Aalto University
School of Engineering

The Effect the Distance of a Grocery Store Has on the Value of an Apartment

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Bachelor of Science
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Abstract

The aim of this thesis is to research the effect an apartment's distance to a grocery store has on its value within the Etelä-Haaga suburban area of Helsinki. Firstly, current academic literature concerning housing price determinants and the effect grocery stores have on housing prices are presented. Thereafter, empirical analysis on the aforementioned effect is conducted.

The data used in the empirical analysis consists of apartment transaction data based on data from the Central Federation of Finnish Real Estate Agencies. A total of 1,381 individual apartment transactions from 2010 to 2016 were used as the primary dataset of the research. Data concerning the grocery stores located within the research area of the 00320 postcode were obtained using the Google Maps service. The ESRI ArcMap desktop application as well as a derived Pythagorean theorem where used to derive the co-ordinates and relative distances of the aforementioned data. Furthermore, additional data concerning macroeconomic factors such as median income and the unemployment rate were added to the apartment transaction data.

The findings of the empirical analysis suggest that distance of a grocery store affects the value of an apartment within the research area. The results indicate that the coefficient for the distance of a grocery store is negative, meaning that the longer the distance to a grocery store, the less valuable an apartment is. The findings suggest that an increase of 100 meters in the distance to a grocery store decreases the value of an apartment by approximately 0.72 percent.

However, a large number of limitations effect the accuracy of the empirical analysis. The addition of numerous housing price determinants, especially more detailed micro- and macro locational determinants, would enhance the accuracy of the findings. Additionally, further research into the effects different grocery store chains and the size of a grocery store would most likely yield interesting results.

Keywords housing price, housing price determinants, grocery store, proximity

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Diplomityön tiivistelmä

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Tiivistelmä

Tämän diplomityön tarkoituksena on selvittää päivittäistavarakaupan etäisyyden vaikutus asunnon hintaan Etelä-Haagan kaupunginosassa Helsingissä. Työssä esitellään olemassa oleva tieteellinen kirjallisuus asuntojen hintatekijöistä sekä päivittäistavarakaupan etäisyyden vaikutuksista asunnon hintaan. Tämän jälkeen aihetta tutkitaan tilastollisen analyysin avulla.

Lähtöaineisto perustuu Kiinteistönvälitysalan Keskusliiton aineistoon toteutuneista asuinhuoneistokaupoista. Käytetty aineisto käsittää yhteensä 1 381 asuinhuoneistokauppaa vuosien 2010 ja 2016 välillä. Päivittäistavarakauppoihin liittyvä aineisto kerättiin Google Maps – palvelusta. ESRI:n ArcMap sovellusta sekä Pythagoraan johdettu lausetta käytettiin märittämään lähtöaineiston koordinaatit sekä suhteellista sijaintia. Lisäksi lähtöaineistoon lisättiin makroekonomisia muuttujia kuten mediaanitulot sekä työttömyysaste.

Tutkimuksen löydökset osoittavat että päivittäistavarakaupan etäisyydellä on vaikutus asunnon hintaan tutkimusalueella. Tulokset osoittavat, että päivittäistavarakaupan etäisyyden koeffisientti on negatiivinen. Tämä tarkoittaa että etäisyyden kasvaessa asunnon hinta laskee. Tulokset osoittavat että päivittäistavarakaupan etäisyyden kasvaessa 100 metriä, asunnon hinta laskee noin 0.72 prosenttia.

Huomionarviosta on tutkimuksen vajavaisuuksien vaikutus tulosten tarkkuuteen. Lisäämällä etenkin mikro- ja makrotason sijainnillisia asunnon hintatekijöitä tilastolliseen analyysiin olisi mahdollista parantaa tutkimuksen tarkkuutta. Lisäksi lisätutkimukset päivittäistavarakaupan ketjun sekä päivittäistavarakaupan koon vaikutukseen asunnon hintaan tuottaisivat mielenkiintoisia tuloksia.

Avainsanat asunnon arvo, asunnon hintatekijät, päivittäistavarakauppa, etäisyys

Preface

“Knowledge is power.”

- Francis Bacon

Helsinki, 27 November 2017

Nicholas Minogue

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Terms and abbreviations

Apartment	This thesis focuses on residential apartments located in multi-story apartment buildings. (Finnish: kerrostaloasunto). Therefore, "apartment", refers to this type of housing unless otherwise stated.
Property	This thesis focuses on residential properties that are most commonly multi-story apartment buildings. (Finnish: kerrostalo). Therefore, "property", refers to this type of housing unless otherwise stated.
Housing company	Refers to apartment housing companies (Finnish: asunto-osakeyhtiö) unless otherwise stated.
CBD	Central Business District
Helsinki Metropolitan Area	Refers to the urban area around the city of Helsinki consisting of the municipalities of Helsinki, Espoo, Vantaa and Kauniainen. (Finnish: Pääkaupunkiseutu)

1 Introduction

1.1 Background

Housing prices in Finland have been rising steadily during the past 20 years. According to Statistics Finland, since the banking crisis of the early 1990's, housing prices have increased, in real terms, by around 100 % in the country as a whole. ECFIN's (Marrez & Pontuch, 2013, pp. 1.) country focus of Finland adds that from 1993 to 2012, "Finnish house prices increased by about 84 % relative to consumer prices".

The rise in housing prices has been even higher in the Helsinki Metropolitan Area (HMA). As is visible from the figure below, housing price development of the HMA and the rest of Finland was relatively uniform until the global financial crisis of 2008 and only began to diverge thereafter. Housing price development in the rest of Finland has remained somewhat stagnant for the past 10 years, reflecting the overall economic situation in Finland. (Statistics Finland, 2016a)

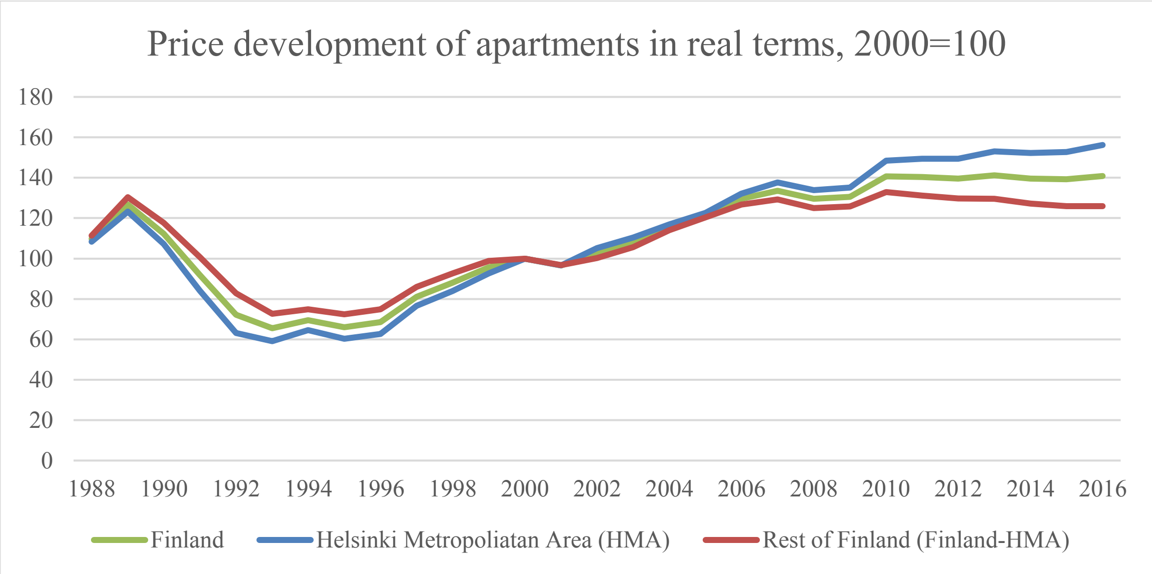

Figure 1. Real price index of old apartments in Helsinki Metropolitan Area, Finland and Rest of Finland, 2000 = 100. Statistics Finland (2016a.)

The figure above raises the question; why have housing prices risen so dramatically during the past 20 years? ECFIN's report states that the rise was mirrored by the increase in household debt that started from relatively low levels and grew to Eurozone average levels throughout the 2000's. The answer, however is much more multifaceted and complex than this. It is, therefore, simpler to divide the question into smaller parts such as the following; what factors affect changes in housing prices and/or what are the specific determinants that makes up the value of an apartment? (Marrez & Pontuch, 2012).

In order to understand why housing prices have risen so greatly in Finland during the past 20 years, it is natural to begin with an investigation of what makes up the value of an apartment. In his groundbreaking article, published in 1974 and titled "Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition", Rosen presented the thinking that a product can be described by each of its measured characteristics and thus its price must also be derived from each of these characteristics. Applying this to housing prices results in the following: the value of an apartment can be derived from the sum of the values of each of its characteristics. (Rosen, 1974)

Since Rosen's article, academics' have considered hedonic regression as the most efficient way of studying housing prices and extensive research has been conducted worldwide on which characteristics affect housing prices. What then are examples of these characteristics of determinants that make up the price of an apartment? (Rosen, 1974; Zietz et al., 2007 and Sirmans et al., 2005)

According to Sirmans et al. (2006) the nine housing characteristics that appear most often in hedonic pricing models for single-family housing are the following:

- square footage
- lot size
- age
- number of bedrooms
- number of bathrooms
- existence of a garage
- existence of a swimming pool
- existence of a fireplace
- existence of air conditioning

Additionally, Sirmans et al. (2005, p. 3.) found that "slanted versus flat roof, sprinkler system, garden bath, separate shower stall, double oven and gated community positively affect selling price while not having attic space, living in an earthquake zone, proximity to a hog farm, proximity to a landfill, proximity to high voltage lines, corporate-owned properties, percentage of Blacks or Hispanics in an area and properties that require flood insurance negatively affect selling price."

As can be seen from these two studies, research has found numerous characteristics that make up and affect the price of residential real estate. One of these characteristics, location, seems to be a very prevalent characteristic. This is in line with the common saying that the three most important determinants of housing prices are "location, location and location". In their research into the effect of location to housing prices, Kiel & Zabel (2003, p. 175.) found that the Metropolitan Statistical Area-, town- and street level each are determinants and that they should all be included in hedonic housing price models.

If location is such an important determinant to housing prices, this would suggest that the distance to services, such as grocery stores, hospitals or restaurants, would also be important determinants of housing prices. Li & Brown (1980), who were one of the one of the first to study the effect micro-neighborhood externalities such as proximity to commercial areas have on housing prices. They found that the coefficient for the logarithmic distance from commercial area was negative. This means that each doubling of the distance to commercial areas decreases house prices by $1,486.

Since then, numerous studies have been conducted to look into the same effect with varying findings. For example, Colwell et al. (1985) as well as Aydin et al. (2010) found that new shopping centers have a decreasing effect on housing prices within approximately 500 meters. Interestingly, beyond the same distance, housing prices increase with increased closeness to the shopping center. Additionally, in Singapore, Addae-Dapaah & Lan (2010) have found that the average premium for the proximity of a shopping center was 4.7 % but found that the premium decreases with an increase in distance from the shopping center. On the other hand, Stadelmann (2010) found that the distance to the nearest shopping facility is negatively correlated to housing prices in his research into housing price determinants within Switzerland.

Based on all of the above, it seems that the amount of research into the determinants affecting housing prices is abundant but sometimes contradictory. A certain characteristic may have a positive effect in one country or within one study and a negative effect in another. This is especially evident with the effect commercial areas and services, specifically grocery- or convenience stores, have on housing prices Due to the contradictory findings of current research on the subject, investigating the relationship the proximity of grocery stores has on housing prices would be useful. (Chang et al., 2015; Stadelmann, 2010; Li &Brown, 1980; Colwell et al., 1985; Aydin et al., 2010; Addae-Dapaah & Lan, 2010)

In this thesis, the effect an apartment's distance to the nearest grocery store has on its value will be researched within the context of Helsinki, Finland.

1.2 Research questions

Due to the contradictory nature of current research on the subject, this thesis will analyze the effect the proximity to grocery stores has on housing prices; more precisely the effect on the prices of apartments located in residential housing blocks operated by residential housing companies within Finland. In order to carry out this research, the following questions were derived and this empirical study will attempt to provide answers to these questions.

- Does the proximity of a grocery store affect the value of an apartment? In other words is there a correlation between the distance to a grocery store and value of an apartment?
- If the proximity of a grocery store does have a direct effect on the value of an apartment, how much is the effect?
- If the proximity of a grocery store affects housing prices, what is/are the reason/reasons behind the affect?

1.3 Scope and limitation

Firstly, an important distinction to be made, in relation to this thesis, is the difference between real estate value and price. As is argued by Kasso (2014), the two can differ greatly from one another. For the purpose of this thesis the price and the value of housing are deemed to be synonyms of one to the other. Selling price is used as a proxy for the value of an apartment. It offers a more objective measure than for example an owner's self-assessment minimizing potential biases. This is also done due to the availability of data. (Sirmans et al., 2005).

Decondly, due to the nature of the data available for this thesis, only transactions concerning apartments located in apartment house companies (Finnish: Asunto-osakeyhtiö) as well as in multi-storey residential buildings (Finnish: kerrostalo) will be included. For this reason, other forms of residential real estate such as single family homes and terrace houses are out of scope. Additionally, as the dataset included in this thesis consists of apartment transactions that were sold by real estate agents, the data is concentrated to the owned residential market. The data is also skewed towards older residential real estate stock due to construction companies selling directly to investors and consumers that are not included in the data used.

Thirdly, the value of real estate is made up of two physical components, the structure and the land the structure is built on. According to academic research, the more significant of the two is the value of land. For the purpose of this thesis, the two components are not separated due to the nature of how residential real estate is owned in Finland through apartment housing companies. (Davis & Heatchote, 2007) Also no distinction is made between the rental- and home ownership markets. The two are found to be co-integrated in the long term. (Ambrose et al., 2013)

Fourthly, the geographical scope of the thesis is limited to a single suburban area post code, 00320 (Etelä-Haaga), within Helsinki. The reasoning behind this choice is elaborated on in chapter 3.2. Noteworthy is also that the data used in this thesis represents apartment transactions between January 2010 and December 2016. This time limitation has an effect on the results of the study and the use of data with a different time limitation would yield different results.

Finally, this thesis only studies the effect grocery stores have on housing prices within the aforementioned geographical area. The effect of any other retail types, both those that sell food items and those that don't, are not included in this thesis.

1.4 Structure of this study

The first chapter of this thesis explains the background of the research subject, the effect proximity to a grocery store has on apartment prices, and its relevance especially within the context of the Finnish real estate market. It illustrates the motivation behind the research and presents the research questions of the thesis as well as its limitations.

The following chapter consists of a review of the current academic literature on the subject. This section presents research on housing price determinants in general, with focus on the effect proximity to retail premises and more specifically grocery retail premises has on housing prices.

Chapter 3 explains the methodology used in this thesis, hedonic OLS-regression, and the reasoning behind its choice and appropriateness. It also details the data used to conduct the regression, its limitations and additions made to the dataset.

The empirical analysis of this thesis is discussed in chapter four. This section describes the steps taken to conduct the hedonic OLS-regression as well as the final form of the regression. Furthermore, chapter 5 presents the results of the regression as well as states its limitations. Discussion concerning the thesis as well as its conclusions are stated in the final chapter.

2 Theory and literature review

2.1 Determinants of residential real estate price

The law of supply and demand is one of the most fundamental economic concepts. It is used in economics to derive the price of a product. It also applies to residential real estate as housing prices reflect the interaction between the supply and demand of housing. Due to some of the special characteristics of real estate, such as spatial fixity and heterogeneity, it does not respond to price dynamics in the same manner as other commodities. (Abelson et al., 2005; Fallis et al., 1988) This is why, a property “cannot have economic value unless it has utility and is scarce. Its value will be determined by these factors together with opportunity cost and budget constraint.” (Wyatt, 2013, p. 6)

According to Savenkov, academic research states that the demand for housing is affected by at least the following factors;

- expected future benefits and costs of owning/occupying the dwelling
- expectations about future housing prices
- changes in disposable income
- labor market trends
- demographics
- search costs
- transaction costs as well as the aforementioned opportunity cost and
- budget/financing constraints.

(Savenkov, 2016; Wyatt, 2013)

Simultaneously the supply of housing is affected by factors such as regulation, the availability and cost of developable land, construction costs and design and construction lags. He summarizes the relationship between the two with the following statement. “Housing prices increase (/decrease) to reflect the insufficiency (or oversupply) of required housing stock.” (Savenkov, 2016, p. 6)

In addition to the more general factors affecting the overall supply and demand of housing, housing prices are also affected by property specific factors. These factors include the size, age and the condition of the apartment as well as more specific factors such as the existence of a fireplace or air-conditioning in the apartment and the availability of parking. (Wyatt, 2013; Sirmans et al., 2005)

Furthermore, locational factors have been found to be vital determinants of housing prices. Kiel & Zabel (2003), amongst others, have found that location has an effect on housing prices on a Metropolitan Statistical Area (MSA)-, town- and street level. The location or the distance of an apartment to points of interest such as services, transportation hubs and city centers have also been found to be housing price determinants. (Laine, 2015; Larinkoski, 2016)

In accordance to the aforementioned, Kasso (2014) has divided the determinants of housing prices into the following three categories.

1. General value factors
2. Locational factors
3. Asset specific value factors.

According to Kasso, general value factors reflect the situation of the property market, the society and the economy as a whole whereas locational factors reflect an apartment's value in relation to the surrounding world as it is an immobile asset. (Kasso, 2014, p. 248)

Laine (2015), on the other hand, divides housing price determinants into two categories; regional- and asset specific factors. In his division, general market or sub-market level factors such as population density have been combined with locational factors as one single category of determinants. The same division is stated by Brunauer et al. (2013, pp. 95). They are of the opinion that housing can be defined by "a bundle of utility-bearing characteristics, such as, structural (physical) characteristics, like floor space area, constructional condition, age, etc., and neighborhood (locational) characteristics, like the proximity to places of work, the social composition of the neighborhood, etc."

Moreover, the categories mentioned can be divided even further into sub-categories. Kasso (2014) also states that asset specific value factors can be divided into building- and apartment level factors. An example of the former is plot ownership and used construction material while examples of the latter are the view from the apartment and layout. Laine (2015), on the other hand, categorizes asset specific factors into three sub-categories; building specific-, apartment specific- and economic factors. He also has five different sub-categories for regional level determinants. Sirmans et al. (2005, p. 11 – 12) came to a similar conclusion; within their research, they divided the found housing price determinants into eight separate categories; 1. Construction & Structure, 2. House internal features, 3. House external amenities, 4. Environmental – natural, 5. Environmental – neighborhood & location, 6. Environmental – public services, 7. Market, occupancy & selling and 8. Financial issues.

Literature does not seem to be uniform in the way housing price determinants are categorized and no clear rule of thumb is evident. It is noteworthy to also mention that there seems to be no structure or guidelines in regard to the categorization of determinants. Each author presents their own style of categorization each having its own merits and flaws.

For the purpose of this thesis, I have organized the following chapters based on the division presented by Kasso (2014) as it, in my opinion, enables the most clarity. Additionally, Kasso has studied the Finnish housing market, which will be the focus of this thesis and this categorization is, therefore, best suited for this thesis. Thus, the following three chapters will introduce each level of housing price determinants;

1. General value factors,
2. Locational factors
3. Asset specific factors.

2.1.1 General value factors

Kasso (2014) believes that general value factors reflect the overall property market as well as the societal and economic situation at any given time. He lists determinants such as employment rate and economic outlook as being significant. The most significant general value factor effecting housing prices, according to him, is, however, interest rate.

Barot & Yang (2002, pp. 209) are of the same opinion. They concluded that "Both nominal and real interest rates matter for house prices in Sweden and the UK. However, the results indicate that Sweden has stronger interest rate effects both on the short and the long term." Nguyên (2014) also used home loan interest rates as a variable in his construction of an automated valuation model for residential real estate using an Artificial Neural Network.
As a whole, general value factors are housing price determinants that are tied to the overall supply and demand for housing. According to Savenkov (2016) such determinants, as stated previously, are demographics, land use and economic growth. Most often, these factors have an indirect effect on housing prices.

Property market functions, in other words the interaction between supply and demand of housing, have been studied extensively and, as previously stated found to effect housing prices. One of the best known illustrations of these functions is the four-quadrant model derived by DiPasquale & Wheaton (1992) and presented below. Their model illustrates the multi-dimensional effects the property market experience by a specific market impulse. The right hand side of the figure makes up the property market while the left side represents the asset market. These two markets are linked at two junctions; "First, the rent levels determined in the property market are central in determining the demand for real assets." Secondly, "If construction increases and the supply of assets grow, not only are prices driven down in the asset market, but rents decline in the property market as well." (DiPasquale & Wheaton, 1992, pp. 186 – 187; Larinkoski, 2016)

The figure below presents the effect a market impulse such as economic growth has on the long-term equilibrium of the real estate market. As is evident, economic growth increases the demand for space at the current rent level. Due to the inelastic nature of real estate, stock is limited as construction is not able to immediately meet the increased demand for space. Thus rents increase. An increase in rents shifts the rent determination curve outward. This is visible in the first quadrant (top right) of the model. This affects asset valuation in the form of higher prices (second quadrant, top left) and is further portrayed in the third quadrant (bottom left) as an increase in construction. Eventually this causes an increase in the stock (fourth quadrant, bottom right) and creates a new equilibrium. This is illustrated in the figure by the dashed box that has shifted outward from the initial equilibrium. Economic contraction, on the other hand, would have an opposite effect. (DiPasquale & Wheaton, 1992; Larinkoski, 2016)

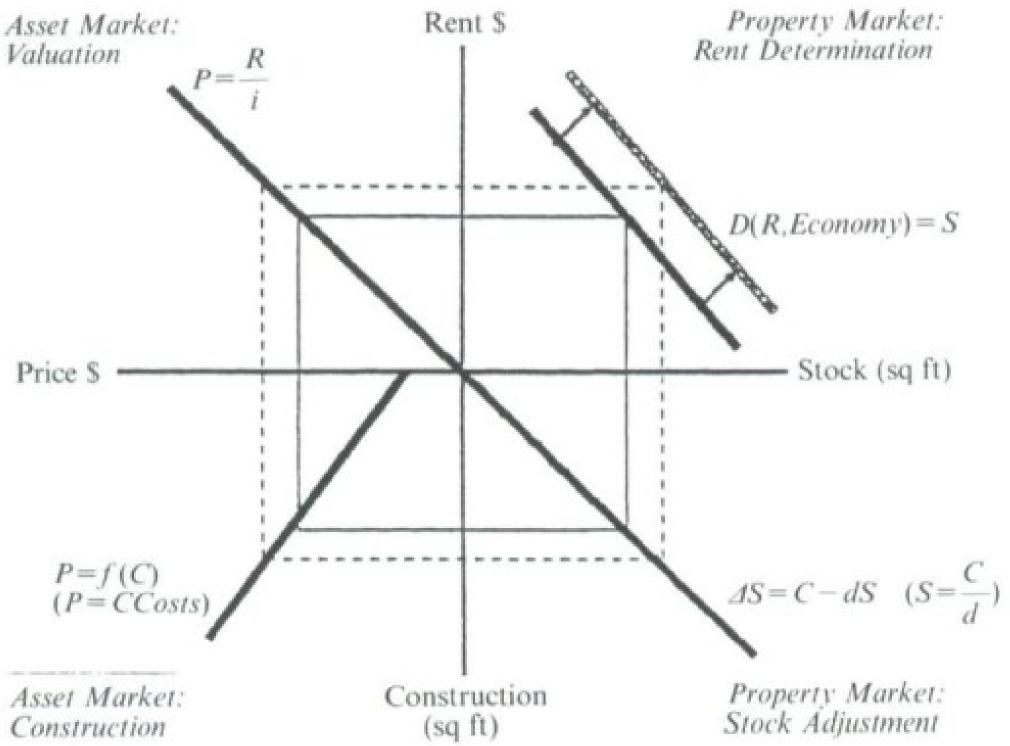

Figure 1. The four-quadrant model of real estate. The property and asset markets: property demand shifts. (DiPasquale & Wheaton, 1992, pp. 191)

In addition to the supply and demand of housing, research has found, on numerous occasions that different types of land use affect surrounding housing prices. Kurvinen and Tyvimaa (2015) found in their research within the city of Tampere, Finland that a senior housing development has a significant positive impact on housing prices within a 500 meter radius. According to them, the highest impact was observed when the senior housing development was located in underdeveloped neighborhoods that have property values lower than the average and where also other types of real estate development occurs. After eliminating confounding effects from all residential and retail developments, the results show that within 12 to 24 months after completion of the senior housing development, the estimated premium is 4.6 %. They also found that the positive effect was consistent from 24 to 12 months before the development is completed to the aforementioned 12 to 24 months after completion. The positive impact was found to be non-linear within this timeframe.

Some general value factors that have been found to have a direct impact on housing prices are median income and tax rate. In his study into housing price determinants of Zurich, Switzerland, Stadelmann (2010) observed that both of the determinants were significant at a level of 1 % using an OLS regression model consisting of 33 variables. The coefficient for median income was positive while that of tax rate was negative. Additionally, the correlation between tax rate and housing prices was found to be negative (-0.747) and that of median income was positive (0.728). Li & Brown (1980) also found property tax to have a negative coefficient on housing prices. Sirmans et al. (2005) list six studies that inspected median income and median household income finding that a majority of the time, in 4 out of 6 cases, this determinant was not statistically significant.

Furthermore, Man & Bell studied the effect sales tax has on housing prices in the Phoenix metropolitan area. They found "local sales tax differentials are capitalized into house selling prices in a similar manner as property tax differentials after holding other factors constant, but to a lesser extent, in part, because a larger portion of the sales tax burden can be shifted to nonresidents than that of the property tax." They conclude that a 10 % increase in the local sales tax rate reduces the market value of houses by 2.3 % or around $2,944, on average. (1994, pp. 128) Within Finland, Kasso (2014) adds that the tax deductibility of mortgage interest costs must have an effect on housing prices.

In his research into the effects that property taxes have on housing prices, Oates (1969, pp. 963) used regression analysis and the ordinary least squares method to determine that "property values bear a significant negative relationship to the property tax rate". This is a logical finding as it can be argued that "the negative association between tax rates and home values stem from a dependence of tax rates on property values". Due to the fact that the nominal property tax rate has wide variations across communities, Oates estimated the "effective" rate by multiplying the nominal tax rate with the assessment ratio. Man & Bell (1994, pp. 127) add that according to their findings, "everything else being equal, a 10% increase in the effective property tax rate leads to a 1.1% decrease in house sales price, which is $1,408 for the average value home."

Stadelmann (2010) also found that the unemployment rate has, at a significance level between 5 % and 10 %, a negative coefficient as a determinant of housing prices. Sirmans et al. (2005) present findings of the opposite nature. According to them, in the four studies they found to have measured unemployment rate's effect on housing prices, the effect was insignificant.

Also the economic outlook of a nation, portrayed for example by the growth of gross domestic product or trade have been proven to have a multidimensional impact on the property market and thus housing prices. Many have also found that public expenditure to healthcare and education have had positive effects on housing prices. (Ng & Feng, 2016; Stadelmann, 2010)

Demographic factors such as overall population and population density are direct determinants of housing prices according to Stadelmann (2010, pp. 180). The ordinary least squares regression coefficients were found to be -1.007 and 0.013 respectively. When discussing the effects of certain housing price determinants, he concludes that "Demographic as well as other socio-economic controls seem to be of minor importance." Ruuskanen (2016) also adds that demographic factors are closely tied to the decision making process of households when choosing housing and thus has a clear indirect effect on housing prices.

Overall, general value factors are determinants that reflect the current condition of the economy and the real estate market as a whole and how these are reflected onto housing prices.

2.1.2 Locational factors

Due to real estate's very nature as a heterogeneous asset, its location, the place or position it is situated in, is a characteristic that is unique to each separate asset and thus should have a major effect in determining its value. As previously stated, Kiel and Zabel found that all three levels, MSA-, town- and street-, are significant when estimating the house price hedonic equation. Through what they have dubbed as the 3L approach, meaning the pooling of variables at each of the three levels to simulate their effect on housing prices of small clusters of houses, Kiel and Zabel were able to prove that individuals care about "the composition/quality of multiple geographic levels." (2008, pp. 188)

In his research regarding the significance of public transport service standards on housing prices, Laine (2015) presents numerous locational factors that have found to be housing price determinants. The table below lists these factors.

Type of determinant	List of determinants
Macro location	Type of area and land use
Distance factors	Distances to city center, places of work, schools, hospitals, the beach as well as the park
Factors concerning the physical environment	Population- and work place density, number of services, proximity of historically significant places, amount of built- and green space areas as well as noise level

Table 1. List of locational factors (Laine, 2015)

Location, and more precisely, distance to the city center has been found to be an explaining factor in real estate prices since von Thünen introduced his model of agricultural location in the 1840's. According to his model, the value of farmland decreases as the distance to the central marketplace increases in order to compensate for the added cost of transporting the sellable goods to the marketplace. This model has been adapted to the housing market since the 1960's with the use of Alonso's bid-rent model that assumes that the housing market is monocentric, in other words, assumes that the housing market in question only has one CBD. This over 150 year old model has, in recent research, still been proven to be accurate. In Shanghai, Yiu & Tam (2004) found that average housing prices drop 5 % for each 1 km that the distance to the CBD increases. De Bruyne & Van Hove (2013) had similar findings. In their research of Belgian housing prices, they found that "An increase in distance to Brussels of 1 % will, ceteris paribus, decrease housing prices by 0.12 %." This means that if the distance to Brussels is doubled, housing prices decrease by 12 %. (Chen & Hao, 2010; Parr, 2013)

Koramaz & Dokmeci (2012, pp. 1222) add that "Proximity attitudes such as distances to central business district (CBD), employment centers, transportation nodes and public amenities are stated to be the most significant spatial determinants, explaining the variance in housing price." According to Abelson et al. (2012, pp. 3) after assuming that "all employment is in the CBD, houses are homogenous, households have similar incomes and preferences and there is a uniform environment across the urban area" housing prices have to fall if commuting costs and travel time costs increase. In equilibrium, the function of house prices and distance to CBD is non-linear and looks like the following.

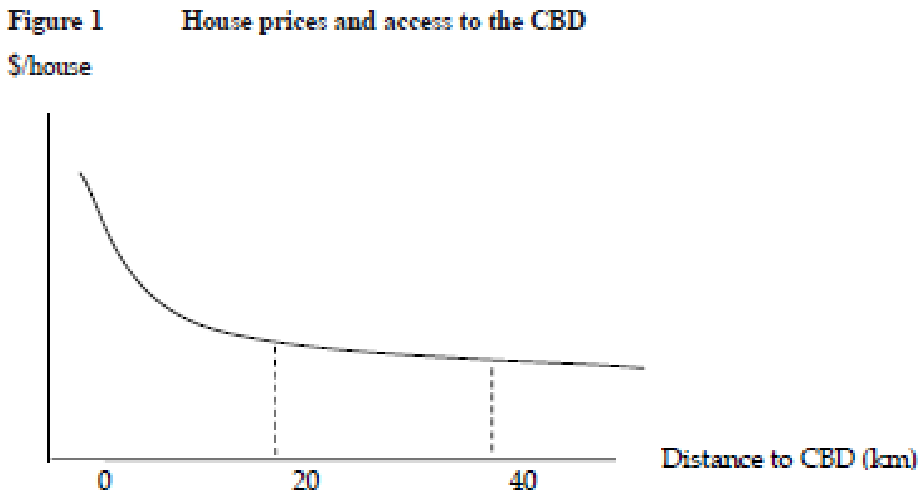

Figure 2. Illustration of the relationship between housing prices and distance to CBD (Abelson et al., 2012, pp. 4)

Laine (2015) states, in regards to public transport, that "travelling time to CBD and connectivity had the foremost price effects". He adds that waiting time, walking distance and placement into service zone had a much lesser effect. Agostini & Palmucci (2006) state that current economic theory believes that different facilities and public transport services will be capitalized either entirely or for the most part into housing prices. However, no consistent and universal relationship between transport lines and housing prices have been detected. They found that in Santiago, Chile, average prices for apartments increased by 4.2 % - 7.9 % after the construction of the new metro line 4 was announced and increased further by 3.1 % - 5.5 % after the location of the stations was unveiled.

A study into the effects proximity to a train station has on housing prices conducted by Larinkoski (2016), found, in the Finnish context, that the effect varied in direction, scale and magnitude depending on the geographical area. Contrarily, Laakso (1997) found the positive effect to be somewhat linear with a maximum positive effect of 4 % - 6 %. However, other research into the effects railway connections and proximity to them have on housing prices have fairly uniform findings; the amount and proximity of railway connections has a positive impact on housing prices. More specifically, Celik and Yankaya found in their research focused on Izmir, Turkey, that, depending on the area, an increase in the walking distance to the nearest subway station decreased property values by $4.76 to $18.70 per meter. (Efthymiou & Antoniou, 2013; Celik and Yankaya, 2005; Strand & Vågnes, 2001; Laine, 2015)

In her research into the effect of traffic noise, Vanhanen (2016) found that the effect of traffic noise on housing prices is approximately -0.4 % for each 1 dB of increased noise level. The effect was, however, observed to be non-linear. Palmquist (1992) had similar findings on housing prices in the state of Washington, USA; in upper middle class neighborhoods, for each decibel of highway noise, property values decreased by 0.48 %. In lower middle class neighborhoods the negative effect per decibel was 0.3 % and in the poorest neighborhoods even lower at 0.08 %. Additionally, noise caused by the vicinity of an airport was found to decrease the average home price in Nevada, USA, by $2,400 in areas where noise levels were 65 decibels or over and approximately 9 % around the Chicago O'Hare airport in areas with the aforementioned noise level. In the HMA, airplane noise levels in excess of 55 decibels were found to decrease housing prices by 2 % - 4 %. (Espey & Lopez, 2000; McMillen, 2004; Laakso, 1997)

Another locational factor effecting housing prices that has been extensively researched is a property's distance to communication antennas, power lines, wind turbines or other such objects. Within Kentucky, Locke & Blomquist (2016, pp. 131) found that "a property with a visible antenna located 1,000 feet away sells for 1.82 % ($3,342) less than a similar property located 4,500 feet away." Likewise, Hamilton & Schwann (1995) observed that properties that are located near high voltage electric transmission lines lose 6.3 % in value due to both the proximity of the power lines as well as the visual impact. Jackson & Pitts (2010), in their analysis of conducted research on the subject, found that a majority of the studies on the subject stated that the effect was small or non-existent. Of the studies that found an effect, the findings ranged from 2 % to 9 %. Surprisingly, they concluded that, in some cases, even a premium was found.

Sirmans et al. (2005) also found within their research into housing price determinants that according to past research, school district had an effect on housing values within the area. Additionally, Stadelmann (2010) found that in Switzerland, distance to a school had a negative coefficient with housing prices meaning that the further away a school is, the lower housing prices are. Another interesting but expected finding by Stadelmann, was that the proximity of a golf course was found the have a positive effect on housing prices in the area as the sport is commonly linked to more affluent people and neighborhoods thus increasing housing prices.

The view of an apartment is tied to its location, thus considered a locational factor, and has been found to have an effect on housing prices. Benson et al. (1998) studied the effect different types of views have on housing prices within the city of Bellingham in the state of Washington, USA. Their findings were that any water view, be it ocean or lake, increases the value of the house in question. An ocean view is found to be more valuable than a lake view; an unobscured ocean view (58.9 %) has a much greater positive effect on housing price than a lake view (18.1 %). Linked to the quality of the view is the distance to the said body of water. According to Benson et al. (2000, pp. 260), "the value of a water view varies inversely with the home's distance from a body of water."

According to Laakso (1997), the effect of proximity to the sea is very significant in Finland. Based on his research, apartments that are located closest to the waterfront are 25 % – 50 % more valuable than similar apartments located over a kilometer from the sea. As is visible from the figure below which presents his findings on the subject, the added value of proximity decreases dramatically as distance increase. After 250 meters the effect is fairly linear while still decreasing constantly.

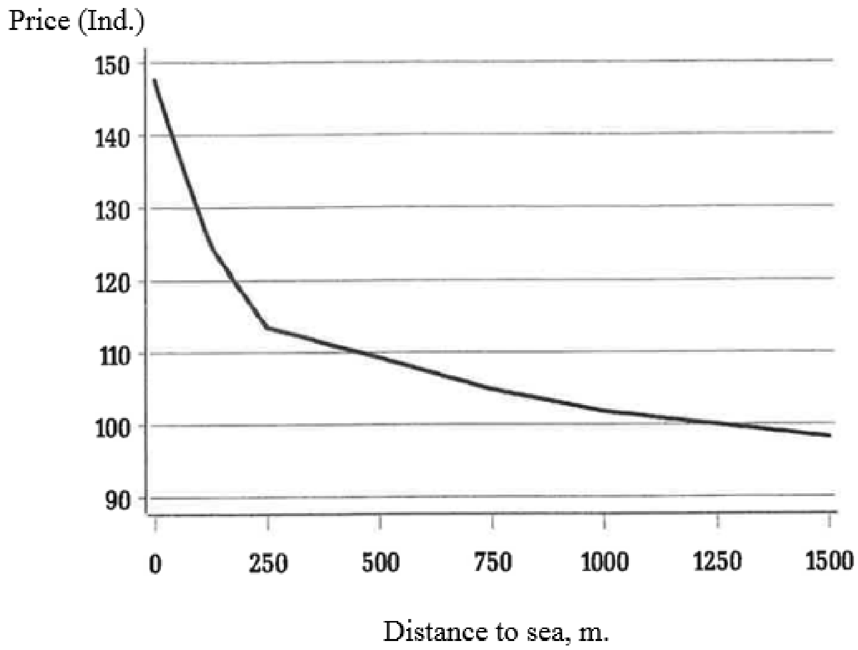

Figure 3. The effect proximity to sea has on apartment prices in the Helsinki Metropolitan Area, translated by the author. (Laakso, 1997, pp. 8)

As is evident from the current literature, the effect locational factors have on housing prices are very regional and can vary greatly from country to country. Based on the literature, generalizations can be derived but it is not possible to observe uniform patterns on the effect different locational determinants have on housing prices. All in all, the location of real estate is unique for each asset and thus has an extremely significant effect on its value.

2.1.3 Asset specific factors

In one of the most thorough examinations of conducted research into residential real estate price determinants, Sirmans et al. (2005) looked into over 120 studies that had used hedonic modeling in order to summarize the most common determinants of housing prices. The studies examined by Sirmans et al. were published in journals such as the Journal of Real Estate Research, the Journal of Urban Economic and The Appraisal Journal within the 10 year period leading up to their research. A majority of the examined literature consisted on research conducted on housing price determinants in the USA. Most of the found determinants consisted of asset specific factors. In total, their research presents a total of around 300 separate determinants effecting housing prices. The table below illustrates the twenty most often appearing characteristics within the studies examined.

The Twenty Characteristics Appearing Most Often in Hedonic Pricing Model Studies

Variable*	Appearances	# Times Positive	# Times Negative	# Times Not Significant
Lot Size	52	45	0	7
Ln Lot Size	12	9	0	3
Square Feet	69	62	4	3
Ln Square Feet	12	12	0	0
Brick	13	9	0	4
Age	78	7	63	8
# Stories	13	4	7	2
# Of Bathrooms	40	34	1	5
# Rooms	14	10	1	3
Bedrooms	40	21	9	10
Full Baths	37	31	1	5
Fireplace	57	43	3	11
Air-Conditioning	37	34	1	2
Basement	21	15	1	5
Garage Spaces	61	48	0	13
Deck	12	10	0	2
Pool	31	27	0	4
Distance	15	5	5	5
Time On Market	18	1	8	9
Time Trend	13	2	3	8

Note: Although some of these variables are the same and just measured differently, they are presented separately so readers can see how they are typically measured.

Figure 4. The Twenty Characteristics Appearing Most Often in Hedonic Pricing Model Studies (Sirmans et al., 2005, pp. 10)

Of the most frequently appearing determinants, a vast majority were found to have a positive effect on housing prices. Examples of these determinants are lot size, size, in either square feet or square meters, and the prevalence of a garage. Referring to figure 4 above, the only determinants, found to clearly have a negative effect were the age of the building and time on the market. Additionally, many of the studies found these determinants to be insignificant highlighting the varied results of current literature. The authors, however, also conclude that the data used in each study has an effect on each finding. (Sirmans et al. 2005)

Furthermore, during his study of the significance of public transport service standards on the housing market, Laine (2015) found several studies of asset specific factors. The table below illustrates a summary of his findings.

Type of determinant	**List of determinants**
Building specific factors	Age, building type, heating method, parking and plot size
Apartment specific factors	Condition, size (sqm), amount of bedrooms, amount of bathrooms as well as quality of finishes and furnishing
Economic factors	Letting status

Table 2. List of asset specific factors (Laine, 2015)

Sirmans et al. (2006, pp. 2015) conducted further research on the most common asset specific factors in the form of conducting a meta-analysis for each of the nine most common housing price determinants by compiling the estimated regression coefficients from the published hedonic pricing literature. Their aim was to "determine if the estimated coefficients vary by geographical location, time, type of data, and model specification."

The most frequent asset specific factors is the size of the apartment or house, in other words, its floor area in square feet or square meters. Research has found it to have an almost unanimously positive effect on housing prices; the larger the house or apartment, the higher its total price. These findings agree with common sense; all else being equal, a larger house is more valuable. Selim (2008, pp. 73) states similar sentiments in his research into housing price determinants in Turkey; "As expected, the higher the number of rooms and house size the higher the house prices." Thanasi (2015, pp. 82) adds, however, that the "effect of the square meters of living on value depends on the square meters, since the relationship between these variables is nonlinear and depends more on the number of rooms." (Sirmans et al., 2005)

It is evident from the literature that the size of the house and factors that are tied to the size of the house, such as amount of bedrooms, are correlated with one another. In Sirmans et al.'s (2006) meta-analysis, the average bedroom was found to have a coefficient of 0.0417 with an average t statistic of 2.21. Ding (2015) found a greater positive effect for the bedroom coefficient; for an additional bedroom, all else being equal, the home's value increases by 15.3 %. However, Thanasi (2015, pp. 82) observed that in Tirana, Albania, the marginal effect of an additional bedroom has been found to decrease with an increasing amount of rooms or in other words a larger house; "Marginal effect for an additional 10 square meters in a house that has two rooms is 7.8 percent while for a house with 3 rooms this effect sits at 6.7 percent, ceteris paribus."

Another determinant that is linked to the overall size of an apartments is the amount of bathrooms. The average coefficient found in Sirmans et al's (2006) meta-analysis was 0.08898 with an average t statistic of 8.34. Sirmans et al. (2006) add that the effect varies in different geographic regions; In the Northeast the coefficient falls in the 0.13 – 0.18 range while in the Southwest the range is wider being 0.015 – 0.18. On average the effect on housing price is between 10 % and 12 %. They conclude that "The bathroom coefficient is not sensitive to time, income, controlling for bedrooms or square footage, or hedonic model size." (pp. 225) Man & Bell (1994) add that in their study regarding the Phoenix metropolitan area, each additional bathroom adds $3,456 to the value of a house.

Within reference to Figure 3, amenities such as a pool, deck or parking have a mostly positive effect on housing prices. In Turkey, Selim (2008) observed the positive effect of a garage to be 7 %. In Tirana, Thanasi (2015) found a parking place to add 12.6 % to an apartment's value. Sirmans et al. (2005) conclude that the effect varies geographically but ranges from only 1 % to 14 %. Man & Bell (1994) found an additional car space in the garage to add $9,344 to housing prices. Regarding swimming pools, Selim (2008) adds that its positive effect was 43.2 % while Sirmans et al. (2005) state a smaller positive effect ranging from 5 % to 15 %.

The age of an apartment or house has been found to have the greatest negative effect on value. Sirmans et al. (2005, pp. 30) state that "There is some variation in the coefficient estimates but there does not seem to be a discernable pattern of differences across regions. The average effect of age on value seems to be about 1 % or less." According to Sirmans et al. (2006) the findings concerning the age vary greatly geographically. The largest negative effect of age was found in Southwest USA which could be explained by rapid recent construction causing a greater proportion of newer houses. Overall, Sirmans et al (2006) found that the mean coefficient for age is -0.00892 with a t statistic of -6.67. Furthermore, Li & Brown (1980, pp. 133) add that "The relatively small coefficient on the age squared variable indicates that houses need to be truly historic (264 years old) before the benefits from their age outweigh the loss in value associated with older and more obsolete units."

The effect time on market has on housing prices has been a controversial subject in academic literature. Sirmans et al. (2005, pp. 9) illustrate the dilemma of this factor by stating that "the longer a house is on the market, the more willing the seller is to concede on the selling price. The opposing theory is that the longer a house is on the market, the more likely the seller is to find the one buyer willing to pay a higher price." They found that in the studies they observed, most often this factor is insignificant as a housing price determinant, but when significant, it is negative eight times more often than positive. Thus indicating that the longer time on market, the lower the selling price.

As is evident from the presented research, asset specific factors have been extensively researched. Studies on the subject have also been conducted within the context of housing prices in Finland. Within the last few years, multiple master's theses have been conducted researching a specific housing price determinant. In 2015, Pennanen found that apartments that are located within buildings with a higher energy efficiency has a positive effect on the selling price. According to her research, energy efficiency classes A – C account for an increase of 4.1 % in apartment value compared to efficiency classes D – E. The most inefficient classes (F – G) were found to be a proxy variable. Additionally, Fuerst et al. (2016) found a 3.3 % price premium for apartments in the top three energy-efficiency categories (A – C). They also added that a favorable energy rating did not decrease the time on market of the analyzed data set.

Similarly, Nikola (2011, pp. 2) studied the effect pipe repairs have on housing prices in Finland. She found that "the market pays excessively for dwellings before and during the repair. Apartment prices start to depreciate six years before the repair but the discount is at no point large enough to account for the discounted value of future pipe repair costs. The results also indicate that the shorter the time from the last pipe repair or alternatively the construction, the larger the dwelling overpricing."

Pihlajaniemi (2014) even found a connection between apartment prices and the architectonic quality of the building. He states that the education, experience and merits of the building designer are factors that have an increasing effect on housing prices. Furthermore, the architectonic style and – appreciation of the building are found to correlate with housing prices.

The overall effect of most of the asset specific housing price determinants vary based on geographic location and the datasets used in each research. In many cases, contradictory findings have been presented and it is thus not possible to draw definitive conclusions on a certain determinants effect on housing prices. It is, however, possible, based on current literature on the subject, to make broad generalizations on the effect of certain determinants; for example the size of the apartment or house is found to have be a positive coefficient, thus as the size of the house increases, so does its value. Furthermore, differences in the significance of some determinants have been perceived. The differences are most often based on the aforementioned differences in datasets and the method with which the effect is being measured.

2.2 Effect of grocery trade

As is stated in previous chapters, an apartment's distance to services has been found to have an effect on its price. This has also been found to be the case for commercial areas. Li & Brown (1980) were one of the first to study the effect micro-neighborhood externalities such as proximity to commercial areas have on housing prices. The result of the research was that the coefficient for the logarithmic distance from commercial area was negative meaning that each doubling of the distance decreases house prices by $1,486. They also found that, in regards to commercial areas, the positive effect of increased accessibility overcomes the negative effects of externalities. As is visible from the figure below, the net effect of proximity to commercial areas, is fairly linear with the largest premium being paid in the direct vicinity of the commercial area with housing prices decreasing steadily as the distance increases. The decrease in value at 1 kilometer is approximately 7,000 $.

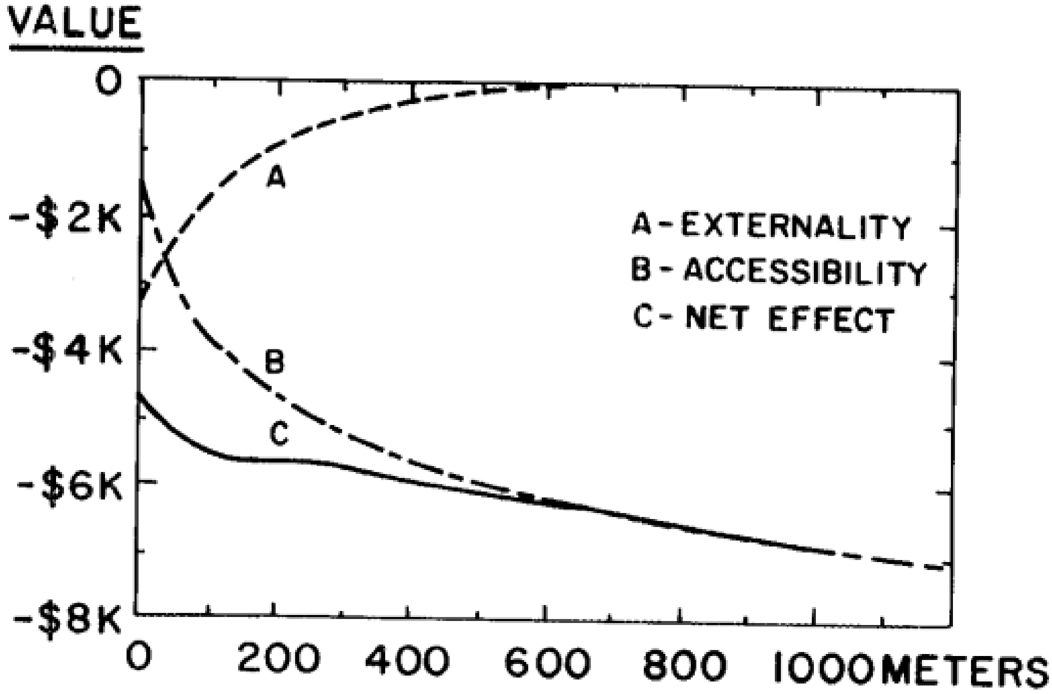

FIGURE 3
EFFECT OF PROXIMITY TO COMMERCIAL AREA

Figure 5. Effect of proximity to commercial area on housing prices (Li & Brown, 1980, pp. 137)

Furthermore, Stadelmann (2010) discovered the in Zurich, Switzerland, average distance to the nearest shopping facility to have a negative coefficient (-0.012) and be significant at a level of below 1 % in an Ordinary Least Squares regression analysis of 33 variables determining housing prices. This indicates that as distance to shopping facilities increases housing prices decrease, all else being equal.

The fairly linear findings concerning the effect proximity of commercial properties has on housing prices of Li & Brown and Stadelmann have been challenged by several researchers. According to the majority of literature on the subject, the effect of commercial development has had mixed results on nearby housing prices. In 1985, Colwell et al. found that a newly constructed shopping center has a decreasing effect on housing prices within 1500 feet, equal to approximately 500 meters. Interestingly, beyond the same distance housing prices increase with increased closeness to the shopping center. Aydin et al. (2010) had similar findings. They also observed a non-linear positive effect of a suburban satellite central business/commercial district in Texas, USA. Both of their findings mean that 500 meters seems to be a dividing distance at which the assumed negative effects of commercial real estate such as noise and increased pollution are outweighed by the positive effect of proximity to commercial services. Thus the positive effect of shopping centers on housing prices is non-linear.

In relation to the effect distance to a shopping center has on housing prices, De Rosiers et al. (1996, pp. 57), used 12 different models to test the relationship. In the linear model, easy access to retail services was clearly positive. When using shopping center distance as dummy variables the findings were different; "house prices first rise, then achieve a maximum within the 200-300 meters buffer and fall almost constantly afterwards – despite the price rise within the 500-600 meters buffer". This suggests that the relationship is non-monotonic, in other words not constantly increasing or constantly decreasing. They conclude that "While the positive impact of shopping center size on residential values is clearly demonstrated, this study brings forward enough empirical evidence to support the non-monotonicity of the price-distance relationship: both the parameter estimates obtained with dummy distance variables in the linear model and those derived from the quadratic form point in that direction."

De Rosiers et al. (1996, pp. 60) also found the positive effect of regional shopping centers on housing prices are maximized at a distance of around 500 meters. According to their findings, the "Optimal distances are respectively established at 0.215, 0.310 and 0.532km for neighbourhood, community and regional shopping centres respectively." Similarly, 1,500 feet or approximately 500 meters was also found to be the point at which the negative effects associated with proximity to a shopping center are overcome by the positive effect of the proximity in Nigeria. (Aliyu et al., 2011)

The figure below shows the gamma functions for the distance to nearest shopping center, no matter of size, and housing prices in Quebec as concluded by De Rosiers et al. (1996).

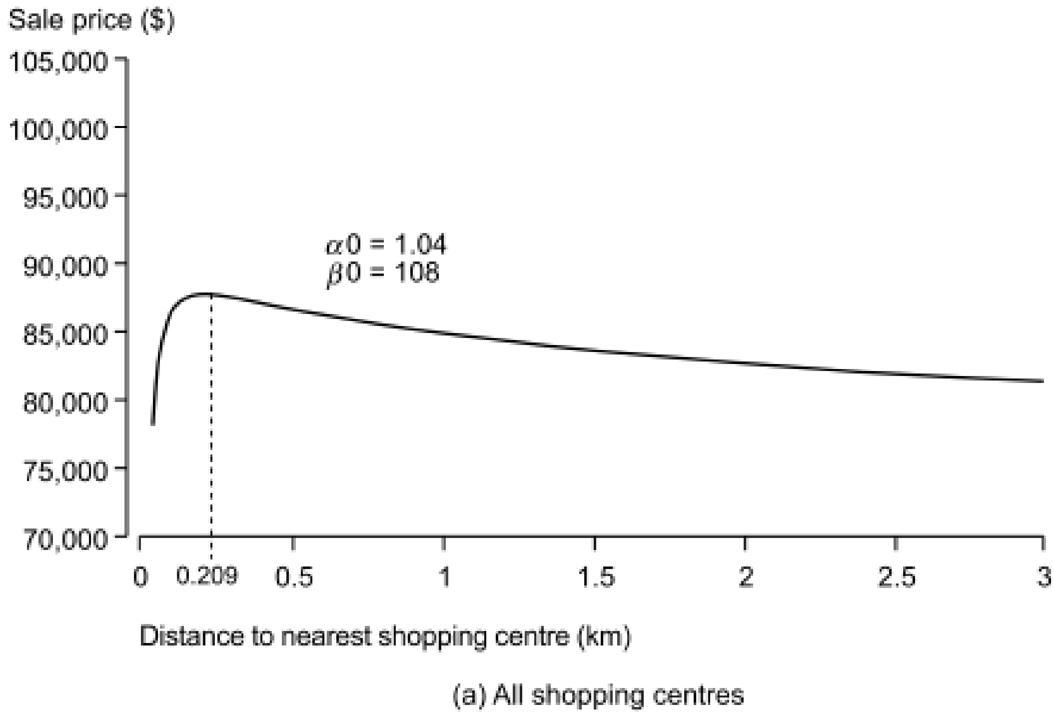

Figure 6. Visualization of Gamma function of housing prices and distance to nearest shopping center (De Rosiers et al., 1996, pp. 56)

In Singapore, Addae-Dapaah & Lan (2010, pp. 2) found that "shopping centers generally command a premium. Notwithstanding the negative externalities of shopping centers, residential properties within 100-metre radius of shopping centers command a higher premium than those farther away although the price-distance relationship is not monotonic while the proximity factor varies from housing estate to housing estate." The average premium for the proximity of a shopping center was 4.7 % but found that the premium decreases with an increase in distance from the shopping center, thus confirming their second hypothesis that property values are inversely related to proximity to shopping centers.

Matthews (2006, pp. XV) also concluded that "On the whole, the positive effect outweighs the negative effect, but up to about 250 feet, the negative effect of disamenities results in a net loss. Beyond a distance of around 250 feet, the effect is positive for almost another 1,000 feet." He also adds that the layout and density of the neighborhood have a significant effect on the magnitude and reach of the travel and straight-line effects on price. Laakso (1997) is of the same opinion. He states that proximity to a local shopping center adds 1 % - 2 % to housing prices and is greatest at a reasonable distance. The disamenities associated with direct vicinity of a shopping center outweigh to added accessibility and proximity.

Sing & Knaap (2004) had slightly varying findings. According to them, neighborhood-scale commercial land use increase housing prices with increased proximity. Proximity to these services within walking distance provides an additional premium. Based on these findings it would be possible to draw a conclusion that the greater an apartment's proximity is to small scale commercial services the higher its value, all else being equal.

Within the context of Gainesville, Florida, Sirpal (1994, pp. 501), found positive price differences ”for residential properties around a larger shopping center as compared to otherwise identical residential properties around a smaller shopping center.” He adds that his findings state that “prices rise with an increase in distance from the nearby shopping center, reach maximum, and then fall.” The findings of Rosiers et al. (1996) were similar. While studying the effect shopping centers have on housing prices in Quebec, Canada, they also found that the shopping center size has a positive impact on surrounding housing prices. According to them, each additional separate store within a shopping center adds roughly $ 27 to the value of the house/apartment. When considering that within their data, that an average regional shopping center had an average of 220 stores compared to 60 stores of a community shopping center, the difference of added value between the two types of shopping center is approximately $ 4,320 or 5 % of the mean property value.

Based on the above studies it is possible to conclude that commercial development and its proximity has a positive effect on surrounding housing prices. Notable is the fact that large commercial developments, in other words shopping centers or commercial centers, have a negative effect on housing prices that are located in its direct vicinity and their positive effect begins from a distance of around 500 meters. Smaller neighborhood shopping centers and commercial hubs, on the other hand, have been found to have no to very little negative effect on housing prices, even in their immediate vicinity. Based on this it is possible to make the assumption that small commercial premises, such as grocery- and convenience stores produce very little disamenities and thus the positive effect of proximity is more linear than that of shopping centers.

This assumption has been found to be true. In the USA, the opening of a Walmart supermarket has been found to have a positive effect on surrounding housing prices. In a study that looked into 159 Walmart openings between 2000 – 2006, the findings were that it had a linear positive effect on housing prices in the vicinity of the supermarket; within 0.5 miles (around 800 meters), housing prices increased 2 % - 3 % while the increase was 1 % - 2 % at a distance of 0.5 miles to 1 mile (approximately 800 meters to 1.6 kilometers). The price hike within 0.5 miles was observed to be $ 7,000 and $ 4,000 between 0.5 miles to 1 mile. (Pope & Pope, 2015)

Similarly, Sale (2015) studied the effect a single shopping center, Walmer Park Shopping Center, had on surrounding housing prices within the city of Port Elizabeth in South Africa. Employing seven functional forms for the estimation of the reduced hedonic model (linear, semi-log, double-log and four Box-Cox transformations) he found that the proximity coefficient to the Walmer Park was negative and statistically significant in all cases. Depending on the functional form, the mean effect on housing price ranged from R106.58 to R116.60 (EUR 7.36 to EUR 8.05) (Xe.com, 2017) per meter. The unrestricted Box-Cox transformation was found to provide the best fit and thus the most accurate implicit price.

Ding (2015) inspected the effect grocery store openings in Durham, North Carolina from 2005 to 2015 had on housing prices. His dataset included the openings of the stores of the following companies; Walmart, Harris Teeter, TROSA Grocery, ALDI and Save-a-lot. Unfortunately, his findings were inconclusive in terms of the effect a certain grocery store chain had on housing prices. He also studied the effects a closing of a grocery store had on housing prices within the area. According to him, one Walmart store closing was found to be statistically insignificant whereas the closing of a TROSA grocery store was found to increase housing prices within a 0.5 mile (approximately 800 meters) radius by 35.9 % and 33.3 % for homes 1 to 2 miles (approximately 1.6 to 3.2 kilometers) away. He concludes, however, that other factors than the closing of the TROSA grocery store affected the decrease in housing prices in the area.

Linked to the proximity of a grocery or retail store is its accessibility. By definition, accessibility refers to someone's capability of reaching the place in question. For example, a grocery store that is located in a place that is easily accessible or along frequently used paths of movement may be used more frequently than a grocery store that is located nearer in absolute terms. Therefore, the absolute proximity of a grocery store may have a smaller effect on housing prices than the actual accessibility of grocery stores in general.

Multiple studies have also looked into this aspect and its effects on housing prices. In Seoul, Korea, Jang & Kang (2015) looked into the effect accessibility and proximity to different types of retail stores have on housing prices. They divided retail stores into five different categories which are defined below.

Type	**Definition**
Department store	A large retail establishment that sells a wide variety of usually high-end consumer goods in various categories
Shopping center	A complex of one or more buildings that sells various categories of merchandise placed along interconnecting aisles, and usually offers other services such as movie theaters and restaurants
Hypermarket	A large store that amalgamates the function of a supermarket and a department store
Supermarket	A large grocery store with a self-services base that sells food products and household items arranged in organized aisles
Convenience store	A small store close to neighborhoods or offices that sells a wide variety of everyday items

Table 3. Division and definition of retail store types according to Jang & Kang (2015)

The authors used straight-line distance as a proxy for spatial proximity. They calculated accessibility using an accessibility index with demand and supply factors for each data point. The index was based on the following: "Here it was assumed that the total floor area of each retail type would represent the classified retail store's relative attractiveness, availability of service, and accessibility for area households. The decay distance parameter was included in the accessibility index to suggest that the farther away the retail store was from home, the lower its level of accessibility. The demand factor was used to represent the outcome that increased competition for retail services among households would lead to less accessibility. This demand factor was calculated by weighting the number of households within the census tract by the distance with spatial impedance." (Jang & Kang, 2015, pp. 519)

Using multilevel hedonic regression modeling and a beta value of 1 as the distance decay parameter, their findings concerning proximity where that of the five retail store types, shopping centers and convenience stores had positive coefficients while the rest of the store types had negative coefficients. In other words, this means that an increase in distance to shopping centers and convenience stores, the more valuable housing becomes, all else being equal. The effect of shopping centers (0.106) on housing prices was significantly greater than that of convenience stores (0.013). Of the five retail store types, the proximity of shopping centers was found to have the greatest effect on surrounding housing prices. In regards to accessibility, Jang & Kang had somewhat different findings. The only negative coefficient was found to be that of accessibility to hypermarkets. The greatest effect on housing prices, was that of shopping centers. (Jang & Kang, 2015)

The effect of convenience store accessibility and density has also been researched in Taipei, Taiwan. Chang et al. (2015) used quantile regression in their research and found that the availability of a convenience store coefficient, in other words, whether an apartment has one store within a 100 meter radius, had a significant positive effect with the lower quantiles. They thus conclude that the existence of a convenience store in lower valued neighborhoods adds value in the local real estate market.

In terms of density (whether an apartment has two or more stores within a 100 meter radius), Chang et al. (2015, pp. 87) had different findings. It was found to have a nonlinear effect on housing prices; its effect in the lowest quantile was significantly positive while negative in the higher quantiles. The authors concluded that this implies "that the 'density' of convenience stores may offer more convenience to local residents in the neighborhoods with lower-priced houses, but, on the other hand, might reduce local living quality (i.e. 24-h noise or potential crime), which are more highly valued by the residents in the neighborhoods with higher-priced houses." They also conducted a simple OLS regression for comparison and found both accessibility- and distance to convenience store regressors to be insignificant.

Studying the effects increased accessibility to retail services has on housing prices in Hillsboro, Oregon, Song & Sohn (2006) found that added accessibility is in fact capitalized into housing prices. They measured accessibility by using the following accessibility index.

$$A_i = \sum_{i=1}^{n} \frac{R_j d_{ij}^{-\beta}}{\sum_{k=1}^{m} d_{kj}^{-\beta}},$$

Figure 7. Equation for calculating the accessibility index value of a household (Song & Sohn, 2006, pp. 283)

"where A_i is the accessibility of household *i* to retail services, *n* the number of retail stores, R_j the floor size of retail store *j*, d_{ij} the distance between household *i* and retail store *j*, β the distance decay parameter; *m* the number of households." (Song & Sohn, 2006, pp. 283)

They used two values as the distance decay parameter: $\beta = 1$ or 2 and found that "the Accessibility Index is not significant when $\beta = 1$, but is significant when $\beta = 2$." (Song & Sohn, 2006, pp. 285) indicating that the positive effect of access to retail services decreases greatly as distance increases.

Some findings also suggest that the brand of the grocery store or supermarket creates different effects on housing prices. A Canadian non-scientific research conducted by theredpin.com compared the effect location within walking distance to No Frills, a discount grocery store and Loblaws, a higher end grocery chain has on housing prices. The findings state the higher end grocery chain averages a 12 % premium compared to the discount grocery chain. They also state that "homes within 10 minutes' walking distance to a Loblaws increases 4.8% between 2014 and 2015. The value on homes within the vicinity of a No Frills remained "relatively stagnant." (De Rosa, 2016). Additionally, Morley (2016) states that in the UK, similar non-scientific studies have shown that the opening of an Aldi, a budget supermarket chain, increases the value of local homes by up to £5,000. The change in value from 3 months before the store opening to 3 months after opening is, on average, 2.5 %. She adds that "a separate study earlier this year by Lloyds bank found living near an Aldi could help to boost the value of nearby property by £1,333". Morley adds that Lloyds found the upmarket supermarket Waitrose to add nearly £40,000 to the value of nearby homes. The accuracy of these findings are easily disputable and should be used with caution but can be generalized to mean that also the brand and thus the selection of goods of the grocery store, in addition to is proximity and accessibility, have an effect on housing prices.

The effect of proximity to smaller retail premises, such as grocery stores, has been found to be the following; the closer the retail premises the more valuable the apartment. The effect, however, differs with different size retail premises. For larger shopping centers, the disamenities associated with close proximity are overcome at around 500 meters and housing prices decrease as distance increase, all else being equal. Overall, current findings on the subject vary based on the data used and on the geographic scope of the research. Thus further research on the subject is welcome.

3 Methodology and Data

As is evident from the illustrated literature on the determinants affecting housing prices in the previous chapter, the most common empirical methodology used in academia is a traditional hedonic regression, which has been the case since Rosen's work in the 1970's (Selim, 2008; Addae-Daapah & Lan, 2010; Sirmans et al., 2005). It has been found to be an effective method to research the effect a certain determinant has on housing prices, also in Finland, and thus has been chosen as the empirical method to be used in this thesis. (Larinkoski, 2016; Forsberg, 2017; Takala, 2016; Pennanen, 2015)

The following section will present hedonic OLS regression and more specific reasoning behind its choice as the methodology of this thesis. In addition, it will elaborate on the data used in the empirical analysis of this thesis. It will also illustrate what modifications and additions were made.

3.1 Hedonic OLS regression

Simplistically put, hedonic regression is a way to mathematically sort out which variables impact the variable you're trying to understand or predict. This variable is called the dependent variable, the variable that is being studied, while the factors that are suspected to have an impact, and whose effect on the dependent variable is being investigated, are called independent variables. The end result answers the following questions: "Which factors matter most? Which can we ignore? How do those factors interact with each other? And, perhaps most importantly, how certain are we about all of these factors?" (Gallo, 2015)

According to Rosen (1974, pp. 34), "hedonic prices are defined as the implicit prices of differentiated products and the specific amounts of characteristics associated with them." In other words, regression attempts to explain the movements of the dependent variable by reference to the movements of the independent variables. In the case of real estate, the dependent variable is most often price or rent. In this thesis the dependent variable is the unit price of apartments (€/sqm). (Brooks, 2008, pp. 27)

The general form of a hedonic regression model is as follows (Brooks, 2008, pp. 28-31)

$y_t = \alpha + \beta x_t + u_t$, where

y denotes the dependent variable,
t denotes the observation number,
α denotes a parameter of the model,
β denotes a regression coefficient created by the model,
x denotes the value of the explanatory or independent variable and
u denotes a random disturbance term

In its most simple form, a hedonic regression consists of two variables, the dependent variable (y-axis in the figure 8 below) and the independent variable (x-axis in figure 8). The figure below illustrates a scatter plot comprising of observations of the aforementioned variables. The regression model is determined by choosing α and β "so that the (vertical) distances from the data points to the fitted lines are minimised (so that the line fits the data as closely as possible). The parameters are thus chosen to minimise collectively the (vertical) distances from the data points to the fitted line." (Brooks, 2008, pp. 30)

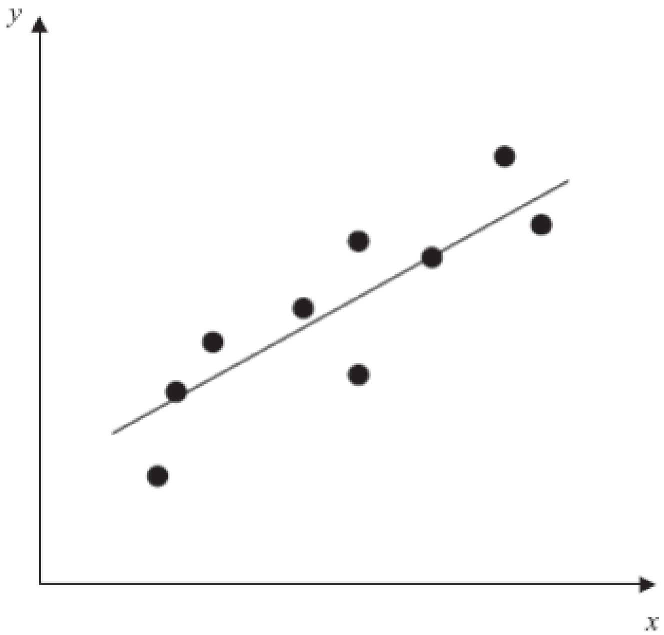

Figure 8. Scatter plot of two variables with a line of best fit chosen by eye
(Brooks, 2008, pp. 30)

Brooks (2008, pp. 30) states that a hedonic OLS regression, “entails taking each vertical distance from the point to the line, squaring it and then minimizing the total sum of the areas of squares (hence ‘least squares’)”. He adds, that in other words, “This can be viewed as equivalent to minimizing the sum of the areas of the squares drawn from the points to the line.” This is presented in the figure below.

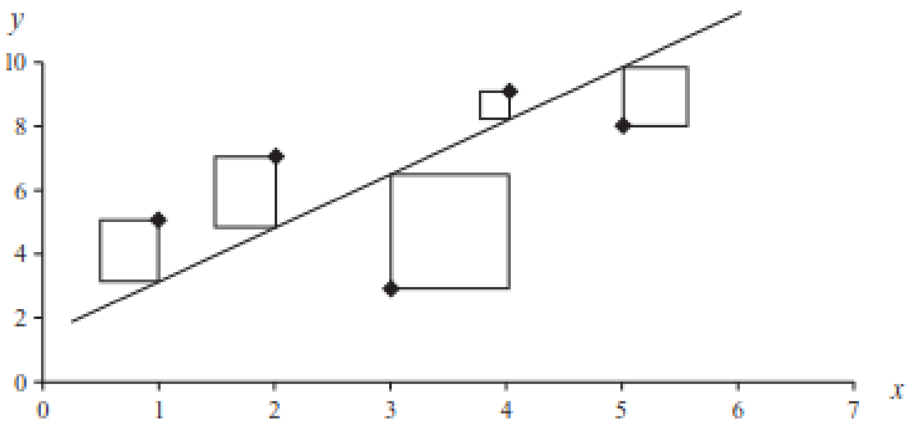

Figure 9. Method of OLS fitting a line to the data by minimizing the sum of squared residuals (Brooks, 2008, pp. 30)

Over the past three decades, hedonic estimation has matured from a new technology to the standard way economists deal with housing’s heterogeneity. (Malpezzi, 2002) Despite its flaws, hedonic OLS regression is the most commonly used empirical method to study housing price determinants and has thus been chosen to be used in this thesis. (Sirmans et al., 2005; Brooks, 2008)

3.2 Scope of analysis

The geographical analysis of the scope is limited to a single suburban area within Helsinki. The chosen post code is 00320 (Etelä-Haaga) which consists of the residential neighborhood Etelä-Haaga in western Helsinki approximately 5.5 kilometers north of Helsinki CBD.

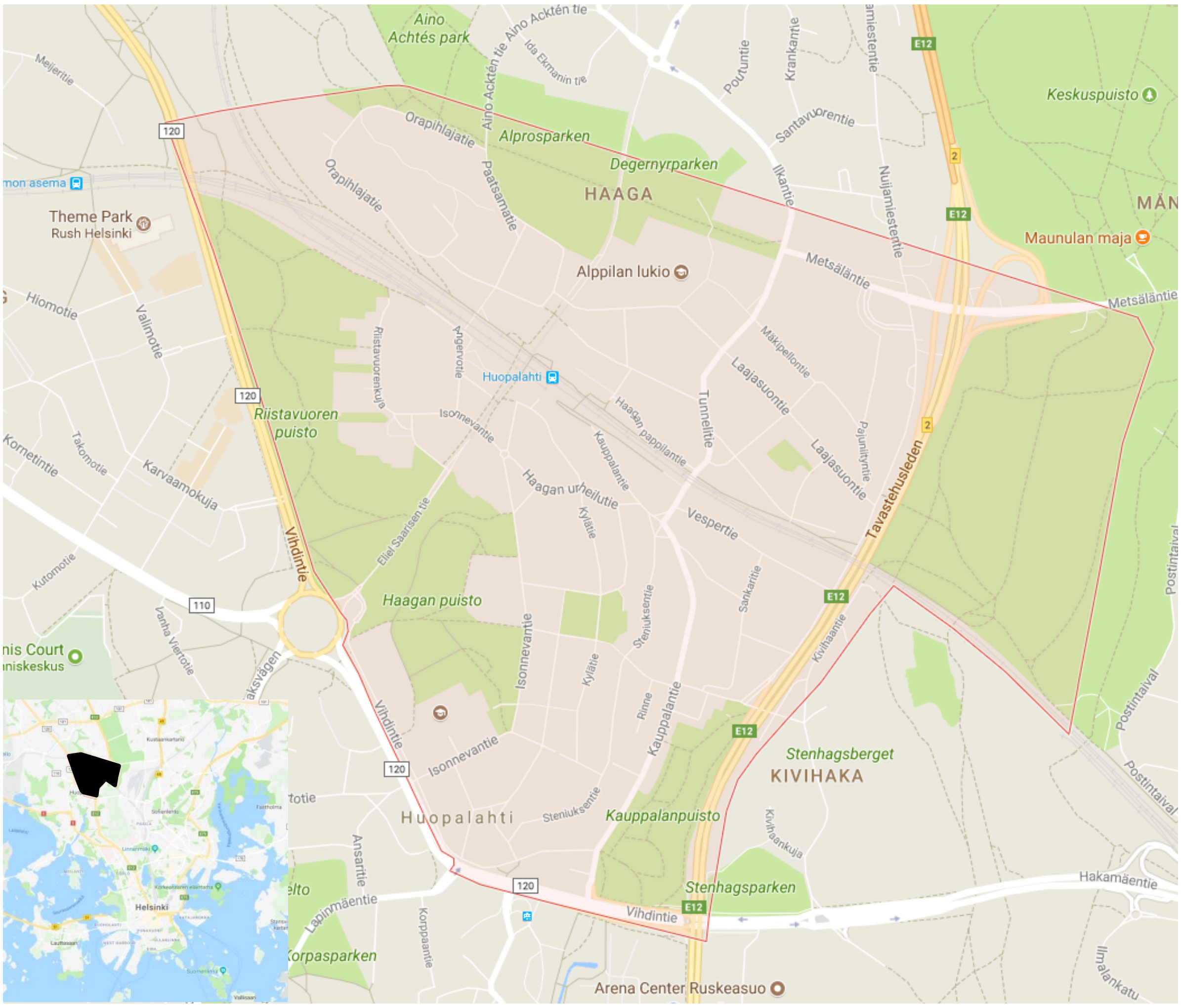

Figure 9. The geographical scope of the analysis visualized on a map

3.3 Apartment Transaction Data

The data used in this thesis is based on information gathered by The Central Federation of Finnish Real Estate Agencies (Fin: Kiinteistönvälitysalan Keskusliitto, KVKL). It is the nationwide advocacy and umbrella organization for real estate brokerage companies and associations in Finland. KVKL publishes data on apartment transactions in Finland on their own online portal, *Hintaseurantapalvelu, KVKL HSP*. Hintaseurantapalvelu is a research and statistics tool meant for the use of companies in the real estate brokerage- and construction industries to aid in determining residential real estate's market value. The tool has data on most residential real estate transactions conducted by real estate brokers in Finland since 1998. (Kiinteistönvälitysalan Keskusliitto, 2017a and 2017b)

The data from Hintaseurantapalvelu does not consist of all apartment transactions in Finland, as around 70 % - 80 % of apartment transaction are conducted with the help of a real estate broker or brokerage firm. As most of the aforementioned 70 % - 80 % of apartment transaction are found on Hintaseurantapalvelu, the data is deemed to be sufficient enough for the purpose of this thesis. Hintaseurantapalvelu also has data on commercial property transaction in the case that a real estate broker was involved in the transaction. (Kiinteisöalan Koulutussäätiö, 2017; Kiinteistönvälitysalan Keskusliitto, 2017a)

The data that is available from Hintaseurantapalvelu provides the following information for each individual apartment transaction:

- Street address
- Post code
- Municipality
- Neighborhood
- Type of building
- If the apartment is new construction
- Floor area in sqm
- Apartment description
- Maintenance charge (€/month)
- Construction year of building
- Construction material of building
- Assessment on condition of apartment
- Plot area in sqm
- Ownership of plot
- Total building right on plot in sqm
- Floor number of apartment
- Total amount of floors in building
- Existence of elevator in the building
- Existence of a sauna in the apartment
- Existence of a balcony in the apartment
- Location of property on the waterfront
- Debt free transaction price
- Apartments share in housing company liabilities
- Transaction price (Unlevered transaction – share in liabilities)
- Unlevered transaction price per sqm
- Date of transaction
- Time on market

However, due to the input nature of the data onto the tool, some of the listed information is not available for each transaction. Despite this, the transaction data is comprehensive and consists of many of the housing price determinants discussed in academic literature in chapter 2 of this thesis. However, noteworthy, is that the transaction data is sometimes submitted manually causing human error and inaccuracies in the data.

The data was collected on February 6th 2017. It consists of all transactions within postcode 00320 (Etelä-Haaga) between the dates of January 1st 2010 and December 31st 2016. As the data was collected in February 2017, it is assumed that it consists of all possible transactions from 2016. In total, the dataset consists of 1,381 unique apartment transactions.

Some transaction did not have information concerning the condition of the apartment. A total of 21 transactions had no information concerning the condition of the apartment. These transactions were eliminated from the dataset. An additional 10 transactions were eliminated from the dataset due to having inaccurate postal code information and being falsely stated as located within the research area of 00320 (Etelä-Haaga).

After the aforementioned eliminations, the dataset totaled 1,350 unique transactions.

The location for each transaction was determined using an ESRI ArcMap desktop application. This provided the ETRS-TM35FIN coordinates for each transaction. If the aforementioned application was unable to locate the coordinates for a certain transaction, they were collected manually using a free web serviced map application provided by the National Land Survey of Finland called MML Karttapaikka. (National Land Survey of Finland, 2016)

The table below presents descriptive statistics of the main variables of the dataset used in this thesis.

	Lower Quartile	Median	Average	Upper Quartile
Floor area (sqm)	31	45	49	58
Room count	1	2	2	3
Floor number	1	2	2	3
Floors in building	3	3	3	4
Construction year	1959	1961	1963	1963
Total time-on-market (TOM)	20	32	47	57
Unlevered transaction price, EUR	141 000 €	179 000 €	196 155 €	227 000 €
Unlevered transaction price, EUR/sqm	3 594 €	4 144 €	4 220 €	4 758 €

	Proportion	Total
Apartment in excellent condition	1 %	8
Apartment in good condition	51 %	685
Apartment in satisfactory condition	43 %	586
Apartment in poor condition	5 %	71
Balcony in apartment	5 %	67
Elevator in building	12 %	156
Sauna in apartment	0 %	1
Freehold plot	89 %	1198

Table 4. Descriptive statistics of transaction data

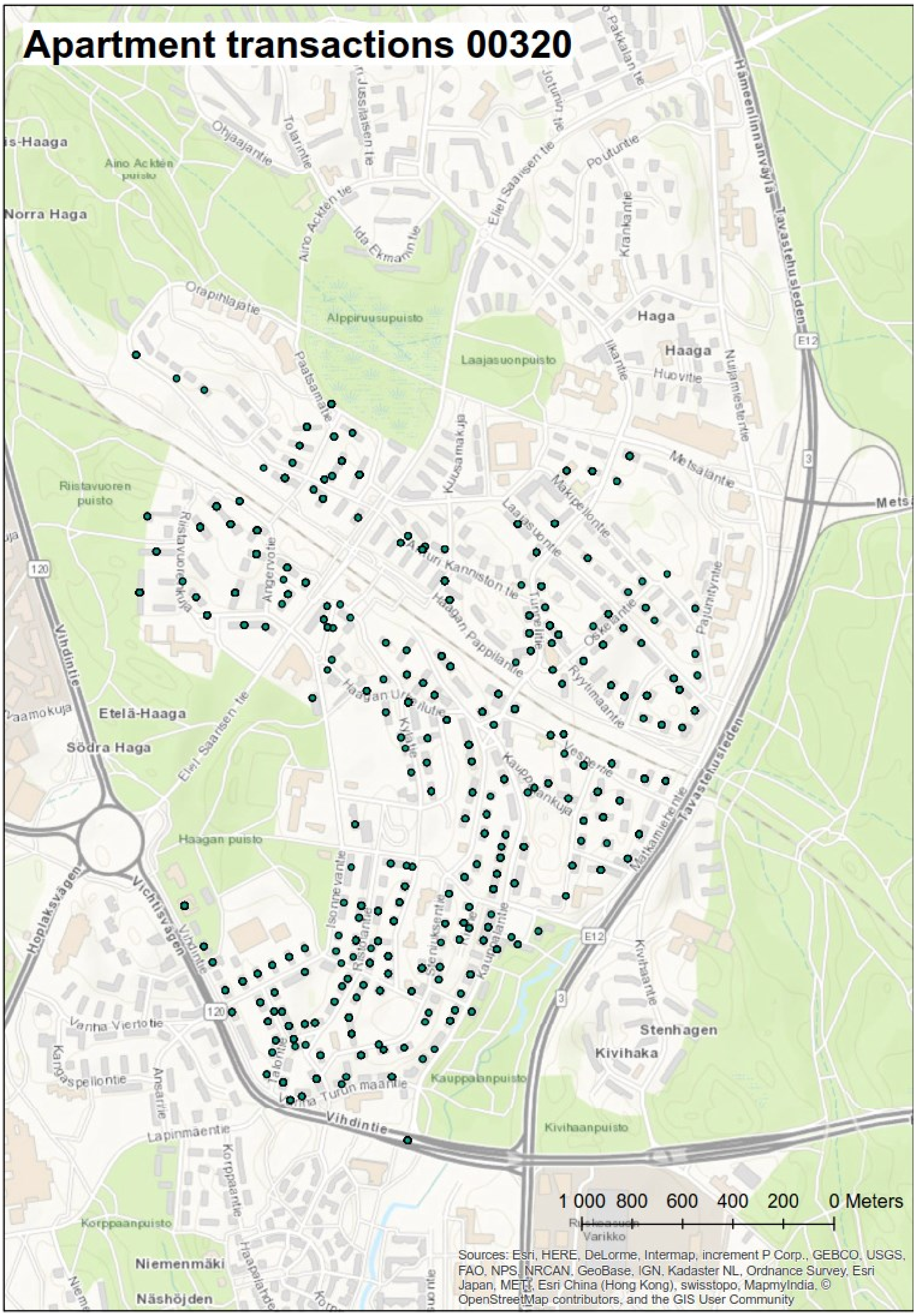

Figure 10. Apartment transactions visualized on a map. Map source: ESRI Arc GIS.

3.4 Grocery Store Data

Data concerning the grocery stores located within the research area of the 00320 postcode were obtained using the Google Maps service and collected on November 4th 2017. A total of four grocery stores are located within the aforementioned postcode and are listed below:

#	Name	Operator	Address
1	K-Supermarket Haaga	Kesko Oyj	Tunnelitie 5
2	K-Market Tunnelitie	Kesko Oyj	Tunnelitie 10
3	K-Market Kauppalantie/Etelä-Haaga	Kesko Oyj	Kauppalantie 23
4	Alepa Vihdintie	HOK-Elanto	Vihdintie 7

Table 5. List of grocery store within the research area (00320, Etelä-Haaga)

Additionally, a convenience store, R-Kioski and a service station, Shell Helsinki Etelä-Haaga, were also found to be located within the research area and both are assumed to sell groceries. They were, however, not included in the dataset as the scope of this thesis was limited to research the effect proximity to grocery stores has on housing prices.

The ETRS-TM35FIN coordinates for each of the grocery stores were obtained using a free web serviced map application provided by the National Land Survey of Finland called MML Karttapaikka. (National Land Survey of Finland, 2016)

The distance of each of the aforementioned grocery stores was calculated to each of the 1,350 apartment transactions. This was done by treating the distance as the Euclidean distance, and the distance between two points was calculated using a derived Pythagorean theorem, using the following inputs: (Black, 2004)

$$S = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

where

x_1 is the E-coordinate of the apartment transaction in ETRS-TM35FIN form
x_2 is the E-coordinate of the grocery store in ETRS-TM35FIN form
y_1 is the N-coordinate of the apartment transaction in ETRS-TM35FIN form
y_2 is the N-coordinate of the grocery store in ETRS-TM35FIN form

This assumes that the coordinates are located on a flat surface and, therefore, does not take into consideration the curvature of earth. Thus, the calculated distances differ very slightly from the true distance, but due to the short total distances this difference has no true effect on the analysis.

3.5 Additional Data

Based on previous research into real estate determinants, the dataset collected from Hintaseurantapalvelu was deemed to require some additions.

Numerous previous studies into determinants of housing prices, both internationally and in Finland, have found that distance to CBD is a significant factor affecting the price of an apartment. For this reason, the distance to CBD of each transaction was calculated treating the distance as Euclidean distance, as was done with distance to each grocery store. The Helsinki Railway station located at Kaivokatu 1, 00100 Helsinki was used as the proxy location for Helsinki CBD. (Laine, 2015; Koramaz & Dokmeci, 2012; Kiel & Zabel, 2008)

Another addition to the data was each transaction's distance to Huopalahti Railway station, the only railway station within the research area. Larinkoski (2016) and Laakso (1997) both found the distance to a railway station to have an effect on housing prices. Huopalahti Railway station is located at Kylätie 25, 00320 Helsinki.

The ETRS-TM35FIN coordinates for both of the aforementioned locations were obtained using a free web serviced map application provided by the National Land Survey of Finland called MML Karttapaikka. (National Land Survey of Finland, 2016)

Furthermore, as discussed in the literature review of past research into housing prices, macroeconomic factors, such as median income and unemployment rates have been found to effect housing prices. (Nguyên, 2014; Barot & Yang, 2002; Stadelmann, 2010; Sirmans et al., 2005)

The transaction data was thus supplemented with data concerning these factors. The aforementioned macroeconomic factors were obtained from the grid database of Statistics Finland which contains co-ordinate based statistical data calculated by map grid. The grid database contains key variables such as population structure, education, income, demographics as well as living circumstances within 250 m x 250m grids. The data covers the whole of Finland. The data used to supplement the transaction data was from 2015. The matching of each transaction to the grid it is situated in was conducted using an ESRI ArcMap desktop application and was based on the ETRS-TM35FIN coordinate-system. (Statistics Finland, 2017)

Additionally, Li & Brown (1980) as well as Oates (1969) found that the property tax level has an effect on housing prices. Data concerning the property tax level during the year of each housing transaction was added to the dataset. The information was obtained from the City of Helsinki website. (City of Helsinki Urban Facts, 2017; City Council of Helsinki, 2015)

Lastly, Man & Bell (1994) have found that the sales tax levied on real estate transactions has an effect on housing prices. In Finland, the sales tax on apartments was increased from the beginning of March 2013. The sales tax rate at the time of each apartment transaction was added to the dataset. (TalousSuomi, 2013)

4 Empirical analysis

The empirical analysis was conducted using Gnu Regression, Econometrics and Time-series Library (GRETL). It is an open-source cross-platform software package for the purpose of econometric analysis. It is written in the C programming language. (Cottrell & Luchetti, 2017)

The data was modified to fit GRETL requirements using Microsoft Excel. The modification included naming all variables in English as well as formatting some of the variable outputs.

The following 21 variables as well as an individual identification number for each apartment transaction were used as the initial dataset for the empirical analysis.

Input variable	Variable description
ID	Is the individual identification number of the apartment transaction
Size	Describes the size of the apartment in sqm
ConstYear	Describes the construction year of the building
RoomC	Describes the room count of the apartment
FloorCount	Describes the amount of floors in the building
Floor	Describes in which floor the apartment is located
DebtFreePrice	Describes the debt free transaction price of the apartment
NewApt	Describes if the apartment was sold as a new construction or as an old construction
Condition	Describes the condition of the apartment
TransQ	Describes the quarter and year in which the apartment was sold
PlotOwner	Describes the land ownership of the building
TOM	Describes the amount of time the apartment was on the market in days
ElevatorDummy	Describes if the building had an elevator
SaunaDummy	Describes if the apartment has a sauna
BalconyDummy	Describes if the apartment has a balcony
DistGrocMin	Describes the apartment's distance to the closest grocery store
DistHuopa	Describes the apartment's distance to Huopalahti train station
DistCBD	Describes the apartment's distance to Helsinki CBD
Unemp	Describes the unemployment rate of the grid the apartment is located in
MedInc	Describes the median income of the grid the apartment is located in
PropTax	Describes the property tax rate at the time of the apartment transaction
SalesTax	Describes the sales tax rate at the time of the apartment transaction

Table 6. List of input variables of OLS-analysis

Prior to beginning the analysis of the data, certain variables were dummified in order to obtain the effect of these qualitative determinants in the regression. The table below illustrates the variables that were dummified, the omitted dummy as well as the description of the omitted dummy.

Input variable	Encoded values	Omitted dummy	Description of omitted dummy
NewApt	New and Old	DNewApt_2	Apartment is located in a new building
Condition	Good, Satisfactory, Poor and Excellent	DCondition_4	Apartment in excellent condition
TransQ	Q12010 – Q42016	DTransQ_28	Apartment sold during Q4 2016
PlotOwner	Owned and Leased	DPlotOwner_2	Building located on a leased plot
ElevatorDummy	Yes and No	DElevatorDummy_2	Building has an elevator
SaunaDummy	Yes and No	DSaunaDummy_2	Apartment has a sauna
BalconyDummy	Yes and No	DBalconyDummy_2	Apartment has a balcony

Table 7. Dummified variables, the omitted dummy as well as its description

In addition to the dummification of some variables, the logarithmic values of some variables were added. The reasoning behind this is to increase the accuracy of the regression. By using the logarithmic values of some variables the extrema in the data can be reduced and it also curtails the effects of outliers. Economic variables are commonly transferred to logarithmic form. The table below illustrates the variables that were transformed to logarithmic form. (Wooldridge, 2006)

Input variable	Variables logarithmic form
DebtFreePrice	1_DebtFreePrice
Size	1_Size
ConstYear	1_ConstYear
TOM	1_TOM
MedInc	1_MedInc

Table 8. Variables transformed to logarithmic form

The first OLS-model executed with the above mentioned 21 variables with the debt free transaction price (Variable DebtFreePrice) as the dependent variable yielded an Adjusted R-squared value of 0,892116, which is equal to around 89.2 %. This means that around 89.2 % of the change in the dependent variable, the apartments value in €, is explained by the used variables. This is a very high figure and suggests that the model does a very good job at explaining apartment value.

When the first OLS-model was executed, GRETL automatically omitted the PropTax variable from the model due to exact collinearity. This means that the PropTax variable can be linearly predicted exactly from the other variables. If left in the model, it causes inaccuracies and is the reason it was omitted. The initial model also dropped 4 transaction due to missing or incomplete observations, in other words meaning that these 4 transactions were missing data in some variables. Thus the model was based on a dataset consisting of 1346 transactions.

In order to increase the accuracy of the regression model, variables with a p-value higher than 0.1 = 10 % were omitted. In other words, a variable with a p-value of 0.1 (10 %) indicates that there is 90 % probability that the variable is having an effect on the dependent variable. (Princeton University Library, 2007)

Using the aforementioned threshold p-value, a total of 14 variables were omitted from the model. The table below lists the omitted variables and their p-values.

Variable	**P-value**
DTransQ_17	0.6193
DTransQ_19	0.2471
DTransQ_21	0.5913
DTransQ_22	0.8264
DTransQ_23	0.8935
DTransQ_24	0.7887
DTransQ_25	0.8973
DSaunaDummy_1	0.7512
DBalconyDummy_1	0.4718
Unemp	0.2423
SalesTax	0.5131
DCondition_2	0.8950
1_MedInc	0.5506
Floor	0.7021

Table 9. Omitted variables and their p-values

```
Omitted: OLS, using observations 1-1350 (n = 1346)
Missing or incomplete observations dropped: 4
Dependent variable: l_DebtFreePrice

                     coefficient    std. error    t-ratio    p-value
  ---------------------------------------------------------------
  const              -21,9648       6,40337       -3,430    0,0006     ***
  l_Size               0,576172     0,0205059     28,10     2,19e-136 ***
  l_ConstYear          4,16742      0,845796       4,927    9,40e-07   ***
  RoomC                0,0709078    0,00823742     8,608    2,09e-017 ***
  DNewApt_1           -0,0765140    0,0290121     -2,637    0,0085     ***
  DTransQ_1           -0,241091     0,0171452    -14,06     6,14e-042 ***
  DTransQ_2           -0,206998     0,0171918    -12,04     9,57e-032 ***
  DTransQ_3           -0,186711     0,0167271    -11,16     1,06e-027 ***
  DTransQ_4           -0,173557     0,0180414     -9,620    3,24e-021 ***
  DTransQ_5           -0,149942     0,0160924     -9,318    4,86e-020 ***
  DTransQ_6           -0,154514     0,0177036     -8,728    7,74e-018 ***
  DTransQ_7           -0,151007     0,0187174     -8,068    1,60e-015 ***
  DTransQ_8           -0,137715     0,0191119     -7,206    9,71e-013 ***
  DTransQ_9           -0,152266     0,0210291     -7,241    7,58e-013 ***
  DTransQ_10          -0,0957036    0,0195889     -4,886    1,16e-06   ***
  DTransQ_11          -0,112911     0,0193501     -5,835    6,76e-09   ***
  DTransQ_12          -0,0650131    0,0177339     -3,666    0,0003     ***
  DTransQ_13          -0,0712884    0,0183737     -3,880    0,0001     ***
  DTransQ_14          -0,0808587    0,0189444     -4,268    2,11e-05   ***
  DTransQ_15          -0,0467627    0,0180608     -2,589    0,0097     ***
  DTransQ_16          -0,0631635    0,0171304     -3,687    0,0002     ***
  DTransQ_18          -0,0371675    0,0182262     -2,039    0,0416     **
  DTransQ_20          -0,0430474    0,0168390     -2,556    0,0107     **
  DTransQ_26           0,0439887    0,0163257      2,694    0,0071     ***
  DTransQ_27           0,0481583    0,0191849      2,510    0,0122     **
  DPlotOwner_1         0,0363561    0,0124876      2,911    0,0037     ***
  DElevatorDummy_1    -0,0616711    0,0112243     -5,494    4,70e-08   ***
  DistGrocMin         -7,19244e-05  2,34606e-05   -3,066    0,0022     ***
  DistHuop             7,16974e-05  3,14575e-05    2,279    0,0228     **
  DistCBD              7,77931e-05  2,66225e-05    2,922    0,0035     ***
  DCondition_1         0,0952897    0,00666723    14,29     3,56e-043 ***
  DCondition_3        -0,0650887    0,0148763     -4,375    1,31e-05   ***
  l_TOM               -0,0259015    0,00396023    -6,540    8,77e-011 ***
  FloorCount          -0,0242943    0,00647548    -3,752    0,0002     ***

Mean dependent var   12,11908   S.D. dependent var   0,356244
Sum squared resid    17,89318   S.E. of regression   0,116782
R-squared            0,895174   Adjusted R-squared   0,892537
F(33, 1312)          339,5128   P-value(F)           0,000000
Log-likelihood       997,7870   Akaike criterion    -1927,574
Schwarz criterion   -1750,608   Hannan-Quinn        -1861,290

Log-likelihood for DebtFreePrice = -15314,5
```

Figure 11. Final results of the OLS-regression analysis

The final results of the OLS-regression analysis can be seen in Figure 11. The model's Adjusted R-squared is essentially unchanged from the initial model and is 0.892537, which is approximately 89.3 %. The increase in the model's ability to replicate the debt free price of apartment transactions is only 0.1 %. This means that the final model is a fraction more accurate than the initial model.

In regression analysis, multicollinearity in the model is a cause of major problems. If it exists, some independent variables are correlated with other independent variables. Severe multicollinearity causes an increase in the variance in the regression coefficients and makes them unstable. This causes coefficients to seem insignificant even though a significant relationship exists between the dependent and independent variables.

The OLS-regression was tested for the existence of multicollinearity in GRETL using the VIF values of each variable. A VIF value of 1 means that no correlation exists. Values between 1 and 5 indicated moderate correlation. A common threshold value that indicates multicollinearity problems is 5. A vast majority of the variables in the final OLS-regression had a VID value of less than 2 meaning that no multicollinearity issues exists. The variables that had a higher VIF value than 5 were 1_Size, Roomc, DistHuop and DistCBD. This is deemed not to be problematic as the size and room count of an apartment are naturally highly correlated with the debt free value of an apartment. Moreover, as the dataset used was from a relatively small geographical area, the high correlation of the two distance variables is not seen as problematic to the model. Additionally, the correlation matrix for the variables used in the final OLS-regression are listed in Appendix 3. (Minitab, 2017)

The figure below visualizes the actual plots compared to the fitted plots of the dataset. The blue line illustrates the derived OLS-model, whereas the red crosses indicate the actual values of the apartment transactions. As can be seen, the data is well aligned with the predicted values produced by the model and captures the observations accurately. There are some outlying observations and the elimination of these datapoints would increase the accuracy of the model. Due to the model's very high Adjusted R-squared value, this is seen as unnecessary.

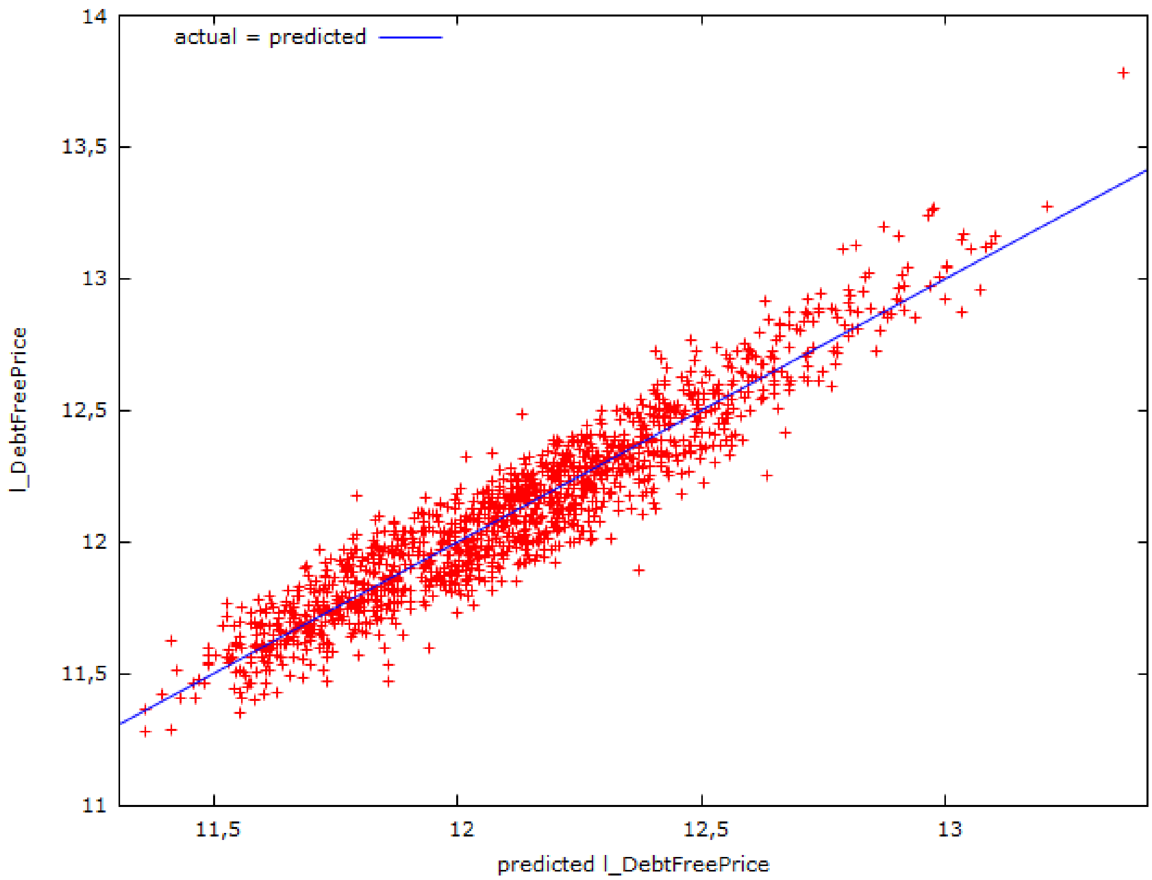

Figure 12. Actual vs. fitted plot

Heteroscedasticity of the OLS-model was tested using the White's test and Breusch-Pagan test with the null hypothesis that heteroscedasticity is not present in the model. The result for both tests was a p-value of 0.000 = 0%. This means that the null hypothesis has to be rejected and that the model contains heteroscedasticity. Thus the model does not provide full accuracy. This, however, is acceptable within this study as the aim is to study the general effect distance to a grocery store has on housing prices.

Furthermore, the normality of residuals was tested to provide further evidence of the relative accuracy of the OLS-regression. As is evident from the figure below, the distribution of the disturbance terms is very much normal and indicates that the model is sound.

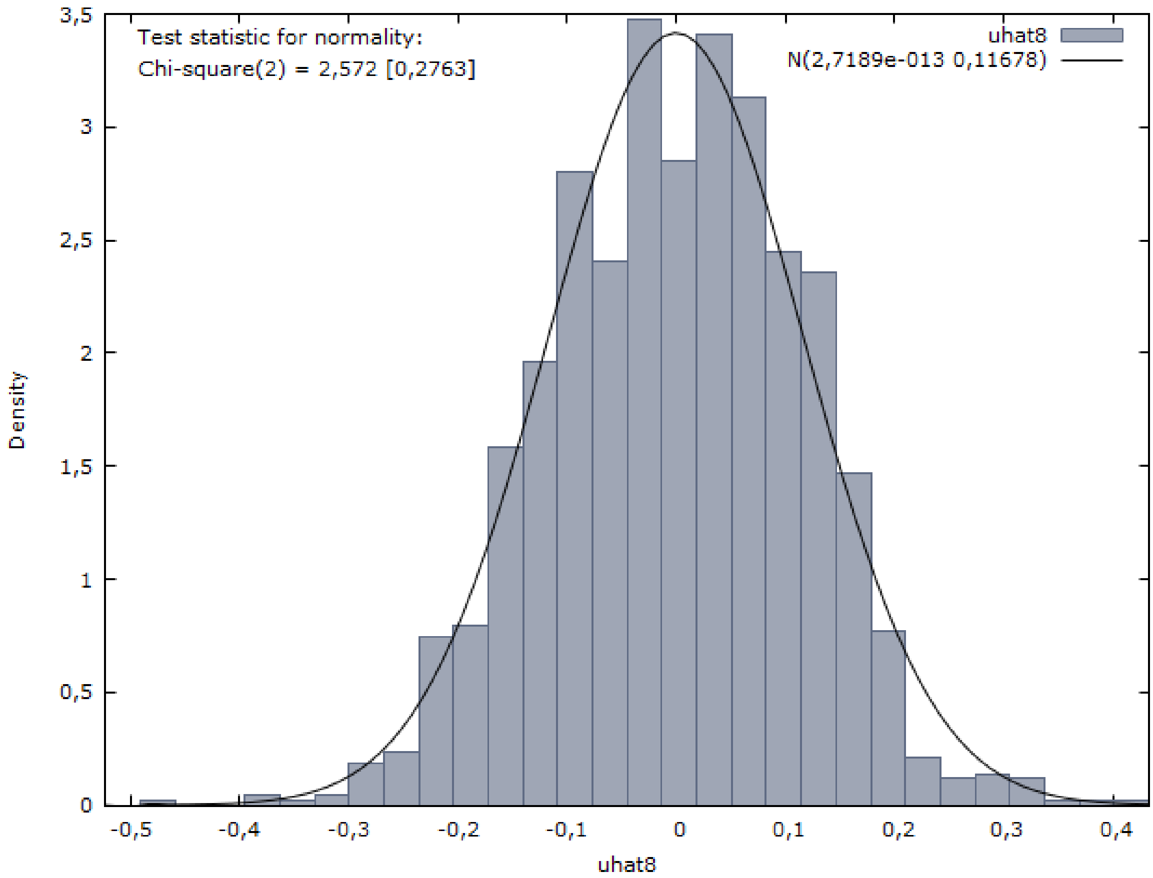

Figure 13. Normality of residuals

5 Results

The result of the conducted OLS-regression is illustrated in the figure below. It shows the derived coefficients for the variables that were not eliminated from the model, as explained in the chapter four, and their effect on the dependent variable, the logarithmic form of the debt free price of an apartment.

```
Omitted: OLS, using observations 1-1350 (n = 1346)
Missing or incomplete observations dropped: 4
Dependent variable: l_DebtFreePrice

                     coefficient    std. error    t-ratio   p-value
  ---------------------------------------------------------------
  const             -21,9648       6,40337       -3,430    0,0006    ***
  l_Size              0,576172     0,0205059     28,10     2,19e-136 ***
  l_ConstYear         4,16742      0,845796       4,927    9,40e-07  ***
  RoomC               0,0709078    0,00823742     8,608    2,09e-017 ***
  DNewApt_1          -0,0765140    0,0290121     -2,637    0,0085    ***
  DTransQ_1          -0,241091     0,0171452    -14,06     6,14e-042 ***
  DTransQ_2          -0,206998     0,0171918    -12,04     9,57e-032 ***
  DTransQ_3          -0,186711     0,0167271    -11,16     1,06e-027 ***
  DTransQ_4          -0,173557     0,0180414     -9,620    3,24e-021 ***
  DTransQ_5          -0,149942     0,0160924     -9,318    4,86e-020 ***
  DTransQ_6          -0,154514     0,0177036     -8,728    7,74e-018 ***
  DTransQ_7          -0,151007     0,0187174     -8,068    1,60e-015 ***
  DTransQ_8          -0,137715     0,0191119     -7,206    9,71e-013 ***
  DTransQ_9          -0,152266     0,0210291     -7,241    7,58e-013 ***
  DTransQ_10         -0,0957036    0,0195889     -4,886    1,16e-06  ***
  DTransQ_11         -0,112911     0,0193501     -5,835    6,76e-09  ***
  DTransQ_12         -0,0650131    0,0177339     -3,666    0,0003    ***
  DTransQ_13         -0,0712884    0,0183737     -3,880    0,0001    ***
  DTransQ_14         -0,0808587    0,0189444     -4,268    2,11e-05  ***
  DTransQ_15         -0,0467627    0,0180608     -2,589    0,0097    ***
  DTransQ_16         -0,0631635    0,0171304     -3,687    0,0002    ***
  DTransQ_18         -0,0371675    0,0182262     -2,039    0,0416    **
  DTransQ_20         -0,0430474    0,0168390     -2,556    0,0107    **
  DTransQ_26          0,0439887    0,0163257      2,694    0,0071    ***
  DTransQ_27          0,0481583    0,0191849      2,510    0,0122    **
  DPlotOwner_1        0,0363561    0,0124876      2,911    0,0037    ***
  DElevatorDummy_1   -0,0616711    0,0112243     -5,494    4,70e-08  ***
  DistGrocMin        -7,19244e-05  2,34606e-05   -3,066    0,0022    ***
  DistHuop            7,16974e-05  3,14575e-05    2,279    0,0228    **
  DistCBD             7,77931e-05  2,66225e-05    2,922    0,0035    ***
  DCondition_1        0,0952897    0,00666723    14,29     3,56e-043 ***
  DCondition_3       -0,0650887    0,0148763     -4,375    1,31e-05  ***
  l_TOM              -0,0259015    0,00396023    -6,540    8,77e-011 ***
  FloorCount         -0,0242943    0,00647548    -3,752    0,0002    ***

Mean dependent var   12,11908   S.D. dependent var   0,356244
Sum squared resid    17,89318   S.E. of regression   0,116782
R-squared            0,895174   Adjusted R-squared   0,892537
F(33, 1312)          339,5128   P-value(F)           0,000000
Log-likelihood       997,7870   Akaike criterion    -1927,574
Schwarz criterion   -1750,608   Hannan-Quinn        -1861,290

Log-likelihood for DebtFreePrice = -15314,5
```

Figure 14. General statistics and results of OLS-model

Some coefficients have negative values while some have positive values. Negative coefficients mean that the value of each such independent variable has a lowering effect on the dependent variable. Independent variables with a positive coefficient have an opposite effect on the dependent variable.

Due to the dependent variable being in logarithmic form, the coefficients for independent variables that are not in logarithmic form are interpreted as follows; a change of one unit in the value of the independent variable will have an effect of 100 x the value of the coefficient of the independent variable on the dependent variable. For example, the coefficient for the independent variable RoomC (room count of the apartment) is approximately 0.071. As the dependent variable is in logarithmic form, the increase in the amount of rooms of the apartment by one has around a 7 percent (0.071*100 = 7) effect on the value of the apartment, all other variables being equal. This is true for all independent variables that are not also in logarithmic form. (Kephart, 2013; Cornell Statistical Consulting Unit, 2012)

For independent variables that are also in logarithmic form, the interpretation of the coefficients of the OLS-model are different than to those that are not in logarithmic form. When both the dependent and independent variables are in logarithmic form, a one percent change in the value of the independent variable, will have a percentage change on the dependent variable equal to the coefficient. For example, the coefficient for the independent variable 1_Size (construction year of the building) is approximately 0.58. As it and the dependent variable are in logarithmic form a one percent change in the size of the apartment has a 0.58 percent change in the debt free value of the apartment, all other variables being equal. (Kephart, 2013; Cornell Statistical Consulting Unit, 2012)

The result for the coefficient concerning the effect distance to a grocery store (DistGrocMin) has on housing prices is presented in the table below.

Variable	Coefficient	Std. Error	T-ratio	P-value
DistGrocMin	-0.0000719244	0.0000234606	-3.066	0.0022

Table 10. Regression statistics and results for DistGrocMin independent variable

Due to the variable's p-value of 0.0022, the distance of a grocery store has an effect on housing prices at a 99 % significance level. As the dependent variable, debt free value of an apartment, is in logarithmic form while the distance to a grocery store variable (DistGrocMin) is not, the coefficient is interpreted as follows; an increase in one meter of the distance to a grocery store has a 0.00719244 percent negative effect on the value of an apartment. In other words, each increase of 100 meters in the distance to a grocery store decreases the value of an apartment by approximately -0.72 percent. Similarly at a distance of 1 kilometer the decrease in apartment value is around 7.2 percent.

Using the average debt free price of the apartment transaction data as a proxy, the aforementioned effect for each meter of increased distance to a grocery store decreases the value of an apartment by approximately 14 euros.

5.1 Limitations

The main limitation of this thesis is its narrow geographical scope. As the research area is only a single post code within Helsinki, the results of the study may not be applicable in other geographical areas. As is stated in chapter two, the results of housing price determinants vary greatly between different geographical areas and can have contrary findings depending on the geographical scope of the data used. By widening the geographical scope of the data and broadening its scope to other cities in Finland or even other countries would have yielded more profound results.

Furthermore, as is evident from the current academic research on housing price determinants, the number of determinants that have been found to have an effect on housing prices is vast. The number of variables chosen to be used in this thesis was not exhaustive meaning that there are many housing price determinants that are not included in the conducted OLS-regression. Thus, by adding further variables to the dataset used to conduct the regression more accurate results would most likely have been found. The main limiter of determinants in this thesis was the Hintaseurantapalvelu data. The dataset only consisted of a limited amount of attributes for each apartment transaction and thus created limitations for the number of variables that could be used in the regression analysis.

The amount of locational determinants used in the regression analysis was limited. Only the distance to Helsinki CBD and Huopalahti railway station, in addition to the distance to the nearest grocery store, were used. Distance to major roads and other forms of public transport, such as tramways and bus routes have been found to effect housing prices. By adding variables that take into consideration transportation possibilities within the geographical scope of the study and in its direct vicinity, accuracy of the regression model could be most probably improved. (Celik and Yankaya, 2005; Agostini & Palmucci, 2006; Vanhanen, 2016)

Furthermore, locational determinants such as distance to nature and the closest body of water have been found to effect housing prices. Laakso (1998) found that within the Helsinki Metropolitan Area, an apartment's distance to the sea has an effect on housing prices. By adding locational variables such as distance to the sea and distance to the Central Park of Helsinki, a large forest area near Etelä-Haaga, would most likely improve the accuracy of the regression mode.

Another limitation of this study is the absence of micro locational determinants such as the view of the apartment and the noise level around the building. These have been found to be determinants of housing prices by previous research both in Finland as well as internationally. The reason for the absence of these variables is the lack of data concerning the aforementioned determinants. (Benson et al., 1998; Benson et al., 2000; Vanhanen, 2016)

Another limitation of the thesis is the type of housing used in the regression analysis. In chapter one, this study was limited to only include apartments located in apartment house companies as well as in multi-storey residential buildings. Hintaseurantapalvelu data also includes transactions of terraced houses as well as single family homes. By adding these transactions to the dataset, the result of the regression analysis would most likely have been altered.

Distance to commercial and retail services other than grocery stores have been found to effect housing prices. An apartment's distance to, for example, restaurants, bars, pubs and shopping centers were not included in this study. The addition of these variables may have increased the accuracy of the OLS-model. (Sing & Knaap, 2004; Addae-Dapaah & Lan, 2010; Stadelmann, 2010)

The study did not take into consideration the size of a grocery store as a housing price determinant. As is evident from previous research, the size of retail premises has been found to have varying effect on housing prices and thus the inclusion of this variable in the regression would have most likely provided more accurate results. (Sirpal, 1994; Rosiers et al., 1996)

As is evident from the research of Pope & Pope (2015) and Ding (2015), the company operating a supermarket has been found to effect housing prices. In other words, different grocery store chains have been found to have varying effects on housing prices. The four grocery stores included in this thesis were from two different grocery store chains and included the separation of the two chains may have improved the regression model.

This thesis uses distance as a proxy for proximity. As is evident from the research conducted by Jang & Kang (2015) as well as Chang et al. (2015), accessibility of retail premises has been found to effect housing prices. By including this aspect into the research conducted in this thesis, the findings may have been different.

Lastly, as discussed in chapter four, the elimination of outlying observations that are evident in figure 12, which plots the actual and fitted values of the OLS-model, would most likely increase the accuracy of the regression model. This may have an effect on the Adjusted R-squared value of the final OLS-model.

6 Discussion and conclusions

The purpose of this thesis was to study if and how much the proximity of a grocery store effects apartment values. Additionally, if the findings suggest that the distance of a grocery store effects housing prices, its purpose was to research why this is the case. The following research questions were set in the first chapter of this thesis.

- Does the proximity of a grocery store affect the value of an apartment? In other words is there a correlation between the distance to a grocery store and value of an apartment?
- If the proximity of a grocery store does affect the value of an apartment, how much is the effect?
- If the proximity of a grocery store affects housing prices, what is/are the reason/reasons behind the affect?

Previous academic literature on the subject had varying results. In general, retail premises were found to have an effect on apartment values. According to the literature, the effect of proximity to smaller retail premises, such as grocery stores, has been found to be the following; the closer the retail premises the more valuable the apartment. The effect, however, differs with different size retail premises. For larger shopping centers, the disamenities associated with close proximity are overcome at around 500 meters and housing prices decrease as distance increase, all else being equal. (De Rosiers et al., 1996; Aliyu et al., 2011; Li & Brown, 1980; Addae-Dapaah & Lan, 2010)

The findings of this thesis were similar to previous research on the topic as the proximity of a grocery store was found to have an effect on housing prices. As was described in chapter five, the effect the distance of a grocery store had on housing prices had a negative coefficient; as the distance increased, the value of the apartment decreased, all else being equal. The coefficient of the effect derived by the OLS-model was -0.0000719244. This means that that an increase of 1 meter in the distance to a grocery store has a 0.00719244 percent negative effect on the value of an apartment. An increase of 100 meters, thus, has a decreasing effect of 0.72 percent on housing prices.

This answers the first research question, as the findings of thesis indicate that the distance of a grocery store does effect the value of an apartment, at least within the suburban area of Etelä-Haaga in Helsinki.

Previous findings on how much the effect distance to a grocery store has on housing prices have been slightly different to the results of this thesis. Pope & Pope (2015) found that in the USA, the opening of a Walmart supermarket had a positive linear effect on housing prices. Within 800 meters, housing prices increased 2 % - 3 % while the increase was 1 % - 2 % at a distance of 800 meters to 1.6 kilometers. The price hike within 0.5 miles was observed to be \$ 7,000 and \$ 4,000 between 0.5 miles to 1 mile. Contrarily, Ding (2015) found that the closing of a TROSA-chain grocery store increased housing prices within an 800 meter radius by 35.9 % and 33.3 % for homes 1.6 kilometers to 3.2 kilometers away. He does, however, conclude that other factors than the closing of the TROSA grocery store affected the decrease in housing prices in the area.

Considering the second research question, how much is the effect grocery stores have on housing prices, the findings of this thesis indicate that the answer is approximately 0.0072 percent, which gives an answer to the question. Using the average debt free price of the apartment transaction data as a proxy, the previously stated effect amounts to approximately 14 euros for each meter. Comparing the findings of this thesis to findings of previous research on the subject, indicates the effect is not uniform. Within the USA, Pope & Pope (2015), found the effect to be 2 % - 3 % within 800 meters while the findings of this thesis indicate that at a similar distance the effect is approximately 5.8 % within the Etelä-Haaga suburb of Helsinki.

The effect seems to be very much dependent on the dataset used in the analysis as well as the geographical scope of the study. Evidently no uniform pattern on the effect can been found. Reasons behind the differences in findings are numerous. Most likely the largest reasons include the size of the grocery store, an aspect that was not included in this thesis. The research of Pope & Pope (2015) looked into Walmart grocery stores, known to be large hypermarkets with a vast majority of customers arriving by car. The grocery stores that were included in the research of this thesis were supermarkets or smaller grocery stores located within a residential neighborhood. While some customers arrive by car, a large amount of customers also visit the grocery stores by foot. The difference in the most common mode of getting to the grocery store is likely linked to a grocery stores effect on housing prices.

As is evident from the plethora of current literature concerning housing price determinants, the field has been extensively researched. Despite this, no uniform effect distance of a grocery store has on housing prices has been found, thus indicating that the third research question, why the distance to grocery stores affects housing prices, is complex and does not have a definitive answer. It seems as though the amount of possible reasons are numerous. As many housing price determinants are subjective in nature, individual preferences have a large effect on housing prices and the value of very similar apartments in even the same building can have large differences. Based on the findings of current literature as well as this thesis, the aforementioned most likely plays a large role in explaining the reasoning behind the effect.

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Appendices

Appendix 1. Initial OLS-model
Appendix 2. List of non-numeric variables used in OLS-model
Appendix 3. Correlation matrix of coefficients of final OLS-model

Appendix 1. Initial OLS-model

Original: OLS, using observations 1-1350 (n = 1346)
Missing or incomplete observations dropped: 4
Dependent variable: l_DebtFreePrice

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−22,6402	6,62822	−3,416	0,0007	***
l_Size	0,577470	0,0207314	27,85	<0,0001	***
l_ConstYear	4,22577	0,874069	4,835	<0,0001	***
RoomC	0,0701554	0,00832236	8,430	<0,0001	***
DNewApt_1	−0,0692800	0,0330876	−2,094	0,0365	**
DTransQ_1	−0,288319	0,0817615	−3,526	0,0004	***
DTransQ_2	−0,253278	0,0818035	−3,096	0,0020	***
DTransQ_3	−0,232855	0,0816727	−2,851	0,0044	***
DTransQ_4	−0,220529	0,0820626	−2,687	0,0073	***
DTransQ_5	−0,197543	0,0816787	−2,419	0,0157	**
DTransQ_6	−0,201464	0,0819126	−2,459	0,0140	**
DTransQ_7	−0,197682	0,0821701	−2,406	0,0163	**
DTransQ_8	−0,185689	0,0822440	−2,258	0,0241	**
DTransQ_9	−0,199186	0,0827166	−2,408	0,0162	**
DTransQ_10	−0,143311	0,0823910	−1,739	0,0822	*
DTransQ_11	−0,159907	0,0822654	−1,944	0,0521	*
DTransQ_12	−0,110998	0,0819448	−1,355	0,1758	
DTransQ_13	−0,110852	0,0774186	−1,432	0,1524	
DTransQ_14	−0,104322	0,0735417	−1,419	0,1563	
DTransQ_15	−0,0708200	0,0732631	−0,9667	0,3339	
DTransQ_16	−0,0852212	0,0730516	−1,167	0,2436	
DTransQ_17	−0,0362656	0,0729739	−0,4970	0,6193	
DTransQ_18	−0,0606048	0,0733238	−0,8265	0,4087	
DTransQ_19	−0,0441836	0,0733595	−0,6023	0,5471	
DTransQ_20	−0,0667127	0,0730175	−0,9137	0,3611	
DTransQ_21	−0,0394019	0,0733612	−0,5371	0,5913	
DTransQ_22	−0,0160061	0,0729630	−0,2194	0,8264	
DTransQ_23	−0,00973997	0,0727486	−0,1339	0,8935	
DTransQ_24	−0,0196240	0,0732048	−0,2681	0,7887	
DTransQ_25	0,00935255	0,0724552	0,1291	0,8973	
DTransQ_26	0,0312887	0,0702103	0,4456	0,6559	
DTransQ_27	0,0369953	0,0707049	0,5232	0,6009	
DPlotOwner_1	0,0354493	0,0126518	2,802	0,0052	***
DElevatorDummy_1	−0,0658006	0,0115149	−5,714	<0,0001	***
DSaunaDummy_1	0,0386476	0,121857	0,3172	0,7512	
DBalconyDummy_1	0,0157599	0,0218980	0,7197	0,4718	
Unemp	0,415132	0,354864	1,170	0,2423	
SalesTax	−6,04628	9,24219	−0,6542	0,5131	
DistGrocMin	−6,27844e-05	2,46002e-05	−2,552	0,0108	**
DistHuop	5,66221e-05	3,39131e-05	1,670	0,0952	*
DistCBD	6,94530e-05	3,05094e-05	2,276	0,0230	**
DCondition_1	0,100735	0,0465213	2,165	0,0305	**
DCondition_2	0,00619810	0,0469517	0,1320	0,8950	
DCondition_3	−0,0597257	0,0489116	−1,221	0,2223	
l_TOM	−0,0261350	0,00401824	−6,504	<0,0001	***

l_MedInc	0,0351659	0,0588995	0,5971	0,5506	
FloorCount	−0,0271599	0,00684173	−3,970	<0,0001	***
Floor	0,00133361	0,00348570	0,3826	0,7021	

Mean dependent var	12,11908	S.D. dependent var	0,356244
Sum squared resid	17,77159	S.E. of regression	0,117011
R-squared	0,895886	Adjusted R-squared	0,892116
F(47, 1298)	237,6401	P-value(F)	0,000000
Log-likelihood	1002,376	Akaike criterion	−1908,752
Schwarz criterion	−1658,917	Hannan-Quinn	−1815,175

Test for omission of variables -
Null hypothesis: parameters are zero for the variables
DTransQ_17
DTransQ_19
DTransQ_21
DTransQ_22
DTransQ_23
DTransQ_24
DTransQ_25
DSaunaDummy_1
DBalconyDummy_1
Unemp
SalesTax
DCondition_2
l_MedInc
Floor
Test statistic: F(14, 1298) = 0,63432
with p-value = P(F(14, 1298) > 0,63432) = 0,837964

Appendix 2. List of non-numeric variables used in OLS-model

```
One or more non-numeric variables were found.
These variables have been given numeric codes as follows.

String code table for variable 11 (NewApt):
  1 = 'Old'
  2 = 'New'

String code table for variable 12 (Condition):
  1 = 'Good'
  2 = 'Satisfactory'
  3 = 'Poor'
  4 = 'Excellent'

String code table for variable 13 (TransQ):
  1 = 'Q12010'
  2 = 'Q22010'
  3 = 'Q32010'
  4 = 'Q42010'
  5 = 'Q12011'
  6 = 'Q22011'
  7 = 'Q32011'
  8 = 'Q42011'
  9 = 'Q12012'
 10 = 'Q22012'
 11 = 'Q32012'
 12 = 'Q42012'
 13 = 'Q12013'
 14 = 'Q22013'
 15 = 'Q32013'
 16 = 'Q42013'
 17 = 'Q12014'
 18 = 'Q22014'
 19 = 'Q32014'
 20 = 'Q42014'
 21 = 'Q12015'
 22 = 'Q22015'
 23 = 'Q32015'
 24 = 'Q42015'
 25 = 'Q12016'
 26 = 'Q22016'
 27 = 'Q32016'
 28 = 'Q42016'


String code table for variable 15 (PlotOwner):
  1 = 'Owned'
  2 = 'Leased'

String code table for variable 17 (ElevatorDummy):
  1 = 'No'
  2 = 'Yes'

String code table for variable 18 (SaunaDummy):
  1 = 'No'
  2 = 'Yes'

String code table for variable 19 (BalconyDummy):
  1 = 'No'
  2 = 'Yes'
```

Appendix 3. Correlation matrix of coefficients of final OLS-model

Correlation coefficients, using the observations 1 - 1350
(missing values were skipped)
5% critical value (two-tailed) = 0,0534 for n = 1350

l_DebtFree-Price	l_Size	l_ConstYear	RoomC	DNewApt_1	
1,0000	0,8912	0,2256	0,8490	-0,1287	l_DebtFree-Price
	1,0000	0,1226	0,9245	-0,0234	l_Size
		1,0000	0,0704	-0,6806	l_ConstYear
			1,0000	0,0166	RoomC
				1,0000	DNewApt_1

DTransQ_1	DTransQ_2	DTransQ_3	DTransQ_4	DTransQ_5	
-0,1071	-0,1047	-0,0896	-0,0116	-0,0409	l_DebtFree-Price
-0,0037	-0,0348	-0,0283	0,0421	0,0032	l_Size
-0,0541	0,0095	0,0302	0,0312	-0,0018	l_ConstYear
-0,0112	-0,0368	-0,0367	0,0516	0,0113	RoomC
0,0343	-0,0361	-0,0324	0,0077	0,0152	DNewApt_1
1,0000	-0,0413	-0,0429	-0,0392	-0,0448	DTransQ_1
	1,0000	-0,0424	-0,0388	-0,0444	DTransQ_2
		1,0000	-0,0403	-0,0461	DTransQ_3
			1,0000	-0,0421	DTransQ_4
				1,0000	DTransQ_5

DTransQ_6	DTransQ_7	DTransQ_8	DTransQ_9	DTransQ_10	
-0,0963	-0,0095	-0,0501	-0,0435	0,0312	l_DebtFree-Price
-0,0527	0,0298	-0,0218	-0,0056	0,0537	l_Size
-0,0417	-0,0092	-0,0535	0,0196	-0,0310	l_ConstYear
-0,0484	0,0309	-0,0131	-0,0163	0,0632	RoomC
0,0329	0,0308	0,0301	0,0270	0,0293	DNewApt_1
-0,0400	-0,0375	-0,0366	-0,0328	-0,0357	DTransQ_1
-0,0396	-0,0371	-0,0362	-0,0325	-0,0353	DTransQ_2
-0,0412	-0,0385	-0,0376	-0,0337	-0,0367	DTransQ_3
-0,0377	-0,0352	-0,0344	-0,0309	-0,0336	DTransQ_4
-0,0430	-0,0403	-0,0393	-0,0353	-0,0383	DTransQ_5
1,0000	-0,0360	-0,0351	-0,0315	-0,0343	DTransQ_6
	1,0000	-0,0329	-0,0295	-0,0321	DTransQ_7
		1,0000	-0,0288	-0,0313	DTransQ_8
			1,0000	-0,0281	DTransQ_9
				1,0000	DTransQ_10

DTransQ_11	DTransQ_12	DTransQ_13	DTransQ_14	DTransQ_15	
-0,0448	0,0337	-0,0157	0,0286	-0,0165	l_DebtFree-Price
-0,0244	0,0243	-0,0117	0,0270	-0,0403	l_Size
-0,0055	-0,0385	-0,0490	-0,0056	-0,0006	l_ConstYear
-0,0379	0,0387	-0,0216	0,0275	-0,0333	RoomC

0,0297	0,0329	0,0315	0,0304	0,0322	DNewApt_1
-0,0361	-0,0400	-0,0383	-0,0370	-0,0392	DTransQ_1
-0,0358	-0,0396	-0,0380	-0,0367	-0,0388	DTransQ_2
-0,0372	-0,0412	-0,0394	-0,0381	-0,0403	DTransQ_3
-0,0340	-0,0377	-0,0361	-0,0348	-0,0369	DTransQ_4
-0,0388	-0,0430	-0,0412	-0,0398	-0,0421	DTransQ_5
-0,0347	-0,0385	-0,0368	-0,0356	-0,0377	DTransQ_6
-0,0325	-0,0360	-0,0345	-0,0333	-0,0352	DTransQ_7
-0,0317	-0,0351	-0,0337	-0,0325	-0,0344	DTransQ_8
-0,0284	-0,0315	-0,0302	-0,0292	-0,0309	DTransQ_9
-0,0309	-0,0343	-0,0328	-0,0317	-0,0336	DTransQ_10
1,0000	-0,0347	-0,0332	-0,0321	-0,0340	DTransQ_11
	1,0000	-0,0368	-0,0356	-0,0377	DTransQ_12
		1,0000	-0,0341	-0,0361	DTransQ_13
			1,0000	-0,0348	DTransQ_14
				1,0000	DTransQ_15

DTransQ_16	DTransQ_18	DTransQ_20	DTransQ_26	DTransQ_27	
0,0049	0,0266	0,0460	0,0696	0,0548	l_DebtFreePrice
0,0068	0,0152	0,0265	0,0069	-0,0071	l_Size
-0,0250	-0,0490	-0,0170	0,0136	0,0221	l_ConstYear
0,0103	0,0246	0,0243	-0,0088	-0,0007	RoomC
0,0346	0,0322	0,0349	-0,0078	0,0301	DNewApt_1
-0,0421	-0,0392	-0,0425	-0,0440	-0,0366	DTransQ_1
-0,0417	-0,0388	-0,0421	-0,0436	-0,0362	DTransQ_2
-0,0433	-0,0403	-0,0437	-0,0453	-0,0376	DTransQ_3
-0,0396	-0,0369	-0,0399	-0,0414	-0,0344	DTransQ_4
-0,0452	-0,0421	-0,0456	-0,0473	-0,0393	DTransQ_5
-0,0404	-0,0377	-0,0408	-0,0423	-0,0351	DTransQ_6
-0,0378	-0,0352	-0,0382	-0,0396	-0,0329	DTransQ_7
-0,0369	-0,0344	-0,0373	-0,0386	-0,0321	DTransQ_8
-0,0331	-0,0309	-0,0334	-0,0347	-0,0288	DTransQ_9
-0,0360	-0,0336	-0,0364	-0,0377	-0,0313	DTransQ_10
-0,0365	-0,0340	-0,0368	-0,0382	-0,0317	DTransQ_11
-0,0404	-0,0377	-0,0408	-0,0423	-0,0351	DTransQ_12
-0,0387	-0,0361	-0,0391	-0,0405	-0,0337	DTransQ_13
-0,0374	-0,0348	-0,0377	-0,0391	-0,0325	DTransQ_14
-0,0396	-0,0369	-0,0399	-0,0414	-0,0344	DTransQ_15
1,0000	-0,0396	-0,0429	-0,0444	-0,0369	DTransQ_16
	1,0000	-0,0399	-0,0414	-0,0344	DTransQ_18
		1,0000	-0,0449	-0,0373	DTransQ_20
			1,0000	-0,0386	DTransQ_26
				1,0000	DTransQ_27

DPlotOwner_1	DElevatorDummy_1	DistGrocMin	DistHuop	DistCBD	
-0,0192	-0,2340	-0,0280	-0,0415	0,0832	l_DebtFreePrice
-0,0026	-0,1933	0,0137	-0,0337	0,0647	l_Size
-0,3011	-0,3055	0,0430	-0,0194	0,1434	l_ConstYear
0,0328	-0,1683	-0,0053	-0,0484	0,0671	RoomC
0,3564	0,1948	0,0339	-0,0584	-0,0478	DNewApt_1

0,0368	0,0265	-0,0246	-0,0059	-0,0143	DTransQ_1
-0,0004	-0,0104	0,0019	0,0187	-0,0174	DTransQ_2
0,0165	-0,0278	0,0235	0,0625	-0,0444	DTransQ_3
0,0051	-0,0182	0,0545	-0,0099	0,0279	DTransQ_4
-0,0338	-0,0203	0,0089	-0,0169	0,0180	DTransQ_5
-0,0170	0,0341	0,0143	0,0461	-0,0461	DTransQ_6
-0,0006	-0,0380	0,0045	-0,0252	0,0309	DTransQ_7
0,0368	0,0114	-0,0414	0,0334	-0,0403	DTransQ_8
-0,0026	0,0137	0,0148	0,0061	-0,0126	DTransQ_9
0,0070	-0,0052	0,0094	0,0162	-0,0153	DTransQ_10
-0,0189	-0,0305	0,0393	-0,0040	0,0184	DTransQ_11
0,0202	0,0341	-0,0076	0,0233	-0,0372	DTransQ_12
0,0411	0,0040	-0,0168	-0,0103	0,0113	DTransQ_13
0,0379	0,0260	-0,0256	-0,0385	0,0255	DTransQ_14
-0,0075	-0,0057	0,0416	-0,0042	0,0047	DTransQ_15
0,0141	0,0159	0,0242	0,0009	0,0050	DTransQ_16
0,0304	0,0068	0,0288	-0,0151	-0,0035	DTransQ_18
0,0506	0,0055	-0,0304	-0,0305	0,0196	DTransQ_20
-0,0028	0,0330	-0,0584	0,0213	-0,0220	DTransQ_26
-0,0172	0,0247	0,0030	-0,0260	0,0378	DTransQ_27
1,0000	0,0985	-0,3872	0,0480	-0,2433	DPlotOwner_1
	1,0000	-0,0571	0,0240	-0,0538	DEleva-torDummy_1
		1,0000	-0,2712	0,4685	DistGrocMin
			1,0000	-0,9004	DistHuop
				1,0000	DistCBD

DCondition_1	DCondition_3	l_TOM	FloorCount	
0,1860	-0,1113	0,1890	-0,0444	l_DebtFree-Price
0,0404	-0,0444	0,2452	0,0061	l_Size
0,0811	-0,0762	0,1315	-0,0752	l_ConstYear
0,0175	-0,0108	0,1984	-0,0070	RoomC
-0,1109	0,0396	-0,1703	0,1734	DNewApt_1
-0,0408	-0,0142	-0,0502	-0,0087	DTransQ_1
-0,0144	-0,0135	-0,0282	0,0211	DTransQ_2
-0,0142	-0,0330	-0,0065	0,0242	DTransQ_3
-0,0028	0,0264	-0,0144	-0,0082	DTransQ_4
0,0180	0,0434	-0,0014	-0,0136	DTransQ_5
0,0206	0,0065	0,0087	0,0152	DTransQ_6
0,0056	-0,0246	-0,0190	0,0322	DTransQ_7
0,0059	-0,0040	-0,0209	-0,0153	DTransQ_8
0,0165	0,0045	0,0231	0,0073	DTransQ_9
-0,0375	0,0567	-0,0248	-0,0180	DTransQ_10
-0,0156	-0,0030	-0,0424	0,0417	DTransQ_11
0,0599	-0,0111	-0,0253	0,0010	DTransQ_12
-0,0273	-0,0077	0,0136	-0,0325	DTransQ_13
0,0353	-0,0238	-0,0369	-0,0103	DTransQ_14
0,0052	-0,0094	-0,0750	0,0134	DTransQ_15
-0,0293	0,0689	-0,0285	-0,0111	DTransQ_16
-0,0348	-0,0273	-0,0022	-0,0154	DTransQ_18
0,0266	-0,0157	-0,0058	0,0067	DTransQ_20

-0,0248	-0,0186	0,0541	0,0037	DTransQ_26
-0,0027	-0,0231	0,0709	-0,0461	DTransQ_27
-0,0744	0,0419	-0,0534	-0,0580	DPlotOwner_1
-0,0085	0,0436	-0,0322	-0,2684	DEleva-torDummy_1
-0,0107	-0,0318	-0,0214	0,1733	DistGrocMin
0,0193	0,0232	0,0288	-0,1216	DistHuop
-0,0116	-0,0405	-0,0087	0,0559	DistCBD
1,0000	-0,2391	0,0022	0,0038	DCondition_1
	1,0000	-0,0424	-0,0200	DCondition_3
		1,0000	-0,0261	l_TOM
			1,0000	FloorCount