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Valuation of Amenities in the Housing Market of Jönköping: A Hedonic Price Approach

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Abstract

This paper intends to examine what fraction of house prices can be accredited to the distance between residential properties and proximity to parks, water and city centers. Although a large body of work on the subject of amenities and house prices using a hedonic model already exists, we wish to contribute with an in-depth analysis on these variables of focus. The empirical analysis uses a dataset concerning 8319 single family house purchases in the Swedish municipality of Jönköping, collected during the years 2000 to 2011. The main findings show that house prices are negatively effected as the distance increases to amenities and that by testing for land value as the dependent variable, we highlight the importance of geographical location while ignoring characteristics surrounding the house.

Keywords: Hedonic price model, amenity, natural amenity, housing market, Central Business District

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1 Introduction

What fraction of the final price in a residential property can be accredited to the proximity of amenities? According to recent studies carried out in several European nations, open spaces and parks helps level the health and socioeconomic inequalities by providing improved quality of life (Mitchel, 2008). Furthermore, research has also concluded that living in proximity to coastlines, lakes and urban water also improves health and wellbeing. (Wheeler, 2012; White, 2010).

In this paper we will examine the importance of some specific amenities in the valuation of single family homes in Jönköping, Sweden. For the purpose of this paper amenities are defined as goods that can only be consumed at a specific point in space and the only way to consume the amenity is therefore to locate where the amenity is located. The valuation of these amenities are at least partially capitalized into land and house prices and the purpose of this paper will be to investigate to what extent they affect these prices. By obtaining understanding and knowledge regarding the influence on house prices of these specific amenities, more sound decisions of house speculations and purchases can be attained.

The real estate market faces several price prediction problems. First of all, as we will discuss at a later stage in this paper, a house is not only a single good but rather a good comprised by a set of characteristics that is utility bearing. Different consumers with different preferences will value these characteristics in their own way. Secondly, there are multiple stakeholders involved in a house transaction such as brokers, the consumer itself and at least one financial institution, all valuing the house independently. The factors we are investigating are how distance to open spaces, water, parks and city centers affect the property value. The relationship between residential property value and amenities has previously been tested and discussed in academic literature (Kitchen & Hendon, 1967; Weigher & Zerbst, 1973; Geoghegan, 2002; Bourassa, Hoesli & Sun 2003). However, it has not been as extensively tested as the relationship with other amenities such as proximity to central business districts and access to transportation (Alonso 1964; Mills 1972; Muth 1969 & Brueckner 1999). Throughout the paper we will refer property value, housing price, housing value and residential value interchangeably as house price.

The remainder of the paper is structured as follows. In section 2 the paper will discuss the theoretical framework and previous literature regarding hedonic pricing, amenities, public goods and environmental urban externalities. Section 3 motivates and discusses the hedonic model approach. Section 4 describes the data and explanatory variables as well as stating the functional form used throughout the paper. Section 5 discusses and analyzes the empirical results conducted by the regressions. Section 6 consists of concluding remarks.

2 Theoretical Framework

In this paper the focus will be on the empirical findings of amenity values within the residential property value, but since our research is heavily based on previous theoretical literature, this part of the paper will provide the reader with a basic background of the main theories relevant to the paper.

2.1 Consumer Theory

Kelvin J. Lancaster was a mathematical economist and will be used in this paper due to his work in 1966 when he published the paper *A New Approach to Consumer Theory* which is heavily cited and commonly used when dealing with modern consumer theory. In his work, Lancaster stepped away from the traditional utility approach to goods, explaining that goods are direct objects of utility. Instead, he introduced a theory that a good holds a single or certain set of utility bearing characteristics and it is not the good itself that bears the utility, it is its characteristics. If we take a house as an example, the house may possess different non-tangible attributes such as an aesthetic view, close distance to water or close distance to a park. All of these characteristics are utility bearing and different consumers will value and rank these characteristics differently (Lancaster, 1966). Hence, the consumer evaluates the utility by the characteristics of the good rather than evaluate the gained utility from the single good itself. Lancaster therefore argues that a consumer does not buy a good, but instead the consumer purchases the bundle of characteristics that the good consists of.

In 1974, Sherwin Rosen built upon the thoughts of Lancaster and contributed with a progressed take on consumer theory with his work in the journal *Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition*. In the journal, Rosen constructs a model based on the theory of utility bearing characteristics of a good and incorporates it in a market equilibrium. This market equilibrium that Rosen creates works as a connection between buyers and sellers, where consumer optimization is attained when the desired good offers a combination of the preferred characteristics (Rosen, 1974). The equilibrium proposed by Rosen takes the form of market quantity demanded $Q^d(z)$ with attributes z, equalling market quantity supplied with those characteristics$Q^s(z)$. Rosen further develops the mathematics of the equilibrium by developing derivations for the function $p(z)$ such that $Q^d(z) = Q^s(z)$.

According to Rosen, the suppliers tailor their goods to incorporate final characteristics desired and demanded by the consumers, this in turn gives the producer returns for serving an economic function as an intermediary (Rosen, 1974). Rosen also departs from Lancaster's earlier assumptions. Rosen argues that some arbitrage and package assumptions from Lancaster are too strong and have to be invalidated. Such an assumption is that a ten meter bus is equivalent to two five meter busses in terms of one characteristic, Rosen states that it is impossible to drive them simultaneously.

2.2 Public goods

Samuelson (1954) defined public goods as goods that can be consumed by an individual without diminishing the consumption of the same good by another individual. Samuelson calls this type of good a common consumption good. Samuelson define public goods in his articles (1954;1955) and compares them to ordinary private goods. However in the work of Tiebout (1956), Tiebout determines that different public goods result in different utilities depending on the preference of individuals. Meaning that an individual tends to settle in an area where the public goods desired are available and hence move from an area where that desired public good is not located.

A public good can also be categorized as a pure public good which implies that the good is non-rival and non-excludable. Buchanan (1965) however, argues in his article that this is seldom the case and it is only in extreme cases where this type of pure public good exist. Buchanan outlines in his theory of clubs (1965) that there is a level of optimal exclusion. This optimal exclusion fills the gap between pure private and pure public goods. Buchanan takes an example of swimming pools in his article, it has been shown that areas with low and middle income earners prefer to share a swimming pool in their community whilst high income people prefer a private swimming pool. Hence, people with similar preferences for public good will end up in the same location where the public good is offered.

We believe this paper is in line with Buchanan (1965) and Tiebout (1956) that public goods do attract people and incentivises them to locate near such public goods and that people will reside where their preferred public goods are present. Thus, people with homogenous preferences tend to settle down in similar locations where their preferred public good can be consumed. In this paper some specific amenities can be argued to be seen as public goods, and thus, we want to identify how people value some specific public goods in the real estate market.

2.3 Amenity valuation

As previously mentioned, amenities can be defined as goods that can only be consumed at a specify point in space. The only way to consume an amenity is thus by being located where the amenity is located. Moreover, amenities are generally not traded in markets but do however partially capitalize into land and house prices. The total economic benefit provided by an amenity can be seen as the sum of what all members of society would be willing to pay for it (Mendelsohn, 2009).

In the table below, we present some examples of amenities categorized by non-excludability and non-rivalry, where non-excludability refers to the impossibility to prevent people from gaining the benefits of the same amenity and where non-rivalry is referring to the possibility of consumers being able to simultaneously consume the good. There are similarities between public goods and amenities since some of them share properties of being either non-excludable, non-rival or both. The focus variables of this paper will however only examine proximity to city centers, parks, open spaces and lakes.

Table 1 –Examples of amenities

Amenity	Non-excludable	Non-rival
Lakes	√	√
Open Spaces	√	√
Parking spaces		
Aesthetic views	√	√
Local buzz	√	√
Private parks		√
Public parks	√	√

Earlier literature concerning valuation of amenities have, amongst other things, been investigating residential property values regarding its influence of distances to urban parks, lakes and open green spaces. The empirical results have shown statistical results that the value of residential properties are decreasing with increasing distance to open green spaces and parks, when holding all other characteristics constant (Kitchen & Hendon, 1967; Weigher & Zerbst, 1973).

The amenity valuation from Geoghegan (2002) on the other hand, only considers open spaces. She chooses to differentiate between two types of open spaces and categorizes the two types as: permanent open spaces (POS) and developable open spaces (DOS) (Geoghegan, 2002). The important difference between the two is whether the open space is containing the valuation of only current or both current and future value expectations of the open space. Permanent open space comes mainly in the form of parks and open land that already have sold their right for further developing and commercializing, therefore making their value contribution to the property permanent. Developable open spaces however do not incorporate the future expectations of the surrounding open spaces, since they may face changes or even demolition in the future. Generally speaking, permanent open spaces are usually owned by the state or nature conservancy organizations, whereas developable open spaces suggest private or agricultural ownership (Geoghegan, 2002). According to Geoghegan's previous work, permanent open spaces increases residential property values over three times as much as an equal amount of developable open space (Geoghegan, 2002 & Geoghegan et. al, 1997).

In this paper we believe, in line with previous work, permanent open spaces is preferred over developable open spaces to consumers and due to this, we will only be using permanent open spaces when constructing and conducting our data and analysis. This is partly because of simplification and consistency, but also since developable open spaces have been shown to hold less significant results in past researches (Geoghegan, 2002).

2.4 Environmental urban externalities

In the early work of Von Thünen (1826) he developed an economic theory called the monocentric city model. In the model Von Thünen discusses a flat homogeneous landscape with one central business district (CBD), which is the main employer of the region. Outside the city centers different sorts of agricultural goods are being produced and a bid-rent relationship was developed suggesting that rent costs diminish with distance to the CBD. Hence, it is increasingly more expensive to locate close to the CBD and increasingly less expensive as one moves further away from the CBD. Yang and Fujita (1983) developed a model to see the effect amenities implies on the location decision among different income groups. Their main findings suggest that high income families tend to locate outside the city centers, regardless of the amenities provided by the CBD.

Bruckner et al. (1999) did a similar research as Yang and Fujita (1983) they did however extend this analysis and found that amenities do matter. They discovered that when exogenous amenities, such as parks, view of the water or historical monuments are located in the city center they have the ability to attract high-income groups. Hence, their conclusion is that if the amenity values of the city center are higher than in the suburbs the high income people will locate in the center.

We may thus assume that, according to Bruckner et al. (1999) that amenities attract high income earners. Thereby arguing that higher housing prices are expected when located near an exogenous amenity. We also believe that the rent (housing prices) diminishes as we move further away from the city center, as stated by Thünen (1826).

3 Models

3.1 Hedonic pricing

The hedonic pricing model act as the main pillar for this paper and will be the main guide to explaining the value of amenities represented in the price of houses. The model works as an intuitive analytical tool for examining the relationship between a good's price and its attributes. The theoretical foundation for hedonic pricing was provided by Lancaster (1966) and was further developed by Sherwin Rosen in 1974, as previously mentioned in section two. Despite the broad history and usage of the model, it still remains debated and new research boundaries of the model are actively being pushed forward (Milon, 1984 & Malpezzi, 2002). Hedonic pricing is a method that utilizes regressions to explain the impact of different characteristics on the final price of a certain commodity. The hedonic price model is traditionally expressed as a relationship between a dependent variable, usually the price, and a set of independent variables that describes the existing variation of goods in the market. There have been many empirical studies where the hedonic pricing model has been used to investigate the price of a good. The equation of the model may take on different forms but the most frequently used one is:

$$P = f(z_1, z_2, \ldots, z_n) \quad (1)$$

Where P is the price of a specific good, in this case it will be the price of specific houses. ($z_1, z_2 \ldots\ldots z_n$) are different characteristics that one believes affect the housing prices.

As a simple example, a pair of jeans will distinguish itself from its competitors by having a differentiated style, fabric, colour or some other characteristics that in the end will determine the price of the pair of jeans in question. The use of the hedonic price model is to determine the amount of the final price that can be accredited to each of these attributes that makes the commodity unique. In this paper however, instead of jeans, we will apply the hedonic price model on the housing market in Jönköping municipality.

Hedonic pricing has been extensively utilized for the purpose of analysing house prices since the price determining characteristics are easily distinguishable (Tyrväinen, 1997). Such characteristics in terms of the housing market involve three sub-groups, consisting of the property itself, the environment and the location. The characteristics belonging to the property itself are interpreted as internal characteristics while the location and environmental attributes are considered to be external characteristics. Consequently, the hedonic pricing method can be used as a way of obtaining the valuation of a house that is solely accredited by external or internal factors respectively.

The hedonic price model has reached a high level of popularity since it is an easy and straight-forward method for analyzing what fraction of the final house price can be accredited to amenities such as distance to green spaces, lakes or parks. In other words, the hedonic price model answers the following question: As there are no markets where actors can trade distances to natural amenities or city centers, how do we know the value of these externalities?

The housing market is a very convenient market to use the hedonic pricing model, since the commodity being sold holds easily distinguishable internal and external characteristics that determines its final price. This is shown by the fact that consumers explicitly express their preference of environmental and neighbourhood quality by purchasing a house with low amounts of crime or close distance to water, parks and city centers in the residential area. The extra premium paid for a house with no crime, compared to an identical house in an area with a higher crime rate, can be interpreted as the specific consumer valuation of the neighbourhood quality.

3.2 Limitations of Hedonic Pricing

A successful model is used to portrait a simplification of the reality with as few assumptions as possible. However, in order to simplify the actuality there will always arise some limitations that need to be addressed.

- The first limitation of the hedonic price model is the probability of omitting variables. As an economist, it is very unlikely to be able to capture all of the good's characteristics that are reflected in its price, which may cause biased outputs of the implicit price of the observed characteristics. The biasedness comes from the chance of the omitted characteristics being correlated with the present characteristics.
- The second problem is regarding the possibility of the explanatory variables being multiple correlated. For example, it is highly probable that large houses located in rural areas also have increased proximity to open green spaces as well as lower levels of air and noise pollution. Small houses however, are more frequently found in urban areas, where open green spaces and parks are scarcer, accompanied by a higher levels of both air and noise pollution.
- The third limitation raises concern regarding information, or lack thereof. The hedonic pricing model requires that each buyer has the ability to acknowledge both the potential negative and positive consequences that may arise with the purchase of a house. These externalities may include close distances to open green spaces, water or parks or less displayed negative amenities such as pollution. Nevertheless, in reality this previous knowledge and complete information is seldom the case, especially if the externalities are negative.
- Lastly, in order for the model to be as accurate as possible, large data is required to support it, resulting in poor estimates when dealing with smaller amounts of data.

4 Data

The data we will use to conduct our regressions and analysis originates from Pia Nilsson's doctoral work in the paper *Price Formation in Real Estate Markets* (Nilsson, 2013). The data contains detailed information from the Municipal Housing and Development Office regarding transactions of single family home purchases in Jönköping municipality during the time period 2000-2011. The data also includes open space amenities such as open green spaces, parks, forest areas and farmlands which is also provided by The Municipal Housing and Development Office. We also want to include natural amenities such as the proximity to water and open space amenities. This data is provided by the Swedish Meteorological and Hydrological Institute, The Swedish Environmental Protection Agency and The Swedish Board of Agriculture (Nilsson, 2013).

The data includes over 8300 single family house purchases during a time span of 10 years, stretching from 2000 to 2011, providing us with a sufficiently large dataset to conduct the hedonic price regressions without being worried about poor estimates.

Table 2 - Expected signs

Variable	Definition	Expected sign (+/-)
Distance to Vättern	Distance to lake Vättern measured in meters	-
Distance to nearest lake	Distance to nearest lake measured in meters	-
Distance to nearest park	Distance to nearest park measured in meters	-
Distance to nearest POS[a]	Distance to the nearest permanent open space measured in meters	-
Distance to Bankeryd	Distance to the urban center of Bankeryd measured in meters	-
Distance to Jönköping	Distance to the urban center of Jönköping measured in meters	-
Distance to Gränna	Distance to the urban center of Gränna measured in meters	-
Distance to Huskvarna	Distance to the urban center of Huskvarna measured in meters	-
Distance to airport	Distance to Jönköping Airport	+
Amount of POS[a] in SAMS[b]	Measures the amount of POS as a fraction in the SAMS[a]	+
Interest rate	3-month mortgage interest rate, set by Swedbank.	-
Lot size	Amount of lot size, measured in square meters	+
Living area	Amount of living area, measured in square meters	+
Density	Density of the SAMS area	+
Median income	Median income based on the particular SAMS area	+
Crime	Number of crime reported in the SAMS area since 2000	-
Dummy 2001-2011	Year Dummy	n/a

[a]*Permanent Open Spaces*
[b]*Based on Small Areas for Market Statistics (SAMS) in Jönköping municipality.*

Control variables are used to easier detect and highlight the relationship between two variables, in our case the house price and an amenity. By adding relevant and correlated control variables, the risk of obtaining biased estimates decreases. Additional variables include internal and external house characteristics that are correlated with the dependent variable. These characteristics will be used as control variables to best isolate the true relationship between price and amenities. Such control variables will include living area and lot size, measured in square meters. These variables are expected to hold a positive relation with house prices since tautologically, a relatively large house and/or garden implies a higher house price. Moreover, precautious interpretations of the lot size is vital since the lot size of a house is already effectively reflected in the living area variable in the analysis.

Furthermore we also aim to control for the economic climate at the time of purchase by including a 3-month interest rate set by the Swedish commercial bank, Swedbank. This 3-month rate is determined and based on the Swedish repo rate set by the Swedish central bank, making them highly correlated, although the mortgage rate portraits the housing market more accurately. The Swedish repo rate has been continuously declining for several years and in April 2015 it hit a record low of -0.25% in order to deal with low inflation and consumption levels (Riksbank, 2015). The interest rate is the main indicator of the real estate market's price levels since a lower interest rate suggests an increase in people's affordability when taking on mortgages. By lowering interest rate and making mortgages more affordable, the demand for residential property increases and as a result so does the price level. Since the 3-month mortgage rate is highly correlated with the repo rate, we therefore expect a negative correlation between the house prices and this variable.

We also control for earning differences within the neighbourhood, sorted according to Small Areas for Market Statistics (SAMS) regions, by including a median income variable. We expect neighbourhoods with a high median income to be willing to pay more for a house, as well as being able to pay an extra premium to cluster with other high income earners.

Furthermore, we also want to test for the distance to Central Business Districts (CBD), since we assume CBD's to be the main employers of the region (Alonso 1964; Mills 1972; Muth 1969). As CBD's we chose to include Jönköping as the largest employer and as descending city centers we include the distance to the neighbouring cities of Bankeryd, Gränna and Huskvarna. These distances highlight the importance of the geographical location of a house and displays whether there is a strong negative correlation with increasing distances to the CBD. The point location used for measuring the distances to urban centers are the train stations in each town, since all of these are located in central areas and are recognized as a good measurement of centrality. In order to gather the distances, we apply the Pythagoras theorem using the SWEREF99 TM coordinates between the two variables. The SWEREF99 TM calculates the specific location by measuring the amount of meters north of the equator (initial value of 0) as well as the amount of meters east from the central meridian, increasing eastwards (Lantmäteriet). The following formula was used to calculate distance:

$$\sqrt{((\mathbf{COR.Y} - \mathbf{COR2.Y})^2) + ((\mathbf{COR.X} - \mathbf{COR2.X})^2)}$$

Where COR and COR2 corresponds to the different coordinates between the two points between which the distance is being calculated. Since the distances we are measuring are no extreme distances, we do not stress precaution about the surface of a sphere and therefore assume a 2D Euclidean plane. However, if the distances are being calculated at very large scales, the distances along the surface are more curved and Pythagoras theorem does not project correct distances. The same method of distance calculations was applied in all cases where the distance was measured, including the proximity to water, open spaces and airports.

The dummy variables included in the regression supports the isolation of the change in house prices affected by that particular year and economic climate, compared to the year 2000. We chose to include 11 dummies ranging from a dummy for year 2001 all the way to 2011. We are therefore excluding the year 2000 dummy since we treat this as the base year and by including a dummy for each and every year creates perfect collinearity with the intercept, avoiding the dummy variable trap.

In table 3, we highlight descriptive statistics to provide simple summaries to enable the entrance of figures for comparability reasons. The descriptive statistics include the explaining variable as well as the explanatory variables. From the descriptive table we can observe that there are more deviations in distance to the lake Vättern compared to the distance to second nearest lake, this is intuitive and logical since the position of lake Vättern is constant at one point on the geographical map and there is more than just one lake in the municipality. Moreover the standard deviation of the amount of permanent open spaces in the different SAMS areas is 2.63, indicating that there is a large difference between the SAMS areas when it comes to open spaces.

Table 3 - Descriptive Statistics

VARIABLES	Mean	Min	Max	Std. Deviation
Price[a]	13.97	11.51	15.92	.76
Distance to Vättern	7.81	-.76	10.44	1.23
Distance to nearest lake	7.96	1.85	9.31	.78
Distance to nearest park	6.40	2.20	9.73	.91
Distance to nearest POS	6.86	1.54	8.38	.88
Distance to Bankeryd	9.24	4.68	10.57	.88
Distance to Jönköping	8.81	6.09	10.65	.80
Distance to Gränna	10.25	4.59	11.09	.69
Distance to Huskvarna	8.90	5.37	10.61	.88
Distance to airport	9.16	6.84	10.78	.60
Amount of POS in SAMS	-4.52	-11.04	-.21	2.63
Lot size	6.74	4.38	10.50	.74
Living area	5.17	3.40	6.82	.34
Density	1.82	-3.55	4.23	1.64
Median income	-1.02	-1.60	-.47	.22
Crime	1.27	-3.69	3.67	1.37
Interest rate	2.40	.42	4.00	1.28

[a]Dependent variable

All variables presented in logged form.

Furthermore, in the appendix we include a map with markers set on the city centers of Jönköping, Bankeryd, Gränna and Huskvarna in order to give some geographic overview to the readers without any prior knowledge about the geographical area surrounding Jönköping.

4.1 Functional form

Linear, semi-logged and double logged functional forms have all been heavily used and examined in previous literature (Rosen, 1974; Freeman, 1974; Nilsson 2013; Tyrväinen, 1997; Milon 1984) and they all contain weaknesses that limit the use of data and the interpretation of the results. For the purpose of this paper, we will be conducting the hedonic regressions in double-log form. We are using a double-logged functional form because there are diminishing returns to the dependent variable as well as most of the explaining characteristics determining the dependent variable.

A problem that might occur by not using a semi-log or double-log form is the risk of obtaining heteroskedasticity. Heteroskedasticity occurs when the error terms in the regression do not have constant variance and are in some way systematically dependent on some explanatory variable (Goodman, 1995). For example, if the errors of house prices increase as the living area increases, we may be exposed to heteroskedasticity. Scatterplots displaying the degree of heteroskedasticity is included in the appendix.

The hedonic price model applied in this paper takes the following form:

$$\ln Price_i = \beta_1 + \beta_2 \ln D.VÄTTERN_i + \beta_3 \ln D.LAKE_i + \beta_4 \ln D.PARK_i + \beta_5 \ln D.POS_i + \beta_6 \ln D.BNKRYD_i + \beta_7 \ln D.JKPG_i + \beta_8 \ln D.GRÄNNA_i + \beta_9 \ln D.HSKVRN_i + \beta_{10} \ln D.AIRPORT_i + \beta_{11} \ln AMOUNT.POS_i + \beta_{12} \ln LOT.SIZE_i + \beta_{13} \ln LIV.AREA_i + \beta_{14} \ln DENSITY_i + \beta_{15} \ln \mathrm{INCOME}_i + \beta_{16} \ln CRIME_i + \beta_{17}\, INTEREST.RATE_i + \varepsilon_i$$

Where $\ln X$ is the natural logarithm of variable X , β_1 is the intercept, D refers to distance and ε_i is an error term.

5 Data results and analysis

In this part of the paper, we will discuss and analyze the outputs from the regressions regarding house prices in Jönköping. We begin by analyzing the fit of the model and our focus variables before examining our control variables.

Below the variables in Table 4, we find an R-squared for each specific regression model. By observing the R-squared we find that there is a decline from 0.327 in model 1 to 0.212 in model 2. This can be interpreted as the goodness of fit for the model and that the independent variables are explaining 32.7% and 21.2% of the variation in the housing prices. Generally, this might seem like a low R-squared. However, as mentioned in section 3.2 the most common limitation of the hedonic regression approach is the risk of omitting variables. By omitting variables, the R-squared will drop due to less explanatory power of the variables. This occurs due to the house characteristics being preferred differently by different individuals, which in turn makes it unmanageable to capture all of these aspects within a single model. We also lack the data regarding all internal and external house characteristics since the costs of obtaining such immense data would be extremely expensive and time consuming.

Table 4 - Regressions

VARIABLES	MODEL 1 β	t	MODEL 2 β	t
(Constant)	11.971**	20.126	13.093**	20.405
Distance to Vättern	-.117**	-9.520	-.104**	-7.885
Distance to nearest lake	-.021*	-1.909	-.024**	-1.964
Distance to nearest park	-.020**	-2.037	-.014	-1.344
Distance to nearest POS	.016	1.627	.017	1.599
Distance to Bankeryd	-.238**	-6.023	-.238**	-5.572
Distance to Jönköping	-.152**	-7.038	-.151**	-6.475
Distance to Gränna	-.100**	-5.391	-.111**	-5.534
Distance to Huskvarna	-.050**	-3.911	-.045**	-3.265
Distance to airport	-.116**	-4.245	-.091**	-3.090
Amount of POS in SAMS	.041**	9.664	.035**	7.689
Lot size	.055**	4.269	.035**	2.514
Living area	.549**	22.869	.536**	20.676
Density	.013*	1.794	.013*	1.761
Median income	-.175**	-3.686	-.044	-.866
Crime	-.053**	-5.219	-.033**	-3.005
Interest rate[a]	-	-	-.111**	-18.920
Dummy 2011	1.009**	27.204		
Dummy 2010	.775**	21.518		
Dummy 2009	.702**	19.545		
Dummy 2008	.590**	16.580		
Dummy 2007	.569**	15.984		
Dummy 2006	.447**	12.478		
Dummy 2005	.203**	5.750		
Dummy 2004	.263**	6.920		
Dummy 2003	.213**	5.449		
Dummy 2002	.115**	2.976		
Dummy 2001	.040	1.032		
R	0.572		0.461	
R-squared	.327		0.212	
Observations	8318		8318	

[a]3-month mortgage rate set by Swedbank
Dependent Variable: Price
***. Significant at the 0.05 level.*
**. Significant at the 0.1 level*

5.1 Focus variables

The focus variables of this paper are the distance-based amenity variables, including distance to city centers, permanent open spaces and other natural amenities. We predicted that as distance to these variables increases the price of the house will decrease, suggesting a negative relationship. Based on our regression, our hypothesis was proven to be true for all except for one amenity variable. The distance to Vättern, the nearest lake and the distance to nearest park all hold this negative relationship with housing prices which we predicted in the section 4, the same holds for the distances to city centers. This is in line with the economic theory of Buchanan (1965), Tiebout (1956), Bruckner et al. (1999) Von Thünen (1826) all of which, with different approaches, state that housing prices will be higher when the house is located near one of these amenities.

Being the second biggest lake in Sweden and the sixth in Europe, Vättern holds an impact of decreasing house prices of 0.117% according to model 1 and 0.104% according to model two, when increasing the distance to Vättern by 1%. Due to the location of Jönköping city and the U-curved shape of the southern part of lake Vättern, this distance variable might be captured in other variables such as the distance to the Jönköping variable. Moreover, due to the extensive length of the Vättern's southern coast line, the different house price levels represented along this region are exposed to significant volatility.

We also wanted to examine how much of an impact the distance to the closest lake and park has on house prices. The result from these variables are as expected, but with mixed significance. Proximity to nearest lake has a decreasing impact of more than 0.02% of the price if the distance to the lake increases by 1%, with a significance level of 10% for model 1 and 5% for model 2. The park-proximity variable holds a similar relationship with house prices and we can observe that we get a negative and statistically significant value of 0.020 for model 1 and a negative value without any significance of 0.014 for model 2. This implies, according to model 1, that the house price will drop slightly with 0.02% as we increase the distance to the nearest park by 1%.

Distance to permanent open spaces (POS) is however positively related with distance to the observed houses, but not to a significant level. This is the contrary to our expectations and thus deviates from the result of the work by (Geoghegan, 2002 & Geoghegan et. al, 1997) where she states that a neighbourhood consisting of a large fraction of permanent open spaces will face an increase in property values. However, a positive relationship may be explained by the definition of what permanent open space amenities are. Since we have distance to parks and lakes as separate variables, the distance to nearest POS-variable may include less attractive open spaces such as swamp marks, farm lands and other government protected environmental areas that may not be very desirable. The distance to the nearest POS-variable therefore absorbs more of the open spaces that does not increase the value of the property. This is shown by the positive but not significant coefficient values of 0.016 for model 1 and 0.017 for model 2.

As additional focus amenities, we chose to include distances to city centers. For the purpose of this paper, we have chosen to include Jönköping, Huskvarna, Bankeryd and Gränna as city centers as they capture complete or parts of the definition of a CBD (Thünen, 1966). The cities are all negatively correlated with property prices and this is in line with our prediction regarding distances to the nearest urban centers. This is explained theoretically in the monocentric city model where the bid-rent curve suggest that the rent is higher near the central business district. In this case, it might be up for debate to define some of our city centers of choice as being central business districts. However, in order to prove a point, this definition is assumed to hold for all city centers and thus is part of the explanation for the negative relation with house prices and distances to CBD's. Furthermore, close distance to the cities of Jönköping, Huskvarna, Bankeryd and Gränna do all absorb other city amenities than being the main employer. Such city amenities are restaurants, bars, shopping, local buzz and other leisure amenities. The results from our regression models all held true to our expectations of the signs and all four of the distances between property and city centers show a negative relation with house prices at a 5% significance level. The most prominent city-distance variable is surprisingly the distance to Bankeryd. This variable shows a coefficient value of -0.238 where both regression models support the negative relationship argued above, and may be interpreted as a decrease in the house price of 0.238% alongside an increase in the distance between Bankeryd and the property by 1%. As Jönköping is the biggest city center amongst these variables, we expected this variable to have more impact on prices as it plays a crucial role as main employer of the region. Contrarily, the distance to Jönköping city was the second most influential city-distance variable and presented that with a 1% increase in distance, we observed a decrease of the house price equivalent to more than 0.15%. The other two city-distance variables of Gränna and Huskvarna are both also statistically significant at a 5% level but have a lower impact on house prices. The reaction of increasing the distances to Gränna and Huskvarna by 1% are equivalent to a price reduction of 0.1% and 0.05%, respectively, according to model 1.

The reasoning behind Bankeryd being the most prominent city-distance variable instead of Jönköping is unclear to us since we expected Jönköping to have the biggest impact due to the comparably higher supply of positive externalities being created in the bigger city of Jönköping. However, according to Yang and Fujita (1983) high income families may tend to locate outside the city centers regardless of the amenities and externalities supplied by the city center, and this might provide one reasoning of why the Bankeryd variable contributes the highest effect on house prices.

5.2 Control variables

In Table 4, regression model 1 includes dummy variables for each year beginning in 2001 and ending in year 2011. These dummies provide a clear indication of the development of the prices on the housing market in Jönköping municipality. All values are significant at a 5% significance level except for the Dummy 2001 variable, meaning that there was not enough changes in housing prices between the year 2000 and 2001. The property prices tend to increase each year according to the estimates, except for the years 2001 and 2005. In 2007 and 2008 house prices experienced minor stagnation due to the recession during these years. If we observe the development of the dummy coefficients over time, there is a very clear increasing trend that corresponds to the overall trend observed in real house prices in Sweden over these specific years. The last year of our observation shows that the prices had risen about 100% in nominal terms since 2000, which is a fair estimate in accordance to the report by Statistics Sweden which states that the overall development of house prices in Sweden increased by 196% in nominal terms since 1990 (Statistics Sweden).

When obtaining the results from regressions containing both the dummy variables and the mortgage rate, we noticed that either our mortgage rate variable or the Dummy 2009 variable got excluded from the regression output. This was due to the variables being too correlated with each other, with a negative Pearson correlation of over 0.5, as shown in Table 5. Our interpretation of this is that the overall trend of the dummy variables are so closely correlated with the 3-month mortgage rate that one of the two has to be excluded. The highest correlation occurred between the interest rate and the dummy for 2009 and that is why that particular dummy got excluded. In order to deal with this issue, we decided to split the regression in two different models, one including the dummy variables to control for change over time and excluding the mortgage rate, and the reverse for model 2.

Table 5 – Pearson Correlation

	Dummy 2009	Interest rate
Dummy 2009	1	-.505**
Interest rate	-.505**	1
**. Correlation is significant at the 0.01 level (2-tailed).		

Furthermore, we checked for multicollinearity between the interest rate and the dummy variables by observing the Variance Inflation Factor (VIF). The VIF values for the dummy variables were all high and for the interest rate variable we observe a very high value of 1277.279, indicating that there indeed are multicollinearity between the variables. The VIF values are all included in the appendix.

In regression model 2, where the mortgage rate is included, we find a negative relation between the interest rate and house prices as hypothesized in section 4. The mortgage rate variable is linear compared to most of the other variables included in the regressions that are logged. This will lead to a different, log-linear interpretation of the variable. The coefficient value of -0.111 is significant at a 5% significance level, suggesting that an increase in the 3-month mortgage rate of 1% will lead to a decrease in house prices by 11.1%. The 3-month mortgage rate set by Swedbank is by far the most dominant factor that contributes to changes in prices. Since investing in a house may be the biggest investment of your life, this is an obvious key factor when purchasing a house.

The outcomes from the regression regarding internal house characteristics are in line with our expectations. In both regression models, the lot size and living area are positively correlated with the house price at a 5% significance level. The amount of square meters are one of the most influential factor on house price and this can be shown by observing the beta coefficients of 0.549 and 0.536, suggesting that a one percent increase in the living area, measured in square meters, will affect the final house price by more than

0.5%. The lot size however does not have nearly the same impact on house prices as the living area. By observing the house transactions where we find the largest lot sizes, we also find that they are most often located on the outskirts of the municipality. According to Von Thünen (1826), this relation is due to falling prices as we increase the distance from urban centers, and this is why the lot size variable is not heavily affecting the house price. The impact of the lot size in model 1 indicates that a 1% increase in the lot size will increase the house price by 0.055% and in the second regression model this value has dropped to a price increase of 0.035%. The values of the coefficient are significant at a 5% level for both models.

The density variable measures the density of the population living in a particular SAM's area. We expected a positive correlation of this characteristic to the house prices and this turned out to hold true according to our regressions. However, the impact of a dense area does not give an impressive impact on the house prices in Jönköping. The beta value for the density is only 0.013, stating that a slight increase of one percent of the SAMS-area density will produce a 0.013% increase in the price. The density variable is significant for both regression models, but only at a 10% level. Our conclusion is that the density of a particular SAM's area contains people that owns single family homes but also people that resides in other forms of living, such as rentals and apartments. This will lead the density variable to not fully capture the effect of only single family home purchases since everybody in the SAMS area are included in the variable. The higher density does therefore not necessarily mean that the demand for houses is greater where the density is larger. Which may be the explanation of a fairly low value of the coefficients.

As neighbourhood variables we have included the median income and crime rate in the specific SAMS areas. When looking at the median income variable, it deviates from our expected direction. As can be observed in Table 4, the sign for both models are negative suggesting a lower price as the median income increases in a particular SAM's area. The coefficient is however only significant in regression model 1. The reasoning and interpretation behind this is unclear, since rational thinking suggest that an area where the median income is high, we would expect that the demand for expensive houses would be higher as well. The outcome from the crime variables are suggesting significantly lower prices as the percentage of crimes increase in the area. For regression model 1, an increase of 1% in crime leads to a decrease in house prices of 0.053% and for model 2, the suggested price decrease is 0.033% if the crime rate would increase by 1%.

5.2.1 Land value and focus variables

The results from the conducted regression models 1 and 2 displayed the falling house price relationship with our focus variables as predicted, however they did not display the relation as clear as expected. It was therefore decided to run a regression with the valuation of the land that each house was built upon as the dependent variable. We conducted this robustness test to merely control for the impact of distances to our focus variables and thereby allow the exclusion of all characteristics and attributes surrounding the house.

This will give us the opportunity to investigate how much the geographical location matters in the valuation of land, and therefore the house prices, since house prices and land value are highly correlated. Consequently, the results obtained may be interpreted without the concern of omitting important house characteristics. Furthermore, the results might provide us with additional insights regarding the importance of our focus variables in relation to the final house price.

In regression model 3, we only included lot size as the describing characteristic of land upon which the house was built on, since this characteristic is the only applicable characteristic that does not necessarily display a house attribute. The results from this regression can be found in regression model 3 in Table 6. By observing the R-squared of model 3 we can see that it is now equivalent to 0.786, suggesting that our focus variables can explain 78% of the variations of land prices where the houses we observed were built. This goodness of fit is comparably larger than the R-squared for both regression model 1 and 2 in which none exceeded an R-squared above 0.35. We believe that the dramatic increase in R-squared shows the difficulties of projecting house prices with a hedonic pricing approach. The boosted R-square occurs since we do not need to control for house attributes and therefore do not risk omitting crucial house attributes explaining the variation in house prices. Moreover, since each home buyer has their own specific set of preferences of what a house should include, it will be close to impossible to include all relevant variables in order to create a perfect model.

Table 6 – Land value and amenities

	MODEL 3	
VARIABLES	**β**	**t**
(Constant)	17.926**	188.726
Distance to Vättern	-.092**	-28.318
Distance to nearest lake	-.080**	-25.773
Distance to nearest park	-.014**	-5.463
Distance to nearest POS	-.009**	-3.524
Distance to Bankeryd	.002	.737
Distance to Jönköping	-.390**	-93.698
Distance to Gränna	-.069**	-14.250
Distance to Huskvarna	-.031**	-10.284
Amount of POS in SAMS	-.002**	-2.188
Lot size	.146**	47.585
R	.887	
R-squared	.786	
Observations	8318	

Dependent Variable: Land value
***. Significant at the 0.05 level.*
**. Significant at the 0.1 level*

The most prominent change can be observed in the relation between land price and the distance to Jönköping city center. This coefficient, according to the regression in Table 6, is now -0.390 which implies that a 1 % increase in distance to Jönköping city decreases the price of the land by -0,390 %. This is more than twice as much as in the regressions in Table 4 where the coefficients are -0.152 in model 1 and -0.151 for model 2 respectively. Our interpretation of this is, when filtering out all internal house characteristics and only focusing on location, Jönköping city center is the most essential. As previously discussed, this might be due to the higher amount of externalities and amenities Jönköping city provides. The municipality of Jönköping holds a somewhat homogenous landscape, suggesting that distances to natural amenities such as water or parks might not play a crucial role since they are fairly distributed over space. Therefore we conclude that the coefficient boost in proximity to Jönköping is based on urban amenities and externalities provided by the city center, beyond the distance to natural amenity variables. This is also the results from regression model 3 where we see that the distance to lake Vättern only decreases the price of the land by 0.092% if the distance to Vättern increases by 1%, significant at a 5% level. Moreover, the distance variables to the nearest lake and park only displays a significant negative relationship of 0.08 for lakes and 0.14 for parks, suggesting a very small change in land prices when increasing the distances from them. Another big deviation between the first two regression models and the regression conducted in Table 6 is the significance of the distance to Bankeryd. From being the most prominent distance-to-city-center variable in Table 4 to being a non-significant variable when excluding all house attributes in regression model 3. This result gives us the reason to doubt our previous reasoning that high income families tend to locate outside the city centers, as mentioned in section 5.2.

6 Conclusion

In this paper we studied the relationship between single family home prices and the distance to natural amenities such as lakes, parks and open spaces. This relationship was also tested for the distance to city centers since it captures urban amenities and being the main employer. This was done by using a dataset containing information regarding single family home purchases in Jönköping, Sweden during the years 2000 and 2011. The valuation of the amenities are based on a hedonic pricing approach stating that the house consists of a bundle of utility bearing characteristics that are subjectively valued. By running regressions according to this model we, as a result, observed and identified the extent to which the fraction of the price is accredited to these specific amenities.

The main findings in the study are that there indeed exists a negative relation with increasing distances between the focus variables and house prices. Although the significance levels of the distance to natural amenity variables do not hold constant over the different regression models, they do however still present a correlated, yet slightly skewed, negative relationship. Beside the natural amenities, we tested what effect the distance to urban centers have on house prices. In Jönköping municipality we chose to include Jönköping, Bankeryd, Huskvarna and Gränna as urban centers since they all possess properties of being a CBD according to the definition by Von Thünen (1826). The outcomes of these variables, observable in Table 4, do overall hold a greater impact on the house prices compared to the natural amenities. Additional research is necessary to investigate what specific factors within the city centers contribute to increased house prices in this geographical study area.

Furthemore, we computed a robustness test by substituting the dependent variable to the land value of the houses, instead of the house price itself, in order to filter out the difficulties of projecting house prices with a hedonic pricing approach. This erased the possibility of omitting crucial house characteristics that explains the variation in the dependent vairable. Moreover, since there is a correlation between the price of a house and the corresponding land value, we where able to explain that geographical location matters without using internal house characteristics in the regression model. The result presented in regression model 3 in Table 4 shows that people value to be located in proximity to Jönköping city center more than the other city centers. Further we see that natural ameneties are attractive and that proximity to water is the most prominent coefficents among the natural ameneties.

Our two main regression models, 1 and 2 in Table 4, obtained an R-squared of 0.327 and 0.212 respectively, compared to a coefficient of determination of 0.787 in model 3. It is therefore suggested that future research investigates how to obtain the optimal functional form that is able to better explain the variations in the dependent variable.

References

Alonso W. Location and Land Use. Toward a general theory of land rate. 1964. Cambridge: Harvard University Press. 1964

Bourassa, Steven C, Hoesli, Martin E., Sun, Jian. 2003. What's in a View?

Brueckner J.K. Why is central Paris rich and downtown Detroit poor?: An amenity-based theory. *European* Economic Review. Volume 43, Issue 1, January 1999, Pages 91–107.

Buchanan, J.M. (1965). An Economic Theory of Clubs. Economica, 32(125), p. 1- 14.

Freeman, A.M. (1979). Hedonic Prices, Property Values and Measuring Environmental Benefits: A Survey of the Issues . The Scandinavian Journal of Economics, 81(2), p. 154-173.

Geoghegan J. (2002). The value of open spaces in residential land use. Land use policy, Vol. 19(1), 91-98.

Geoghegan et. al, 1997. Spatial landscape indices in a hedonic framework: an ecological economics analysis using GIS. Ecological Economics, 23 (3) (1997), pp. 251–264

Goodman, A.C, 1997. Dwelling-Age-Related Heteroskedasticity in Hedonic House Price Equations: An Extension. Journal of Housing Research, Vol. 8 Issue 2.

Kitchen W. & Hendon S. Land Values Adjacent to an Urban Neighborhood Park. Land Economics, Vol. 43, No. 3 (Aug., 1967), pp. 357-360

Lancaster, Kelvin J. A New Approach to Consumer Theory. *The Journal of Political Economy*, Vol. 74, No. 2 (Apr., 1966), 132-157.

Malpezzi, Stephen. 2002. Hedonic Pricing Models: A Selective and Applied Review. *Housing Economics and Public Policy*. Blackwell Science Ltd, Oxford, UK, 2002.

Mendelsohn, R. & Olmstead, S. 2009. The Economic Valuation of Environmental Amenities and Disamenities: Methods and Applications. *Annu. Rev. Environ. Resour*. 2009. 34:325–47

Milon, JW. 1984. Hedonic Amenity Valuation and Functional Form Specification. *Land Economics* Vol. 60, No. 4 (Nov., 1984), pp. 378-387

Mitchell, R. 2009. Effect of exposure to natural environment on health inequalities: an observational population study. The Lancet 372 (9650), 1655-1660.

Nilsson, Pia. Price Formation in Real Estate Markets. JIBS Dissertation Series No. 088, 2013.

Penningpolitik | Sveriges Riksbank . 2015. [ONLINE] Available at: http://www.riksbank.se/sv/Penningpolitik/. [Accessed 27 April 2015].

Rosen, Sherwin. Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition. *The Journal of Political Economy*, Volume 82, Issue 1 (Jan. - Feb., 1974), 34-55.

Samuelsson, P.A. (1954). The Pure Theory of Public Expenditure. The Review of Economics and Statistics, 36(4), p. 387-389.

Samuelsson, P.A. (1955). Diagrammatic Exposition of a Theory of Public Expenditure. The Review of Economics and Statistics, 37(4), p. 350-356.

SWEREF 99, projections - Lantmäteriet. 2015. [ONLINE] Available at: https://www.lantmateriet.se/en/Maps-and-geographic-information/GPS-and-geodetic-surveys/Reference-systems/Two-dimensional-systems/SWEREF-99-projections/. [Accessed 27 April 2015].

Tiebout, C.M. 1956 . A Pure Theory of Local Expenditure. Journal of Political Economics, 64(5), p. 416-424.

Tyrväinen, Liisa. The amenity value of the urban forest: an application of the hedonic pricing method. *Landscape and Urban Planning*, Volume 37, Issues 3–4, July 1997, Pages 211–222.

Thünen, Von J.H. 1826. Die isolierte Staat in Beziehung auf Landwirtshaft und Nationalökonomie. Pergamon Press, New York. English translation by Wartenberg C M in 1966, P.G. Hall, editor.

Weigher J.C. & Zerbst R.H. The Externalities of Neighborhood Parks: An Empirical Investigation. Land Economics, Vol. 49, No. 1 (Feb., 1973), pp. 99-105

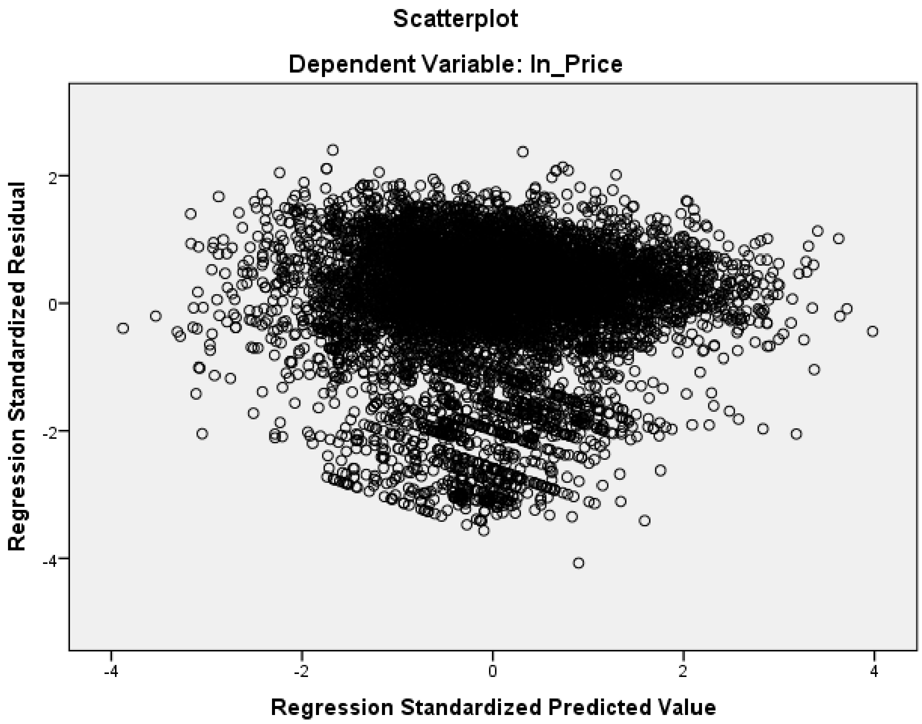
Wheeler, B.W. 2012. Does living by the coast improve health and wellbeing? Health & Place. Volume 18, Issue 5, September 2012, Pages 1198–1201.

White, M. 2010. Blue space: The importance of water for preference, affect, and restorativeness ratings of natural and built scenes.Journal of Environmental Psychology. Volume 30, Issue 4, December 2010, Pages 482–493.

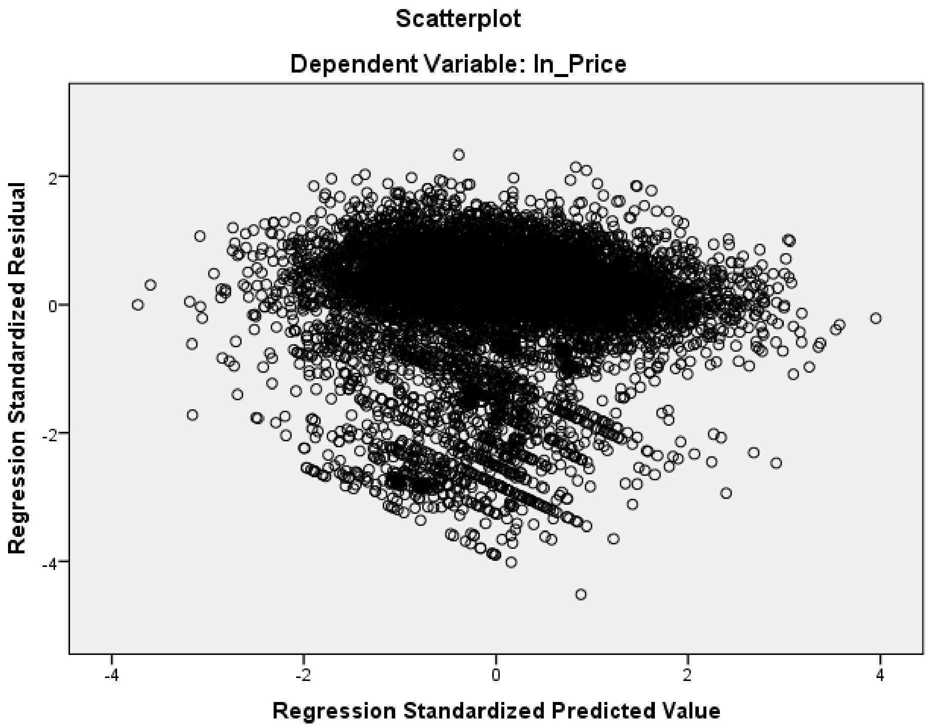
Yang, C H., and Fujita, M. (1983). Urban Spatial Structure with Open Space. Environment and Planning A, 15(1), p. 67-84.

Appendix

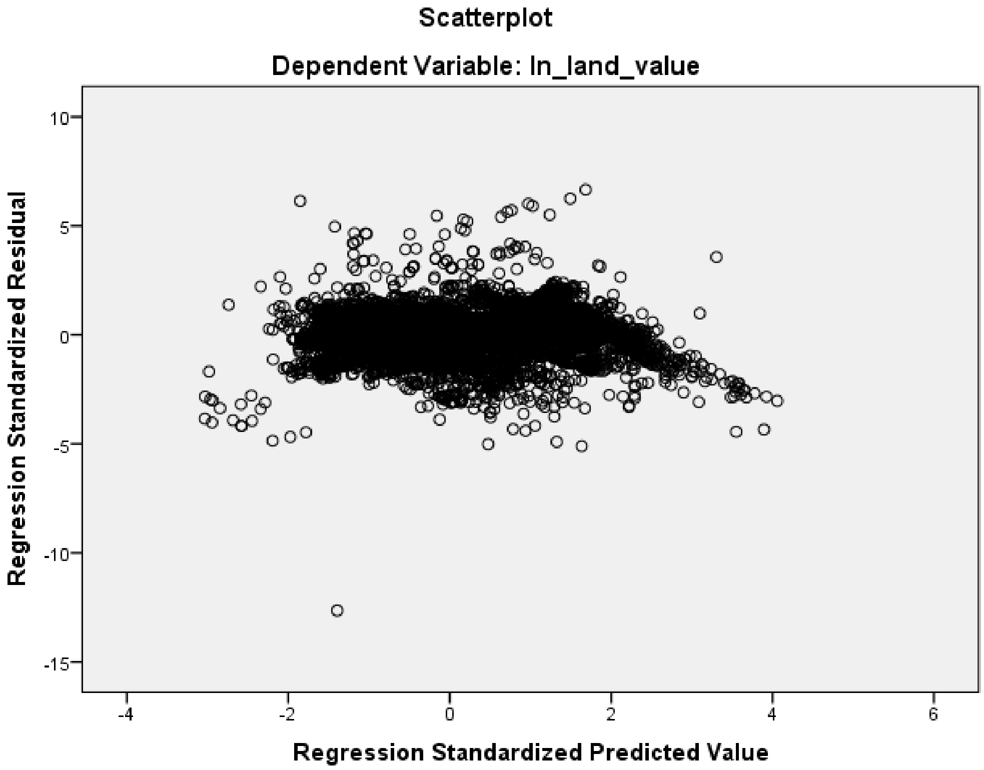
Heteroskedasticity plot with Swedbank 3-month mortgage rate:



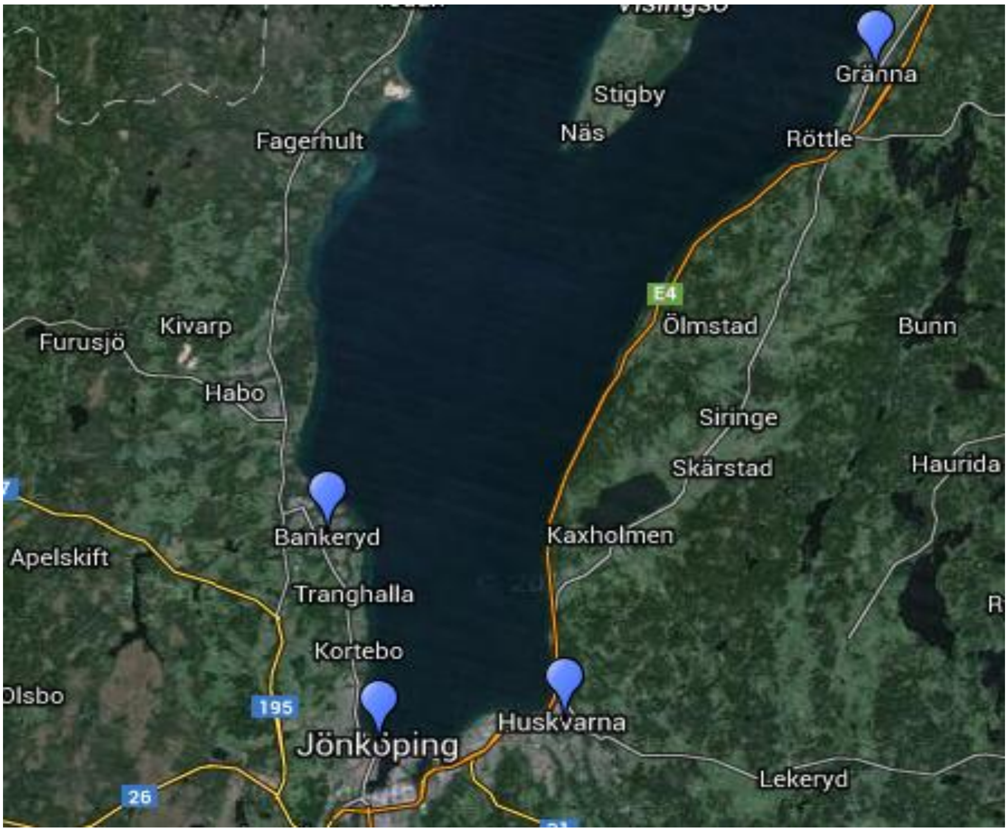
Heteroskedasticity plot with Dummy variables (2001-2011):



Heteroskedasticity plot with land price as dependent variable:



Map of the geographic overview surrounding Jönköping municipality with markers set on the city centers of Jönköping, Bankeryd, Gränna and Huskvarna:



Collinearity Statistics:

Coefficients[a]

Model		Unstandardized Coefficients	Standardized Coefficients	t	Collinearity Statistics	
		B	Beta		Tolerance	VIF
1	(Constant)	14,305		16,645		
	Dummy_2011	,582	,208	1,260	,004	264,670
	Dummy_2010	,093	,036	,130	,001	729,040
	Dummy_2009	,005	,002	,007	,001	844,659
	Dummy_2008	,514	,203	12,579	,397	2,518
	Dummy_2007	,480	,188	5,912	,102	9,835
	Dummy_2006	,033	,013	,068	,003	335,075
	Dummy_2005	-,305	-,122	-,571	,002	441,350
	Dummy_2004	-,101	-,035	-,238	,005	204,125
	Dummy_2003	,039	,013	,202	,027	37,723
	Dummy_2002	,110	,036	2,441	,477	2,097
	Dummy_2001	-,034	-,011	-,320	,087	11,514
	Mortgage_Rate	-,194	-,325	-,894	,001	1277,279

a. Dependent Variable: ln_Price