970's, a strong migration wave was born due to industrialization, which led to a situation where people moved from the countryside to the south. The large housing shortage in Helsinki was tried to fulfill with fast and affordable housing construction, and therefore, housing construction from this era is not aesthetically appreciated comparing to the early 19th and beginning of the 20th properties. Because of these arguments, the change in *age of a property* does not bring any remarkable results for the price.

Table 5 column 10 shows that according to sales time, the coefficient for adding one day to sales time, the increase of the debt-free price is 45,54 euros. Presupposition was that the longer an apartment is available for sale, the debt-free price will decrease because the demand and supply have not met immediately.

In table 5, *good condition* variable is presented in columns 8,9 and 10. In the sample data, there were five variables to describe the condition; *new*, *excellent*, *good*, *satisfying* and *bad*, but because of the multicollinearity, only the *good condition* dummy-variable was taken into consideration. In columns 8 and 9, *good condition's* unstandardized coefficient is not statistically remarkable, and therefore its effect in two models cannot be estimated further.

However, in column 10, variable's coefficient for the debt-free price is 9279,63 euros and the result is statistically remarkable. So, if the apartment is rated for good condition, the debt-free price increases 9279,63 euros. Even though the significance level is statistically remarkable in column 10, the level of condition is subjective because real estate agents have evaluated the condition according to their own subjective opinion, which decreases the reliability. However, this variable point necessary reference to the dwelling's general condition level, which was the major reason to add the variable to the empirical research.

In the table 5, the maintenance fee per square is included in eight columns, and the results from the variable are statistically significant only in columns 3 and 4. Because of the statistically remarkable levels, analyzing only these two models, increase of one euro per square meter in maintenance, connects for dwelling's value by 9557,94 euros in column 3 and 7934,25 euros in column 4. The difference between these columns is that in column 4, age of the property has been taken into account which decreases the amount of the maintenance fee per square coefficient, where other variables are constant.

In table 5, columns' 3 and 4 other variables are *distance to kamppi* and *size of the apartment*. When comparing apartments that have an equally long journey to centrum and are equal in size, one euro increase in maintenance fee decreases the debt-free price by -9557,94 euros and -7934,25 euros. The maintenance fee covers all the maintenance expenses such as property's heating costs, common areas cleaning expenses, property management and property tax. Greater maintenance fee does not affect the possible amount of housing company loan, and therefore, higher maintenance fee means greater monthly costs.

If we suppose that you own 50 square meters flat and the maintenance fee is increased by one euro per square meter, monthly costs are 50 euros higher and the change of the total costs is six hundred euros per year. This simple example explains the situation and the negative coefficient of the maintenance fee per square meter to the debt-free price is justified. Hence, the amount of the coefficient in column 3 and 4 is pretty low, concerning the fact how much this change increases the monthly costs.

Variable *size of the apartment* has been taken into account in nine columns, excluding column one. All the variable's results are statistically significant. The connection for the one square meter increase in size has the coefficient from 5474,18 euros to 5657,99 euros for the debt-free price in all nine regression models. According to HSP, Helsinki's and Espoo's average square meter price from the collected data from 1.1.2018 to 30.6.2018 is 5219,00 euros (HSP, 2019). So, when other variables are added to the regression models, one square meter increase has greater for the price in every model than sample data's average square meter price. This model is not taking into account all of the variables which are presented in HSP's sample data, which might distort the results. However, the numbers are quite close to each other so there is no major uncertainty concerning this fact.

Table 5 Linear regression model results from Helsinki and Espoo (Kiinteistönvälitysalan Keskusliitto ry, KVKL HSP- hintaseurantapalvelu).

EXPLANATORY VARIABLE	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Distance to Kamppi	-16974,427 (517,327)***	-17134,563 (333,621)***	-17336,117 (346,351)***	-19605,246 (385,997)***	-19043,087 (380,623)***	-18816,749 (380,726)***	-18511,145 (379,172)***	-18618,675 (381,182)***	-18640,827 (382,620)***	-18742,748 (387,648)***
Size of the apartment		5626,600 (64,037)***	5610,562 (68,086)***	5614,298 (67,305)***	5657,993 (66,082)***	5503,219 (70,039)***	5587,047 (70,188)***	5584,732 (70,188)***	5583,200 (70,206)***	5474,184 (71,584)***
Maintenance fee			-9557,938 (1847,095)***	-7934,249 (1830,072)***	-1199,195 (1855,985)	-1295,053 (1848,682)	-2210,742 (1838,199)	-2172,141 (1838,000)	-2192,822 (1838,165)	-3209,738 (1852,613)
Age of the property				-771,048 (61,775)***	-891,178 (61,170)***	-671,345 (69,776)***	-825,495 (71,480)***	-854,827 (73,524)***	-858,961 (73,781)***	-712,419 (78,378)***
Own plot					57383,055 (4024,021)***	56140,688 (4012,662)***	52603,312 (4003,947)***	52562,274 (4003,281)***	52516,756 (4004,976)***	50182,965 (4041,376)***
Sauna						30977,642 (4792,138)***	30609,197 (4757,396)***	29754,869 (4783,045)***	29777,184 (4787,210)***	31012,618 (4864,294)***
Balcony							-32665,510 (3739,633)***	-32951,504 (3742,734)***	-33184,830 (3747,845)***	-25643,732 (3897,772)***
Good condition								5908,783 (3479,170)	5796,334 (3480,315)	9279,630 (3522,871)***
Top floor									3712,458 (4293,079)	5535,637 (4297,229)
Sales time										45,542 (18,796)*
R^2	0,16	0,65	0,65	0,66	0,67	0,68	0,68	0,68	0,68	0,68
N	5495	5495	5495	5495	5495	5495	5495	5495	5495	5495

Significance levels: *** $p \leq 0{,}001$, ** $p \leq 0{,}01$, $* p \leq 0{,}05$

4.6 Results from Lauttasaari

This chapter includes the results from the area of Lauttasaari. In table 6 column 4, all the results from the variables have a remarkable significance level in level of 0,001 which increases the model's reliability.

In table 6 column 1 states that 1-kilometer increase in distance to Lauttasaari metro station, rises the price by 75 125,47 euros. The reason for this increase is that the column does not take into account any other variables. Moreover, seaside apartments locate further from the metro station which can be the reason for the extremely remarkable increase in price. In column 2, *distance to lauttasaari metro station*, unstandardized coefficient is 11 079,02 euros when *size of the apartment* variable was added. However, the result is not statistically remarkable so any further conclusions cannot be drawn which is the same situation in the column 3.

In column 4, the change of distance of one kilometer to metro station, decreases dwelling's price -44 467,85 euros. In this column, age, size and by the sea is controlled and therefore the change of connection between the distance to metro station and debt-free is justified. Comparing to table 5 column 10 results, distance plays a greater role in Lauttasaari's housing price formation. However, results are not entirely comparable because the number of variables vary between the models and investigated area is different. Moreover, the location variable in table 5 measures a distance to Helsinki center, whereas in table 6, it measures distance to metro station.

On table 6 column 4 shows that *age of the property* decreases the connection between the variable and the debt-free price -1149,31 euros when one year is added to the property's age. In table 6 column 3 *by the seaside* variable got remarkable high value, and therefore the property's construction year was a necessity to take into account. The cause of the low level is that this model does not take into account e.g. plumb renovation, which can be crucial for the actual price and not the actual construction year. Moreover, in Lauttasaari, there is no old-fashioned housing stock which contains prestigious architecture. That might be one reason why the values are higher for this variable in this regression model comparing to Helsinki and Espoo empirical research.

The variable's *size of the apartment* connection for the debt-free remained relatively stable in columns 2,3 and 4, reaching the values from 5705,71 euros to 5068,01 euros. Thinking about dwellings' absolute prices in Lauttasaari, connection is small to debt-free prices. This can due from another variable's stronger connection for the actual price.

According to dummy-variable *by the seaside* in table 6 column 4, the connection of the dummy-variable is 189 431,52 euros which can be considered the highest connection for the debt-free price of whole research. Comparing to column 3, the change between the dummy-variable is 562,92 euros, so adding the variable *age of the property* for the column 4, regression model did not increase the value significantly but kept the amount at a high level. The result is also statistically significant level, which increases the reliability. Seashore's connection for the debt-free price greater than the presumption of the actual result.

To conclude, if we take into consideration seaside apartments with a dummy-variable, the most expensive dwellings in Lauttasaari are located further from the metro stations, next to the ocean. However, if the apartment is located further from the metro station and is not by the seaside, the value decreased –44 467,85 per kilometer. As we can see, seaside apartments are further from the metro station which explains the result from the table 6 column 1 positive effect for the price when the distance is increased by one kilometer and *by the seaside* variable was not taken into account.

Table 6. Linear regression results from Lauttasaari (Kiinteistönvälitysalan Keskusliitto ry, KVKL HSP- hintaseurantapalvelu).

EXPLANATORY VARIABLE	(1)	(2)	(3)	(4)
Distance to Lauttasaari metro station	75125,496 (28485,474)**	11079,016 (14681,177)	-13561,513 (12735,438)	-44467,85 (12757,281)***
Size of the apartment		5705,709 (235,896)***	5158,443 (208,936)***	5068,059 (192,743)***
By the seaside			188868,598 (21091,143)***	189431,519 (19399,441)***
Age of the property				-1149,314 (187,914)***
R^2	0,03	0,75	0,82	0,85
N	230	230	230	230

Significance levels: *** $p \leq 0,001$, ** $p \leq 0,01$, $* p \leq 0,05$

5 DISCUSSION

The main research question of the thesis was to determine which attributes have the most remarkable connection to the apartment's debt-free price? Our results indicate that the own plot has the most significant connection to the debt-free price in Helsinki and Espoo dataset. The major reason for this result might be that the greatest share of the properties locates in the rental plot and therefore scarcity of supply might enhance the variable's connection for the price.

Moreover, decreasing distance to Kamppi in Helsinki's and Espoo's dataset and increasing distance to the metro station in Lauttasaari's dataset connected for the price notably. The importance of location for the people is justified because nowadays people are more likely to live nearby the services, and what's more, they are willing to pay for it. Especially, location plays a huge role if there is no decent public transportation to the centrum. People require easy access to services through public transportation or by locating themselves to the proximity of services. Construction companies have struggled to sell new properties which are placed in the outskirts of cities and have a bad public transportation connection.

In addition, dummy-variable *by the sea* in Lauttasaari data set resulted the most remarkable connection for the debt-free price, comparing both parts of the studies. Connection for the price was surprisingly high. However, the presupposition was that dwellings next to the sea with a good location are more expensive, comparing to similar kind of dwelling nearby off ground. The small data size and the lack of variables decrease the reliability of this finding.

Another research question was how much the distance to the metro station has a connection for the debt-free price in Lauttasaari? The connection is strong, and it is obvious that the effect of the western metro, which created two metro stations to Lauttasaari has improved area's demand in the housing market and increased the price level. Therefore, the distance to the metro station has a strong connection to the price.

Observing all the results, the data itself is not completely accurate. It is the best data available of Finnish housing markets, but all the realized home sales will not end up to the HSP's database. Moreover, the size of the data is relatively small, especially in Lauttasaari's model. However, the idea was to focus on the physical factors of the dwelling and if data's collection time was extended, there would have come other external factors to control for the model. Hence, the significance level of most of the variables and the coefficient of determination of models are at a high level which increases the credibility towards the models chosen.

Further, the reliability of the results from the variables *sauna* and *balcony* are not at a high level because they were built from the apartment description section which increases the margin of error. In addition, variable *good condition* is real estate agent's subjective opinion about dwelling's condition and hence problematic.

There are reasons, why same variable's connections to the price differs in Helsinki and Espoo dataset and Lauttasaari's data set. Firstly, it goes without saying that Lauttasaari's model has taken into account all the realized home sales in Lauttasaari, and therefore the data is different in these two models.

In Lauttasaari's model, the connection between the *distance to Lauttasaari metro station* and *debt-free price* is much higher than between *distance to kamppi* and *debt-free price* in Helsinki and Espoo model. The one reason is that the overall area of Lauttasaari is small and therefore a small change in distance to the metro station within Lauttasaari reacts stronger. Another model is taking into account whole cities, Helsinki and Espoo, and this might be the reason why the connection appears smaller. Moreover, the location variable in Helsinki and Espoo model is created through the postal code, and therefore there is no possibility to investigate the apartment's accurate location.

Taking into account *by the seaside* variable was crucial in Lauttasaari's model because Lauttasaari is an island that is part of Helsinki, and therefore there are multiple apartments next to the sea. I conducted the variable by using Google Maps that enabled me to locate the apartments. The location define was implemented by using the dwelling's home address and therefore the accuracy of the real seaside homes are justified.

In both models, the correlation between the *debt-free price* and *the size of the apartment* gained relative strong correlation. In the Finnish housing market, especially in the growth centers, when the size of the dwelling increases, it correlates to the price. This outcome is not always reliable because also in Helsinki, bigger apartment from the same property might be cheaper. The reason is that bigger dwelling has a greater maintenance fee per month and when some renovations comes, bigger apartment is responsible for the bigger share of the property's renovation. To conclude, the strong correlation between the *debt-free price* and the *size of the apartment* is justified in areas where the demand is high. Moreover, other correlation levels were relatively small and therefore they are not analyzed further. The outcome of the VIF values remained at a low level and clearly below the determined threshold value of 5.

6 CONCLUSION

The goal of this research was to explain hedonic housing price formation in Helsinki and Espoo and the area of Lauttasaari by investigating the dwelling's physical attributes. I conducted the study by using HSP's realized home sales data, which enabled me to collect dwelling's different features and combine them with a coherent whole. For the outcome, I utilized the linear regression model and estimated variables by using the least squares method. The linear regression model enabled the study to show different variables' connection to the debt-free price in euros, which brought the results to more practical level.

Based on the quantitative analysis in Helsinki and Espoo model, own plot has the strongest connection to the debt-free price. Moreover, the main result is that when the distance increases to the Helsinki centrum, the price will decrease remarkably. Results of the Lauttasaari model shows that the connection of the seaside apartment for the price is the greatest.

The main statement of this study is that only looking at the dwelling's physical attributes, it shows that how great is the variables connection differences to the debt-free price. Overall, some variables connection to the debt-free price is nearly nonexistent and other variables connection is remarkable. The structure of the housing market is changing during the time and therefore the valuation level of various characters varies as well.

In long-term, it is hard to estimate how the housing markets are developing in Finland. Investigation of housing markets over longer period of time and accounting for larger patterns of macro and social-economic factors, such as interest rate changes and area's income end educational level are preferred starting points for further academic inquiry. Finally, Helsinki's and Espoo's housing market areas could be investigated more specifically by region because within the cities, there is a great amount of variability.

To conclude, housing price formation is an extensive and multifaceted phenomenon, and the mechanics of housing price determination can always be sharpened, detailed and studied further. By investigating the fundamental basis of housing price formation with a special regard to dwellings' physical attributes, this study has attempted to fabricate solid basis for such further elaboration on price formation.

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