# Size matters…

Rotterdam, 29 November 2017

# Size matters…

…spatial proximity too, a study on urban parks and house prices.

**'Valuation of urban parks: mechanisms of green space in capitalization of housing.'**

Empirical research on the housing markets for sold houses in The Hague & Utrecht

Master thesis Economics and Business

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# Preface

After having completed nearly all steps in the educational process from elementary school until obtaining my Master's Degree, I realise that reaching this goal in this fashion would not be possible, without the support of the most important people during my life until now. Foremost, I would like to stress the importance of the unconditional and endless support I have received from my parents during all these years. Mum and dad, you have let me make my own decisions and determine my own future and both of you were always there when I needed advice or help, during roughly twenty years of education. I know that I do not have to thank you for this, which is convenient because I do not know how I could do this appropriately.

Regarding this Master's thesis, several people have contributed substantially to this paper. Jeroen, I would like to thank you for supervising this process in a strikingly fluent and natural way. Before every time we met to discuss my progress, I was stuck in some way. During every meeting, you provided useful advice and tips, which gave me new energy to proceed afterwards. Every single time. In my opinion, this is exactly how an ideal supervisor should act.

Regarding my internship, I want to thank Ecorys for giving me the opportunity to write my thesis with them, while I was able to gain some practical experience simultaneously. I want to thank all my colleagues of Regions & Cities for the feedback, brainstorms and tips during my internship. In addition, special thanks to Arjan Slaakweg for supporting me with obtaining data with respect to distances, sizes and locations.

Furthermore, I want to thank Frank Harleman, on behalf of the NVM, for making available the dataset I used for this research.

Constructing the ideal structure of my paper has been a tough assignment and I want to thank Dionne, for providing highly useful feedback in this respect. In addition, you have been a great support in this entire period of writing my thesis.

# Summary

In this paper, valuation of urban parks is researched. Urban parks serve a mainly recreative function, so one could posit that geographical proximity of parks and park size influence the appreciation of these urban parks. Additionally, a synergetic effect of proximity and size on urban park valuation has been researched. Findings indicate that geographical proximity indeed influences the valuation of urban parks: Residents value urban parks more positively when geographical proximity is high than when it is low. Secondly, partial evidence has been found for the claim that park size positively influences the appreciation of urban parks. Additionally, indication of the existence of a synergetic effect of both distance and size has been found, in one case.

A distance effect on transaction prices has been demonstrated: in both The Hague and Utrecht transaction prices are higher for residences closer to urban parks. In Utrecht, a park size effect has been found as well: when the nearest urban park is larger, transaction prices are higher. In Utrecht, a synergetic effect has been found too. Two explanations of the synergetic effect are possible: (1) as distance to urban parks increases, the park size effect on transaction prices decreases and (2) as the size of an urban park increases, the distance effect on transaction prices increases.

Data of transaction prices and urban parks from the period 2004-2006 in The Hague and Utrecht is used, obtained from the Dutch Association of Realtors and Appraisers (NVM). In this research the Hedonic Pricing Method is used. With this method the implicit price of housing characteristics can be estimated: a housing price is the price of a bundled good. Hedonic Pricing can estimate the level of contribution of all housing characteristics included in the model, in the transaction price. Because proximity and size of the nearest urban park are also housing characteristics that can be added to the model, it is desirable to use proxies to estimate proximity to the nearest urban park and the associated size. Hence, also the premium residents are willing to pay to live near an urban park can be estimated.

People derive utility from urban parks using four different mechanisms. Firstly, direct utility from visiting the park and 'consuming' this amenity is used. Secondly, people derive utility from the possibility to visit an urban park, a more indirect mechanism. Thirdly, earlier research shows that residents derive utility from a pleasant view on green spaces. Lastly, neighborhoods can be more attractive for their 'green image'. Urban parks can contribute positively to this image.

Research on the valuation of urban parks has been done before. Proximity as well as size can have a positive impact on the valuation of urban park, although results are not always unambiguous. This research contributes to literature, because the interaction between park size and proximity and their effect on the valuation of urban parks in urban areas in the Netherlands has not been demonstrated yet. From a societal perspective, urban planners can use insights of this research in urban planning regarding the creation and/or conservation of urban green space: are various smaller urban parks or a small amount of large parks appreciated more by residents? In order to increase the perceived quality of living in cities, acting in line with the results of this study should increase neighborhood attractiveness, at least in the researched cities.

Assuming that urban parks create value for residents through these mechanisms, one could expect that residents value these parks more positively when they live closer to urban parks and/or when the nearest urban park has a bigger geographical size. A possible manner to measure this valuation of urban parks objectively, is looking at residential transaction prices, housing prices, in relation to their distance to the nearest park and the associated size of that park.

# 1 Introduction

This thesis is about the valuation of urban parks in the Netherlands. In this introduction the research topic is introduced briefly and the contribution of this paper to existing research and societal challenges is explained. Furthermore, the research question is posed and the outline is provided.

## 1.1 Topic

Research indicates that the presence of urban parks is an important element of the physical environment. Different features of urban parks are stressed in literature: urban parks provide social and psychological benefits to human societies (Chiesura, 2004) and leisure opportunities and aesthetic enjoyment (Kong, Yin, & Nakagoshi, 2007). Changes in urban vegetation with respect to amount, size, location and condition appear to affect the amount of benefits and costs directly (Nowak & McPherson, 1993). Luttik (2000) shows that, in the Netherlands (apart from the value of water) a pleasant view has a positive effect on the housing price (Luttik, 2000). Other research shows that houses are valued 6 percent higher when there is an urban park within 400 meters, ceteris paribus (Fennema, Veeneklaas, & Vreke, 1996).

In the rest of Europe similar research has been done on valuation of green, often using a hedonic pricing model (e.g. (Choumert & Travers, 2010; Helgers et al., 2016; Votsis, 2017)). An overview of research on this valuation of urban green space in Europe can be found in Visser & Dam (2006).

## 1.2 Relevance

Although some research partly overlaps, differences in mechanisms are also shown. These differences in mechanisms offer an opportunity to make a additional contribution to existing academic research. Urban parks seem to provide value for residents, but underlying mechanisms are not fully understood yet: conceivably, geographical and/or locational features of urban parks can influence the valuations of urban parks and these phenomena can possibly also influence each other. From an academical perspective, underlying geographical mechanisms which can reinforce each other have not yet been uncovered for Dutch urban areas. Therefore, this paper aims to enrich theory by giving an opinion on the extent of the existence of these effects.

From a policy perspective, it is relevant to determine the mechanisms through which the value of green space is capitalized and who benefits. Three crucial questions need to be answered: why do people value green space? How is this capitalized into house prices? Who benefits to what degree? If these questions are answered, policy makers can use the answers as arguments for persuasion or for value capturing. “The economic value of green space is often being underestimated, which blocks decent political decision making” (van Leeuwen, 1997, p. 7). On the other hand, one could posit that the value of urban parks is overestimated due to the presence of forests and other larger green spaces just across the border of municipalities. Also, economic value of urban parks could be low(er) due to the presence of private gardens, having a comparable function.

In valuation of urban parks, existence of a synergetic effect with respect to accessibility and size would open doors for policy on urban parks in cities (preferably many small recreative green spaces versus fewer bigger central recreative green spaces) and for project developers (would it be beneficial to do private investments in urban parks in a new district?). For house appraisers this information will offer a more accurate measure for the market price of an urban park, while realtors could use it as an additional sales argument.

Urban areas are characterized by a large share of urban development and intensive physical infrastructure compared to rural areas. Simultaneously, due to several pull factors (amenities) demand for land is higher in urban areas, as is the residential density, causing prices of land to rise. Conceivably, land use and urban planning are under higher pressure in cities (connected to the Dutch discussion of 'Rood betaalt voor Groen' (Dutch for 'Red pays for Green') (Luttik & Zijlstra, 1997)). Literature confirms that provision of urban green space in a dense area is costly (Panduro & Veie, 2013). As a consequence, the societal value of this research increases when it is focused on a particular bounded, dense area. In short, cities are interesting, relevant and complicated to study with regard to urban green areas; especially in the Netherlands, which is known for its high population density and large number of medium-sized cities.

In areas without large green areas such as forests or nearby National parks, it is valuable to research how urban planners take care of the provision of green areas that are used by residents for recreational activities: This research is much more relevant on these dense areas, than on areas with large green areas nearby. After all, large green areas – having similar recreational functions as urban green areas to a certain extent - can decrease the desire for urban green areas at the expense of other destinations of land use.

## 1.3 Research question

This paper aims to find an answer to the following research question: how is recreative urban green space valued and to which extent are geographical mechanisms affecting this valuation?

## 1.4 Method

Because of the increased societal relevance in the case of researching mechanisms of valuation of urban green space in dense areas, this papers focuses on the cases of Utrecht and The Hague. In order to be able to formulate an answer to the research question, mechanisms for valuing urban green areas are recognized. Subsequently, quantifiable measures are linked to these mechanisms. After adding these quantifications to the model, presence of certain effects can be demonstrated if they exist. Finally, findings are discussed in order to be able to answer the research question.

## 1.5 Outline

The next section is dedicated to the theoretical framework, while the conceptual model is explained in the third section. The method and data are separately explained in section four and five. The model used in this research is discussed in the sixth section. In the seventh section the results of the model are discussed and interpreted. Discussion of these results can be found in section eight. Section nine and ten form the synthesis and the conclusion, while in section eleven limitations are identified. Finally, section twelve contains practical implications and recommendations for further research.

# 2 Theoretical framework

In this chapter the development of urban green spaces will be reviewed. The functions of parks are described with a specific emphasis on environmental and recreational value for residents. Subsequently, the influence of urban green space on housing prices is discussed. Furthermore, empirical findings regarding particular quantified effects will be provided.

## 2.1 Why is urban green space valuable?

The first considerable cohesive action in providing public green space in Europe emerged during the 19$^{th}$ century, when European urban population was booming due to industrialization. At the time, urban parks were already considered to be increasing the health of the urban population in general along with the general quality of life. Both existing private parks and newly developed green spaces in Western Europe gradually became publicly accessible during the period 1850-1900 (Konijnendijk, Ricard, & Kenney, 2006). Plenty examples of urban parks originating from this period exist: the Dutch 'Vondelpark' in Amsterdam, opened (and became publicly accessible) from 1865 onwards (Gemeente Amsterdam, n.d.) and the London 'Victoria Park' was founded in 1845. This urban park has received the nickname 'The People's Park' since the park became an essential amenity for the working class in the second half of the 19$^{th}$ century (Cole, 2008), which underlines the importance of the amenity value of urban parks back then. In The Hague and Utrecht (Netherlands) the Huijgenspark (1860) and the 'Tivoli Park' (1828) respectively originate from this period. While Tivoli Park was never publicly accessible and does not exist anymore (Meulen van der, n.d.), the 'Huijgenspark' still exists as small public park (Den Haag Marketing, n.d.). Until the latter half of the 20$^{th}$ century, planning and management of European public greenspace had been rather sectoral. Starting as late as the 1970's more comprehensive approaches to greenspace planning and management emerged (Konijnendijk, 2003; Werquin et al., 2005).

A couple of decades later nearly 50% of the worldwide population is living in an urban area and nowadays we are still having to deal with a trend towards urbanization: as this trend continues it becomes more and more clear that access to some form of "nature" is a fundamental human need (Thompson, 2002).

In the academic discourse for the potential of cities was focused on a comparative advantage in production capabilities within cities - geographical concentrations of economic activity – for a remarkable period in the 20$^{th}$ century. Much attention has been spent on the impact of specialization economies and unrelated versus related variety in relation to the future of cities (Frenken, Van Oort, & Verburg, 2007; Glaeser & Kallal, 1992; Henderson & Kuncoro, 1995; Jacobs, 2016). Even more politically oriented statements have been made: in response to the striking differences in welfare between US inner cities, Porter (1995) stirred up the debate of the possible future of inner cities. He also focused on the production side of the inner city, but he advocated a liberal economic model, in which for-profit business should be stimulated by the government to locate and use the competitive advantages of the inner city and its residents. The importance of a sustainable economic base was stressed: scholars wrote about employment opportunities and wealth creation. Fueled by this discussion, the academic debate in urban economics and urban planning changed with regard to the potential of cities from the production side to the consumption side. According to traditional urban economics, cities have disadvantages in consumption. On the production side firms and workers earn more in cities, while on the consumption side users pay higher rents, commute longer and face more crime. Also, gradually academic attention emerged for the possible consumption side of cities and the seemingly improbable advantage on this side (Glaeser, Kolko, & Saiz, 2001).

In the consumption city, four critical urban amenities have been recognized. The most obvious is a rich variety of services and consumer goods. Aesthetics and physical setting is the second amenity: architectural eye-catchers and the local climate belong to this category, amongst other things. The third and fourth critical amenities are good public services and speed, measured in transport costs (Glaeser et al., 2001).

More clues that exist, supporting the importance of urban amenities: a neoclassical city growth model has been calibrated which supports the claim that consumer city is in upswing, making cities more attractive for consumption. An important share in the employment growth effect between 1940 and 1990 is caused by the growth of quality of life, apart from the growth in productivity. This contradicts the claim that productivity growth is the only manner by which human capital generates employment growth. Moreover, it seems that this effect may operate through the critical urban amenities described above, such as aesthetics and physical setting (Shapiro, 2006).

Glaeser provided descriptions of four critical urban amenities. Urban parks could belong to the first group as well as to the second group of critical amenities.

Urban parks could be part of the rich variety of services and consumer goods, or at least be supporting to these services and goods. Taking a stroll, jogging or performing other recreational activities can be seen as consumption, notwithstanding that an urban park is - or at least it meets the crucial requirements to be - a public good, see (del Saz Salazar & Garcia Menendez, 2007). An argument for urban parks to belong to Glaeser's group of consumer goods is that environmental 'consumption' of urban forests stimulates a pleasant living environment and recreation opportunities, which are associated with improvement of people's mental and physical health (Tyrväinen, 1997). However, more obvious is the link of urban parks with aesthetics and physical setting (Kong et al., 2007), Glaeser's second group. For the sake of the empirical research in this paper it is redundant to elaborate more on the particular group urban parks should be designated to: most important is to make clear that urban parks can be treated as urban amenity, contributing to individual perceived welfare of urban residents.

Chiesura (2003) already noticed that urban nature provides important social and psychological positive effects for human societies. Other research confirms that open space enhances the economy and quality of life in cities, by providing recreational opportunities and enhancing aesthetic values (Nowak & McPherson, 1993). Some literature goes one step further: because models explaining growth of cities from the glory days of industrial manufacturing are outdated, new insights concerning the influence of cultural activities are developed (Clark, Lloyd, Wong, & Jain, 2002). Aesthetic qualities of cities have been demonstrated to be the most important factor determining the place to live for young recent university graduates (Florida, Steiger, & Wilson, 2006). In urban parks, recreational activities based on enjoying the contact with nature are becoming increasingly widespread. They also carry out the same environmental functions as forests and green areas (Morancho, 2003). Also, in (Luttik, 2000) and (Luttik & Zijlstra, 1997) the socio-economic value of ecological factors in a neighborhood is stressed. Similar types of functions are mentioned by (Panduro & Veie, 2013), by which urban parks contribute to the provision of recreational opportunities, floodways, improved air quality and reduced housing density.

> **"Citizens in the postindustrial city increasingly make quality of life demands, treating their own urban location as if tourists, emphasizing aesthetic concerns" (Clark et al., 2002, p. 493).**

## 2.2 Capitalization of urban green space

Research in the Netherlands assumes that an attractive environment tends to influence house prices. A positive relationship between environmental factors in the direct neighborhood of residential property and prices of residential property has been found (Luttik, 2000): this relationship has been demonstrated via gardens facing water of a sizeable lake, a pleasant view or an attractive landscape type. Additional research also emphasizes the positive influence of a various landscape (Luttik & Zijlstra, 1997). These valuations have all been demonstrated using hedonic price models, which can estimate the value of (urban) green space to residents by estimating the premium of those areas in housing prices. In other types of research the positive effect of a view on green space decreases when physical barriers between residence and the associated green space, like roads, exist (van Huijssteeden & Schep, 1988). This research is performed by interviewing realtors (as opposed to hedonic modelling). As a result, a premium in housing prices is estimated. Also, tax revenue could be increased as a consequence of an increase in property value due to natural elements like trees or open water (Tagtow, 1990).

An ecological mechanism regarding value of urban parks can be found as well: air purification by trees can reduce costs of pollution reduction and prevention measures. Furthermore, the attractiveness of the city as a tourist destination could be increased by aesthetic, historical and recreational values of urban parks, which will generate employment and revenues (Chiesura, 2004). With help of a hedonic model, (Poudyal, Hodges, & Merrett, 2009) show the value of urban parks by measuring the change in consumer surplus when increasing average park size.

## 2.3 Earlier findings

Regarding empirical findings, research in the Netherlands on the effect of urban green space on housing prices already showed particular effects before (Luttik, 2000): attractive landscapes attract a premium of 5-12% over less attractive environmental settings. More specifically: in the case of Apeldoorn a premium of 6% on residential property prices has been found near parks. However, the same research shows no significant effect of proximity of a park in the cases of Emmen and Leiden.

Van Huijssteeden (1988) discovered, using qualitative research, that realtors in Zoetermeer estimated a 5-10% premium on house prices in the case of a view on an urban park or forest. Without a view on the park, a near urban park was estimated to have a premium of only a small percentage. Furthermore, this research indicates an inhibitory positive effect of a view on green space in case of a physical barrier, like a road. However, due to this research having been done on five realtors in Zoetermeer and Bleiswijk: statistical significance and external validity with respect to larger cities are questionable. Research using more realtors (134) in the Randstad resulted in two main findings: the average premium on house prices of very royal presence of green space within a neighborhood was 11,6%, and the premium for houses within 15 minutes cycling distance to a nature reserve or attractive agrarian landscape was 9,8% (Sijtsma, Stelder, Elhorst, & Oosterhaven, 1996). In other research an average premium on house prices has been estimated to be 6-7% when the house was adjacent to green space. This effect was based on interviews with 380 Dutch realtors (van Leeuwen, 1997). Effects shown on the basis of realtors' insights are based on stated preference: this type of research relies on survey techniques eliciting values and individual preferences for economic goods and services (Harrison, Smersh, & Schwartz, 2001). As a consequence, outcomes in research based on stated preference can differ from actual behavior. Therefore, found effects could be biased due to a so called hypothetical bias (Adamowicz, Swait, Boxall, & Louviere, 1997). An elaboration on the type of preference used in this research can be found the fourth section, when the method used for this paper is substantiated.

In Luttik & Zijlstra (1997) the effects of attractive green surroundings on housing prices have been researched for eight different regions in the Netherlands. In general, a view on urban green space with a significant size increased the housing price with 8%. However, in more than half of the cases no significant effect could be demonstrated. One of the regions in this research was the region around the city of Utrecht (Bilthoven, De Bilt, Zeist, Bunnik and Houten). In this case has been focused on the division of market segments: on the west/south side of Utrecht more affordable houses can be found in Houten, while housing prices are relatively more expensive on the north-east/east side. A central finding in this research was the premium for houses in De Bilt/Bilthoven, Zeist and Bunnik as a consequence of the high proximity to large green areas (forests). These findings clearly insinuate a positive relation between housing prices and large green space in a relevant region in De Randstad. However, the municipality of Utrecht has not been addressed in this research: geographically, the research area in (Luttik & Zijlstra, 1997) slightly overlaps with the research area in this paper (municipalities of Utrecht & The Hague). This could function as motivation for a similar expectation in this paper with regard to the shown findings around Utrecht. However, the used method in Luttik (1997) is different on two essential points: the focus is on less dense areas (small cities regarding population size) and large green areas (forests). On the contrary, this research focuses on more dense urban areas (medium sized cities regarding population size) and urban green spaces which are, in terms of acreage, smaller in size. Furthermore, creation and conservation of urban parks require a cost-benefit analysis from a urban planning point of view, which differs from the type of analysis require for forests.

Research in Castellón (Spain) confirms an inverse relationship between the selling price of a dwelling and its distance from a green urban area, with support of a hedonic analysis. In a linear function, every 100 meter further away from a green area results in a €1800 drop in the house price (Morancho, 2003).

Regarding geographical proximity, one could posit that people performing recreational activities prefer an area in direct neighborhood of their home or workplace. Findings in literature confirm this expectation: the majority of users of urban parks wants to come by foot and will only do so on a regular basis if the park is within 3-5 minutes' walk of their home- or workplace (Kaplan & Kaplan, 1989). Research in the Netherlands is in line with Kaplan & Kaplan (1989): a premium of 6% in residential property prices is shown for houses, located closer to a park than 400 meters (Fennema et al., 1996). These two papers indicate two striking phenomena: firstly, a general desire to visit an urban park by foot. Secondly, the willingness to travel (measured in meters) for visiting an urban park is relatively low: assuming a walking pace of 5 kilometers an hour, the maximum willingness to travel for visiting an urban park is approximately 410 meters. From this finding one can deduce the following: people living (or working) within 410 meters of an urban park tend to value this park more positively than people with a travelling distance exceeding 410 meters. Actually, according to this research one should ask whether these people outside the travelling radius of 410 meters value this park at all. Anyhow, this is a clear indication that people are willing to pay a higher premium for a more accessible park than for a park which is located further away, measured in walking distance.

From an academic perspective, there is a discussion regarding the existence of the influence of the size of urban parks. In Spain the effect of park size was found to be insignificant, which indicates that provision of numerous small green areas is more relevant than their size. Large park areas only serve as complements to small landscaped gardened areas, if size is relevant at all (Morancho, 2003). However, in Poland findings indicate that large parks have the most important key benefits, reflected in implicit prices, as opposed to smaller parks (Czembrowski & Kronenberg, 2016). In the United States it has been shown that urban recreational park acres are related to an increase of nearby property values and that an increase of the size of a park by 20% will cause an increase in consumer surplus of $160 per household. This indicates a positive correlation between park size and park valuation (Poudyal et al., 2009).

## 2.4 Hypotheses

In order to be able to answer the research question, in this paper three hypotheses are tested. Funded on theory the effects of accessibility and size of urban parks on the valuation of urban parks are researched.

1. The geographical proximity of an urban park positively affects valuation of the park, as reflected by residential property prices.

2. The size of urban parks positively affects the valuation of the park, as reflected by residential property prices.

3. A synergetic effect exists between distance to an urban park and size of urban parks on the one side, and valuation of urban parks on the other side, reflected by residential property prices.

Due to earlier theoretical and empirical findings mentioned, the first hypothesis is expected to be confirmed.

Regarding the second hypothesis, relations between park size and housing prices seem relatively ambiguous, which means that a weaker confirmation is to be expected. The chosen geographical scope in this paper is dense urban areas. In this scope, urban parks are expected to be valued positively by their residents, who derive utility from an opportunity of a temporary flee from the urban hustle and bustle. In line with this expectation one could posit that larger urban parks are valued more positively than smaller parks. Therefore, the second hypothesis is also expected to be confirmed.

Finding a confirmation for both hypotheses (1) and (2) would raise another question regarding the value, or implicit price, of an urban park. On the condition that people are willing to pay more to be able to perform mentioned recreational activities more proximate to their home- or workplace and that the premium is higher in the case of a larger park, one could argue that on top of both of these premiums, additional value is assigned to a combination of these effects. An exponentially higher premium for houses which are near a large park would indicate the existence of such a synergetic effect. Hence, a synergetic (negative) effect of distance (-) and park size (+) on transaction prices, and hereby confirmation of the third hypothesis, is expected.

# 3 Conceptual model

In this section, a conceptual model of utility derivation from urban parks is sketched: five mechanisms are recognized, divided in two groups. Firstly, utility through consumption will be explained. Secondly, utility due to indirect effects will be explained.

## 3.1 Consumptive utility

The most substantial way in which residents derive utility from urban parks is through consumption: by actually visiting the park. Although, seemingly the terms ‘urban green space’ and ‘urban parks’ have been used interchangeably in this paper, this is not the case. Urban green space exists within the span from highly maintenanced urban parks till buffer space between noisy infrastructure (Panduro & Veie, 2013). Functions of green buffer space and urban parks may partly overlap, however urban parks have a wider variety of functions: the most striking difference is the possibility for residents to derive utility from visiting the park. Urban parks are the most popular outdoor recreation environment in Europe (Konijnendijk, 2003): conceivably people’s quality of life enhances due to walking the dog, running or exercising, picnicking or just taking a stroll in the park. In literature this assumed way of deriving utility is often called the recreational function of an urban park (Brander & Koetse, 2011; Tyrväinen & Miettinen, 2000). (Kong et al., 2007) claim that urban green space has an important amenity value with respect to leisure opportunities, which is similar to a recreational function in this respect. Also the fact that an area is peaceful and quiet can be seen as a positive characteristic of an urban park (Tyrväinen, 1997). Furthermore, for children a park is an attractive area to play in: for this reason playground equipment and benches are provided in many parks.

## 3.2 Indirect utility derivation

The second group of deriving utility from an urban park consists of more indirect effects: there is no direct consumption of the park (no actual visit), but absence of urban parks would prevent people from utility derivation according to the following four mechanisms: utility of a view, ecological value, external image and the possibility of using a park.

One possibility of utility derivation from urban green space is that people derive utility from a pleasant view (Tyrväinen, 1997). Urban parks can be seen as an attractive landscape, so a view on the urban park can have a positive effect on people’s mood. In Morancho (2003) this is called ‘collective aesthetic value’, and this is also confirmed by research for the Netherlands: (Luttik & Zijlstra, 1997) find a positive effect of a pleasant view.

Secondly, people can derive utility from urban parks due to ecological effects. Urban parks contribute to cleaner air (Nowak & McPherson, 1993; Tyrväinen, 1997) in the direct vicinity, because urban parks absorb carbon dioxide (CO2) emissions. Cleaner air contributes to a more pleasant environment and a higher standard of living. For this reason, people can derive utility from an urban park.

Thirdly, urban parks contribute to the amount and quality of green space in neighborhoods. One could posit that neighborhoods with a higher share of green space have a relatively ‘green image’. As a consequence, this green image could contribute to the popularity of a particular neighborhood, as neighborhoods with a green image could be valued higher. Clues for the existence of this effect can be found in (Luttik & Zijlstra, 1997): presence of green space and appreciation of neighborhoods are positively related. In that case, a certain neighborhood effect would exist, which is stimulated by the presence of urban parks.

The fourth way of deriving utility from an urban park, is the possibility of using this park. This mechanism is loosely related to the direct effect of consumption, because the absence of the effect of consumption will automatically mean that utility derivation of the possibility of consumption will drop to zero. However, this more indirect effect differs from actually using the park, because people derive utility from the possibility of using it, without actually using it.

# 4 Method

In this chapter the method used to find the hypothesized effect is explained. Firstly, the choice for the used model type is substantiated. Secondly, three different measures are determined for the identified mechanisms. Thirdly, an explanation of the measurement of locations of parks is provided.

## 4.1 Hedonic Pricing Method

In this paper the Hedonic Pricing Method is used. The Hedonic Pricing Method became widely known in the 1970's: after several scholars elaborated on hedonic pricing in general (Gordon, 1973; Griliches, 1971), Rosen (1974) linked the hedonic pricing method to the valuation of different housing characteristics. Although there is academic ambiguity about the origin of this methodology (Colwell & Dilmore, 1999), nowadays the Hedonic Pricing Method has become the academic standard for valuing different attributes in both locational (price of land) and building characteristics (price of structure) of residential buildings (Davis & Heathcote, 2006; Sheppard, 1999; Tse, 2002).

The Hedonic Pricing Method connects to the notion of 'implicit markets', denoting the process of producing, exchanging and consuming commodities primarily traded in 'bundles'. Housing characteristics can be seen as implicit markets: goods which are usefully combined and thought of as being traded in a single 'market', whilst being particularly heterogeneous (Tyrväinen & Miettinen, 2000; Witte, Sumka, & Erekson, 1979). On the contrary, explicit markets are related to the bundles (of characteristics) themselves, with observable prices. To analyze these markets for houses, a conventional economic model like the widely known model of supply and demand (Gale, 1955) does not suffice in analyzing, because there is no such thing as a single price. Rather, price ranges of these bundles depend upon the quality of the commodity and/or the characteristics it contains (Sheppard, 1999) on the supply side. The Hedonic Pricing Method is meant to fill the gap between 'implicit' and 'explicit' markets by estimating prices for individual characteristics.

> **"The primary goal of hedonic prices is to exhibit a generating mechanism for the observations in the competitive case and to use that structure to clarify the meaning and interpretation of estimated implicit prices" (Rosen, 1974, p. 35)**

The Hedonic Pricing Method is the most frequently used method to value different housing characteristics (Li & Brown, 1980; Malpezzi, 2003). A house can be seen as a bundle of characteristics (for example as a bundle of 'year of construction', 'size', 'location', and 'quality'). Each house has its own unique set of characteristics, which means that per definition every house is unique. For this reason valuation of houses can be difficult. A total set of housing characteristics has a market value, which is observed when transaction takes place: residential transaction price. The central objective in the Hedonic Pricing Method is estimating what individuals are willing to pay for different attributes of a house. More generally, to estimate the marginal contribution of an individual characteristic of a good consisting of a bundle of characteristics, a hedonic regression can be used (Sirmans, Macpherson, & Zietz, 2005).

To run a regression in general, the following conditions are necessary: a sufficient amount of observations and variation between them (Wooldridge, 2012). Due to the fact that every house has a unique set of characteristics which are valued differently, there is quite a lot of variation among the data. Also, housing characteristics are administrated quite accurately, at least in Western countries, creating a possibility of a robust quantitative analysis. Therefore, Hedonic Pricing Method is the most frequently used method in valuation of housing characteristics.

The Hedonic Pricing Method is a typical example of research based on revealed preference (Freeman III, Herriges, & Kling, 2014). Research based on revealed preference uses observed market choices of individuals in order to estimate their values and underlying preferences for goods and services (Freeman III et al., 2014). For two reasons revealed preference is preferred over stated preference for this type of analysis: first and foremost, there is a lower probability of under- or overestimating particular effects because answers in surveys may be different from actual behavior. After all, you never know whether people act like they say they would (until they have actually acted, which would be revealed preference). Failing to reflect actual behavior is also called 'hypothetical bias' (Adamowicz et al., 1997). Secondly, one could posit that due to the nature of obtained data often there are more observations available when research is based on revealed preference, because data does not have to be obtained via surveys: for example, real transactions can be used.

As a consequence of this high amount of observations, a regression method provides more robust results. Although theoretical evidence exists indicating the same results for researches performed on stated and revealed preference (Koning, Filatova, & Bin, 2017) in research on housing prices, other literature in the same research field indicates the contrary, namely different outcomes for analyses on the basis of revealed preference and stated preference (Bateman, Day, Lake, & Lovett, 2001).

In literature two main reasons have been found for the existence of hedonic price functions. Firstly, for the construction of price indices accounting for changes in the quality of goods produced and secondly as input of the analysis of consumer demand for attributes of heterogeneous goods (Sheppard, 1999). In this paper the second function is the most relevant one. Once houses have been built, they are often sold multiple times, while the quality is not considered to be changing much in the short term: in general the relative price of real estate across locations is stable over time (DiPasquale & Wheaton, 1996). It is not so much the change in quality of the house which is topic of many research. Moreover, the analysis in consumer demand for (different attributes of) housing in different housing markets has been extensively researched, e.g. housing demand in the short run or housing demand for location (Quigley, 1976; Wheaton, 1977).

Two disadvantages of this method are worth mentioning. The first is about the analysis of residential transaction prices based on revealed preference and the second is about the hedonic pricing model.

Firstly, observed market transactions possibly do not exactly display the correct market price of the bundle of characteristics. This could have three possible causes. Firstly, information asymmetry could exists between buyers and sellers: buyers do not have full information regarding the good concerned, which could bias their estimation of the value of a house. Secondly, in most cases transaction prices of houses have been established as a result of a negotiation process. If buyers or sellers (or realtors on their behalf) have better negotiation skills than their 'opponents' in this process, conceivably the final transaction price could differ from the actual market price. Thirdly, personal circumstances could influence the willingness to pay of potential buyers or the 'willingness to receive' of sellers.

Not having full information regarding a nearby urban park, could be easily prevented by potential buyers by visiting the nearby park before deciding to bid on a potential residence. When potential buyers do not visit the nearby park beforehand, it is improbable that their future utility derivation from that nearby park will change substantially compared with their estimation beforehand. Furthermore, differences in negotiation skills are expected to cancel each other out as observations increase, just as personal circumstances.

Altogether, the disadvantage of revealed preference is limited and a better type of analysis has not been found (yet) to my knowledge: it seems unlikely that an analysis based on stated preference provides better results. Hence, the analysis based on revealed preference is used in this research.

The second disadvantage is about the hedonic pricing model: this model is suitable to display the prices of component attributes of residential property for marginal amenity changes, showing the average marginal willingness to pay for every observation. However, when amenities change radically the hedonic pricing model cannot provide adequate results. For example regarding the value of the component attribute of infrastructure: when travelling time decrease from 10 to 3 minutes by building a new bridge, this is clearly an improvement. Although the value of the improved infrastructural situation can theoretically be measured with help of the difference between the old (10 minutes travelling time) and the new (3 minutes travelling time) situation, interpreting a marginal change of travelling minutes would be incorrect: while an improvement to 5 minutes travelling time theoretically would have a positive value, intuitively one sees that a travelling time of 5 minutes is not realistic and therefore cannot be labeled with a particular value. In literature (Freeman III et al., 2014) this nonmarginal change is already introduced as a disadvantage in the hedonic pricing method. However, in this paper such nonmarginal changes are irrelevant.

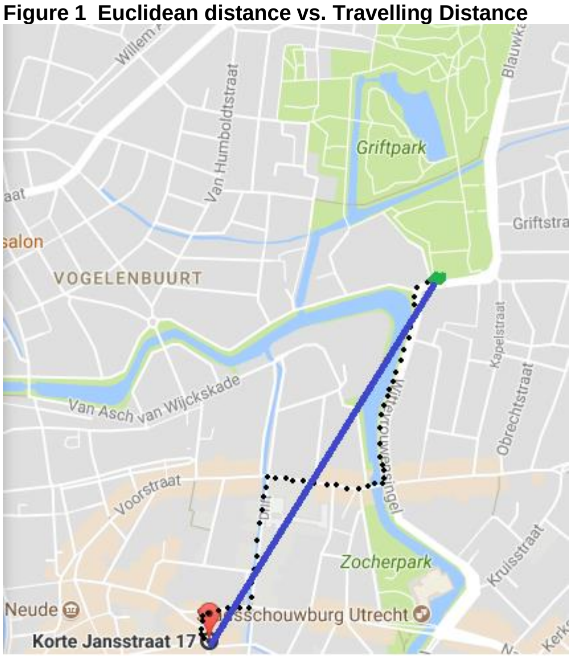
## 4.2 Measurement of utility derivation

The five identified mechanisms of utility derivation from urban parks have been quantified by three different measures: accessibility, size and an interaction of those measures.

Accessibility will be measured by the travelling distance in meters from a house to the nearest park. As a consequence: the lower the travelling distance to a park, the higher the accessibility of that park for this observation. This is logical, because residents which have to travel only a small distance to an urban park (departing from their residence), will experience this park as highly accessible. On the contrary, in the case of a large travelling distance for residents to an urban park, this park will be considered as difficult to reach, with a low accessibility.

Measuring accessibility of urban parks will be used to cover effects of three identified mechanisms, described in the previous section: utility of a view, the ecological value and utility of the possibility of use. When distance is smaller, utility of a view will most certainly increase: when a view improves in quality, utility will probably increase. The most probable increase in quality of the view is caused by a higher proximity to the park. Secondly, ecological value to residents will increase when the air is cleaner. The air in direct vicinity of the park will be cleaner than in the case where distance is increased. Therefore, also the utility from ecological value will increase with a higher accessibility. Furthermore, utility derivation from the possibility of consumption will most certainly be higher when the accessibility of an urban park is higher. For the three mechanisms described above accessibility works in the same direction regarding the valuation of urban parks. Therefore, a higher accessibility is considered to have a positive effect on the willingness-to-pay for residential property. In order to be able to show this effect, the assumption is made that the revealed premium on transaction prices as a consequence of geographical proximity of an urban park represents the value of the presence of an urban park on that location to residents.

**Figure 1  Euclidean distance vs. Travelling Distance**




Accessibility measured by distance has been used in research before: (Tyrväinen, 1997) used 'walking/cycling distance to the nearest fores' and 'Euclidean distance to the nearest forest' in order to show a positive relation between presence of green space and housing prices. For the effect of ecological value, a more precise indicator would probably be the Euclidean distance: air does not move itself by the same route as people move. However, travelling distance fits better as explanatory variable in this research because it is conceivable that the bigger part of derived utility from urban parks, is from visiting those particular parks (direct utility) or the possibility to visit those parks (indirect utility). In addition, Euclidean distance is an approximation for travelling distance. In turn, travelling distance in meters probably is an approximation for the perceived effort to enter a park (and return back home). However, the perceived effort to enter a park is quite difficult to measure and probably travelling distance in meters is the best possible and workable approximation. Values of the explanatory variable 'travelling distance' are in meters, similar to the Euclidean distance and the used travelling distance is the route by foot, making use of all roads (except for highways and runways) available, to the nearest access point of one of the urban parks. An example of this measure of travelling distance, as opposed to Euclidean distance, can be seen in Figure 1: the blue straight line represents the Euclidean distance between 'Korte Jansstraat 17' and the entrance of the nearest identified urban park, Griftpark. In the same figure, the black dotted line represents the travelling distance to Griftpark. In Figure 1 both Euclidean distance and travelling distance to the nearest park have the same destination, namely Griftpark. However, it is possible that these different measures show different destinations: for each different measure, the nearest park is to be determined. The reason why Zocherpark is not the nearest park, is explained in 4.3.

The size of the nearest urban park is used as measure to show effects of four identified mechanisms described in the previous section: utility of consumption, ecological value, the image effect and utility from the possibility of consumption. First and foremost, the utility of consumption will increase when the size of the park increases; it sounds logical that people are willing to pay a higher premium for near parks in which you can perform a bigger variety of activities. Not every type of activity requires a large park, but normally a larger park will be able to host a bigger variety of activities. In turn, this increases the parks attractiveness. Secondly, larger urban parks conceivably absorb more $CO_2$, causing a cleaner air. Therefore, utility from ecological value is higher for larger urban parks. Thirdly, utility from the image will increase when the size increases:

the average portion of green in a certain neighborhood will be bigger in the case of larger parks. A probable development in the image of a neighborhood would be that the external image turns 'greener' as size of parks increases. Fourthly, utility from the possibility to consume will rise: this is in line with the increasing effect of utility from actual consumption, which is already mentioned. For this measure is assumed that the revealed premium on transaction prices as a consequence of the size of the nearest urban park represents the value of the presence of an urban park of that particular size on that location.

Every identified mechanism for utility derivation from urban parks in this research is measured by the accessibility and/or size of urban parks. In addition to these measures, an synergetic measure is added: this is done because it could be possible that the implicit price for the size of the nearest urban park changes as accessibility (of a park) changes. Also vice versa, this is possible: the implicit price for the accessibility of a park will change as the size of that park changes. Not inserting this interaction would mean that results are not able to provide any additional insights on the fact whether premiums on residential property prices (with respect to the valuation of parks) change in the same pace as distance and/or size. In order to gain more insights in the valuation of urban parks in relation to the mentioned mechanisms, it is valuable to highlight a possible synergetic effect of these measures. Because some identified mechanisms are partly explained by both measures, clarification of the interaction effect for several mechanisms will be difficult in this research. However, adding an interaction effect of size and accessibility does provide additional insights on the level of influence the measures size and accessibility have on each other (additionally to the level of influence they have on the valuation of parks). Furthermore, demonstrating synergetic effects encourages further research regarding the identified mechanisms and their interaction on valuation of green space. Moreover, acknowledging and researching these additional synergetic and exponential effects create a more realistic reflection of the contemporary dynamics in urban planning with regard to the creation and preservation of urban green space.

## 4.3 Measurement of urban parks

In this paper, urban parks are urban green areas having a mainly recreational function, which are publicly accessible (and free of charge, so Botanische Tuinen in Utrecht is not taken into account). In urban parks people can meet each other and get comfortable with their surroundings (Gemeente Utrecht, 2007). For this research an urban green space needs to have a minimum size of 2 hectares to be an urban park: the loss of space usable for other purposes needs to be substantial (opportunity costs), which creates/created a bottleneck for urban planners. In research on effects of accessibility and maintenance level on housing prices is noticed:

> **"Provision of green space in a dense urban environment is costly. The rent from alternative land-use for areas allocated to green space is high" (Panduro & Veie, 2013, p. 8).**

Somewhere in the past the choice should have been made to construct a park on a certain location instead of a substantial other type of destination, which created costs for the municipality and still costs in the form of opportunity costs. Hence, for urban green space to be labeled as an urban park in this research, urban green space needs to have a certain level of accessibility, function and size. Therefore, in this research urban parks include slightly other areas than those areas bearing the name 'park'. For this reason, Zocherpark (visible in Figure 1) is not the nearest park for Korte Jansstraat 17: Zocherpark is not incorporated in this dataset. In addition also certain green space recognized as scenery parks and stroll forests have been taken into account, because of the similar functional character. On the other side, some urban green areas identified as park by the municipality do not actually have the substantial size required for an urban park, so these are not included. To put it simply: all urban green spaces of a minimum size of two hectares with a (mainly) recreational function within the border of the municipality of Utrecht and The Hague (+ 800 meters beyond this border) have been taken into account for this research.

However, a distinction has been made between small parks and Medium-sized/large parks. These requirements are set after having evaluated the size of parks combined with the associated functions. Small parks are parks which have a lower variety of functions and these parks are less typical for their neighborhood. Therefore, in Utrecht the Wilhelminapark is the smallest park belonging to the category medium-sized parks. Park Voorn is the largest park belonging to the category of small parks, because this park is less typical for the neighborhood and Park Voorn has a substantial lower variety of functions compared with the Wilhelminapark. Because this measure can only be grouped by size, medium-sized parks are sized at least 9,5 hectares in both The Hague and Utrecht. This group is only used as robustness check.

In this paper is assumed that valuation of urban parks by residents are only influenced by characteristics of the nearest urban park. Starting from the sketched conceptual mechanisms, selecting the nearest park is a logical step: conceivably the bigger part of all utility derivation of urban residents from urban parks will come from the nearest park. Moreover, research shows that people only visit a park regularly when it is near their home- or workplace (Kaplan & Kaplan, 1989). These insights are convincible enough to assume that most utility derived from urban parks (by residents) should have been caught in the distance and size variables used with respect to the nearest park.

In reality however, people do not necessarily always derive all utility from the nearest park. It could be possible that people prefer another park than the nearest, for example when they derive utility from urban parks by running through a park. A park needs a substantial minimum size to be able to provide a conventional running route, and the nearest park may be too small to provide such a running route. This methodological simplification is dealt with in the following manner: a possible flaw in the found effects would be uncovered by checking the results when only medium-sized and large parks are incorporated (hence, excluding small parks). This check is only desirable when no significant size effect is observed.

In the paper the influence of the geographical location of urban parks on the valuation of those parks is being researched. Therefore, the incorporation of the exact geographical location needs to be discussed. In the conceptual model can be found that the core of utility derivation from urban parks is from consumption. For this reason, the geographical locations of the nearest entrance of an urban park is incorporated in the model as proxy for the associated park. Probably this decision does not result in imprecise or false views of estimates with regard to other mechanisms for utility derivation from parks. On the contrary, performing the analysis with this adjustment will make estimates regarding the influence of accessibility of urban parks substantially more accurate compared with other methods, for example taking a nearest park's centroid.

Demonstrated effects in this paper and associated conclusions and implications only relate to geographical locations and/or sizes of urban parks represented in premiums in transaction prices (revealed preference): other park characteristics like safety perception, quality of walking trails or presence of playground equipment are beyond the scope of this research. Making this assumption creates the possibility of regressing the distance between every house (in the sample) to the nearest urban park on every transaction price. As a result the influence of the geographical proximity to the nearest urban park can be shown.

# 5 Data

In this chapter is elaborated on the used data. Firstly, characteristics of the transaction price dataset from NVM are explained. Secondly, information is provided on used data for urban green space. The third part will shed light on the connection between these datasets. Finally, all used variables are identified and described.

## 5.1 Data of residences

The cross-sectional dataset regarding transaction prices and other individual housing characteristics originates from the Dutch Association of Realtors and Appraisers (NVM). The choice for transaction price as dependent variable is because data of the majority of transaction prices of houses in the Netherlands and associated housing characteristics is available in detail and relatively easy to use in hedonic pricing models. Furthermore, data is reliable and relatively complete: NVM represents approximately 70% of the total market for housing sale (NVM, 2017). Because a better coverage of the total market is almost impossible and 70% is particularly high and by approximation normally distributed, this is seen as enough to perform a reliable analysis. Constructing a hedonic pricing model with transaction prices as dependent variable is a generally accepted method in academic literature and widely used (see theory section).

The transactions from the years 2004, 2005 and 2006 are incorporated in the dataset. Initially the dataset with transaction prices contained 30.219 observations. In order to be able to construct a reliable regression, the dataset has been adjusted on the following points.

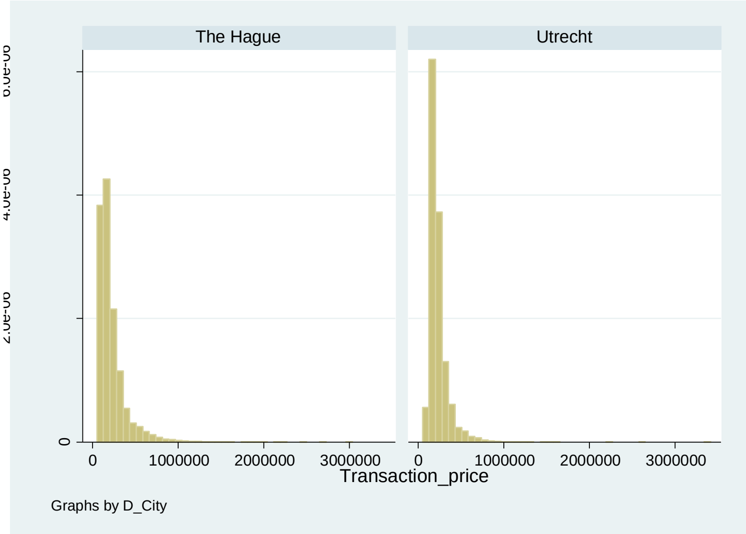
Firstly, double observations have been deleted, in order to have unique observations. This is done by address and transaction date, for 6 observations. Despite this action, some addresses still have double observations. This is due to the fact that they have been sold more than once in the years 2004, 2005 and 2006.

Secondly, every (unique) observation receives a unique identification code based on postal code and address. Also based on the address, coordinates of the associated transaction prices are assigned to every observation. Due to a small error in the converting system (probably because the system does not recognize unconventional addresses), 124 missing values have been created. These are dropped. Also one observation with an unknown transaction price has been dropped.

After these adjustments, 30.088 unique observations of transactions are left. Thirdly, suspicious data is dropped: 1 observation is dropped because the transaction price is unknown (value = -1). Unusually low and high transaction prices have been checked on characteristics, and after associated square meters and locations have been checked, transaction prices below €50.000 and above €4.000.000 have been deleted from the dataset. These are 41 observations in total. These observations were considered not to represent the market value of the underlying asset, causing the estimates in the model to be biased.

With respect to transaction prices, 30.046 observations can still be used. As percentage, 0,6% of all observations is deleted before incorporating all data in the model. 12.282 observations are used for Utrecht (including Vleuten, De Meern & Haarzuilens) and 17.764 for The Hague. As can be seen in Figure 2, distributions of transaction prices are slightly right-skewed. This means that the sample is not normally distributed, meaning that there could be omitted variable bias. An elaboration on this topic is provided later in this paper.

**Figure 2  Distribution of Transaction prices**




## 5.2 Urban green space

As explained in the method section, the measure for urban green space in this paper consists of urban parks. Urban parks are defined as publicly accessible urban green spaces of at least two hectares. Further definitions are already described and substantiated in the method section. In line with this definition, this research is performed with a total of 44 urban parks: 19 parks in Utrecht and 25 in The Hague. The average park size is 29 hectares in Utrecht and 36 hectares in The Hague. In Utrecht, only 40% of the parks is at least medium-sized. On the contrary, in the Hague 70% of the parks is at least medium-sized. This image is less distinctive for large parks: in Utrecht 21% of the urban parks is large, while in The Hague 24% of the parks is large. These are the most striking differences between the ‘park populations’ of The Hague and Utrecht. In short, The Hague has more and larger urban parks than Utrecht.

**Table 1  Urban Parks in The Hague**

| Park | Size (in ha) | Percentile |
|---|---|---|
| ‘t Hofpark | 2,1 | |
| Bokkefort | 3,7 | |
| Schoonoord | 4,0 | |
| ‘t Loopark | 6,5 | |
| Julianapark | 7,1 | |
| Vreugd en Rust | 7,4 | |
| Sint Hubertuspark | 8,0 | 28% |
| Rijswijkse Bos | 10,2 | |
| Marlot Reigersbergen | 13,9 | |
| Nieuwe Scheveningse Bosjes | 14,9 | |

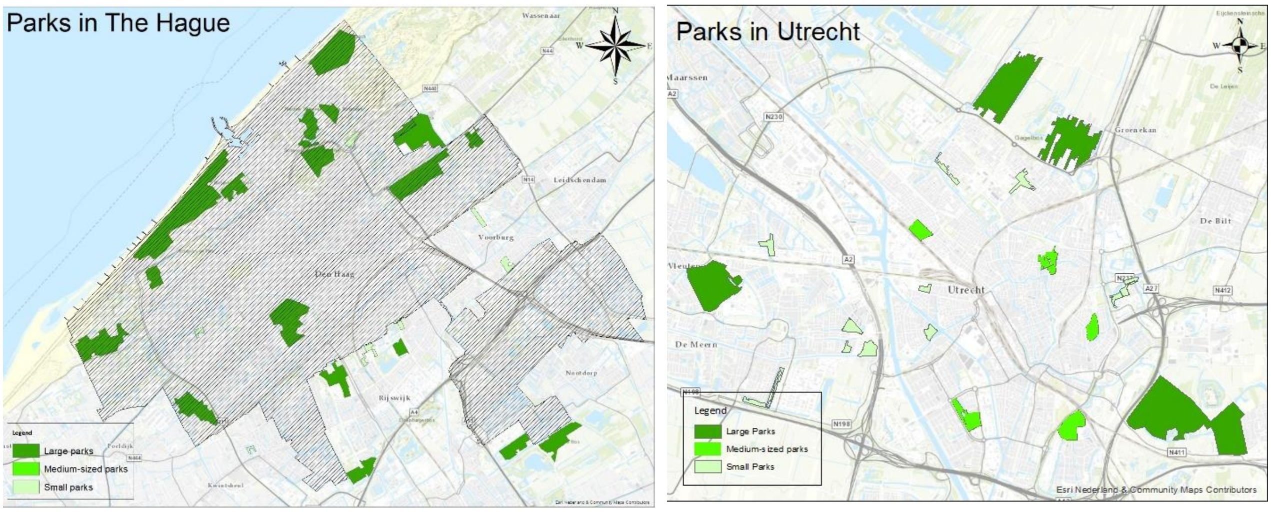
| Park | Size (in ha) | Percentile |
|---|---|---|
| Meer en Bos | 17,9 | |
| Bosjes van Poot | 24,4 | |
| Hertenkamp | 24,8 | |
| Stadslandschap Hoekpolder | 25,6 | |
| Westbroekpark | 30,8 | |
| Overvoorde | 31,0 | |
| Bieslandse Bos | 38,2 | |
| Scheveningse Bosjes | 40,0 | |
| De Uithof | 45,1 | 76% |
| Ockenburgh | 64,5 | |
| Zuiderpark | 72,2 | |
| Clingendael | 73,7 | |
| Haagse Bos | 76,9 | |
| Oostduinpark | 82,4 | |
| Westduinpark | 174,4 | 100% |
| **Average** | **36,0** | |

**Table 2 Urban parks in Utrecht**

| Park | Size (in ha) | Percentile |
|---|---|---|
| Archeologiepark | 2,2 | |
| Majellapark | 3,1 | |
| Park Oog in Al | 4,9 | |
| Vechtzoompark | 5,4 | |
| Waterwinpark | 6,7 | |
| Park de Hoge Weide | 7,0 | |
| De Watertoren | 8,2 | |
| Park Bloeyendael | 8,6 | |
| park bij Oudenrijn | 8,7 | |
| Park Voorn | 9,1 | 53% |
| Wilhelminapark | 9,7 | |
| Julianapark | 10,9 | |
| Griftpark | 11,4 | |
| Park Transwijk | 15,1 | |
| Beatrixpark | 21,0 | 79% |
| Ruigenhoekpolder | 73,1 | |
| Maximapark | 73,4 | |
| Gagelpark | 90,1 | |
| De Kromme Rijn | 186,7 | 100% |
| **Average** | **29,2** | |

According to the used definition regarding the geographical borders (municipality +800 meters), also ‘Fort bij Rhijnauwen’, ‘Maarsseveense Plassen’ & ‘Van Boetzelaerpark’ are urban parks for the municipality of Utrecht. However, no transaction price is located with these parks as nearest park. Therefore, they are not part of the dataset. In The Hague this holds for Kruisvaarderspark. Therefore, also Kruisvaarderspark is not in this research.

**Figure 3 Spatial Distribution of urban park in The Hague and Utrecht**




In Figure 3 the spatial distribution of all urban parks in the dataset can be seen. The municipality of The Hague is made grey, because the municipality of The Hague has a somewhat unconventional shape. Not all parks are located within the borders of the municipality, because in some cases residents of The Hague which live close to the borders experience their nearest urban park on the other side of the border. A striking difference is that urban parks in The Hague seem to locate relatively more dense on one side of the city, the coastal side. In Utrecht, we see a more gradually divided spatial distribution. A striking feature in Utrecht is, that all big parks are located at the spatial periphery of the city: far distant from the center of Utrecht, outside the highway ring of Utrecht. On the contrary, all medium-sized parks are located quite proximate to the center.

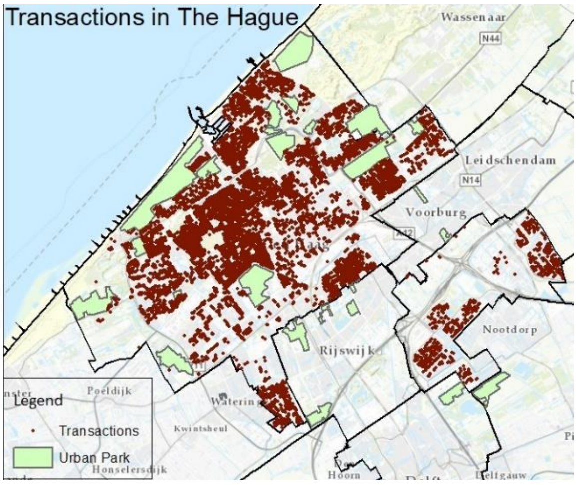
## 5.3 Connection

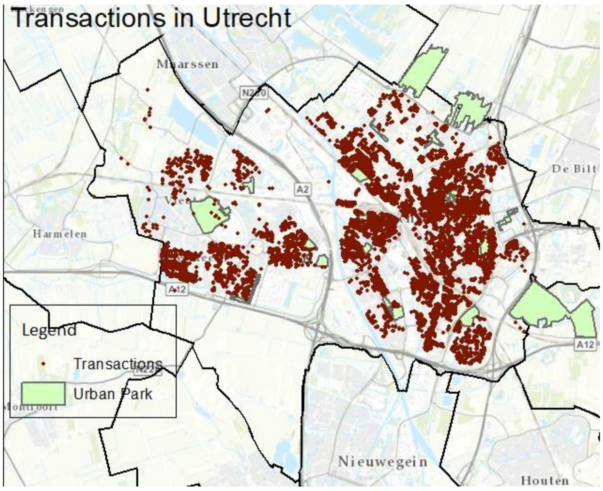
To show a relation between transaction prices and the distance to a park and/or the size of that park, several locations need to be identified: a transaction price is linked to a physical address, of which the location needs to be identified. Furthermore, entrances of all urban parks have been identified. Then, every address is linked to the associated nearest park (nearest entrance). The travelling distance is determined for every address to the nearest entrance. This is calculated by incorporating a roadmap in ArcGIS. This roadmap is adjusted in order to incorporate only the roads which can be used to reach an urban park in the way this is done most likely: this means that all footpaths, cycle paths and regular motorways have been incorporated. On the contrary, runways and highways have not been taken into account. Then, identified points, locations of addresses and locations of entrances are connected to each other via this roadmap. ArcGIS automatically assigns the travelling distance from every address to the nearest entrance. Hence, every address receives a number, which represents the travelling distance to the nearest urban park in meters. In The Hague the average travelling distance to the nearest park is 1000 meters, while in Utrecht the average travelling distance to the nearest park is 800 meters. A possible explanation for the difference between these amounts is that the spatial division in Utrecht is more even, causing the possibility that a house is closer to an urban park to be higher. The smallest travelling distance to an urban park in The Hague is 8 meters, while in Utrecht this is 2 meters. In both cases this particular house is practically adjacent to an urban park. A difference of 6 meters is quite small, and also in the regression model differences of this magnitude will not substantially change our estimates. The biggest distance to the nearest park in The Hague is 4900 meters, so approximately 5 kilometers. However, 95% of all distances are equal or lower than 2050 meters, so 5 kilometers can be considered as a outlier. In Utrecht, the biggest distance to the nearest park is 4660 meters, which is comparable with the case of The Hague: also in Utrecht this amount is an outlier, because 95% is equal to or smaller than 1670 meters. When the distance to the nearest park is known for all houses, the size of the associated park is being added to each observation (address). This size is calculated by determining the acreage of every park; this is done with help of ArcGIS.

## 5.4 Variables & descriptives

After this process, the dataset is enriched with the following additional variables: walking distance from every house to the nearest park and to the nearest park excluding small parks. Additionally, the sizes of the associated urban parks have been recognized and added to the dataset. This step creates the possibility to construct interaction variables between distance and size, which is one of the tested hypotheses.

**Figure 4  Transactions in The Hague and in Utrecht**




### Variables in final model

| | |
|---|---|
| Dependent variable: | The dependent variable consists of transaction price, measured in euros[1]. This variable is displayed by 'TP'. See Figure 4 for the spatial distribution of all observed transaction prices. |
| Independent variables: | These independent (or explanatory) variables are used to proof the existence of an effect of accessbility and/or size on transaction prices. 1. the independent variable measuring distance is defined as the travelling distance in meters from the residence (front door) to the nearest park entrance. A diminishing effect is measured by adding a quadratic term of travelling distance in meters. This variable is displayed by 'TDist'. <br><br> 2. the independent variable measuring size consists of the acreage, measured in hectares, of the associated nearest urban park (based on travelling distance). This variable is displayed by 'TSize'. |
| Interaction variable: | To measure an interaction effect, an interaction variable is constructed. This interaction effect consists of 'travelling distance in meters' * 'park acreage in hectares'. This variable is displayed by 'Inter'. |

[1] The final model is a level-level model. A logarithmic-level model is also tested and gave similar outcomes, except from the insignificance of estimates with respect to park size.

Control variables: Control variables used in the model can be classified in four classes.

1. Structural characteristics, displayed by 'SC'. (Source: NVM)
   The usable area is measured by square meters, including a term to check for diminishing effects (square meters + square meters$^2$). The year of construction is controlled for by dummies of nine different periods (see appendix). The type of residence is controlled for by dummies of 16 different types[2]. The garden is controlled for by three different variables: a dummy for the presence of a garden, eight dummies for the cardinal direction of the garden (N, N-E, E, S-E, S, S-W, W, N-W) and the garden acreage is controlled for, including a check for diminishing returns (garden acreage + garden acreage$^2$). Also, a control for dwelling acreage is added, including a diminishing effect (dwelling acreage + dwelling acreage$^2$). Furthermore, variables indicating ceiling height in meters, the number of balconies and the number of rooms are included. Finalizing this class of control variables, two dummies check for a monumental status (official) and a monumental character (unofficial).
2. Transactional characteristics, displayed by 'TC'. (Source: NVM)
   Three dummies for the year of transaction are included[3] as well as a dummy indicating the presence of costs payable by the buyer (as opposed to costs payable by the vendor).
3. Locational characteristics, displayed by 'LC'. (Source direct neighborhood: NVM; Source amenity distances: ArcGIS)
   Six dummies control for the location of the residence: a dummy indicating the adjacency to a busy road (as opposed to a quiet road), and five mutually exclusive dummies with regard to locational beauty: a dummy indicating a nice view, a dummy indicating adjacency to woodlands, a dummy indicating the presence of a water front and a dummy indicating 'not reported' (none)[4]. Furthermore, the Euclidean distance in meters from each residence to the following four amenities have been incorporated (computed with ArcGIS from the front door to the centroid of the amenity): to the nearest monument, to the nearest highway ramp, to the city hall (measuring centrality) and to the nearest train station.
4. Neighborhood fixed effect, displayed by 'NFE'. (Source: NVM)
   Finally, dummies are added controlling for a neighborhood fixed effect: these dummies correct for a collection of neighborhood characteristics like average educational level, unemployment, composition with respect to ethnicity and age, population density and the neighborhood image[5].

[2] The reference category is 'Eengezinswoning'.

[3] A variable indicating the presence of a leasehold is not incorporated, because there were only 25.000 observations and no significant estimated effect has been found. Also a variable indicating buying conditions (existence of additional costs for the buyer) is excluded from the model becaue it did not show a significant estimated effect.

[4] Adjacency to a park is the fifth dummy, this variable has a special treatment because of the high correlation with explanatory variables. An explanation can be found later in this paper.

[5] In The Hague, 42 unique neighborhoods (districts) are identified. Because in Utrecht on this level of measurement only 10 unique neighborhoods (districts) would exist, in Utrecht is chosen for a lower spatial level of measurement with 90 unique neighborhoods (buurten). As a consequence, more nuance between different neighborhoods is incorporated in Utrecht.

# 6 Model

In this section, the functioning of the model is described. Firstly, the specifications of the model are explained. The second part contains an elaboration on the use of a multilevel model. Thirdly, the final model is discussed.

## 6.1 Specifications

### *6.1.1 Creation of a hedonic price*

Before the functioning of hedonic prices is explained, first the functioning of the market for heterogeneous goods and equilibria in these hedonic markets are explained, along with the theory of hedonic prices. Hedonic markets assume the following: consumers, in this case households, derive utility (*u)* from all characteristics (*Z)* of a house, their income *(M)* minus the bid rent *(*$\beta$*)*, which can be spent to all other consumption, in combination with their preferences *(*$\alpha$*).*

Utility function

$$u = u(Z, M - \beta, \alpha) \tag{2.1}$$

From this utility function we can deduct the bid rent function, $\beta(Z, M, u, \alpha)$. The derivative of the bid rent function with respect to a certain characteristic '*b'* (as part of the collection of characteristics Z) reflects the willingness to change expenditures as that particular characteristic increases:

Derivative of bid rent function

$$\frac{\partial \beta}{\partial Z_b} \tag{2.2}$$

For example, subscript '*b'* stands for balcony. The derivative function 2.2 represents the rate of the willingness to change expenditure for an extra balcony, holding total utility constant. For consumers, this is the level of all other consumption they are willing to give up in order to have an additional balcony. To put it simply: how much are you willing to pay more for an extra balcony (keeping the same level of total utility).

'Z' (the total collection of characteristics) and consuming the composite commodity 'Y' combined embody the total product a household obtains. A household tries to maximize utility with as constraint their total spendable income. Utility depends on characteristics of the house, the composite good and the preferences of the particular actor (a certain household). Household income 'M' should be at least equal to the price of housing (the sum of prices of characteristics 'Z' and composite good 'Y').

Optimization function

$$\underset{Z,Y}{max}\ u(Z, Y, \alpha) \text{ with respect to } M \geq P(Z) + Y \tag{2.3}$$

Consumption of the composite commodity Y will benefit a household with utility $u_Y$, while the characteristic of a balcony will yield a utility of $u_b$. Assuming that utility derived from the composite commodity Y will be higher than the sum of utilities of all characteristics, this problem requires that

Price of balcony in comparison of utility

$$P_b = \frac{u_b}{u_Y} \tag{2.4}$$

The hedonic price of a balcony is equal to the utility derived from that balcony divided by the utility derived from the consumption of the composite good 'Y'. This price is expressed in share of the total house price. For the price in currency, for example euros, this share needs to be multiplied with the total house price.

In equation 2.4, the utility of one additional balcony is equal to the change in total utility divided by the change in the number of balconies:

Utility of balcony

$$u_b = \frac{\partial u}{\partial Z_b} \tag{2.5}$$

Ultimately, as share of the total house price P, the hedonic price of a balcony is equal to the change in P divided by the change in the amount of balconies (Sheppard, 1999).

Hedonic price of a balcony

$$P_b = \frac{\partial P}{\partial Z_b} \tag{2.6}$$

***"The hedonic approach provides a methodology for identifying the structure of prices of the component attributes"* (Sheppard, 1999, p. 3).**

### *6.1.2 Controlling for related characteristics*

In the final model is corrected for four classes of effects: structural characteristics, transactional characteristics and locational characteristics per house, and additionally a neighborhood fixed effect is included in the model.

The model controls for structural characteristics, because scholars demonstrate that these characteristics have influence on housing characteristics. Users acreage has a substantial influence on residential property price (Cropper, Deck, & McConnell, 1988; Geoghegan, 2002) and usable space also influences individual valuation of environmental elements in the neighborhood (Bolitzer & Netusil, 2000), meaning that the final model should correct for this effect in order to prevent omitted variable bias. A similar argument holds for other structural characteristics which are incorporated in the model as control variables (see (Bateman et al., 2001; Irwin, 2002; Luttik & Zijlstra, 1997)). Special attention needs to be given to the presence and size of a garden. Average green space in the direct neighborhood affects housing prices (Kong et al., 2007) and the size of a garden is also positively correlated with housing price (Bateman et al., 2001). Because a garden is often a (private) green space with a recreational function as well, three different corrections for this possibility for omitted variable bias have been added to the final model: presence of a garden, direction of the garden and acreage of the garden (if present).

Secondly, the final model controls for transactional characteristics: the year of transaction is used to correct for inflation and conjunctural trends in the housing market. (Irwin, 2002) confirms that the year of transaction influences residential prices.

Thirdly, the model controls for locational characteristics. This is done in order to control for possible effects of the direct neighborhood on the housing price. Also for the distance to crucial amenities is corrected.

The fourth class of control variables, neighborhood fixed effects, is explained in more detail in subsection 'Multilevel'.

## 6.2 Multilevel

Multilevel modelling is a method to analyze clustered data. In (Tse, 2002) hedonic models are also prevented from suffering from spatial dependence. Multilevel modelling is desirable when data of different levels of analysis is used in the same model: in this research data of two different levels is analyzed: the dependent variable and the main explanatory variable are on individual housing level. However, the control variable 'neighborhood fixed effect' controls for all characteristics on neighborhood level. This is called 'contextual effects'. These contextual effects are, by definition, similar for every residence in the same neighborhood. Because of this similarity, this variable on neighborhood level contains less variation than characteristics on individual residence level. Standard errors of these estimates are biased: usually they are too small. Not using multilevel modelling means that observed effects are too easily significant (Van Haaren & Witte, 2016). Therefore, we use multilevel modelling.

## 6.3 Final Model

After having tried OLS models with Euclidean distances from residences to parks, significance rises in models where travelling distances are used. Seemingly, travelling distances provide a more realistic approximation of the mechanisms valuing urban parks. Therefore, in the final model travelling distance is incorporated.

Before arriving at the final model in both cities, first the existence of the 'distance' and 'size' effect is analyzed. On the basis of these findings, the final model can be constructed:

$$TP = constant + \beta 1 * TDist + \beta 2 * TDist^2 + \beta 3 * TSize + \beta 4 * Inter + \beta 5 * SC + \beta 6 * TC + \beta 7 * LC + \beta 8 * NFE + \varepsilon$$

$TP = transaction\ price$
$TDist = Travelling\ Distance$
$TSize = Size\ of\ nearest\ park$
$Inter = Interactionterm: TDist * TSize$
$SC = stuctural\ characteristics$
$TC = transactional\ characteristics$
$LC = locational\ characteristics$
$NFE = neighborhood\ fixed\ effect$
$\varepsilon = error\ term$

In this econometric model, the estimated effects of travelling distance and park size cannot be interpreted by just a particular β: because an interaction term of these observations is added to the model, the total effect of both characteristics is split in two parts. The first part of both effects is as follows: the estimated effect of solely travelling distance on the transaction price (independent of the size) consists of $(\beta 1 + \beta 2)$ for every travelling distance. The estimated effect of solely park size on the transaction price is equal to $\beta 3$ (independent of the travelling distance). The way these two variables interact with each other is quantified in $\beta 4$: this estimate demonstrates in which way both park size and travelling distance influence each other in their relation with transaction prices.

$(\beta1 + \beta2)$ connects to the first hypothesis and is therefore expected to be negative: more distance decreases transaction prices. $\beta3$ connects to the second hypothesis and is therefore expected to be positive: a bigger size increase transaction prices. According our third hypothesis, $\beta4$ is expected to be negative. This can be explained in two ways: (1) as travelling distance increases, the size effect decreases and (2) as the size increases, the distance effect increases.

Because only the nearest park has been connected to every observation, a possible flaw in this analysis could be that people also derive utility from a park which is not the nearest. To check for this theoretical possibility, a similar analysis has been done with a different dataset with respect to urban parks: in this check, small parks are excluded from the dataset (only medium-sized and large parks are included). For this check a disadvantage is that conceivably a lot of utility derivation from urban parks is lost, because all utility derived from small parks which are nearer than a medium-sized or large park is not taken into account.

# 7 Results

This section provides regression results of the used hedonic price models: it contains an elaboration on the sign, magnitude and significance of the observed effects. Furthermore, this section provides an explanation about the extent to which identified hypotheses are confirmed.

## 7.1 Results & Significance

With respect to the results, for Utrecht and The Hague the following estimates are found[6]:

(1.1) Utrecht $$TP = constant -28^{*}TDist + 0.018^{*}TDist^2 + 530^{*}TSize - 0.36^{**}Inter + SC + TC + LC + NFE + \varepsilon$$

(1.2) The Hague $$TP = constant -32^{**}TDist + 0.009^{**}TDist^2 + \cancel{30}TSize + SC + TC + LC + NFE + \varepsilon$$

In regression model 1.1 the effects for Utrecht are estimated[7]. $TDist$ has an estimate of -28, while $TDist^2$ has an estimate of 0,018, and they are jointly significant[8]. The effect of $TSize$ is estimated to be 530. Furthermore, the interaction effect of $TDist$ and $TSize$ is estimated to be -0.36[9]. In regression model 1.2 the effects in The Hague are estimated. $TDist$ has an estimate of -32, while $TDist^2$ has an estimate of 0,009, and they are jointly significant[10]. The effect of $TSize$ turns out to be insignificant for The Hague. Therefore, the estimate of the interaction term is not interpreted.

## 7.2 Distance effect

In the results can be seen that accessibility measured by travelling distance affects transaction price. In the model the sum of both estimates $\beta 1$ and $\beta 2$ represents the effect of accessibility on park valuation. $\beta 2$, the quadratic of travelling distance, is positive in both regressions. However, the linear term of travelling distance, $\beta 1$, is negative.
For Utrecht, the following estimates are observed:

Utrecht

$$\Delta TP = \beta 1 * TDist + \beta 2 * TDist^2$$
$$\Delta TP = -28TDist + 0.018TDist^2$$

These estimates can be interpreted as follows: travelling distance to the nearest park has a quadratic effect on transaction price, this effect is non-linear: at a distance of 500 meter the marginal effect of increasing distance by one meter is $-28 + 0.018 * 2 * 500 = -10$ euro, while at a distance of 1500 meter the marginal effect has increased to +25 euro, ceteris paribus: for small travelling distances, an additional travelling distance has a negative effect on transaction price,

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6 This model has also been regressed with an additional dummy indicating whether a house is adjacent to a park or not. Regarding main explanatory variables, only the magnitude of the linear distance and size effects showed a slight difference. However, the shown effect of adjacency to a park was estimated to be 10.000, meaning that adjacency to a park increases residential value with €10.000. This could be an interesting topic for further research.

7 + = significant on 10% level, * = significant on 5% level, ** = significant on 1% level, ~~0.123~~ = insignificant effect

8 These estimates are jointly significant on 10% level.

9 The interaction term combined with $TDist$ and $TSize$ is jointly significant.

10 These estimates are jointly significant on 1% level.

ceteris paribus. As travelling distance becomes large enough (= as accessibility decreases) the distance effect on transaction price diminishes. Observing marginal increases at 500 meter distance and 1500 meter distance, suggests the existence of a turning point.

The diminishing effect $\beta 2$ exactly neutralizes the linear distance effect $\beta 1$ at a particular point. At this point, the partial derivative with respect to $TDist$ is 0. Marginal increases in travelling distance higher (further) than this point, will affect transaction price positively. On the contrary, marginal travelling distance increases lower than this point, will affect transaction price negatively.

For which $TDist$ the travelling distance effect is exactly 0?

$$-28TDist + 0.018TDist^2 = 0$$

Partial derivative with respect to $TDist$:

$$\frac{\partial TP}{\partial TDist} = 0$$

$$-28 + 0.036\,TDist = 0$$

$$TDist \approx 780$$

For the model estimated for Utrecht, the distance effect is equal to 0 when travelling distance is 780 meters. Because the average distance for observations in Utrecht is 800 meters (see Appendix ‘Summarizes’), for a substantial part of all observations a positive effect of travelling distance on transaction price is estimated. Because in general a negative influence of travelling distance on transaction price is expected, the influence of observations with larger distances than 800 meters is checked along with the influence of observations with smaller distances than 800 meters. The regression with observations <800 meters shows similar image, with a turning point on 460 meter: uptill travelling distance of 460 meters the marginal effect of travelling distance on transaction price is negative. From this point onwards, the marginal effect of travelling distance on transaction price is positive[11].

Calculating the same turning point for The Hague, the point where the distance effect is equal to 0, gives a travelling distance of 1780 meters. In The Hague, 90% of all observations are below 1740 travelling meters. Hence, for The Hague this distance effect, which decreases transaction price as travelling distance increases, holds for nearly the entire population.

Therefore, accessibility affects park valuation positively. In The Hague this is true for almost the entire population. In Utrecht, accessibility to the park especially affects transaction prices positively within 500 meters.

## 7.3 Size and interaction effect

The effect of park size on transaction price is only demonstrated for Utrecht. Therefore, interpretation can be done only for Utrecht: a size effect of 530 means that increasing the size of the nearest park with 1 hectare, will increase transaction price with €530. In addition to this size effect, for Utrecht an interaction effect between accessilibity and size is found: additional travelling distance of 100 meters, will decrease the park size effect with €36. This interaction effect is discussed in more detail in 8.5.

[11] The regression with observations >800 meter shows insignificant results.

## 7.4 Confirming hypotheses

The first hypothesis tested in this research is: the geographical proximity of an urban park affects valuation of the park, as reflected by residential property prices, positively. The estimated effect of travelling distance on transaction prices in the final model provides proof for this hypothesis for both cities, although only till a certain turning point: the closer residences are located to a park, the more positive this accessibility effect turns out to be. Therefore, this hypothesis is partially confirmed.

The second hypothesis tested in this research is: the size of urban parks affects the valuation of the park, as reflected by residential property prices, positively. The estimated effect of park size on transaction prices in the final model provides proof for this hypothesis in only one city (out of two): therefore, this hypothesis is partially confirmed.

The third hypothesis tested in this research is: a negative synergetic effect exists between distance to an urban park and size of urban parks on the one side, and valuation of urban parks on the other side, reflected by residential property prices. The estimated effect of the interaction between travelling distance and park size provides proof for this hypothesis in only one city (out of two): therefore, this hypothesis is only partially confirmed.

# 8 Discussion

Section eight contains a discussion of the results, which are described in the previous section. In section eight is explained to which extent observed results indicate the working of the mechanisms of utility derivation from urban parks, identified in section three. Furthermore, this section discusses the striking results from the previous section, in particular with respect to (the marginal effect of) travelling distance and the synergetic effect.

## 8.1 Mechanisms

In section 3 four different mechanisms of deriving utility from urban parks are identified: direct consumption, a view, ecological value, contributing to an external image and the possibility to use the park. A higher level of utility derivation of urban park is assumed to provide a more positive valuation of urban parks. To confirm the existence of these mechanisms of utility derivation from urban parks, three measures have been constructed: travelling distance has been used to measure accessibility, park size is used to measure quality and to quantify the influence they have on each other an interaction of these measures is included. To measure urban park valuation, transaction prices are used.
These measures can show the effect of the influence of these identified mechanisms as a group on the valuation of urban parks. Because these measures partially overlap with certain mechanisms, the existence (and magnitude) of a particular mechanism cannot be demonstrated in this research.

The results show that both travelling distance and size affect transaction price. However, not in every city these variables affect transaction price in the same way. From the previous section can be deduced that an effect of accessibility on transaction price has been found. Also, in one of two cases an effect of quality on transaction price has been found. In this case, also an interaction effect between accessibility and quality on transaction prices has been found.
According to the conceptual model explained in section 3, these results provide empirical proof that identified mechanisms in total have a positive effect on valuation of urban parks.

## 8.2 From Euclidean to travelling distance

Incorporating travelling distances provides the same results as Euclidean distances, with respect to sign and magnitude of the observed effect. Only in significance an improvement is observed. This suggests that our choice to use travelling distances instead of Euclidean distance, provides a better approximation of reality, which is logical in this research. The measure 'accessibility of an urban park' is more accurately estimated if travelling distance is used, because the mechanisms of utility derivation connect better to this use of measurement: when accessibility increases (measured by travelling distance), consumption of a park becomes more attractive. Travelling distance is a quite precise approximation of accessibility. Consequently, utility increases. However, when Euclidean distance decreases this is a more imprecise approximation of an increase in accessibility.

## 8.3 Utrecht: Marginal effect of distance

Regarding the distance effect for the case of Utrecht, a further explanation of the results is desirable. Although for the entire Utrecht sample, results with respect to travelling distance indicate a positive effect (where a negative effect is hypothesized), this image changes when the most relevant group of observations is emphasized: residences within walking distance of a park (500 meters). For this particular group of observations, a negative distance effect on transaction price is demonstrated. Accordingly, for residences within walking distance of a park, marginal increase of travelling distance will decrease transaction price. This result is expected beforehand and is in line with identified mechanisms: urban parks within walking distance are valued more positively by residents as these parks are located closer to a particular residence.

## 8.4 Different findings in The Hague and Utrecht

Not both findings regarding travelling distance and size are the same for The Hague and Utrecht. Apparently, residents in Utrecht value a bigger park more positively than a smaller park. On the contrary, this size effect is not demonstrated in The Hague. Testing possible explanations for these difference in findings is beyond the scope of this research, but in theory four possible explanations are worth mentioning, which could serve as starting point for further research.

The first possible explanation for this difference in results is that the population of parks in The Hague differs from the population of parks in Utrecht: in Utrecht half of the urban parks is smaller than 10 hectares, while in The Hague this is only 30%; in Utrecht only, 26% percent of the parks is bigger than 20 hectares, while in The Hague this is 56%. In short, in The Hague parks are bigger. If parks within The Hague are bigger than those in Utrecht (on average), the perceived difference in experience when visiting different sized parks in The Hague could be lower. After all, smallest parks in The Hague could provide a higher level of utility than the smallest parks in Utrecht. Consequently, among the individual valuation of size of the nearest urban park a convergence in levels of derived utility in all parks in one city could take place. This neutralizes the so-called park size effect researched in this paper. Although this paper does not provide any proof for this explanation, this issue could be shown by stricter (size) requirements regarding urban parks: by increasing the minimum size in the definition of an urban park. Consequently, in this research the researched park population would change; in Utrecht more thorough than in The Hague. When the park size effect which is demonstrated in this research disappears in Utrecht with the new dataset, it would be an extra clue in explaining the different results for The Hague & Utrecht (with respect to park size) using the current park population.

Secondly, from a spatial perspective urban development in Utrecht is more dense than in The Hague: current urban planning policy with respect to urban green space seems to focus on a more qualitative spatial planning (Gemeente Utrecht, 2007), because there is no space available to add green space in a quantitative way. However, in The Hague there are more possibilities for a quantitative extension of urban green space. Deduced from these different features of The Hague and Utrecht one could posit that a difference exists among residents in experiencing the urban space: an experience of less open space in Utrecht, creates more pressure on existing urban parks in Utrecht. Consequently, additional park size has a more substantial effect on valuation in Utrecht than additional park size would have in The Hague.

A third possible explanation is the fact that The Hague is near the sea, which is the reason The Hague quite a substantial amount of beach. Utrecht is in the geographical center of the country and does not have any beach in the region. Because a beach has a recreational function, just as an urban park has, a beach could serve a substitute for an urban park regarding the consumptive mechanism of utility derivation. This would change the functioning of this identified mechanism for the valuation of urban parks, at least in some way. Because The Hague has a quite long coastline with substantial kilometers of beach, this substitution effect would be more extreme in The Hague than in Utrecht. This effect could be neutralized when the model controls for all other recreational features than urban parks, within a city.

Fourthly, the difference in found effects for The Hague and Utrecht could have a methodological reason: quality/variety of urban parks has been measured by the size of the nearest park. In Utrecht, where a size effect is found, this method to measure quality is possibly a more precise approximation than it is in The Hague. In the city of Utrecht, a bigger park indicates that people judge the park as being of better quality; more valuable. However, in The Hague different parks of the same size could be valued more differently: when we look at the Zuiderpark and Clingendael, the Zuiderpark is suitable for activities as letting your dog out and smoking a quick cigarette: shot stay activities. Zuiderpark is less suitable for an extensive stroll. However, Clingendael has a much more historical and natural character. Due to this character Clingendael is more suited to function as small forest for strolls. This is partly due to the difference in vegetation and facilities. However, the difference in size possibly will not represent this difference in experiencing nature, and therefore the difference in utility derivation from these urban parks. Nevertheless, valuation of these urban parks substantially differs from each other due to aforementioned features.

## 8.5 Elaborating on the synergetic effect

For Utrecht all three hypotheses tested are confirmed: improved accessibility of a park increases valuation of urban parks and increased park size is related to a higher park valuation as well. On top of these found effects, empirical proof for an additional synergetic effect has been found: apart from mentioned effects, park size and accessibility also influence each other in affecting park valuation. To my knowledge, this had not been found before in empirical research. For correct interpretation an elaboration on this synergetic effect of accessibility and size on park valuation is desirable.

From a statistical perspective, a synergetic effect can only be demonstrated when both components of the synergetic effect affect the dependent variable. For Utrecht this was the case for both travelling distance and park size affecting park valuation. Accordingly, a check for a synergetic effect is possible: an interaction term is used to quantify the influence one of both measures exercise on the other, when influencing park valuation. Hence, a synergetic effect is not a direct effect on the dependent variable itself, but a synergetic effect indicates that the effect of one of both measures (component) depends on the magnitude (and sign) of the other measure (component) (Wooldridge, 2012). Therefore, from a statistical perspective this synergetic effect has two possible explanations.

For useful interpretations of this synergetic effect in Utrecht, it is desirable to take appropriate values for each variable concerned[12].

1. As park size increases, the positive effect of (increased/decreased) accessibility on park valuation increases.
   For an average Utrecht park size of 30 hectares, a decrease in travelling distance of 100 meters will increase transaction price with €1100 (additional to the regular distance effect), according to the estimate in our model, ceteris paribus. When the park size is 10 hectares, a decrease in travelling distance of 100 meters will increase transaction price with an additional €350, ceteris paribus. On the contrary, for a park size of 50 hectares, a decrease in travelling distance of 100 meters will increase transaction price with an additional €1800, ceteris paribus.
   This is only the synergetic effect; the distance effect and the size effect still have to be added to this synergetic effect.
2. As accessibility decreases, the effect of (increased/decreased) park size diminishes.
   In the case of an average travelling distance of 800 meters, an increase in park size of 10 hectares will be diminished by €2900 in the transaction price (this has to be subtracted from the regular size effect), according to the estimate in our model, ceteris paribus. When travelling distance is 600 meters, the effect of an increase in park size of 10 hectares will be diminished by only €2150. On the contrary, when travelling distance is 1000 meters, the effect of an increase in park size of 10 hectare will be diminished by €3600 in the transaction price.

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[12] In these examples the (rounded) population mean of park size has been taken, along with the 'mean +/- (0.5*standard deviation)'. For travelling distance the (rounded) average accessibility has been used, along with the 'mean +/- (0.5*standard deviation)' to explain n the different meanings.

# 9 Synthesis

Section nine sheds light on the issue whether and to which extent found effects are in line with existing literature on valuation of urban parks.

## 9.1 General

After an extensive study on the topic of urban park valuation and performance of empirical research on both the influence of accessibility and park size on urban park valuation, this article states that empirical findings in this research are, in general terms, in line with existing literature. Furthermore, based on mentioned theoretical and empirical findings, this paper states that urban residents tend to value the extent of geographical proximity of an urban park more positively than they value the size of that particular park, if they value the size at all.

In general sense, one can argue that findings in this research are in line with the discourse of the consumer city (Glaeser & Kallal, 1992; Glaeser et al., 2001), providing substantial advantages (pull factors) of living (and consuming) in cities. In this light, this research emphasizes the desire of urban residents to experience nature in an urban context, without leaving the city.

Focusing on the character and functions of urban parks, this research builds on literature describing the value and different functions of green space in general, and urban parks in particular. Benefits of urban parks have been identified in literature: from social and psychological value (Chiesura, 2004) to leisure opportunities and aesthetic enjoyment (Kong et al., 2007) or environmental functions similar to forests and larger green areas (Morancho, 2003).

As foundation for this research in particular, theoretical and empirical evidence is found for the relation between urban park valuation and geographical characteristics with respect to accessibility and quality. Most striking findings regarding these delicate topics for geographical comparable areas are summarized and compared with results and findings in this paper.

A premium on housing prices for an attractive landscape in general (5-12%), and in particular an urban view (8%) and a park nearby (6%) are found in the Netherlands (Luttik, 2000; Luttik & Zijlstra, 1997; van Huijssteeden & Schep, 1988). Other, more subjective, research in the Netherlands, indicates the same direction of effects of urban green space: premiums on house price are being estimated on respectively 11,6% and 9,8% when a royal green space is present and when a nature reserve is within 15 minutes cycling distance (Sijtsma et al., 1996). Although the research method varied widely across aforementioned research academical research, the direction of the results is in line with findings in this paper: presence of urban parks is experienced positively by the urban population.

## 9.2 Accessibility

Regarding the distance effect, findings for Castellón (Spain) demonstrate similar effects as particular results indicate in this paper: a linear function of €1800 per 100 meter additional distance to a green area (Morancho, 2003) can be identified as highly comparable with the demonstrated distance effect, discussed in 7.2. This comparison holds for The Hague in particular. For Utrecht, only residences within walking distance show this effect. Although nuances between the two researches differ, direction and magnitude of the demonstrated distance effect are in line with each other for the bigger part of the population. Also (Fennema et al., 1996) state find a 6% premium of house prices in the neighborhood of parks, which is a more nuanced conclusion than in Morancho (2003). Therefore, especially findings in (Fennema et al., 1996) are in line with findings in this paper. Regarding related research on this topic, it is not surprising that outcomes of research on the Netherlands show more similarities than research on Spain.

## 9.3 Size

Regarding the park size effect, findings in this paper are more ambiguous, since this park size effect is confirmed for only one city in the dataset (out of two). This image of ambiguous results can also be found in literature: (Poudyal et al., 2009) confirm that increase in park size is related to an increasing housing price. In Poland small parks have less influence on housing prices than larger parks (Czembrowski & Kronenberg, 2016). These findings are in line with results for Utrecht, where increased size is related to higher transaction prices. However, (Morancho, 2003) searched for a park size effect in transaction prices as well, but did not find a substantial park size effect. In this paper, a similar image is observed for The Hague.

## 9.4 Synergetic effect

From a theoretical perspective, (Panduro & Veie, 2013) find a positive relation between accessibility & maintenance level of green space and quality of life. This paper empirically confirms these relations, not only by finding both a distance effect and a park size effect. Moreover, a synergetic effect between these distance and size effects on park valuation has been found. Although this synergetic effect has not been demonstrated before (to my knowledge), scarce academic research touching upon this narrow research area has been insinuating such a phenomenon.

# 10 Conclusion

In the conclusion, a concise answer to the research question is provided along with a brief recapitulation of the research design.

## 10.1 Research design

In this paper valuation of urban parks has been researched. Theoretical evidence is used to identify mechanisms for utility derivation from urban parks and determine the value of parks for urban residents. To measure these mechanisms, the effects of park accessibility, park size and synergetic effects on transaction prices are researched. A hedonic pricing model is used to regress three factors: travelling distance to the nearest park, park size of the nearest park and an interaction term of these variables on transaction prices.

Results in this research indicate a positive exponential effect of spatial proximity to urban parks with respect to residential property value: people are willing to pay a premium to live nearby an urban park, and this premium increases exponentially when spatial proximity increases. Another finding of this research is the existence of a (positive) park size effect on transaction prices, although only in Utrecht.
Where significant influences of park size on transaction prices have been found in Utrecht, a synergetic effect of spatial proximity and park size has been indicated as well.

## 10.2 Answer to the research question

The research question of this paper is: how is recreative urban green space valued and to which extent are geographical mechanisms affecting this valuation? From theoretical and empirical findings, it can be determined that recreative urban green space is valued positively by urban residents. As spatial proximity to urban parks increases, urban residents value urban parks more positively. Empirical findings in this paper indicate partial evidence for a park size effect: as park size increases, valuation of urban parks also increases. This only holds for Utrecht. Additionally, a synergetic effect of spatial proximity and park size on park valuation is observed in Utrecht. Two possible explanations are provided: (1) as spatial proximity increases, the influence of park size on park valuation increases or (2) as park size increases, the influence of spatial proximity on park valuation increases.

# 11 Limitations

In the limitations section, the most important limitations of this research are highlighted. Firstly, the possibility of endogeneity is addressed. Secondly, the extent of internal and external validity is explained. Furthermore, a possible selection bias is discussed.

## 11.1 Endogeneity

A limitation of an OLS regression model is the possibility of endogeneity, which emerges when explanatory variables and the dependent variable are correlated with the residuals (Wooldridge, 2012). After regressing the models for The Hague and Utrecht, the correlation between the main explanatory variables and the residuals is estimated. Although the mean of the residuals in both regressions is close to 0, it is not equal to 0, indicating correlation between the error term and the dependent variable. In addition, correlation between the error term and explanatory variables is not equal to 0.
The problem of endogeneity could be solved by using an instrumental variable. However, it is not easy to find an instrumental variable for this possible limitation that satisfies the exclusion restriction. Moreover, the fact that correlations of residuals and explanatory/dependent variables are small indicates that the probability and extent of endogeneity is rather small. Therefore, estimated effects should still be considered unbiased.

## 11.2 Validity

The amount of data available for this hedonic regression depends on geographical boundaries and boundaries in time; the bigger the region and/or the period of time researched, the larger the amount of data. For this reason, robustness of the results has to be weighed against the extent and direction of external validity regarding geographical areas: while a bigger geographical research area will probably provide less area specific results, it is conceivable that it will result in a more robust outcome, this paper aims to give policy makers in dense areas – particularly urban areas – handles when constructing urban green space policy. E.g.: taking the Netherlands as research area will provide the model with many more transaction prices than picking one city. However, an average result for the Netherlands does not say very much about a specific smaller dense area, by its very nature of being an average result over the entire country. On the other side, picking one city may provide the model with fewer observations, however results could possibly be applicable to more cities than just the one in the research.

Findings in this paper only directly apply to The Hague and Utrecht, because the used data is from The Hague and Utrecht. However, findings in this research can be used to support arguments for creation or preservation of urban parks in other urban areas. The extent to which these findings can be used, depends on the similarity of urban characteristics with Utrecht and/or The Hague: areas with similar features will conceivably provide the same results when this analysis is done for those regions, meaning that findings would be similar as well.

## 11.3 Selection bias

A disadvantage of residential transaction prices is that data is only collected from residences which have actually changed owners. As a consequence, only a portion of the market is in the dataset: residences in the rental sector (both private and social housing) are not participating in this analysis. For the private rental sector, it is assumed that monthly rents are representative for the value of the house. This sector contains different levels of housing values, which is the main reason to assume that this is a random group. Hence, adding this group of observations to the existing dataset probably would not provide a substantially different result. However, the social housing sector is not a random group: most residents in this sector live in houses which would be less valuable on the housing market, taking their characteristics into account. Neither regarding urban green space this is a group, which is randomly distributed. One could posit that less green space in the direct neighborhood is related to less income and less valuable residences: smaller garden acreage on average and a less green neighborhood are conceivable arguments for a lower residential price. This group is not incorporated in this research and therefore possibly creates a selection bias. However, the residential market is used for this type of academic analysis in other literature as well, for example in (Daams, Sijtsma, & van der Vlist, 2016). A possible argument could be that adding this market segment to the research requires substantial changes in method. This, in turn, could raise other complications, for example regarding the amount unified data per observation. Apart from these complications the question would be whether the outcome of an adjusted research would be substantially different: using the current method has resulted in (partial) confirmation of tested hypotheses. Hence, adjustments for the aim of this research adjustments in the data are not of crucial importance, although for the share of unconfirmed tested hypotheses it could make a difference.

# 12 Recommendations

This final section provides recommendations in two subsections: firstly, three recommendations for further research are provided and secondly, practical implications are explained.

## 12.1 Further academic research

Clearly the shown effects of park accessibility and size on transaction price needs more academic attention, especially regarding the different findings in The Hague and Utrecht. Possibly this difference is due to the fact that park size approximates park quality/variety, but before concluding this, more research is certainly needed.

Furthermore, the synergetic effect between on the one side the distance to and size of the nearest park and on the other side the transaction price of a house is an interesting opportunity for further research. In this way literature is enriched with information about the mechanisms of valuation of urban parks in The Hague and Utrecht, which is academically relevant. Although this synergetic effect between measures is found, in this research cannot be made clear to which mechanism(s) this effect can be assigned to.

Thirdly, this research focused on the presence of a synergetic effect in a quantitative measure, with a financial measurement as unit of analysis. However, from other research is known that urban parks also have functions which are more difficult to be represented by a financial measure, for example medical health or water storage (Konijnendijk, Ricard, & Kenney, 2006). For measuring these types of functions and contributing value of urban parks, another – perhaps more qualitative - research method is desired.

Fourthly, with respect to the different mechanisms at work resulting in particular accessibility and size effects on park valuation, residential adjacency to an urban park could be added to this analysis as extra measurement. Possibly, analyzing this extra feature could provide more insights in the way identified mechanisms relate to each other with respect to the valuation of urban parks.

## 12.2 Practical implications

With respect to these findings for valuation of park accessibility and size, most striking recommendation in practice for urban planning would be to increase accessibility to an urban park for every household, in order to increase the quality of life. Based on this research, an important link in this process is (walking) distance from residences to the nearest urban park. Based on this research, provision of numerous smaller urban parks is being valued more positively than fewer large urban green space facilities, in order to raise quality of urban life: in both cities researched a distance effect has been found and the size effect is only found in Utrecht. Because the magnitude of both effects is considerably difficult to compare with each other and the size effect is only shown in one city, overall the effect of proximity to urban parks on neighborhood attractiveness is demonstrated to be more clearly present than the effect of park size on neighborhood attractiveness. On the basis of this study can be concluded that residents derive more utility from living nearby an urban park than they derive from the size of the nearest urban park. However, the conditional working of these mechanisms remains unclear. Certainly, among earlier research regarding urban parks, this paper confirms: the existence of urban parks contributes to the quality of urban life.

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# Appendix

*Stata Output*

**Summarizes**

```
. summarize Transaction_price, det

                      Transaction_price
-------------------------------------------------------------
      Percentiles      Smallest
 1%        72000          50000
 5%        90000          50000
10%       106000          50000       Obs              30,046
25%       137500          50000       Sum of Wgt.      30,046

50%       185000                      Mean           224694.1
                        Largest       Std. Dev.      151106.6
75%       258000        2610000
90%       375000        2690000       Variance       2.28e+10
95%       505000        2980000       Skewness       3.870353
99%       820000        3420000       Kurtosis       35.39661
```

```
. tab D_City
```

| D_City | Freq. | Percent | Cum. |
|---|---|---|---|
| The Hague | 17,764 | 59.12 | 59.12 |
| Utrecht | 12,282 | 40.88 | 100.00 |
| Total | 30,046 | 100.00 | |

Reis_distance Utrecht:

```
. sum REIS_DIST_ALLPARKS, det

                      REIS_DIST_ALLPARKS
-------------------------------------------------------------
      Percentiles      Smallest
 1%     82.03644       1.670991
 5%      193.435       11.55217
10%     274.9643       12.50459       Obs              12,282
25%     439.8191       13.87867       Sum of Wgt.      12,282

50%     731.2215                      Mean           801.4137
                        Largest       Std. Dev.      455.3336
75%     1094.177        3445.45
90%     1452.622       3467.614       Variance       207328.7
95%     1669.654       3551.395       Skewness       .7558273
99%     1964.104       4658.817       Kurtosis       3.744379
```

### Reis_distance The Hague:

```
. sum REIS_DIST_ALLPARKS, det

                      REIS_DIST_ALLPARKS
-------------------------------------------------------------
      Percentiles      Smallest
 1%     95.44719       7.752551
 5%     227.3822       10.76876
10%     314.4656       11.90667       Obs              17,764
25%     549.6713       13.28038       Sum of Wgt.      17,764

50%     890.0842                      Mean           1010.719
                        Largest       Std. Dev.      699.9532
75%     1315.977       4873.489
90%     1738.846       4873.489       Variance       489934.5
95%      2047.09       4873.489       Skewness        2.15479
```

### Park size Utrecht

```
. sum Size, det

                             Size
-------------------------------------------------------------
      Percentiles      Smallest
 1%          2.2            2.2
 5%          2.2            3.1
10%          3.1            4.9       Obs                  19
25%          6.7            5.4       Sum of Wgt.          19

50%          9.1                      Mean           29.22632
                        Largest       Std. Dev.      46.51749
75%           21           73.1
90%         90.1           73.4       Variance       2163.876
95%        186.7           90.1       Skewness       2.356553
99%        186.7          186.7       Kurtosis       8.008837
```

## Regression Output

### Figure 5: final regression Utrecht

```
. reg `y' `year' `WSFE' `GPFE' `BFE' `structural' `location' REIS_DIST_ALLPARKS REIS_DIST_ALLPARKS2 REIS_SIZE_AL
> LPARKS REIS_INTER_ALLPARKS, cluster (buurt_ID)
note: BFE_74 omitted because of collinearity

Linear regression                               Number of obs     =     12,216
                                                F(55, 89)         =          .
                                                Prob > F          =          .
                                                R-squared         =     0.7710
                                                Root MSE          =      56809

                                      (Std. Err. adjusted for 90 clusters in buurt_ID)
```

| Transaction_price | Coef. | Robust Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| year2005 | 12582.21 | 1774.858 | 7.09 | 0.000 | 9055.608 | 16108.82 |
| year2006 | 26775.14 | 2399.996 | 11.16 | 0.000 | 22006.4 | 31543.89 |
| D_WS_Eenvoudige_woning | -8793.355 | 2698.964 | -3.26 | 0.002 | -14156.14 | -3430.571 |
| D_WS_Woonboot | 36293.52 | 37385.66 | 0.97 | 0.334 | -37990.99 | 110578 |
| D_WS_Grachtenpand | 63512.09 | 44786.4 | 1.42 | 0.160 | -25477.53 | 152501.7 |
| D_WS_Herenhuis | 38474.99 | 8014.305 | 4.80 | 0.000 | 22550.74 | 54399.25 |
| D_WS_Woonboerderij | -24064.7 | 48441.71 | -0.50 | 0.621 | -120317.4 | 72187.95 |
| D_WS_Bungalow | 104827.9 | 43718.49 | 2.40 | 0.019 | 17960.15 | 191695.6 |
| D_WS_Villa | 112465.7 | 13659.84 | 8.23 | 0.000 | 85323.92 | 139607.6 |
| D_WS_Landhuis | 336281 | 87519.96 | 3.84 | 0.000 | 162380.7 | 510181.3 |
| D_WS_Benedenwoning | 3596.309 | 2738.659 | 1.31 | 0.193 | -1845.348 | 9037.967 |
| D_WS_Bovenwoning | -8850.188 | 2773.769 | -3.19 | 0.002 | -14361.61 | -3338.767 |
| D_WS_Maisonette | 285.1152 | 7856.229 | 0.04 | 0.971 | -15325.05 | 15895.28 |
| D_WS_Portiekflat | 7357.683 | 3660.462 | 2.01 | 0.047 | 84.4236 | 14630.94 |
| D_WS_Galerijflat | 1387.529 | 5357.193 | 0.26 | 0.796 | -9257.1 | 12032.16 |
| D_WS_Verzorgingsflat | 3126.209 | 5082.206 | 0.62 | 0.540 | -6972.027 | 13224.44 |
| D_WS_Benedenbovenwoning | -28798.96 | 12055.38 | -2.39 | 0.019 | -52752.75 | -4845.172 |
| D_GardenN | -5037.069 | 2395.725 | -2.10 | 0.038 | -9797.324 | -276.8146 |
| D_GardenNW | 1279.28 | 2417.773 | 0.53 | 0.598 | -3524.783 | 6083.343 |
| D_GardenO | -4987.716 | 2447.77 | -2.04 | 0.045 | -9851.383 | -124.0494 |
| D_GardenW | 1932.649 | 3071.18 | 0.63 | 0.531 | -4169.72 | 8035.019 |
| D_GardenZ | -1163.343 | 2803.372 | -0.41 | 0.679 | -6733.584 | 4406.899 |
| D_GardenZO | 6375.19 | 4242.362 | 1.50 | 0.136 | -2054.293 | 14804.67 |
| D_GardenZW | 5952.962 | 3921.968 | 1.52 | 0.133 | -1839.906 | 13745.83 |
| D_No_Garden | 2791.167 | 2441.686 | 1.14 | 0.256 | -2060.41 | 7642.744 |
| BFE_1 | 60764.04 | 12686.62 | 4.79 | 0.000 | 35555.99 | 85972.09 |
| BFE_10 | -28073.26 | 45866.74 | -0.61 | 0.542 | -119209.5 | 63062.97 |
| BFE_11 | 72476.92 | 13252.97 | 5.47 | 0.000 | 46143.56 | 98810.28 |
| BFE_12 | 62724.12 | 13792.32 | 4.55 | 0.000 | 35319.07 | 90129.17 |
| BFE_13 | 45397.98 | 13933.87 | 3.26 | 0.002 | 17711.68 | 73084.28 |
| BFE_14 | 54315.57 | 12956.38 | 4.19 | 0.000 | 28571.51 | 80059.63 |
| BFE_15 | 44896.68 | 12655.77 | 3.55 | 0.001 | 19749.93 | 70043.43 |
| BFE_16 | 23428.52 | 13679.39 | 1.71 | 0.090 | -3752.135 | 50609.17 |
| BFE_17 | 35008.6 | 13189.38 | 2.65 | 0.009 | 8801.583 | 61215.63 |
| BFE_18 | 43517.08 | 14300.96 | 3.04 | 0.003 | 15101.38 | 71932.78 |
| BFE_19 | 33986.2 | 14712.92 | 2.31 | 0.023 | 4751.945 | 63220.46 |
| BFE_2 | 120014.3 | 12305.37 | 9.75 | 0.000 | 95563.79 | 144464.8 |
| BFE_20 | 35651.14 | 13824.28 | 2.58 | 0.012 | 8182.594 | 63119.69 |
| BFE_21 | 41297.17 | 13771.82 | 3.00 | 0.004 | 13932.85 | 68661.49 |
| BFE_22 | 52020.48 | 15229.33 | 3.42 | 0.001 | 21760.13 | 82280.83 |
| BFE_23 | 27289.05 | 13035.9 | 2.09 | 0.039 | 1386.987 | 53191.11 |
| BFE_24 | 41339.04 | 13942.94 | 2.96 | 0.004 | 13634.72 | 69043.36 |
| BFE_25 | 43969.68 | 15547.75 | 2.83 | 0.006 | 13076.63 | 74862.74 |
| BFE_26 | 34539.54 | 14426.31 | 2.39 | 0.019 | 5874.761 | 63204.31 |
| BFE_27 | 35932.66 | 13951.76 | 2.58 | 0.012 | 8210.816 | 63654.51 |
| BFE_28 | 25069.81 | 19120.73 | 1.31 | 0.193 | -12922.66 | 63062.29 |
| BFE_29 | 8723.754 | 20179.95 | 0.43 | 0.667 | -31373.38 | 48820.89 |
| BFE_3 | 83852.8 | 12465.94 | 6.73 | 0.000 | 59083.25 | 108622.3 |
| BFE_30 | 8545.337 | 21096.63 | 0.41 | 0.686 | -33373.22 | 50463.89 |
| BFE_31 | 124199.1 | 38302.1 | 3.24 | 0.002 | 48093.61 | 200304.5 |
| BFE_32 | 120011.8 | 11343.14 | 10.58 | 0.000 | 97473.22 | 142550.4 |
| BFE_33 | 83547.81 | 12181.05 | 6.86 | 0.000 | 59344.32 | 107751.3 |
| BFE_34 | 96198.21 | 12265.69 | 7.84 | 0.000 | 71826.55 | 120569.9 |
| BFE_35 | 83095.34 | 11501.15 | 7.22 | 0.000 | 60242.8 | 105947.9 |
| BFE_36 | 91449.32 | 11263.11 | 8.12 | 0.000 | 69069.77 | 113828.9 |
| BFE_37 | 140992.9 | 11854.27 | 11.89 | 0.000 | 117438.7 | 164547.1 |
| BFE_38 | 86233.05 | 12536.89 | 6.88 | 0.000 | 61322.52 | 111143.6 |
| BFE_39 | 101336.3 | 10871.53 | 9.32 | 0.000 | 79734.79 | 122937.8 |
| BFE_4 | 67269.32 | 12102.96 | 5.56 | 0.000 | 43221.01 | 91317.64 |
| BFE_40 | 114516.5 | 11548.93 | 9.92 | 0.000 | 91569.02 | 137464 |
| BFE_41 | 108626.8 | 10695.95 | 10.16 | 0.000 | 87374.16 | 129879.4 |
| BFE_42 | 74622.34 | 13512.84 | 5.52 | 0.000 | 47772.61 | 101472.1 |
| BFE_43 | 108546.2 | 10768.5 | 10.08 | 0.000 | 87149.38 | 129942.9 |
| BFE_44 | 76609.79 | 11578.4 | 6.62 | 0.000 | 53603.75 | 99615.82 |
| BFE_45 | 87116.02 | 12937.75 | 6.73 | 0.000 | 61409 | 112823 |
| BFE_46 | 68072.87 | 11048.34 | 6.16 | 0.000 | 46120.05 | 90025.69 |
| BFE_47 | 63822.03 | 11115.29 | 5.74 | 0.000 | 41736.18 | 85907.89 |
| BFE_48 | 76127.99 | 13087.57 | 5.82 | 0.000 | 50123.26 | 102132.7 |
| BFE_49 | 116392.7 | 12236.1 | 9.51 | 0.000 | 92079.84 | 140705.6 |
| BFE_5 | 62673.78 | 11815.69 | 5.30 | 0.000 | 39196.26 | 86151.3 |
| BFE_50 | 82042.28 | 11518.26 | 7.12 | 0.000 | 59155.74 | 104928.8 |
| BFE_51 | 99394.7 | 11324.53 | 8.78 | 0.000 | 76893.09 | 121896.3 |
| BFE_52 | 191999.9 | 13046.11 | 14.72 | 0.000 | 166077.6 | 217922.3 |
| BFE_53 | 131653.9 | 13794.89 | 9.54 | 0.000 | 104243.7 | 159064 |
| BFE_54 | 33413.36 | 22562.46 | 1.48 | 0.142 | -11417.77 | 78244.48 |
| BFE_55 | 74348.84 | 13815.54 | 5.38 | 0.000 | 46897.65 | 101800 |
| BFE_56 | 91777.6 | 11957.13 | 7.68 | 0.000 | 68019.04 | 115536.2 |
| BFE_57 | 134898.1 | 15975.27 | 8.44 | 0.000 | 103155.5 | 166640.6 |
| BFE_58 | 133529.4 | 12618.64 | 10.58 | 0.000 | 108456.4 | 158602.3 |
| BFE_59 | 132586.7 | 11748.75 | 11.29 | 0.000 | 109242.2 | 155931.2 |
| BFE_6 | 69379.35 | 11395.26 | 6.09 | 0.000 | 46737.21 | 92021.5 |
| BFE_60 | 119188.3 | 14515.9 | 8.21 | 0.000 | 90345.5 | 148031.1 |
| BFE_61 | 134263.5 | 13254.26 | 10.13 | 0.000 | 107927.5 | 160599.4 |
| BFE_62 | 142818.3 | 12885.18 | 11.08 | 0.000 | 117215.7 | 168420.8 |
| BFE_63 | 71050.65 | 12494.21 | 5.69 | 0.000 | 46224.91 | 95876.39 |
| BFE_64 | 88609.42 | 17625.02 | 5.03 | 0.000 | 53588.89 | 123629.9 |
| BFE_65 | 67903.13 | 16040.92 | 4.23 | 0.000 | 36030.16 | 99776.11 |
| BFE_66 | 43310.16 | 13636.47 | 3.18 | 0.002 | 16214.78 | 70405.55 |
| BFE_67 | 49239.45 | 13496.76 | 3.65 | 0.000 | 22421.68 | 76057.21 |
| BFE_68 | 36388.39 | 11295.35 | 3.22 | 0.002 | 13944.77 | 58832.01 |
| BFE_69 | 62631.53 | 11726.24 | 5.34 | 0.000 | 39331.74 | 85931.32 |
| BFE_7 | 52776.65 | 11938.21 | 4.42 | 0.000 | 29055.68 | 76497.62 |
| BFE_70 | 51740.11 | 12195.2 | 4.24 | 0.000 | 27508.5 | 75971.72 |
| BFE_71 | 45019.69 | 11566.24 | 3.89 | 0.000 | 22037.81 | 68001.56 |
| BFE_72 | 66790.92 | 11588.5 | 5.76 | 0.000 | 43764.82 | 89817.02 |
| BFE_73 | 69399.7 | 10227.4 | 6.79 | 0.000 | 49078.07 | 89721.34 |
| BFE_74 | 0 | (omitted) | | | | |
| BFE_75 | 57291.95 | 11863.18 | 4.83 | 0.000 | 33720.08 | 80863.83 |
| BFE_76 | 48351.83 | 13119.26 | 3.69 | 0.000 | 22284.15 | 74419.52 |
| BFE_77 | 46646.35 | 15391.79 | 3.03 | 0.003 | 16063.19 | 77229.5 |
| BFE_78 | 41768.52 | 13931.22 | 3.00 | 0.004 | 14087.47 | 69449.56 |
| BFE_79 | 21129.32 | 17638.01 | 1.20 | 0.234 | -13917.04 | 56175.68 |
| BFE_8 | 61373.97 | 12249.63 | 5.01 | 0.000 | 37034.21 | 85713.72 |
| BFE_80 | 16137.47 | 13738.97 | 1.17 | 0.243 | -11161.57 | 43436.52 |
| BFE_81 | 37692.71 | 14554.05 | 2.59 | 0.011 | 8774.121 | 66611.31 |
| BFE_82 | 104052.6 | 29703.76 | 3.50 | 0.001 | 45031.9 | 163073.4 |
| BFE_83 | 69640.65 | 34435.7 | 2.02 | 0.046 | 1217.651 | 138063.7 |
| BFE_84 | 35534.36 | 20599.06 | 1.73 | 0.088 | -5395.537 | 76464.26 |
| BFE_85 | 82916.38 | 22876.64 | 3.62 | 0.000 | 37460.99 | 128371.8 |
| BFE_86 | 25757.38 | 20595 | 1.25 | 0.214 | -15164.45 | 66679.21 |
| BFE_87 | 24066.95 | 18671.94 | 1.29 | 0.201 | -13033.81 | 61167.7 |
| BFE_88 | 45734.29 | 17326.13 | 2.64 | 0.010 | 11307.63 | 80160.94 |
| BFE_89 | 119159.9 | 17836.75 | 6.68 | 0.000 | 83718.62 | 154601.1 |
| BFE_9 | 35847.56 | 13968.42 | 2.57 | 0.012 | 8092.604 | 63602.52 |
| BFE_90 | 179976.5 | 36999.08 | 4.86 | 0.000 | 106460.1 | 253492.9 |
| D_cohort_1 | 34805.75 | 23956.13 | 1.45 | 0.150 | -12794.58 | 82406.08 |
| D_cohort_2 | -16142.36 | 6738.88 | -2.40 | 0.019 | -29532.37 | -2752.351 |
| D_cohort_3 | -21214.09 | 7158.949 | -2.96 | 0.004 | -35438.76 | -6989.407 |
| D_cohort_4 | -21611.52 | 8026.642 | -2.69 | 0.008 | -37560.29 | -5662.752 |
| D_cohort_5 | -39003.94 | 6003.411 | -6.50 | 0.000 | -50932.59 | -27075.29 |
| D_cohort_6 | -42272.99 | 7354.588 | -5.75 | 0.000 | -56886.4 | -27659.58 |
| D_cohort_7 | -43881.48 | 6427.41 | -6.83 | 0.000 | -56652.6 | -31110.35 |
| D_cohort_8 | -26128.13 | 6796.452 | -3.84 | 0.000 | -39632.53 | -12623.72 |
| D_cohort_9 | -12989.18 | 4512.71 | -2.88 | 0.005 | -21955.84 | -4022.522 |
| plafondhoogte | 31056.14 | 3574.88 | 8.69 | 0.000 | 23952.93 | 38159.34 |
| nearroad_busy | -7318.516 | 3029.397 | -2.42 | 0.018 | -13337.86 | -1299.17 |
| sit_View | 2012.545 | 1385.176 | 1.45 | 0.150 | -739.7693 | 4764.86 |
| sit_Waterfront | 16815.33 | 3248.123 | 5.18 | 0.000 | 10361.37 | 23269.28 |
| sit_Woodlands | 31474.27 | 19577.61 | 1.61 | 0.111 | -7426.02 | 70374.57 |
| squaremeters | 1431.4 | 278.3959 | 5.14 | 0.000 | 878.2334 | 1984.567 |
| squaremeters2 | 1.210112 | 1.031171 | 1.17 | 0.244 | -.8388035 | 3.259028 |
| D_monument | 11660.72 | 7797.146 | 1.50 | 0.138 | -3832.043 | 27153.48 |
| D_monumental | 14431.4 | 9976.405 | 1.45 | 0.152 | -5391.504 | 34254.31 |
| balcony | 5857.29 | 2327.353 | 2.52 | 0.014 | 1232.889 | 10481.69 |
| rooms | 2221.128 | 956.9425 | 2.32 | 0.023 | 319.704 | 4122.553 |
| perceel | 11.84132 | 4.125066 | 2.87 | 0.005 | 3.644902 | 20.03774 |
| perceel2 | -.0009034 | .0003951 | -2.29 | 0.025 | -.0016884 | -.0001184 |
| Garden_acreage | 291.3596 | 36.31681 | 8.02 | 0.000 | 219.1989 | 363.5204 |
| Garden_acreage2 | -.1212195 | .0245174 | -4.94 | 0.000 | -.169935 | -.0725039 |
| NEAR_DIST_MONUMENT | -14.36438 | 8.002479 | -1.79 | 0.076 | -30.26513 | 1.536374 |
| NEAR_DIST_OPRIT | 2.956631 | 5.654096 | 0.52 | 0.602 | -8.277936 | 14.1912 |
| NEAR_DIST_STADHUIS | .9559622 | 3.046373 | 0.31 | 0.754 | -5.097115 | 7.00904 |
| NEAR_DIST_TREIN | -2.068916 | 5.449762 | -0.38 | 0.705 | -12.89748 | 8.759645 |
| REIS_DIST_ALLPARKS | -28.12496 | 11.42365 | -2.46 | 0.016 | -50.82351 | -5.426402 |
| REIS_DIST_ALLPARKS2 | .0175474 | .0079886 | 2.20 | 0.031 | .0016742 | .0334206 |
| REIS_SIZE_ALLPARKS | 532.2105 | 212.0843 | 2.51 | 0.014 | 110.8035 | 953.6176 |
| REIS_INTER_ALLPARKS | -.3592987 | .1335183 | -2.69 | 0.009 | -.6245968 | -.0940007 |
| _cons | -102431.1 | 27451.97 | -3.73 | 0.000 | -156977.6 | -47884.63 |

## Figure 6: testing joint significance for Utrecht

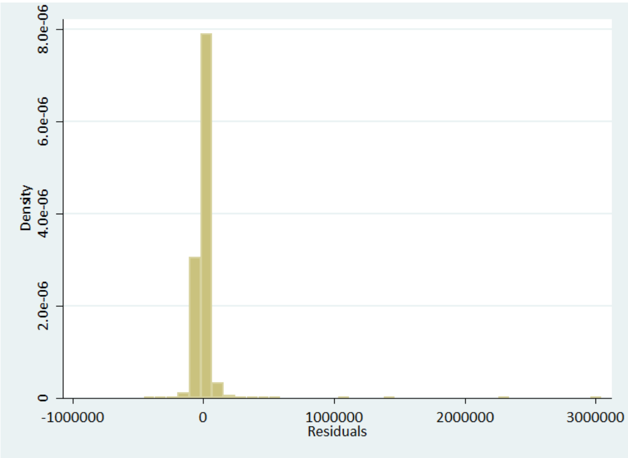
```
. test REIS_DIST_ALLPARKS REIS_DIST_ALLPARKS2

 ( 1)  REIS_DIST_ALLPARKS = 0
 ( 2)  REIS_DIST_ALLPARKS2 = 0

       F(  2,    89) =    3.05
            Prob > F =    0.0522


. test REIS_DIST_ALLPARKS REIS_DIST_ALLPARKS2 REIS_SIZE_ALLPARKS REIS_INTER_ALLPARKS

 ( 1)  REIS_DIST_ALLPARKS = 0
 ( 2)  REIS_DIST_ALLPARKS2 = 0
 ( 3)  REIS_SIZE_ALLPARKS = 0
 ( 4)  REIS_INTER_ALLPARKS = 0

       F(  4,    89) =    4.61
            Prob > F =    0.0020


. test REIS_DIST_ALLPARKS REIS_SIZE_ALLPARKS REIS_INTER_ALLPARKS

 ( 1)  REIS_DIST_ALLPARKS = 0
 ( 2)  REIS_SIZE_ALLPARKS = 0
 ( 3)  REIS_INTER_ALLPARKS = 0

       F(  3,    89) =    3.91
            Prob > F =    0.0113
```

## Figure 7: residuals Utrecht

```
. predict newvar1, residuals
(66 missing values generated)

. sum newvar1
```

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| newvar1 | 12,216 | 1.58e-07 | 56468.96 | -454884.4 | 3046758 |

```
. hist newvar1
(bin=40, start=-454884.38, width=87541.066)
```



## Figure 8: Final regression The Hague

```
. reg `y' `year' `WSFE' `GPFE' `NFE' `structural' `location' REIS_DIST_ALLPARKS REIS_DIST_ALLPARKS2 REIS_SIZE_AL
> LPARKS, cluster (neighbourhood_ID)
note: NFE_1 omitted because of collinearity

Linear regression                               Number of obs     =     17,657
                                                F(39, 41)         =          .
                                                Prob > F          =          .
                                                R-squared         =     0.8144
                                                Root MSE          =      73099

                            (Std. Err. adjusted for 42 clusters in neighbourhood_ID)
```

| Transaction_price | Coef. | Robust Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| year2005 | 11920.51 | 1984.507 | 6.01 | 0.000 | 7912.713 | 15928.3 |
| year2006 | 22093.84 | 3253.351 | 6.79 | 0.000 | 15523.57 | 28664.12 |
| D_WS_Eenvoudige_woning | -18796.59 | 8536.859 | -2.20 | 0.033 | -36037.13 | -1556.055 |
| D_WS_Woonboot | 49234.09 | 9558.969 | 5.15 | 0.000 | 29929.36 | 68538.82 |
| D_WS_Grachtenpand | 70012.32 | 27345.19 | 2.56 | 0.014 | 14787.58 | 125237 |
| D_WS_Herenhuis | 58191.8 | 10330.99 | 5.63 | 0.000 | 37327.94 | 79055.66 |
| D_WS_Woonboerderij | 389270 | 21753.75 | 17.89 | 0.000 | 345337.4 | 433202.6 |
| D_WS_Bungalow | 47686.14 | 14971.25 | 3.19 | 0.003 | 17451.08 | 77921.2 |
| D_WS_Villa | 216839.6 | 26582.79 | 8.16 | 0.000 | 163154.6 | 270524.6 |
| D_WS_Landhuis | 121013.8 | 12458.69 | 9.71 | 0.000 | 95852.91 | 146174.6 |
| D_WS_Benedenwoning | -5441.243 | 3098.511 | -1.76 | 0.087 | -11698.81 | 816.3257 |
| D_WS_Bovenwoning | -11973.03 | 6586.693 | -1.82 | 0.076 | -25275.13 | 1329.068 |
| D_WS_Maisonette | -18346.67 | 6022.144 | -3.05 | 0.004 | -30508.64 | -6184.704 |
| D_WS_Portiekflat | -8487.037 | 7593.467 | -1.12 | 0.270 | -23822.35 | 6848.281 |
| D_WS_Galerijflat | -6803.447 | 6522.961 | -1.04 | 0.303 | -19976.83 | 6369.94 |
| D_WS_Verzorgingsflat | -45155.99 | 10404.82 | -4.34 | 0.000 | -66168.96 | -24143.03 |
| D_WS_Benedenbovenwoning | -6468.976 | 5130.893 | -1.26 | 0.215 | -16831.02 | 3893.074 |
| D_GardenN | -5870.345 | 6269.653 | -0.94 | 0.355 | -18532.17 | 6791.476 |
| D_GardenNW | -2214.491 | 5963.687 | -0.37 | 0.712 | -14258.4 | 9829.42 |
| D_GardenO | 14.43862 | 3223.6 | 0.00 | 0.996 | -6495.754 | 6524.631 |
| D_GardenW | -2740.252 | 4882.865 | -0.56 | 0.578 | -12601.4 | 7120.894 |
| D_GardenZ | 5132.045 | 4981.45 | 1.03 | 0.309 | -4928.197 | 15192.29 |
| D_GardenZO | 9778.469 | 5290.672 | 1.85 | 0.072 | -906.2599 | 20463.2 |
| D_GardenZW | 2927.187 | 4710.244 | 0.62 | 0.538 | -6585.344 | 12439.72 |
| D_No_Garden | 5903.704 | 4717.914 | 1.25 | 0.218 | -3624.316 | 15431.72 |
| NFE_1 | 0 | (omitted) | | | | |
| NFE_2 | -147773.9 | 23434.97 | -6.31 | 0.000 | -195101.8 | -100446.1 |
| NFE_3 | -36774.2 | 22411.6 | -1.64 | 0.108 | -82035.35 | 8486.954 |
| NFE_4 | -105485.7 | 27119.36 | -3.89 | 0.000 | -160254.3 | -50717.02 |
| NFE_5 | -60222.83 | 27021.08 | -2.23 | 0.031 | -114793 | -5652.651 |
| NFE_6 | -40509.05 | 23463.12 | -1.73 | 0.092 | -87893.78 | 6875.685 |
| NFE_7 | -158598.9 | 25344.06 | -6.26 | 0.000 | -209782.2 | -107415.5 |
| NFE_8 | -222304.3 | 28068.42 | -7.92 | 0.000 | -278989.6 | -165619 |
| NFE_9 | -124254.6 | 25931.23 | -4.79 | 0.000 | -176623.8 | -71885.41 |
| NFE_10 | -80648.25 | 26768.24 | -3.01 | 0.004 | -134707.8 | -26588.68 |
| NFE_11 | -159804.7 | 28342.2 | -5.64 | 0.000 | -217042.9 | -102566.5 |
| NFE_12 | -192858.5 | 27710.49 | -6.96 | 0.000 | -248820.9 | -136896 |
| NFE_13 | -80157.37 | 22488.64 | -3.56 | 0.001 | -125574.1 | -34740.63 |
| NFE_14 | -188242.4 | 25112.39 | -7.50 | 0.000 | -238957.9 | -137526.9 |
| NFE_15 | -93872.89 | 15672.25 | -5.99 | 0.000 | -125523.6 | -62222.13 |
| NFE_16 | -186816.9 | 24095.33 | -7.75 | 0.000 | -235478.4 | -138155.4 |
| NFE_17 | -208621.4 | 24447.25 | -8.53 | 0.000 | -257993.6 | -159249.2 |
| NFE_18 | -196950.4 | 26192.86 | -7.52 | 0.000 | -249848 | -144052.9 |
| NFE_19 | -189524.7 | 29202.35 | -6.49 | 0.000 | -248500.1 | -130549.4 |
| NFE_20 | -208245.6 | 30842.03 | -6.75 | 0.000 | -270532.4 | -145958.9 |
| NFE_21 | -204302.4 | 31976.33 | -6.39 | 0.000 | -268879.9 | -139724.9 |
| NFE_22 | -183123.8 | 30166.63 | -6.07 | 0.000 | -244046.6 | -122201.1 |
| NFE_23 | -78238.23 | 30411.91 | -2.57 | 0.014 | -139656.3 | -16820.14 |
| NFE_24 | -179664.1 | 33594.67 | -5.35 | 0.000 | -247509.9 | -111818.3 |
| NFE_25 | -155813.5 | 32058.06 | -4.86 | 0.000 | -220556.1 | -91070.97 |
| NFE_26 | -166900.3 | 31497.36 | -5.30 | 0.000 | -230510.6 | -103290.1 |
| NFE_27 | -212432.4 | 34267.26 | -6.20 | 0.000 | -281636.6 | -143228.3 |
| NFE_28 | -148814.2 | 32628.22 | -4.56 | 0.000 | -214708.2 | -82920.17 |
| NFE_29 | -232825.1 | 33184.53 | -7.02 | 0.000 | -299842.6 | -165807.6 |
| NFE_30 | -236435.8 | 32392.18 | -7.30 | 0.000 | -301853.1 | -171018.4 |
| NFE_31 | -212409.8 | 31832.94 | -6.67 | 0.000 | -276697.7 | -148121.9 |
| NFE_32 | -204353.2 | 30186.33 | -6.77 | 0.000 | -265315.7 | -143390.6 |
| NFE_33 | -195416.8 | 28026 | -6.97 | 0.000 | -252016.5 | -138817.1 |
| NFE_34 | -202598.4 | 28566.09 | -7.09 | 0.000 | -260288.8 | -144908.1 |
| NFE_35 | -219735.3 | 32033.56 | -6.86 | 0.000 | -284428.4 | -155042.2 |
| NFE_36 | -252610.6 | 30804.62 | -8.20 | 0.000 | -314821.8 | -190399.4 |
| NFE_37 | -217130 | 31024.65 | -7.00 | 0.000 | -279785.6 | -154474.5 |
| NFE_38 | -200717.5 | 32010.08 | -6.27 | 0.000 | -265363.2 | -136071.8 |
| NFE_39 | -104179.7 | 27852.16 | -3.74 | 0.001 | -160428.3 | -47931.1 |
| NFE_40 | -205544.5 | 32786.9 | -6.27 | 0.000 | -271759 | -139330 |
| NFE_41 | -227325.1 | 20918.76 | -10.87 | 0.000 | -269571.4 | -185078.8 |
| NFE_42 | -224030 | 48733.22 | -4.60 | 0.000 | -322448.7 | -125611.2 |
| D_cohort_1 | -84290.22 | 28477.99 | -2.96 | 0.005 | -141802.7 | -26777.76 |
| D_cohort_2 | -51109.89 | 10946.03 | -4.67 | 0.000 | -73215.84 | -29003.94 |
| D_cohort_3 | -74261.87 | 9556.981 | -7.77 | 0.000 | -93562.58 | -54961.15 |
| D_cohort_4 | -79954.06 | 8964.294 | -8.92 | 0.000 | -98057.82 | -61850.3 |
| D_cohort_5 | -76293.14 | 9427.412 | -8.09 | 0.000 | -95332.19 | -57254.1 |
| D_cohort_6 | -77766.86 | 11100.69 | -7.01 | 0.000 | -100185.2 | -55348.56 |
| D_cohort_7 | -70819.66 | 11693.41 | -6.06 | 0.000 | -94434.99 | -47204.33 |
| D_cohort_8 | -51602.73 | 9884.957 | -5.22 | 0.000 | -71565.8 | -31639.65 |
| D_cohort_9 | -15803.82 | 3742.653 | -4.22 | 0.000 | -23362.26 | -8245.382 |
| plafondhoogte | 24609.45 | 4093.843 | 6.01 | 0.000 | 16341.76 | 32877.13 |
| nearroad_busy | -15762.31 | 4028.872 | -3.91 | 0.000 | -23898.79 | -7625.842 |
| sit_View | 6461.356 | 1546.656 | 4.18 | 0.000 | 3337.821 | 9584.892 |
| sit_Waterfront | 8032.39 | 7488.539 | 1.07 | 0.290 | -7091.023 | 23155.8 |
| sit_Woodlands | 4742.62 | 7872.93 | 0.60 | 0.550 | -11157.08 | 20642.32 |
| squaremeters | 1434.018 | 197.2609 | 7.27 | 0.000 | 1035.642 | 1832.395 |
| squaremeters2 | 1.273914 | .5418955 | 2.35 | 0.024 | .1795336 | 2.368294 |
| D_monument | 46115.46 | 19142.9 | 2.41 | 0.021 | 7455.594 | 84775.32 |
| D_monumental | 45038.82 | 12564.06 | 3.58 | 0.001 | 19665.19 | 70412.46 |
| balcony | 6386.734 | 2805.105 | 2.28 | 0.028 | 721.7093 | 12051.76 |
| rooms | -50.79408 | 1667.389 | -0.03 | 0.976 | -3418.154 | 3316.565 |
| perceel | 3.660188 | 1.929381 | 1.90 | 0.065 | -.2362763 | 7.556653 |
| perceel2 | -.0002633 | .0001551 | -1.70 | 0.097 | -.0005766 | .0000499 |
| Garden_acreage | 568.2099 | 93.42844 | 6.08 | 0.000 | 379.5273 | 756.8925 |
| Garden_acreage2 | -.4764505 | .239486 | -1.99 | 0.053 | -.9601022 | .0072012 |
| NEAR_DIST_MONUMENT | -28.66458 | 9.209013 | -3.11 | 0.003 | -47.26256 | -10.0666 |
| NEAR_DIST_OPRIT | 6.897542 | 6.783393 | 1.02 | 0.315 | -6.801799 | 20.59688 |
| NEAR_DIST_STADHUIS | -3.158276 | 5.378039 | -0.59 | 0.560 | -14.01945 | 7.702894 |
| NEAR_DIST_TREIN | 1.071202 | 7.221652 | 0.15 | 0.883 | -13.51322 | 15.65562 |
| REIS_DIST_ALLPARKS | -31.78172 | 8.94367 | -3.55 | 0.001 | -49.84383 | -13.71962 |
| REIS_DIST_ALLPARKS2 | .008578 | .0027318 | 3.14 | 0.003 | .003061 | .0140949 |
| REIS_SIZE_ALLPARKS | 29.70949 | 28.11276 | 1.06 | 0.297 | -27.06538 | 86.48436 |
| _cons | 196768.1 | 42084.4 | 4.68 | 0.000 | 111776.9 | 281759.2 |

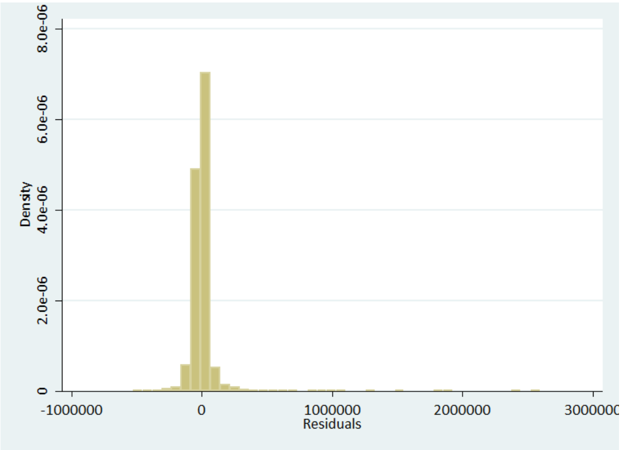
**Figure 9: testing joint significance The Hague**

```
. test REIS_DIST_ALLPARKS REIS_DIST_ALLPARKS2

 ( 1)  REIS_DIST_ALLPARKS = 0
 ( 2)  REIS_DIST_ALLPARKS2 = 0

       F(  2,    41) =    7.51
            Prob > F =    0.0017
```

**Figure 10: residuals The Hague**

```
. predict newvar2, residuals
(107 missing values generated)

. sum newvar2
```

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| newvar2 | 17,657 | -5.84e-07 | 72897.91 | -528652.6 | 2599302 |



## Figure 11: Regression The Hague incl parkside dummy

```
. reg `y' `year' `WSFE' `GPFE' `NFE' `structural' `location' REIS_DIST_ALLPARKS REIS_DIST_ALLPARKS2 REIS_SIZE_AL
> LPARKS sit_Parkside, cluster (neighbourhood_ID)
note: NFE_1 omitted because of collinearity

Linear regression                               Number of obs     =     17,657
                                                F(39, 41)         =          .
                                                Prob > F          =          .
                                                R-squared         =     0.8147
                                                Root MSE          =      73033

                             (Std. Err. adjusted for 42 clusters in neighbourhood_ID)
```

| Transaction_price | Coef. | Robust Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| year2005 | 11753.47 | 1978.365 | 5.94 | 0.000 | 7758.077 | 15748.85 |
| year2006 | 21897.58 | 3216.336 | 6.81 | 0.000 | 15402.06 | 28393.11 |
| D_WS_Eenvoudige_woning | -19057.66 | 8508.818 | -2.24 | 0.031 | -36241.57 | -1873.758 |
| D_WS_Woonboot | 50014.91 | 9639.297 | 5.19 | 0.000 | 30547.95 | 69481.87 |
| D_WS_Grachtenpand | 70510.51 | 27071.02 | 2.60 | 0.013 | 15839.48 | 125181.5 |
| D_WS_Herenhuis | 58459.63 | 10397.78 | 5.62 | 0.000 | 37460.89 | 79458.37 |
| D_WS_Woonboerderij | 394138.5 | 21725.74 | 18.14 | 0.000 | 350262.5 | 438014.5 |
| D_WS_Bungalow | 48755.89 | 14915.6 | 3.27 | 0.002 | 18633.22 | 78878.56 |
| D_WS_Villa | 216557.8 | 26566.08 | 8.15 | 0.000 | 162906.5 | 270209.1 |
| D_WS_Landhuis | 120203.5 | 12508.04 | 9.61 | 0.000 | 94942.99 | 145464 |
| D_WS_Benedenwoning | -5490.802 | 3079.128 | -1.78 | 0.082 | -11709.23 | 727.6239 |
| D_WS_Bovenwoning | -12016.28 | 6576.284 | -1.83 | 0.075 | -25297.36 | 1264.793 |
| D_WS_Maisonette | -18327.25 | 6051.27 | -3.03 | 0.004 | -30548.04 | -6106.461 |
| D_WS_Portiekflat | -8589.254 | 7551.865 | -1.14 | 0.262 | -23840.56 | 6662.047 |
| D_WS_Galerijflat | -6971.824 | 6506.234 | -1.07 | 0.290 | -20111.43 | 6167.782 |
| D_WS_Verzorgingsflat | -49598.99 | 11073.7 | -4.48 | 0.000 | -71962.79 | -27235.19 |
| D_WS_Benedenbovenwoning | -6262.24 | 5186.222 | -1.21 | 0.234 | -16736.03 | 4211.547 |
| D_GardenN | -5715.672 | 6188.763 | -0.92 | 0.361 | -18214.13 | 6782.788 |
| D_GardenNW | -2076.899 | 5968.098 | -0.35 | 0.730 | -14129.72 | 9975.918 |
| D_GardenO | 120.0647 | 3225.013 | 0.04 | 0.970 | -6392.982 | 6633.112 |
| D_GardenW | -2917.45 | 4882.425 | -0.60 | 0.553 | -12777.71 | 6942.807 |
| D_GardenZ | 5060.796 | 4953.698 | 1.02 | 0.313 | -4943.4 | 15064.99 |
| D_GardenZO | 9886.347 | 5264.845 | 1.88 | 0.068 | -746.2229 | 20518.92 |
| D_GardenZW | 2992.552 | 4739.242 | 0.63 | 0.531 | -6578.541 | 12563.65 |
| D_No_Garden | 6035.663 | 4675.937 | 1.29 | 0.204 | -3407.584 | 15478.91 |
| NFE_1 | 0 | (omitted) | | | | |
| NFE_2 | -147051.6 | 23571.16 | -6.24 | 0.000 | -194654.5 | -99448.7 |
| NFE_3 | -37293.95 | 22436.96 | -1.66 | 0.104 | -82606.32 | 8018.417 |
| NFE_4 | -106044.6 | 27055.07 | -3.92 | 0.000 | -160683.4 | -51405.78 |
| NFE_5 | -60458.39 | 26960.65 | -2.24 | 0.030 | -114906.5 | -6010.245 |
| NFE_6 | -44802.61 | 23138.03 | -1.94 | 0.060 | -91530.8 | 1925.582 |
| NFE_7 | -158115.7 | 25488.6 | -6.20 | 0.000 | -209590.9 | -106640.4 |
| NFE_8 | -221901.6 | 28200.77 | -7.87 | 0.000 | -278854.3 | -164949 |
| NFE_9 | -124026.3 | 26037.19 | -4.76 | 0.000 | -176609.4 | -71443.08 |
| NFE_10 | -81917.95 | 26609.16 | -3.08 | 0.004 | -135656.2 | -28179.66 |
| NFE_11 | -160335.8 | 28324.84 | -5.66 | 0.000 | -217539 | -103132.7 |
| NFE_12 | -193760.5 | 27707.61 | -6.99 | 0.000 | -249717.2 | -137803.9 |
| NFE_13 | -79879.99 | 22589.59 | -3.54 | 0.001 | -125500.6 | -34259.39 |
| NFE_14 | -188411.9 | 25251.01 | -7.46 | 0.000 | -239407.4 | -137416.5 |
| NFE_15 | -93252.65 | 15673.4 | -5.95 | 0.000 | -124905.7 | -61599.57 |
| NFE_16 | -186382.3 | 24370.3 | -7.65 | 0.000 | -235599.1 | -137165.4 |
| NFE_17 | -208428.5 | 24688.59 | -8.44 | 0.000 | -258288.1 | -158568.9 |
| NFE_18 | -196430.2 | 26491.86 | -7.41 | 0.000 | -249931.6 | -142928.8 |
| NFE_19 | -189711 | 29382.01 | -6.46 | 0.000 | -249049.1 | -130372.8 |
| NFE_20 | -208686.1 | 30917.45 | -6.75 | 0.000 | -271125.1 | -146247 |
| NFE_21 | -205262.6 | 31949.19 | -6.42 | 0.000 | -269785.3 | -140739.9 |
| NFE_22 | -183145.6 | 30151.59 | -6.07 | 0.000 | -244037.9 | -122253.2 |
| NFE_23 | -78619.25 | 30298.8 | -2.59 | 0.013 | -139808.9 | -17429.59 |
| NFE_24 | -185941.7 | 32769.78 | -5.67 | 0.000 | -252121.6 | -119761.8 |
| NFE_25 | -156155.4 | 32098.89 | -4.86 | 0.000 | -220980.4 | -91330.35 |
| NFE_26 | -167001.4 | 31449.39 | -5.31 | 0.000 | -230514.7 | -103488 |
| NFE_27 | -215960.1 | 33866.88 | -6.38 | 0.000 | -284355.7 | -147564.6 |
| NFE_28 | -149058.6 | 32530.4 | -4.58 | 0.000 | -214755.1 | -83362.1 |
| NFE_29 | -233196 | 33128.23 | -7.04 | 0.000 | -300099.8 | -166292.2 |
| NFE_30 | -236871.1 | 32378.19 | -7.32 | 0.000 | -302260.2 | -171482 |
| NFE_31 | -212426 | 31946.76 | -6.65 | 0.000 | -276943.8 | -147908.2 |
| NFE_32 | -204334.5 | 30349.64 | -6.73 | 0.000 | -265626.9 | -143042.2 |
| NFE_33 | -195485.5 | 28291.23 | -6.91 | 0.000 | -252620.8 | -138350.2 |
| NFE_34 | -202428.2 | 28769.53 | -7.04 | 0.000 | -260529.5 | -144327 |
| NFE_35 | -220047.8 | 32088.57 | -6.86 | 0.000 | -284852 | -155243.6 |
| NFE_36 | -252115.6 | 30879.23 | -8.16 | 0.000 | -314477.5 | -189753.8 |
| NFE_37 | -218017.7 | 30891.86 | -7.06 | 0.000 | -280405.1 | -155630.4 |
| NFE_38 | -200758.5 | 32063.06 | -6.26 | 0.000 | -265511.2 | -136005.8 |
| NFE_39 | -104937.3 | 27832.63 | -3.77 | 0.001 | -161146.5 | -48728.2 |
| NFE_40 | -206015.4 | 32857.92 | -6.27 | 0.000 | -272373.3 | -139657.5 |
| NFE_41 | -235862 | 20524.8 | -11.49 | 0.000 | -277312.7 | -194411.3 |
| NFE_42 | -223609.7 | 48852.44 | -4.58 | 0.000 | -322269.2 | -124950.2 |
| D_cohort_1 | -82848.06 | 28966.69 | -2.86 | 0.007 | -141347.5 | -24348.64 |
| D_cohort_2 | -50063.44 | 11037.23 | -4.54 | 0.000 | -72353.57 | -27773.31 |
| D_cohort_3 | -73295.32 | 9640.991 | -7.60 | 0.000 | -92765.69 | -53824.94 |
| D_cohort_4 | -79253.52 | 9101.321 | -8.71 | 0.000 | -97634.01 | -60873.03 |
| D_cohort_5 | -76133.65 | 9527.16 | -7.99 | 0.000 | -95374.14 | -56893.16 |
| D_cohort_6 | -78003.2 | 11168.21 | -6.98 | 0.000 | -100557.9 | -55448.54 |
| D_cohort_7 | -71164.91 | 11746.87 | -6.06 | 0.000 | -94888.19 | -47441.63 |
| D_cohort_8 | -51570.87 | 9960.798 | -5.18 | 0.000 | -71687.11 | -31454.63 |
| D_cohort_9 | -15834.97 | 3809.494 | -4.16 | 0.000 | -23528.4 | -8141.54 |
| plafondhoogte | 24453.84 | 4079.361 | 5.99 | 0.000 | 16215.41 | 32692.28 |
| nearroad_busy | -15724.58 | 4017.892 | -3.91 | 0.000 | -23838.88 | -7610.282 |
| sit_View | 7637.72 | 1654.425 | 4.62 | 0.000 | 4296.541 | 10978.9 |
| sit_Waterfront | 9257.954 | 7499.16 | 1.23 | 0.224 | -5886.908 | 24402.82 |
| sit_Woodlands | 7161.292 | 7871.481 | 0.91 | 0.368 | -8735.486 | 23058.07 |
| squaremeters | 1422.645 | 194.0353 | 7.33 | 0.000 | 1030.783 | 1814.507 |
| squaremeters2 | 1.292848 | .5349783 | 2.42 | 0.020 | .2124373 | 2.373259 |
| D_monument | 44159.32 | 19437.64 | 2.27 | 0.028 | 4904.202 | 83414.43 |
| D_monumental | 44388.39 | 12579.33 | 3.53 | 0.001 | 18983.92 | 69792.87 |
| balcony | 6411.964 | 2765.212 | 2.32 | 0.025 | 827.5051 | 11996.42 |
| rooms | -39.70674 | 1668.873 | -0.02 | 0.981 | -3410.065 | 3330.651 |
| perceel | 3.640003 | 1.913826 | 1.90 | 0.064 | -.2250479 | 7.505054 |
| perceel2 | -.0002651 | .000151 | -1.76 | 0.087 | -.00057 | .0000398 |
| Garden_acreage | 571.9509 | 93.53877 | 6.11 | 0.000 | 383.0456 | 760.8563 |
| Garden_acreage2 | -.4882844 | .2417152 | -2.02 | 0.050 | -.9764382 | -.0001306 |
| NEAR_DIST_MONUMENT | -28.56183 | 9.271399 | -3.08 | 0.004 | -47.2858 | -9.83786 |
| NEAR_DIST_OPRIT | 6.819334 | 6.858279 | 0.99 | 0.326 | -7.031242 | 20.66991 |
| NEAR_DIST_STADHUIS | -3.214536 | 5.363705 | -0.60 | 0.552 | -14.04676 | 7.617686 |
| NEAR_DIST_TREIN | 1.014102 | 7.297424 | 0.14 | 0.890 | -13.72335 | 15.75155 |
| REIS_DIST_ALLPARKS | -30.47451 | 9.022522 | -3.38 | 0.002 | -48.69586 | -12.25316 |
| REIS_DIST_ALLPARKS2 | .008302 | .0027076 | 3.07 | 0.004 | .0028338 | .0137701 |
| REIS_SIZE_ALLPARKS | 27.48765 | 27.73545 | 0.99 | 0.327 | -28.52523 | 83.50052 |
| sit_Parkside | 17704.63 | 6392.855 | 2.77 | 0.008 | 4794.001 | 30615.27 |
| _cons | 196648.7 | 41870.58 | 4.70 | 0.000 | 112089.4 | 281208.1 |

## Figure 12: Regression Utrecht inc d_parksize

```
. reg `y' `year' `WSFE' `GPFE' `BFE' `structural' `location' REIS_DIST_ALLPARKS REIS_DIST_ALLPARKS2 REIS_SIZE_AL
> LPARKS REIS_INTER_ALLPARKS sit_Parkside, cluster (buurt_ID)
note: BFE_74 omitted because of collinearity

Linear regression                               Number of obs     =     12,216
                                                F(56, 89)         =          .
                                                Prob > F          =          .
                                                R-squared         =     0.7713
                                                Root MSE          =      56777

                                  (Std. Err. adjusted for 90 clusters in buurt_ID)
```

| Transaction_price | Coef. | Robust Std. Err. | t | P>\|t\| | [95% Conf. | Interval] |
|---|---|---|---|---|---|---|
| year2005 | 12388.75 | 1746.238 | 7.09 | 0.000 | 8919.016 | 15858.49 |
| year2006 | 26640.82 | 2395.877 | 11.12 | 0.000 | 21880.26 | 31401.38 |
| D_WS_Eenvoudige_woning | -8891.847 | 2657.363 | -3.35 | 0.001 | -14171.97 | -3611.724 |
| D_WS_Woonboot | 35594.78 | 37465.19 | 0.95 | 0.345 | -38847.76 | 110037.3 |
| D_WS_Grachtenpand | 63047.91 | 44626.93 | 1.41 | 0.161 | -25624.84 | 151720.7 |
| D_WS_Herenhuis | 38502.04 | 8023.978 | 4.80 | 0.000 | 22558.56 | 54445.51 |
| D_WS_Woonboerderij | -23759.39 | 48344.34 | -0.49 | 0.624 | -119818.6 | 72299.78 |
| D_WS_Bungalow | 105443.5 | 43253.53 | 2.44 | 0.017 | 19499.69 | 191387.4 |
| D_WS_Villa | 112608.6 | 13866.94 | 8.12 | 0.000 | 85055.25 | 140161.9 |
| D_WS_Landhuis | 336664.6 | 87185.73 | 3.86 | 0.000 | 163428.4 | 509900.8 |
| D_WS_Benedenwoning | 3405.822 | 2730.69 | 1.25 | 0.216 | -2020.001 | 8831.646 |
| D_WS_Bovenwoning | -9243.245 | 2743.58 | -3.37 | 0.001 | -14694.68 | -3791.81 |
| D_WS_Maisonette | -375.8953 | 7766.997 | -0.05 | 0.962 | -15808.75 | 15056.96 |
| D_WS_Portiekflat | 6639.205 | 3589.297 | 1.85 | 0.068 | -492.6517 | 13771.06 |
| D_WS_Galerijflat | 382.4658 | 5314.227 | 0.07 | 0.943 | -10176.79 | 10941.72 |
| D_WS_Verzorgingsflat | -5998.558 | 7060.278 | -0.85 | 0.398 | -20027.18 | 8030.065 |
| D_WS_Benedenbovenwoning | -28678.99 | 12003.25 | -2.39 | 0.019 | -52529.19 | -4828.8 |
| D_GardenN | -4749.704 | 2437.812 | -1.95 | 0.055 | -9593.585 | 94.17685 |
| D_GardenNW | 1477.423 | 2404.906 | 0.61 | 0.541 | -3301.073 | 6255.919 |
| D_GardenO | -4861.455 | 2426.053 | -2.00 | 0.048 | -9681.971 | -40.93887 |
| D_GardenW | 2021.329 | 3098.998 | 0.65 | 0.516 | -4136.315 | 8178.973 |
| D_GardenZ | -1128.248 | 2826.51 | -0.40 | 0.691 | -6744.463 | 4487.968 |
| D_GardenZO | 6397.201 | 4223.025 | 1.51 | 0.133 | -1993.86 | 14788.26 |
| D_GardenZW | 6002.914 | 3908.542 | 1.54 | 0.128 | -1763.276 | 13769.1 |
| D_No_Garden | 2943.202 | 2460.526 | 1.20 | 0.235 | -1945.811 | 7832.215 |
| BFE_1 | 58777.72 | 12817.71 | 4.59 | 0.000 | 33309.21 | 84246.23 |
| BFE_10 | -24003.12 | 45590.38 | -0.53 | 0.600 | -114590.2 | 66583.99 |
| BFE_11 | 72423.96 | 13147.67 | 5.51 | 0.000 | 46299.81 | 98548.1 |
| BFE_12 | 62510.84 | 13673.59 | 4.57 | 0.000 | 35341.72 | 89679.97 |
| BFE_13 | 45286.62 | 13869.28 | 3.27 | 0.002 | 17728.66 | 72844.58 |
| BFE_14 | 54027.65 | 12905.25 | 4.19 | 0.000 | 28385.2 | 79670.1 |
| BFE_15 | 45037.44 | 12640.82 | 3.56 | 0.001 | 19920.4 | 70154.47 |
| BFE_16 | 23009.58 | 13655.47 | 1.69 | 0.095 | -4123.551 | 50142.71 |
| BFE_17 | 34642.56 | 13181.38 | 2.63 | 0.010 | 8451.434 | 60833.69 |
| BFE_18 | 43308.92 | 14308.94 | 3.03 | 0.003 | 14877.36 | 71740.48 |
| BFE_19 | 33449.28 | 14698.28 | 2.28 | 0.025 | 4244.114 | 62654.45 |
| BFE_2 | 119945.5 | 12314.27 | 9.74 | 0.000 | 95477.33 | 144413.7 |
| BFE_20 | 35197.35 | 13813.47 | 2.55 | 0.013 | 7750.273 | 62644.43 |
| BFE_21 | 41071.41 | 13797.44 | 2.98 | 0.004 | 13656.19 | 68486.62 |
| BFE_22 | 52333.02 | 15251.16 | 3.43 | 0.001 | 22029.3 | 82636.75 |
| BFE_23 | 27163.09 | 12974.67 | 2.09 | 0.039 | 1382.695 | 52943.49 |
| BFE_24 | 40852.22 | 13914.71 | 2.94 | 0.004 | 13203.99 | 68500.45 |
| BFE_25 | 42643.02 | 15449.1 | 2.76 | 0.007 | 11945.99 | 73340.05 |
| BFE_26 | 34118.66 | 14378.43 | 2.37 | 0.020 | 5549.018 | 62688.3 |
| BFE_27 | 33119.52 | 13906.73 | 2.38 | 0.019 | 5487.149 | 60751.89 |
| BFE_28 | 25087 | 19063.05 | 1.32 | 0.192 | -12790.87 | 62964.86 |
| BFE_29 | 5505.036 | 19857.65 | 0.28 | 0.782 | -33951.7 | 44961.77 |
| BFE_3 | 83069.26 | 12516.22 | 6.64 | 0.000 | 58199.8 | 107938.7 |
| BFE_30 | 8136.676 | 20909.07 | 0.39 | 0.698 | -33409.2 | 49682.55 |
| BFE_31 | 124039.7 | 38261.99 | 3.24 | 0.002 | 48013.93 | 200065.5 |
| BFE_32 | 120264.7 | 11261.8 | 10.68 | 0.000 | 97887.72 | 142641.6 |
| BFE_33 | 83495.37 | 12088.84 | 6.91 | 0.000 | 59475.11 | 107515.6 |
| BFE_34 | 94288.26 | 12305.94 | 7.66 | 0.000 | 69836.61 | 118739.9 |
| BFE_35 | 82768.47 | 11453.88 | 7.23 | 0.000 | 60009.85 | 105527.1 |
| BFE_36 | 91012.24 | 11210.12 | 8.12 | 0.000 | 68737.97 | 113286.5 |
| BFE_37 | 140671.6 | 11834.48 | 11.89 | 0.000 | 117156.8 | 164186.5 |
| BFE_38 | 85642.1 | 12561.5 | 6.82 | 0.000 | 60682.66 | 110601.5 |
| BFE_39 | 101157.6 | 10892.44 | 9.29 | 0.000 | 79514.6 | 122800.7 |
| BFE_4 | 67170.21 | 12079.17 | 5.56 | 0.000 | 43169.16 | 91171.25 |
| BFE_40 | 113887 | 11666.37 | 9.76 | 0.000 | 90706.19 | 137067.9 |
| BFE_41 | 108315.2 | 10688.62 | 10.13 | 0.000 | 87077.13 | 129553.2 |
| BFE_42 | 74420.65 | 13529.14 | 5.50 | 0.000 | 47538.54 | 101302.8 |
| BFE_43 | 108557.3 | 10729.92 | 10.12 | 0.000 | 87237.23 | 129877.5 |
| BFE_44 | 76734.18 | 11488.44 | 6.68 | 0.000 | 53906.9 | 99561.46 |
| BFE_45 | 87260.96 | 12848.37 | 6.79 | 0.000 | 61731.53 | 112790.4 |
| BFE_46 | 67912.32 | 10961.11 | 6.20 | 0.000 | 46132.83 | 89691.81 |
| BFE_47 | 63842.02 | 11073.9 | 5.77 | 0.000 | 41838.42 | 85845.62 |
| BFE_48 | 75783.01 | 13049.79 | 5.81 | 0.000 | 49853.35 | 101712.7 |
| BFE_49 | 116609.1 | 12223.15 | 9.54 | 0.000 | 92321.94 | 140896.2 |
| BFE_5 | 62734.63 | 11782.37 | 5.32 | 0.000 | 39323.32 | 86145.93 |
| BFE_50 | 82334.2 | 11474.61 | 7.18 | 0.000 | 59534.4 | 105134 |
| BFE_51 | 99594.49 | 11293.54 | 8.82 | 0.000 | 77154.47 | 122034.5 |
| BFE_52 | 190939.8 | 13280.34 | 14.38 | 0.000 | 164552.1 | 217327.6 |
| BFE_53 | 131220.5 | 13780.5 | 9.52 | 0.000 | 103839 | 158602.1 |
| BFE_54 | 33694.33 | 22465.56 | 1.50 | 0.137 | -10944.27 | 78332.92 |
| BFE_55 | 74763.18 | 13633.67 | 5.48 | 0.000 | 47673.37 | 101853 |
| BFE_56 | 92011.56 | 11804.28 | 7.79 | 0.000 | 68556.71 | 115466.4 |
| BFE_57 | 135655.8 | 15691.65 | 8.65 | 0.000 | 104476.8 | 166834.8 |
| BFE_58 | 134032.5 | 12411.42 | 10.80 | 0.000 | 109371.2 | 158693.7 |
| BFE_59 | 132976.8 | 11572.66 | 11.49 | 0.000 | 109982.2 | 155971.5 |
| BFE_6 | 69405.64 | 11376.94 | 6.10 | 0.000 | 46799.91 | 92011.37 |
| BFE_60 | 119639.4 | 14302.84 | 8.36 | 0.000 | 91219.99 | 148058.9 |
| BFE_61 | 134239.2 | 13099.41 | 10.25 | 0.000 | 108211 | 160267.5 |
| BFE_62 | 141983.2 | 12804.73 | 11.09 | 0.000 | 116540.5 | 167425.9 |
| BFE_63 | 71336.51 | 12345.93 | 5.78 | 0.000 | 46805.42 | 95867.6 |
| BFE_64 | 89521.19 | 17361.58 | 5.16 | 0.000 | 55024.1 | 124018.3 |
| BFE_65 | 68320.18 | 15912.8 | 4.29 | 0.000 | 36701.8 | 99938.57 |
| BFE_66 | 43463.93 | 13614.18 | 3.19 | 0.002 | 16412.85 | 70515.01 |
| BFE_67 | 48105.56 | 13526.69 | 3.56 | 0.001 | 21228.31 | 74982.81 |
| BFE_68 | 36292.29 | 11267.17 | 3.22 | 0.002 | 13904.66 | 58679.92 |
| BFE_69 | 62102.9 | 11711.24 | 5.30 | 0.000 | 38832.92 | 85372.88 |
| BFE_7 | 52941.24 | 11943.54 | 4.43 | 0.000 | 29209.68 | 76672.79 |
| BFE_70 | 50835.92 | 12187.57 | 4.17 | 0.000 | 26619.48 | 75052.35 |
| BFE_71 | 44951.31 | 11583.41 | 3.88 | 0.000 | 21935.33 | 67967.3 |
| BFE_72 | 66712.73 | 11533.89 | 5.78 | 0.000 | 43795.14 | 89630.32 |
| BFE_73 | 68931.19 | 10221 | 6.74 | 0.000 | 48622.28 | 89240.1 |
| BFE_74 | 0 | (omitted) | | | | |
| BFE_75 | 53077.45 | 12174.73 | 4.36 | 0.000 | 28886.52 | 77268.38 |
| BFE_76 | 48305.06 | 13105.93 | 3.69 | 0.000 | 22263.87 | 74346.26 |
| BFE_77 | 45351.76 | 15313.94 | 2.96 | 0.004 | 14923.29 | 75780.22 |
| BFE_78 | 41039.85 | 13890.42 | 2.95 | 0.004 | 13439.88 | 68639.82 |
| BFE_79 | 21257.24 | 17651.62 | 1.20 | 0.232 | -13816.14 | 56330.63 |
| BFE_8 | 60776.04 | 12225.83 | 4.97 | 0.000 | 36483.59 | 85068.5 |
| BFE_80 | 14349.69 | 13863.53 | 1.04 | 0.303 | -13196.85 | 41896.24 |
| BFE_81 | 37175.14 | 14598.75 | 2.55 | 0.013 | 8167.74 | 66182.54 |
| BFE_82 | 103801.5 | 29766.41 | 3.49 | 0.001 | 44656.33 | 162946.8 |
| BFE_83 | 71872.48 | 34730.59 | 2.07 | 0.041 | 2863.546 | 140881.4 |
| BFE_84 | 34759.39 | 20560.69 | 1.69 | 0.094 | -6094.277 | 75613.05 |
| BFE_85 | 79911.28 | 22853.2 | 3.50 | 0.001 | 34502.45 | 125320.1 |
| BFE_86 | 25838.7 | 20652.11 | 1.25 | 0.214 | -15196.59 | 66874 |
| BFE_87 | 23245.76 | 18686.71 | 1.24 | 0.217 | -13884.34 | 60375.85 |
| BFE_88 | 44766.55 | 17289.82 | 2.59 | 0.011 | 10412.04 | 79121.05 |
| BFE_89 | 118429.6 | 17761.71 | 6.67 | 0.000 | 83137.46 | 153721.7 |
| BFE_9 | 35062.63 | 13943.95 | 2.51 | 0.014 | 7356.308 | 62768.95 |
| BFE_90 | 178924.3 | 36790.48 | 4.86 | 0.000 | 105822.4 | 252026.2 |
| D_cohort_1 | 34225.58 | 23380.9 | 1.46 | 0.147 | -12231.77 | 80682.94 |
| D_cohort_2 | -15696.84 | 6701.152 | -2.34 | 0.021 | -29011.89 | -2381.796 |
| D_cohort_3 | -20767.41 | 7063.139 | -2.94 | 0.004 | -34801.72 | -6733.1 |
| D_cohort_4 | -21195.54 | 7943.469 | -2.67 | 0.009 | -36979.04 | -5412.038 |
| D_cohort_5 | -38629.9 | 5983.02 | -6.46 | 0.000 | -50518.03 | -26741.77 |
| D_cohort_6 | -41716.3 | 7294.301 | -5.72 | 0.000 | -56209.92 | -27222.68 |
| D_cohort_7 | -43295.82 | 6360.258 | -6.81 | 0.000 | -55933.52 | -30658.12 |
| D_cohort_8 | -25964.88 | 6807.387 | -3.81 | 0.000 | -39491.02 | -12438.75 |
| D_cohort_9 | -12575.29 | 4483.429 | -2.80 | 0.006 | -21483.77 | -3666.816 |
| plafondhoogte | 30987.05 | 3549.742 | 8.73 | 0.000 | 23933.79 | 38040.31 |
| nearroad_busy | -7508.314 | 3033.888 | -2.47 | 0.015 | -13536.59 | -1480.042 |
| sit_View | 2892.184 | 1466.319 | 1.97 | 0.052 | -21.35992 | 5805.728 |
| sit_Waterfront | 17642.7 | 3160.673 | 5.58 | 0.000 | 11362.51 | 23922.89 |
| sit_Woodlands | 32279.49 | 19648.13 | 1.64 | 0.104 | -6760.929 | 71319.91 |
| squaremeters | 1423.405 | 279.558 | 5.09 | 0.000 | 867.9293 | 1978.881 |
| squaremeters2 | 1.225383 | 1.03055 | 1.19 | 0.238 | -.822298 | 3.273064 |
| D_monument | 11598.25 | 7783.572 | 1.49 | 0.140 | -3867.537 | 27064.05 |
| D_monumental | 14094.08 | 9931.97 | 1.42 | 0.159 | -5640.533 | 33828.69 |
| balcony | 5914.724 | 2351.85 | 2.51 | 0.014 | 1241.648 | 10587.8 |
| rooms | 2241.914 | 962.204 | 2.33 | 0.022 | 330.0354 | 4153.793 |
| perceel | 11.65165 | 4.114503 | 2.83 | 0.006 | 3.47622 | 19.82708 |
| perceel2 | -.0008805 | .0003924 | -2.24 | 0.027 | -.0016602 | -.0001008 |
| Garden_acreage | 291.0037 | 36.49365 | 7.97 | 0.000 | 218.4916 | 363.5158 |
| Garden_acreage2 | -.1199887 | .0244198 | -4.91 | 0.000 | -.1685103 | -.071467 |
| NEAR_DIST_MONUMENT | -13.87123 | 7.862375 | -1.76 | 0.081 | -29.4936 | 1.751147 |
| NEAR_DIST_OPRIT | 2.868764 | 5.618709 | 0.51 | 0.611 | -8.295491 | 14.03302 |
| NEAR_DIST_STADHUIS | .9985625 | 3.028931 | 0.33 | 0.742 | -5.019858 | 7.016983 |
| NEAR_DIST_TREIN | -2.100798 | 5.399021 | -0.39 | 0.698 | -12.82854 | 8.626941 |
| REIS_DIST_ALLPARKS | -26.10484 | 11.51008 | -2.27 | 0.026 | -48.97511 | -3.234559 |
| REIS_DIST_ALLPARKS2 | .0165208 | .0079408 | 2.08 | 0.040 | .0007426 | .032299 |
| REIS_SIZE_ALLPARKS | 525.1707 | 210.6869 | 2.49 | 0.015 | 106.5404 | 943.8011 |
| REIS_INTER_ALLPARKS | -.3534686 | .1312817 | -2.69 | 0.008 | -.6143226 | -.0926146 |
| sit_Parkside | 9986.537 | 4924.471 | 2.03 | 0.046 | 201.7184 | 19771.36 |
| _cons | -102908.6 | 27136.57 | -3.79 | 0.000 | -156828.4 | -48988.85 |

Correlation residuals & explanatory variables Utrecht (after figure 8, instead of NFE, BFE is used)

```
. corr REIS_DIST_ALLPARKS REIS_DIST_ALLPARKS2 REIS_SIZE_ALLPARKS REIS_INTER_ALLPARKS residuals
(obs=12,216)

             | REIS_D~S REIS_D.. REIS_S~S REIS_I~S residu~s
-------------+---------------------------------------------
REIS_DIST_~S |   1.0000
REIS_DIST~S2 |   0.9456   1.0000
REIS_SIZE_~S |   0.3791   0.3762   1.0000
REIS_INTER~S |   0.6002   0.6292   0.9030   1.0000
   residuals |   0.0845   0.1126   0.0918   0.1057   1.0000
```

Correlation residuals & explanatory variables The Hague (after figure 9)

```
. corr REIS_DIST_ALLPARKS REIS_DIST_ALLPARKS2 REIS_SIZE_ALLPARKS REIS_INTER_ALLPARKS residuals
(obs=17,657)

             | REIS_D~S REIS_D.. REIS_S~S REIS_I~S residu~s
-------------+---------------------------------------------
REIS_DIST_~S |   1.0000
REIS_DIST~S2 |   0.9161   1.0000
REIS_SIZE_~S |  -0.1261  -0.1469   1.0000
REIS_INTER~S |   0.3432   0.1719   0.7314   1.0000
   residuals |  -0.0048   0.0588  -0.0090  -0.0857   1.0000
```

# About Ecorys

Ecorys is a leading international research and consultancy company, addressing society's key challenges. With world-class research-based consultancy, we help public and private clients make and implement informed decisions leading to positive impact on society. We support our clients with sound analysis and inspiring ideas, practical solutions and delivery of projects for complex market, policy and management issues.

In 1929, businessmen from what is now Erasmus University Rotterdam founded the Netherlands Economic Institute (NEI). Its goal was to bridge the opposing worlds of economic research and business – in 2000, this much respected Institute became Ecorys.

Throughout the years, Ecorys expanded across the globe, with offices in Europe, Africa, the Middle East and Asia. Our staff originates from many different cultural backgrounds and areas of expertise because we believe in the power that different perspectives bring to our organisation and our clients.

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- Economic growth;
- Social policy;
- Natural resources;
- Regions & Cities;
- Transport & Infrastructure;
- Public sector reform;
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- programme management;
- communications;
- capacity building;
- monitoring and evaluation.

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