The effect of park related urban renewal projects on the prices of surrounding houses in six Dutch cities

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Abstract.

This thesis studies the external effects of 13 Dutch park renovations. Park renovations are mostly financed using public money and aim to implement nature into cities, make cities more beautiful and increase land prices. This thesis uses a hedonic regression method and a difference-in-difference method to analyse if park related urban renewal projects have an external effect on surrounding house prices. The difference-in-difference method distinguishes between the time during the renovation and after the renovation and controls for a control group. Using the hedonic regression method, a positive external effect of park renovations on house prices is found. When distinguishing between park attributes positive effects of playground renovation and trail renovation are found and negative effects of playground replacement, court renovation, new lights and field renovation are found. Contrary, to the results of the hedonic regression when measuring renovation as a single measure, the difference-in-difference method finds a negative external effect on house prices of houses within 1500 metres from the project after the completion. This negative effect is 0 at around 650 metres from the park. By using the Chow test and by running the models again for large and small parks new results are found. For both methods large parks have positive external effects, whereas small parks have negative external effect.

Keywords: House prices, external effects, park renovations, regression, difference-in-difference

1. INTRODUCTION

1.1. Motivation

Urban renewal, urban regeneration or urban revitalization in general, are terms for processes of redevelopment in urban areas. Urban renewal often happens at places with urban decay (HUD, 2017). One of the characteristics of urban renewal projects is that they aim to increase the quality of a wider area than the development site itself. In the 60's, the Dutch government studied the living conditions of residential areas and compared neighbourhoods with each other. It concluded that neighbourhoods built before and just after the war were of lower quality than the neighbourhoods built at the time of the study (Ministry of VROM, 2002). In these lower quality neighbourhoods, crime rates were higher compared with other neighbourhoods (Ministry of VROM, 2002). This resulted in investments by the Dutch government in residential areas. Society benefits from these urban renewal projects, because housing quality improves, crime rates decline and neighbourhoods become more attractive (Schuiling, 2007). According to the Ministry of VROM (2002) this resulted in many urban renewal projects where the quality of life, as well as the quality of houses and surroundings increased. In 1985 19% of all residential units belonged to the category poor houses. In 2000 this percentage dropped to 1% (Ministry of VROM, 2002). Urban renewal projects do not only focus on the improvement of residential areas, but can also be a project for old industry areas or old railway zones (Ruimte met toekomst, 2013). Examples of urban renewal projects of old industrial areas are the Oostelijk Havengebied in Amsterdam (Derksen, 2013) or the stadhavens in Rotterdam (Rijksoverheid, 2017). The urban renewal project in Tilburg is a good example of an urban renewal project in railway zone (Spoorzone013, 2016).

Another example of a type of urban renewal are park related urban renewal projects. Parks in the urban area are an old phenomenon. The Birkenhead Park in Liverpool, built in 1843, is considered as the first park in a city and the Vondelpark in Amsterdam, built in 1865, is the oldest Dutch park (Wijsen, 2002). In reaction to the industrial revolution, cities had three reasons to build parks. The first one is to implement nature in cities. The second is to increase prices of nearby properties by increasing land prices and the third is city beautification (Wijsen, 2002). Between the time of creation of parks and the 80's, parks were deteriorating. The increasing car ownership, resulting in more people moving out of the city to see nature and lack of maintenance from governments made parks less popular. At the end of the 80's parks are back on the political agenda. This resulted in urban renewal projects of parks (Wijsen, 2002). The renovation of parks is still on the political agenda these days (Wijsen, 2002). These renewal projects aimed for the same three original aims when building a park in the first place (Wijsen, 2002). Recent studies by municipalities show that parks are getting more popular (Bakker, 2014, Remmers, 2013). It is not only a place to walk around on a Sunday afternoon, but it has become a place to meet others, to work and to sport. According to Bakker (2014) recent urban renewal projects of parks created more open and saver park. This, in combination with the opening of small restaurants or grand cafes in parks, makes parks more popular. A good example of increasing popularity after a park related urban renewal project is the Vondelpark in Amsterdam, where 89% of the inhabitants of Amsterdam visited the park in 2008, compared with 58% in 1996 (Bakker, 2014; Municipality of Amsterdam, 2008).

Park related urban renewal projects are a type of urban renewal. Firstly, because the park developments lie within the urban area and are therefore urban. Second, they are a renewal project, because the park is renewed. The difference between a renewal project and maintenance work lies in the fact that a renewal projects tries to improve the quality of a wider area than the side itself. This way, park related urban renewal projects are classified as a type of urban renewal. All park related urban renewal projects have in common that the whole park is redeveloped. In most cases, this redevelopment results in a new lay out of the park, with new paths, green spaces and trees. Testing whether park related urban renewal projects improves its surrounding, is an interesting study object. A second reason to study park related urban renewal projects is about money. These projects are public projects financed by the government (De Heer, 2010; Municipality of Amsterdam, 2018). These projects are, mostly, financed by the municipality. For certain exceptions, external parties also contribute to the financing. For example, when cultural heritage is involved the Cultural Heritage Agency (Rijksdienst voor Cultureel Erfgoed) may contribute (Municipality of Amsterdam, 2018). From a national perspective, no policy related to urban parks exists which applies to all municipalities. Park related urban renewal projects can be expansive, for example the Vondelpark project (which is the largest project) costs around 29,6 million euros (Municipality of Amsterdam, 2018). By studying the external effects of park related urban renewal projects, it is tested if this money is wisely spent. A third reason to study external effect of park related urban renewal projects is because society is supposed to benefit from these projects. But information about if this is really the case is missing. Although it seems that the popularity of parks has been increasing in the Netherlands, this does not necessarily mean that households want to pay more to live in close proximity to a park.

1.2 Academic relevance

The effect of urban renewal projects is mostly studied by looking at house prices (Bäing & Wong, 2012; Chau & Wong, 2014; Rossi-Hansberg et al., 2010). House prices are used because they are a good indicator of the housing market performance (Bäing & Wong, 2012). Since houses are immobile and durable, its price can be used as an indirect measure of its quality and the quality of its surrounding (Chau & Wong, 2014). Furthermore, Rossi-Hansberg et al. (2010) argue that the price of the house reflects a variety of nonmarket interactions between houses, residents and the location. Nonmarket interactions are the quality of the surrounding houses, green areas, streets and other location specific characteristics. A change in one of these nonmarket interactions will lead to a change in the house price, which can be measured and used for analyses (Rossi-Hansberg et al., 2010). Therefore, house prices are a good indicator to measure the effects of urban renewal projects.

The effects of urban renewal projects on surroundings are studied by multiple academics. Mostly, the results they find are positive. So does Kauko (2009) finds that urban renewal projects in Budapest and Amsterdam have a positive effect on house prices. Also, Van Duijn et al. (2016) find evidence for positive effects of redevelopment of cultural heritage on house prices after the project is finished. Koster and Van Ommeren (2017) find that urban renewal projects in 83 Dutch neighbourhoods increase the price with 3,5%. Moreover, Rossi-Hansberg et al. (2010) also find positive external effects. In their study about urban renewal programs in Richmond, Virginia they find that over a 6-year period every dollar of home improvement generates between $2 and $6 for the surrounding land value. But, not all results are positive. For example, Chau and Wong (2014) find that the price of properties just outside the project area decrease, because these surrounding properties are excluded from the project. These properties do not benefit from the scale effect of being redeveloped with the urban redevelopment project (Chau & Wong, 2014).

Based on the academic knowledge provided above, a research gap can be identified. So far academic literature focussed on the effect of urban renewal projects in residential areas (Chau & Wong, 2014; Koster & Van Ommeren, 2017; Rossi-Hansberg et al., 2010), or industrial areas (Van Duijn et al., 2016). Little attention has been paid to the effect of urban renewal projects related to parks and green areas and their influence on house prices. Previous studies about parks and green areas focussed on the effect of a proximity on house prices and the value of parks (for example Anderson & West., 2006; Bolitzer & Netusil, 2000; Daams et al., 2016) and not so much on the effect of park related urban renewal projects. Livy and Klaiber (2016) study the effects of park renovations on house price in Baltimore County, US by calculating the capitalized value. They find a statistically negative effect of park renovations and house prices and also differentiate by park attributes. This thesis is different from the paper written by Livy and Klaiber (2016) in different ways. First, this paper focusses on Dutch parks, whereas their paper focusses about Baltimore County, Maryland. Second, this thesis studies the topic with the same method as Livy and Klaiber (2016) did, but also with another method. Livy and Klaiber (2016) used a hedonic regression model and a repeat sales method, whereas this thesis uses a hedonic regression model, as well as a difference-in-difference model. The difference-in-difference model is a version of the hedonic model. The advantages and disadvantages of both methods are discussed in chapter 3.

1.3 Research problem statement

Little is known about the effects of park related urban renewal projects on the surrounding area in The Netherlands. Therefore, the aim of this study is to investigate the effect of park related urban renewal projects on house prices of surrounding properties. This aim leads to the following central research

question: *What is the effect of park related urban renewal projects on house prices of surrounding properties?*
This central research question is subdivided into the following sub questions:

- *What are the external effects of urban renewal projects on house prices of other projects?*

This question is answered by literature. In the literature review of the introduction the most important academic results related to urban renewal projects are shortly mentioned. To answer this first sub question, more research is performed about the methods previous academics used and under which circumstances their findings hold. To answer this question, literature is found about urban renewal, urban regeneration, urban revitalization, place based investment, redevelopment and city centre investment, green area value and park value on academic sources google scholar and EBSCOHOST.

- *What is the effect of park related urban renewal projects on house prices of surrounding properties in Amsterdam, The Hague, Utrecht, Almere, Nijmegen and Arnhem?*

For the projects it must be taken into account that data on house prices must be available before and after the renewal project. So, the project must be finished for a couple of years. Therefore, projects which started and finished between 1999 and 2011 are selected. Also, enough cases must be presented to be able to do statistical analyses. It is expected no document is present with information about all projects in the Netherlands. So, the case studies have to be selected manually. This is done by systematically investigating if there was an urban renewal project between 1999 and 2011, starting with the biggest cities (number of inhabitants) and moving to the smaller cities.

Only projects in cities bigger than 150.000 inhabitants are qualified. First of all because park related urban renewal projects mostly happened in bigger cities (Wijsen, 2002). Second, for smaller cities it is more likely that they have more nature just outside the city. Because of scarcity, nature in bigger cities could be higher appreciated compared with smaller cities and therefore the effect on house prices could be larger in bigger cities. This idea is supported by Daams et al. (2016), who find that the price effect of natural space is higher in urban areas compared with less urban areas, due to more scarcity of natural spaces in more urbanised areas (Brander & Koetse, 2011). Third, enough transactions must have taken place in order to perform statistical analysis. By looking at bigger cities the change of getting too little transactions is minimised. Based on this, 13 park related urban renewal projects are identified in six different cities: Amsterdam, The Hague, Utrecht, Almere, Nijmegen and Arnhem. The projects are listed in the appendix A1.

Data about house prices is asked from and provided by the NVM.

To measure the effect, a hedonic regression method and a difference-in-difference method is used. The hedonic regression method regresses house prices as the dependent variable and the renovation of the park as independent variable, together with certain control variables. The difference-in-difference method uses two periods, one before and one after the project, and two groups (target group and control group). The target group consists of all NVM transactions within proximity to the project. The control group consists of all NVM transactions within a ring around the target group. This study must investigate how big the target group ring and the control group ring must be. Based on these two groups a difference-in-difference method can be used. To determine what can be defined as close to the project, the distance decay is calculated. The difference-in-difference method is used to test if the external effects diminish over space, as literature suggests (Van Duijn et al., 2016; Rossi-Hansberg et al., 2010).

- *What is the difference in effect between large parks and small parks?*

This question looks at subgroups, based on the size of the park. The sub question before assumed that the park related urban renewal projects are homogeneous, that each project can be seen in the same way as another project. This assumption does not hold in practice, because each project is different and has its own characteristics. This sub question splits the dataset in two based on size of the park, assuming that the projects are less homogeneous than assumed before. It may be that the results found are driven by larger park, because it might be that bigger parks get more attention or are more important to policy makers and citizens. This question is answered with the same dataset and a hedonic regression method and a difference-in-difference method. To answer this question, the Chow test is used. By using the Chow test, the robustness of the model is tested (Chow, 1960; Brooks & Tsolacos, 2010).

The remainder of this paper is organized as follows. Section 2 describes the existing theory and section 3 the empirical approach and data. Section 4 presents the results and section 5 concludes and discuss the theses.

2. THEORY

This chapter performs a literature review. It discusses relevant literature resulting in literature based hypotheses. Furthermore, this chapter tries to find an answer to the first sub question: *What are the external effects of urban renewal projects on house prices of other projects?* The outline of this chapter is in line with the regression formulas, which will be presented in the next chapter. This chapter is outlined as follows: it starts with the dependent variable in de regressions, which is the house price. Secondly, the basis of urban renewal is discussed and the influence of urban renal projects on house prices. After that the core of this thesis, the effects of park related urban renewal projects, is discussed. The chapter ends with a discussion of the control variables of the regressions.

2.1 House prices

When studying external effects of urban renewal projects, academics mostly use house prices as a proxy for the measured external effect (Bäing & Wong, 2012; Chau & Wong, 2014; Rossi-Hansberg et al., 2010). Houses are immobile and durable, therefore its price can be used as an indirect measure of its quality and the quality of its surrounding (Chau & Wong, 2014). This argument will not hold completely, because houses can be moved and, more likely, houses can be broken down. However, it is assumed that this argument is valid to a certain extend. Moreover, Rossi-Hansberg et al. (2010) argue that the price of the house reflects a variety of nonmarket interactions between houses, residents and the location. Nonmarket interactions are the quality of the surrounding houses, green areas, streets and other location specific characteristics. A change in one of these nonmarket interactions will lead to a change in price, which can be measured and used for analyses (Rossi-Hansberg et al., 2010). Therefore, an external effect in the surrounding of a property, keeping everything else constant, is measurable by looking at house prices.

When looking at house price determinants, the distinction between macro and micro can be made. On the macro level, house prices are determined by demand and supply (Evans, 2004) in a completely efficient market. In an efficient market all the information is available to sellers and buyers, the market is big and the product is homogeneous. The demand side is driven by fundamentals like household wealth, population growth, inflation, credit availability, interest rates and unemployment (Algieri, 2013; Oestermann & Bennohr, 2015). The supply side is more fixed because of the shortage of land for houses and the time needed to construct new houses (Hornstein, 2009; Algieri, 2013). Therefore, house prices are largely demand driven, especially in the short run (Hornstein, 2009). These external influences on both demand and supply can generate shocks which influences the housing market. An example of an external shock is the great financial crisis of 2007-2009 (Rots, 2017). Over time, house prices follow an asymmetric business cycle pattern (Defrénot& Malik, 2012; Canepa & Chini, 2016). Price increase at an exponential rate during expansion periods but decrease at a logarithmic rate (Canepa & Chini, 2016).

The property market however, is not a completely efficient market as described above (Evans, 2004). Micro determinants create an inefficient market. Firstly, not all information is available to sellers and buyers. Both parties do not know the price at which the property will sell. So, both parties have to search the market to acquire information. Information can be obtained from experts or from own experience. The information gathered is different for every party and cannot contain all information there is. This information will determine the price asked by sellers or the price offered by the buyers. After the determination of the price by sellers and buyers, both parties determine their strategy. A seller might ask a higher price than the expected price to wait and see. Or a seller might ask a lower price than the expected price hoping for higher offers (Evans, 2004). Buyers have to determine at what price they bid. Second, the heterogeneity of the properties creates an inefficient market (Evans, 2004). The housing market is not a homogeneous market, since no property is exactly the same as another one. One reason is that houses are fixed on a location. This difference in location may cause a different price for two identical houses on all other aspects. Next to that, in order to determine the price of a property the prices of the characteristics of the house must be determined. The different location and the different characteristics of houses creates a heterogeneous market instead of a homogeneous market (Evans, 2004).

2.2 Urban renewal

Place based policies are governmental policies for a specific place (Koster & Van Ommeren, 2016). Place based policies could be active to a wide variety of fields, for example place-based labour market programs or place-based housing policies (Koster & Van Ommeren, 2016). A neighbourhood is an environment where people interact with each other and with the environment. If all properties are maintained well, everyone would benefit of the external effects of all these well maintained properties. When some residents do not maintain their property, the neighbourhood could deteriorate. One solution for this problem of deteriorating neighbourhoods is governmental intervention to initiate urban renewal (Chau & Wong, 2013). Lee et al. (2017) note that urban renewal projects "*are carried out in the context of urban planning to promote the sustainable use of the overall environment and to improve environmental quality and quality of life*" (Lee et al., 2017, p.408). Important is that urban renewal does not focus on one property in particular, but more on a wider area. The characteristic of an urban renewal project is that not only the side is being redeveloped, but the surrounding area is studied as well. Therefore, urban renewal projects are typically set for areas, instead of individual sites (Chau & Wong, 2013).

Schwartz et al (2006) argue that there are three moments in time when a project might have an influence on nearby house prices. First, already after the announcement of the renewal project the relative price to the neighbourhood may increase. Second, between the start and the completion of the project prices may increase even more. Third, after the completion of the project prices are at the highest point. These three moments in time are shown in figure 1. Literature also suggest that before the start disamenities may be present. Negative effects may be present due to the fact that a location before renewal might cause some kind of pollution, higher crime rates, abandonment buildings or other sources of nuisance (Rossi-Hansberg et al., 2010; Van Duijn et al., 2016; Schwartz, 2006).

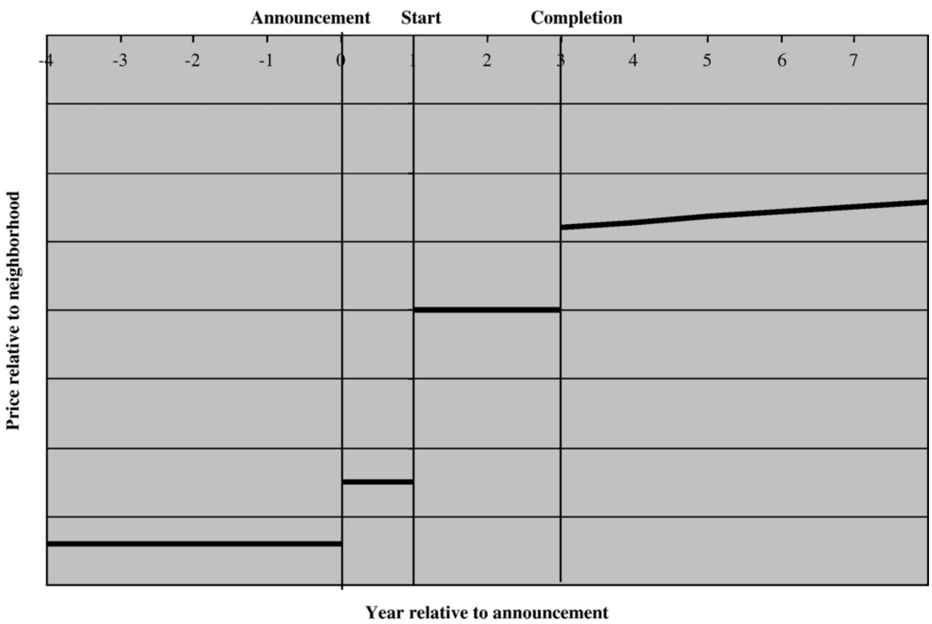

Figure 1: Timeline of the impact of an urban renewal project on nearby house prices (Schwartz, 2006, p. 682).

Urban renewal has multiple external effects, which heavily depends on the type of urban renewal project. Chau and Wong (2013) note that the demolition of old and deteriorated buildings should reduce negative external effects, like health or safety issues. Replacement of deteriorated buildings with something more beautiful should produce positive external effects, by taking away these health and safety issues resulting in higher house prices. Hereby it is assumed that urban renewal adds something to a neighbourhood. On the other hand, urban renewal projects might also have negative external effects on house prices. This is the case when it involves adding more residential units to an area, thereby increasing the supply and in that way decreasing the prices of nearby properties (Chau & Wong, 2013).

The effects of urban renewal projects on house prices are studied by multiple academics (e.g. Rossi-Hansberg, 2010; Chau & Wong, 2013, Koster & Van Ommeren, 2016; Van Duijn et al., 2016; Lee at al., 2017). Rossi-Hansberg et al. (2010) find positive effects of urban renewal projects on house prices. They find that over a 6 year period every dollar of home improvement generates between $2 and $6 in house prices in the neighbourhood. However, they also find that the effect deceases rapidly over space, approximately it halves every 1000 feet (300 metres) further away from the project (Rossi-Hansberg et al., 2010). Koster and Van Ommeren (2016) studied the effect of urban renewal projects in 83 neighbourhoods where the quality of public housing is improved. They find a positive effect of 4,5 percent of urban renewal projects on house prices. When controlling for housing attributes, the effect is 3,5 percent (Koster & Van Ommeren, 2016). Positive effects are also found by Van Duijn et al. (2016). However, unclear is when these effects occurred. Van Duijn et al. (2016) find in some areas evidence for positive effects before the completion of the project and for other areas these positive effects occurred gradually over time after the completion. Lee at al. (2017) performed a study in Taipei. According to their results there is a positive effect of the urban renewal project in Taipei on neighbourhood house prices. Chau and Wong (2013) find two effects. Firstly, a positive effect of urban renewal projects on nearby house prices is found. Second, urban renewal projects have a negative effect on the redevelopment option value of nearby houses. Because nearby houses are excluded from the project, their value is increasing less than the houses which are included in the project. The values of houses in the project are increasing fast, because they are redeveloped and the value of the surrounding houses only increases a bit by the external effect of these renewal projects. This decreases the redevelopment option value of these surrounding houses. This negative effect is due to the high transaction costs of redevelopment, which can most easily overcome by government initiatives, but not by private developers. Furthermore, even if these nearby properties would be redeveloped, they do not benefit from the scale effect of being redeveloped together with the urban redevelopment project (Chau & Wong, 2013).

2.3 Parks

In the section above, the effects of the more general urban renewal projects were discussed. This section will focus on the topic of this thesis, park related urban renewal projects (Municipality of Utrecht, 2007; Municipality of Nijmegen, 2007; Berkhout, 2013; Municipality of Amsterdam, 2018). Firstly, the value of parks is addressed and secondly the effect of parks on house prices. Sirina et al. (2017) studied the value of a park in Troyes based on a willingness to pay analysis of park users, where they asked how much users are willing to pay in the form of a donation. They find that age and contact with nature are the factors that matter in relation with the willingness to pay for the park. Interestingly, living close does not seem to have an influence on the willingness to pay. Sirina et al. (2017) argued that this may be because people living close by see the park as a part of their environment which they could access any time they want and therefore valuing it lower (Sirina et al., 2017). Also Pepper at al. (2005) do not find significant evidence that people living closer to the park are more willing to pay. Contrary to the findings of Pepper et al. (2005) and Sirina et al., (2017), Salazar and Menéndez (2007) find that the willingness to pay is considerably higher for people living closer to the park. There are two important aspects which causes the difference. The study of Sirina et al. (2017) focuses on an existing park, while the study of

Salazar and Menéndez (2007) focuses an urban renewal project where an old train station is replaced by a new urban park. Second, Sirina et al. (2017) measured willingness to pay in the form of a donation, while Salazar and Menéndez (2007) used pre-defined bids. The results of Salazar and Menéndez (2007) are confirmed by Latinopoulos et al. (2016). Their study also finds evidence that respondents closer to the project site are more willing to pay than those further away. The willingness to pay goes to 0 when the travel time exceeds 17 minutes (Latinopoulos et al., 2016). Latinopoulos et al. (2016) used an oral survey where they asked inhabitants their willingness to pay in the form of a donation.

The effects of parks and other green space as a fixed object on house prices has been studied by multiple researchers and by a wide variety of methods. Anderson and West (2006) use a hedonic analysis of home transactions to estimate the effects of closeness to open space on sales prices. They find that the effect is larger in neighbourhoods that are dense, close to the central business district, high income, high crime or home to many children (Anderson & West, 2006). Daams et al. (2016) study the perceived attractiveness of natural spaces. Their study indicates that Dutch property buyers pay higher prices for properties up to 7 km from an attractive natural space (Daams et al., 2016). Bolitzer and Netusil (2000) also show that public parks have a positive and significant effect on home's sale prices. Trojanek (2016) also finds positive effects of green areas on house prices. The study indicates that an increase of distance by 1 km from the green area lowers the price of a property by more than 3% (Trojanek, 2016). Morancho (2003) finds a house price decrease of €1800 every 100 metre further away from a green area.

In contrast to the more often studied effects of parks and green spaces on house prices, the effect of park related urban renewal projects is less studied. So, the presence of a park is studied by academics, but the effects of the renewal of a park is not. Livy and Klaiber (2016) add to the existing literature of the effect of parks on house prices by looking at park renovations. Treating renovations as a single measure leads to a significant negative effect (Livy & Klaiber, 2016). But Livy and Klaiber (2016) argue that park renovation should not be measured as a single effect, because of the heterogeneity of parks and park renovations. When treating specific park attributes, Livy and Klaiber (2016) find positive and significant effects of playground replacement, trail renovation, court renovation, fence renovation and lighting renovation and a negative effect of new lighting.

2.4 House and neighbourhood characteristics

The previous section described the effects of park related urban renewal projects on house prices. In order to measure the effect, house prices have to be controlled by house and neighbourhood characteristics. Houses are a heterogeneous good, a combination of inherent characteristics consisting of housing structure, neighbourhood and location (Fan et al., 2006). Multiple academic used hedonic-based models to regress the house price against its characteristics (Berry et al., 2003; Fan et al., 2006). Inherent house characteristics used in academic research are floor space, age, condition, number of bedrooms etc. (Brunauer et al., 2013), number of rooms and the size (Von Graevenitz, 2015) or the type of house, number of garages and if the property has central air (Chen & Harding, 2016). All available inherent house characteristics are used as a control variable when measuring the effect of an external effect.

Neighbourhood based literature suggests that high quality schools and desirable neighbourhood amenities have a positive influence on house prices and encroachment of minorities and low income households have a negative impact (Lynch & Rasmussen, 2004). Other examples are the average age of a neighbourhood, its density and the share of high educated (Brunauer et al., 2013), or air quality, green space and crime rates (Von Graevenitz, 2015). One could include these neighbourhood characteristics in the regression, but then the problem of omitted variables might occur. This happens when the model does not accurately capture the spatial variation (Von Graevenitz & Panduro, 2015). This occurs, because the location of the property remains constant over time (Brooks & Tsolacos, 2010). To include neighbourhood characteristics, it is common to use spatial fixed effects. These spatial fixed effects take into account all the spatial characteristics of the district or neighbourhood (depending on the scale of the spatial effect) (Anselin & Lozano-Garcia, 2008). This also solves the problem of omitted variables. Moreover, the neighbourhood characteristics, in the form of a spatial fixed effect, are used as a control variable (Anselin & Lozano-Garcia, 2008).

2.5 Hypotheses

Based on previous literature, hypotheses can be formulated. Earlier studies about urban renewal projects mostly find positive external effects on house prices nearby (Rossi-Hansberg, 2010; Chau & Wong, 2013, Koster & Van Ommeren, 2016; Van Duijn et al., 2016; Lee at al., 2017). On the contrary, Livy and Klaiber (2016) find a negative external effect of park renovation on nearby house prices when they measure renovations as a single measure. Although their study does find a significant negative effect, the first hypothesis of this thesis is that park related urban renewal projects do have a significant positive external effect on nearby house prices when the park related urban renewal project is treated as a single measure. The 13 park related urban renewal projects are selected, because policy documents imply that the renovations are a way to improve the neighbourhood. This characteristic is similar with other urban renewal projects (Rossi-Hansberg, 2010; Chau & Wong, 2013, Koster & Van Ommeren, 2016; Van Duijn et al., 2016; Lee at al., 2017) which find a positive external effect on house prices. Therefore, it is expected that the park related urban renewal projects have a positive external effect on house prices. Disamenities before the start of the project are not likely, because several studies show that the presence of a park has positive effects on nearby house prices (Bolitzer & Netusil, 2000; Daams et al., 2016; Trojanek, 2016).

The second hypothesis is based on the study of Livy and Klaiber (2016). Their study finds a significant positive effect of playground replacement, trail renovation and court renovation and a significant negative effect of new lightning on nearby house prices. For the second hypothesis, the park related urban renewal project as a single measurement is divided by specific park attributes. The second hypothesis is that the same 3 attributes as in the study of Livy and Klaiber (2016), playground replacement, trail renovation and court renovation have a significant positive external effect on nearby house prices and new lighting has a significant negative effect.

3. DATA & METHOD

This thesis studies the external effect of park related urban renewal projects. The external effect cannot be measured directly, therefore the external effects are measured in an indirect way. This is done by looking at house prices. Literature suggests two ways of regressing external effects. One is a hedonic regression method and the other is a difference-in-difference method. Both methods will be discussed, starting with the hedonic regression. The hedonic regression model regresses the house price on the distance to the renewal project and the interaction between the year of the renewal project and the distance, controlling for property and neighbourhood characteristics. Detailed information about the property characteristics is necessary to get reliable results (Goh et al., 2012). If there are any external effects, the interaction variable of the year and the distance is expected to be significant (Livy & Klaiber, 2016; Rosen, 1974). A disadvantage of the regression model is the issue of omitted variable bias. If this occurs, the model does not accurately capture the spatial variation (Von Graevenitz & Panduro, 2015). This occurs, because the location of the property remains constant over time (Brooks & Tsolacos, 2010). One way to solve for these omitted variables is to add spatial fixed effects (Brook & Tsolacos, 2010; Von Graevenitz & Panduro, 2015). Another disadvantage which cannot be solved within this method is the omitting of houses which are sold more than once. Because of multicollinearity reasons the model cannot handle houses which are more than once in the dataset (Goh et al., 2012). The advantage of the hedonic regression model is that it is a relatively simple one and the results can be compared with the results of Livy and Klaiber (2016).

The difference-in-difference method is useful, because it can distinguish between different times. This is not possible when using hedonic regression alone as in the previous method. The difference-in-difference method improves the results from the hedonic regression method in multiple ways. First, the hedonic regression model does not account for possible anticipation effects (Van Duijn et al., 2016). As indicated by Schwartz et al. (2006) there are three moments in time when there could be an impact on house prices. When these moments are neglected, the regression can give biased results. The hedonic regression model cannot distinguish between those time moments, the difference-in-difference method can. Second, it is likely that next to the aspects measured in the hedonic regression method more aspects may influence house prices, which may cause omitted variable bias when these aspects are unobserved (Van Duijn et al., 2016). The difference-in-difference method does not only regress certain variables, but also controls for a target group and a control group. Therefore, it minimises the risk of omitted variable bias. Third, the difference-in-difference method adds new and more in depth knowledge about the external effects of park related urban renewal projects.

A repeat sales method is not performed in this thesis due to multiple reasons. It is true that the information which can be obtained from houses sold more than once is neglected by the hedonic regression method and the difference-in-difference method. However, the repeat sales method neglects those houses which are sold only once. Next to that, the repeat sales method often has the inherent selection bias problem, because only those houses sold more than once are used (Schwartz et al., 2006; Van Duijn et al., 2016). Third, it is argued that the cases used for the repeat sales method are not representative for the housing market as a whole (Rappaport, 2007; Silverstein, 2014). For example, cheap starter homes tend to sell more often and will therefore be more represented in the dataset, resulting in a dataset which is not representative (Silverstein, 2014). Or houses sold more than once found to be considerably more expensive (Rappaport, 2007). Moreover, the repeat sales method is often used because the hedonic regression method may have the problem of omitted variable bias. The repeat sales method solves this problem, because it assumed that all time-irrelevant characteristics stay constant over time. However, the difference-in-difference already minimises the omitted variable bias problem when compared with the hedonic regression method, because it controls for a target and control group (Van Duijn et al., 2016).

3.1 Hedonic regression method

The first method used is the hedonic regression method, which is used to answer both hypotheses. To answer the first hypothesis mentioned in the previous chapter, an analysis like the one Livy and Klaiber (2016) use is performed. For this method a hedonic regression model is used to analyse if park related urban renewal projects have an external effect on house prices. In the hedonic model, park related urban renewal projects are used as a single measure. Equation 1 shows the equation used.

$$lnP_{ijt} = \alpha + \beta_k \mathrm{X}_{\mathrm{kit}} + \mu_j \mathrm{N}_{\mathrm{j}} + \delta_{\mathrm{i}} \mathrm{I}_{\mathrm{i}} + \gamma_{\mathrm{t}} \mathrm{Y}_t + \varepsilon_{\mathrm{t}} \qquad [1]$$

Where P is the transaction price of property *i* located in neighbourhood *j* at transaction year *t* on a log scale; X are the property characteristics *k* of property *i* sold in year *t*; N is a neighbourhood dummy variable taking one for neighbourhood *j*; I is a dummy variable indicating if the property *i* lies within the sphere and if the transaction date of property *i* lies after the completion date of the renewal project, taking 1 when this is the case and 0 otherwise; Y is the year taking one for year *t* and zero otherwise; ε is an error term. The parameters to be estimated are $\alpha, \beta, \mu, \delta$ and γ. The neighbourhood and time variable control for neighbourhood and time fixed effects. The neighbourhood fixed effects control for the issue of omitted variable bias.

To answer the second hypothesis again the study of Livy and Klaiber (2016) is used. The equation used to answer hypothesis 2 is almost similar to equation 1. The only difference is that park related urban renewal projects are now not measured as a single measure, but as a vector of park attributes, as argued by Livy and Klaiber (2016). The difference between equation 1 and equation 2 is the interaction of the houses affected (variable I) with a certain park attribute (variable V). The renewed equation is shown in equation 2.

$$lnP_{ijt} = \alpha + \beta_k \mathrm{X_{it}} + \mu_j \mathrm{N_j} + \theta_p \mathrm{V_p I_i} + \gamma_\mathrm{t} \mathrm{Y}_t + \varepsilon_\mathrm{t} \qquad [2]$$

P is the transaction price of property *i* located in neighbourhood *j* at transaction year *t* on a log scale; X are the property characteristics *k* of property *i* sold in year *t*; N is a neighbourhood dummy variable taking one for neighbourhood *j*; V is a vector of park attributes of park *p* taking 1 if a certain park attribute is present and 0 otherwise; I is a dummy variable indicating if the property *i* lies within the sphere and if the transaction date of property *i* lies after the completion date of the renewal project, taking 1 when this is the case and 0 otherwise; Y is the year taking one for year *t* and zero otherwise; ε is an error term. The parameters to be estimated are $\alpha, \beta, \mu, \theta$ and γ. The neighbourhood and time variable control for neighbourhood and time fixed effects. Again, the property characteristic variables and the neighbourhood dummies are the same as the ones used for method 1. The different park attributes are shown in table 5 in the 5th paragraph of this chapter. Two park attribute distributions are made. The first one in based on Livy and Klaiber (2016) in order to compare their results with the results of this study. For the second distribution the category 'other' from the first distribution is split up into multiple other attributes.

According to Brooks and Tsolacos (2010) the linear regression model has five assumptions. These are: (1) the errors have zero mean, (2) the variance of the errors is constant and infinite over all values, (3) the errors are statistically independent of one another, (4) there is not relationship between the error and corresponding *x* variable and (5) *u* is normally distributed. These assumptions are tested in appendix D.

3.2 Difference-in-difference method

By using the difference-in-difference method, the sample is divided into groups based on the variable time and some kind of effect. As mentioned before, Schwartz et al (2006) argue that there are three points in time when a project might have an influence on nearby house prices, namely the time of announcement, the start and the completion of the project. Due to data limitations it is impossible to distinguish between all these three time periods, because for most renewal projects only the start time and completion time is known. In the setting of this thesis, the sample is split by cases before, between and after the renewal project and by being nearby the renewal project or not. If a case nearby the renewal project, it is considered as treated. The houses which are not treated are called the control group (Lechner, 2010). So, the sample is split into a group before the renewal project and not treated, a group between the start and completion and not treated, a group after the renewal project and not treated, a group before the renewal project and treated, a group between the start and completion and treated and a group after the renewal project and treated (Lechner, 2010). So, four groups are not affected by the renewal project, the three groups not nearby and the group before the renewal project, and two groups are affected, the one nearby and between the start and completion of the project and the one nearby and after the redevelopment project. The difference-in-difference method assumes that both the target and the control group are affected the same, except for the effect of the renewal project. This assumption is tested by plotting the average price if the target and control group over time of those transactions which occurred before the start of the project. If over time, the house prices in the target group increase faster than the control group, relative to the prices before the redevelopment project, than it is shown that the redevelopment project influences prices of houses nearby. This is schematically shown in figure 2, where the green line (below) is the control group, the red line (up) is the target group and β3 is the external effect. The figure shows that before the intervention both lines (red and green) move parallel. After the intervention the line for the target group (red) moves steeper than the green line. In other words, after the intervention an outcome trend is observed for the target group and not for the control group, which implies there is an intervention effect only for the target group. Figure 2 presents only one two time periods, before and after the intervention, whereas this thesis distinguishes between three time periods. However, figure 2 explains the basics of the difference-in-difference method.

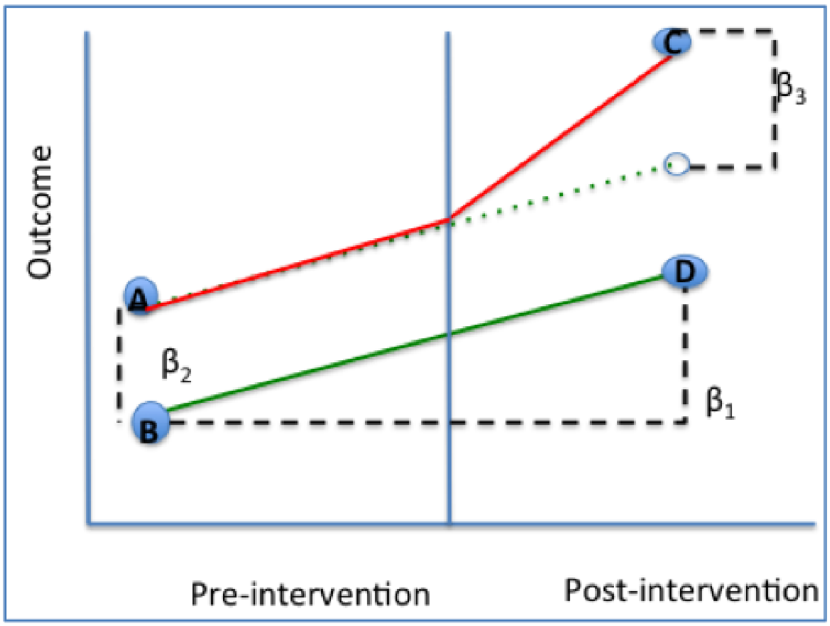

Figure 2: Difference-in-Difference method schematically shown (Columbia University, 2013).

The following hedonic regression model based on Schwartz et al. (2006) is used to test hypothesis one.

$$lnP_{ijt} = \alpha + \beta_k X_{it} + \mu_j N_j + \lambda_{is} G_i T_s + \gamma_t Y_t + \varepsilon_t \qquad [3]$$

Where P is the transaction price of property i located in neighbourhood j at transaction year t on a log scale; X are the property characteristics k of property i sold in year t; N is a neighbourhood dummy variable taking one for neighbourhood j; G is a dummy variable of property i taking 1 if the property is in the target group and 0 if it is in the control group; T is a timing variable taking into account three time periods, s = before, s = between or s = after; Y is the year taking one for year t and zero otherwise; ε is an error term. The parameters to be estimated are α, β, μ, λ and γ. The neighbourhood and time variable control for neighbourhood and time fixed effects. The property characteristic variables and the neighbourhood dummies are the same as the ones used for method 1.

The interaction variable $G_i T_s$ takes into account if a property is within the target group or the control group and if the transaction date of the property is before the renewal project, during the renewal project, so between the start and completion date, or after the renewal project. The variable of interest is the target group after the renewal project, because this variable indicates the presence and strength of an external effect or not.

3.3 Sensitivity analyses

In this study two types of sensitivity analyses are used. The first type is the natural outcome of performing two methods. By performing two methods, the results of these methods can be compared and are therefore a type of sensitivity analysis. This sensitivity analysis is only performed for the first hypothesis, because the second hypothesis is only answered by one method.

The second sensitivity test is the Chow test (Brooks & Tsolacos, 2010; Chow, 1960), where the data is split in two. The dataset is split by the size of the park, where large is defined as larger than or equal to 20 hectares and where small is defined as smaller or equal than 20 hectares. The described methods above assume that the parks and the projects are completely homogeneous. In the hedonic regression method and the difference-in-difference method all park projects are put into one dataset. By doing this all projects are treated the same way. In reality this will not hold, because parks and projects are not completely homogeneous. Parks differ by location and by characterises. By defining by size, it is assumed that the parks and the projects are less homogeneous than assumed before. It may be that the results found are driven by larger park, because it might be that bigger parks get more attention or are more important to policy makers and citizens. The Chow test also gives an answer to the third sub question. Equation 4 represents the formula for the Chow test (Brooks & Tsolacos, 2010).

$$\frac{RSS-(RSS1+RSS2)}{(RSS1+RSS2)} * \frac{T-2k}{k} \qquad [4]$$

Where RSS = residual sum of squares for the whole sample

RSS_1 = residual sum of squares large parks

RSS_2 = residual sum of squares small parks

T = number of observations

k = number of regressors in each unrestricted regression, including a constant

3.4 Data

Data about house prices and house characteristics is obtained from the NVM (Dutch Association of Real Estate Agents). NVM is the owner and administrator of a database from 1974 onwards. In the database all transactions where an NVM agent is involved, which is around 75% of all transactions, are listed (NVM, 2018). Property characteristics include 19 number of variables. These variables are shown in table 1. The neighbourhood dummy variable corresponds with 101 number of neighbourhoods and the year dummy variable corresponds with 27 number of years. The NVM provided 464.541 cases over the six cities. In total 190.644 of those cases were deleted due to missing data, outliers or duplicates, resulting in a total number of 273.897 cases. The data logbook can be found in the appendix E. Important removals were the missing data of the variables building period, number of rooms and living size. Outliers of the transaction price variable and the lot size variable were also removed to make the distribution more normally distributed. Next to that, large and/or expansive houses can blur the results, because they have a lot of influence in the regression on the median houses. Also, the duplicates were removed, because the methods used cannot handle multiple observations of a single house. In order to perform analyses, all cases had to be geocoded in order to calculate the distance between the houses and the parks. The geocoder could not find the address of 36.465 cases. So, in total 237.432 cases are used in the analyses.

Table 1: Variables used

Variable	Explanation	Variable	Explanation
Home type		Dormer window	Number of dormer windows
2	Simple	Roof terrace	Number of roof terraces
5	Single family	Kitchens	Number of kitchens
6	Cannel house	Sculleries	Number of sculleries
7	Mansion	Toilets	Number of toilets
8	Farmhouse	Bathrooms	Number of bathrooms
9	Bungalow	Indoor parking	Indoor parking yes or no
10	Villa	Quality outdoor maintenance	Quality indoor maintenance (1-9)
11	Manor	Quality indoor maintenance	Quality outdoor maintenance (1-9)
12	Ranch	Monument	Monumental building yes or no
21	Downstairs apartment	Living size	Living size of the house
22	Upstairs apartment	Year	Year of transaction
23	Maisonette	Building period	
24	Portico apartment	*1*	1500-1905
25	Gallery flat	*2*	1906-1930
26	Nursing flat	*3*	1931-1944
27	Combined downstairs and upstairs apartment	*4*	1945-1959
Elevators	Elevator yes or no	*5*	1960-1970
Floors	Number of floors	*6*	1971-1980
Rooms	Number of rooms	*7*	1981-1990
Attic	Attic yes or no	*8*	1991-2000
Loft	Loft yes or no	*9*	After 2001
Balconies	Number of balconies		

The 13 parks (table 4) are manually selected from cities bigger than 150.000 inhabitants. There are three reasons why only parks in bigger cities are classified. First, park related urban renewal projects mostly happened in bigger cities (Wijsen, 2002). Second, for smaller cities it is more likely that they have more nature just outside the city. Because of scarcity, nature in bigger cities could be higher appreciated compared with smaller cities and therefore the effect on house prices could be larger in bigger cities. This idea is supported by Daams et al. (2016), who find that the price effect of natural space is higher in urban areas compared with less urban areas, due to more scarcity of natural spaces in more urbanised areas (Brander & Koetse, 2011). Third, the analyses require enough cases. The exact number of enough is unclear, but the more case, the better (Brooks & Tsolacos, 2010). By looking at bigger cities, the possibility that not enough cases are found is minimised. Parks are only selected if their construction and completion date is between 1999 and 2011. Furthermore, the parks are only selected if the renovation of the park is a mean to improve one or more neighbourhoods. So, the renovation must not be a renovation on its own. Based on this, 13 park related urban renewal projects are identified in six different cities: Amsterdam, The Hague, Utrecht, Almere, Nijmegen and Arnhem. The projects are listed in table 4. Data about the park related urban renewal projects is obtained from reports from the corresponding municipality.

The population investigated are the park related urban renewal projects in bigger cities (150.000 or more inhabitants) between 1999-2010. The 13 park projects are representative for all park related urban renewal periods in the bigger cities of the Netherlands in the period 1999-2011, because this research treats all park related urban renewal projects occurred in the bigger cities between 1999-2011. The studied population does not account for projects outside this time frame of for smaller cities (less than 150.000 inhabitants).

3.6 5escriptive statistics NVM data

Table 2 presents the descriptive statistics for the hedonic regression methods and table 3 presents the descriptive statistics for the difference-in-difference method. The N (number of cases) is different for both methods, because for the hedonic regression model all cases are involved and for the difference-in-difference only those cases which are in the target or control group. In order to compare both methods, the catchment area of the hedonic regression model and the target group of the difference-in-difference are set equally.

Table 2: Descriptive statistics hedonic regression method

Variable	Mean	Std. Dev.	Min.	Max.
Log transaction price	12,17	0,57	9,5188	14,897
Living size	107,79	46,18	21	402
Elevators (yes = 1)	0,15	0,36	0	1
Floors	1,94	0,96	1	8
Rooms	4,06	1,56	1	104
Attic (yes = 1)	0,12	0,33	0	1
Loft (yes = 1)	0,04	0,20	0	1
Number of balconies	0,44	0,54	0	5
Number of dormer windows	0,08	0,28	0	2
Number of roof terrace	0,10	0,31	0	3
Number of kitchens	0,79	0,45	0	5
Number of sculleries	0,06	0,23	0	3
Number of toilets	3,39	1,87	0	20
Number of bathrooms	0,91	0,44	0	7
Indoor parking	0,04	0,19	0	1
Quality outdoor maintenance (1 excellent – 9 poor)	7,14	0,99	1	9
Quality indoor maintenance (1 excellent – 9 poor)	7,04	1,25	1	9
Monument (yes = 1)	0,02	0,13	0	1
Year	2006,36	6,31	1990	2016
Building period				
1500-1905 (1=yes)	0,10	0,30	0	1
1906-1930 (1=yes)	0,19	0,40	0	1
1931-1944 (1=yes)	0,11	0,32	0	1
1945-1959 (1=yes)	0,08	0,26	0	1
1960-1970 (1=yes)	0,11	0,32	0	1
1971-1980 (1=yes)	0,06	0,24	0	1
1981-1990 (1=yes)	0,10	0,31	0	1
1991-2000 (1=yes)	0,15	0,36	0	1
After 2001 (1=yes)	0,09	0,28	0	1
Home type				
2 (1=yes)	0,02	0,14	0	1
5 (1=yes)	0,28	0,45	0	1
6 (1=yes)	0,00	0,05	0	1
7 (1=yes)	0,08	0,27	0	1
8 (1=yes)	0,00	0,02	0	1
9 (1=yes)	0,01	0,08	0	1
10 (1=yes)	0,02	0,12	0	1
11 (1=yes)	0,00	0,02	0	1
12 (1=yes)	0,00	0,00	0	1
21 (1=yes)	0,10	0,30	0	1
22 (1=yes)	0,23	0,42	0	1
23 (1=yes)	0,03	0,18	0	1
24 (1=yes)	0,15	0,35	0	1
25 (1=yes)	0,08	0,27	0	1
26 (1=yes)	0,00	0,03	0	1
27 (1=yes)	0,01	0,09	0	1

Note: N = 237.432.

Table 3: Descriptive statistics difference-in-difference method

Variable	Mean	Std. Dev.	Min.	Max.
lntransactionprice	12,17	0,60	9,5189	14,897
Livingsize	104,27	47,69	21	401
Elevators	0,14	0,97	0	1
Floors	1,89	0,97	1	8
Rooms	3,94	1,62	1	20
Attic	0,11	0,32	0	1
Loft	0,04	0,20	0	1
Balconies	0,46	0,54	0	5
Dormerwindow	0,08	0,28	0	2
Roofterrace	0,11	0,32	0	3
Kitchens	0,80	0,46	0	5
Sculleries	0,05	0,23	0	3
Toilets	3,20	1,91	0	20
Bathrooms	0,91	0,45	0	7
Indoorparking	0,03	0,16	0	1
Qualityoutdoormainenance	7,11	1,01	1	9
Qualityindoormaintenance	7,00	1,28	1	9
Monument	0,02	0,15	0	1
Year	2006,10	6,51	1990	2016
Building period				
1500-1905 (1=yes)	0,15	0,36	0	1
1906-1930 (1=yes)	0,24	0,43	0	1
1931-1944 (1=yes)	0,14	0,34	0	1
1945-1959 (1=yes)	0,07	0,25	0	1
1960-1970 (1=yes)	0,10	0,30	0	1
1971-1980 (1=yes)	0,03	0,18	0	1
1981-1990 (1=yes)	0,09	0,29	0	1
1991-2000 (1=yes)	0,12	0,32	0	1
After 2001 (1=yes)	0,06	0,24	0	1
Home type				
2 (1=yes)	0,02	0,14	0	1
5 (1=yes)	0,23	0,42	0	1
6 (1=yes)	0,004	0,06	0	1
7 (1=yes)	0,07	0,26	0	1
8 (1=yes)	0,0004	0,02	0	1
9 (1=yes)	0,004	0,06	0	1
10 (1=yes)	0,01	0,09	0	1
11 (1=yes)	0,0003	0,02	0	1
12 (1=yes)	0	0	0	0
21 (1=yes)	0,12	0,32	0	1
22 (1=yes)	0,27	0,44	0	1
23 (1=yes)	0,03	0,17	0	1
24 (1=yes)	0,15	0,36	0	1
25 (1=yes)	0,08	0,27	0	1
26 (1=yes)	0,001	0,02	0	1
27 (1=yes)	0,01	0,09	0	1

Note: N=140.205.

3.6 Descriptive statistics parks

Table 4 presents the 13 selected parks and their size, start date and completion date. These projects are selected because they took place between 1999 and 2011 and the parks were located in cities larger than 150.000 inhabitants. Wijsen (2002) suggests that park related urban renewal projects mostly happen in larger cites. Moreover, in bigger cities nature is higher appreciated compared with smaller cities due to scarcity (Brander& Koetse, 2011; Daams et al., 2016). The projects were found by looking at policy documents of cities with more than 150.000 inhabitants if a park related urban renewal project took place between 1999 and 2011. Table 5 presents the descriptive statistics of the park attributes. Interesting to see in table 4 is that both the size of the parks and the time frame in which they are renovated shows high variations. So is the smallest park 2,7 ha (Huijgenspark) and the largest 54,8 ha (Beatrixpark). Also, the time between the start and completion of the project differs from within the same year (Beatrixpark) to 11 years (Vondelpark). These two aspects indicate that the size of the projects differs between parks and projects. The park attributes listed per park in table 5 are found in policy document about the renovations. These policy documents described the plans for the renovations and what eventually changed in such detail that the park attributes could be based on these documents. From table 5 it is clear that trail renovation happened in all projects. Playground replacement, field renovation and other happened in almost all projects. Playground renovation, court renovation, new lights, restaurant added and monument added are the attributes which are used the least. The variable 'other2' is the category of the remaining attributes when the attribute 'other' is split into restaurant added, animals added and monument added.

Table 4: Information selected parks per city

City	Park	Size (in ha)	Start date	Completion date
Amsterdam	Martin Luther King Park	10,3	2003	2005
	Vondelpark	47	1999	2010
	Bijlmerpark/Nelson Mandelapark	43	2009	2011
Den Haag	Huijgenspark	2,7	2002	2002
Utrecht	Julianapark	9,5	2003	2004
	Park de Gagel	18	2005	2005
	Park de Watertoren	11,6	2005	2006
	Park Transwijk	16,3	2005	2005
	Vechtzoompark	20	2006	2006
Almere	Beatrixpark	54,8	2002	2002
	Den Uylpark	10	2004	2004
Nijmegen	Kronenburgerpark	5,2	2004	2006
Arnhem	Park Presikhaaf	19,7	2004	2007

Table 5: Descriptive statistics park attributes

Attribute	Number of times present	Mean	Std. Dev	Min.	Max.
Playground renovation	4	0,31	0,48	0	1
Playground replacement	11	0,85	0,38	0	1
Trail renovation	13	1	0	1	1
Court renovation	4	0,31	0,48	0	1
New lighting	3	0,23	0,44	0	1
Field renovation	12	0,92	0,28	0	1
Other	11	0,85	0,38	0	1
Restaurant added	3	0,23	0,44	0	1
Animals added	5	0,38	0,51	0	1
Monument added	4	0,31	0,48	0	1
Other2	7	0,62	0,51	0	1

4. RESULTS

In this chapter the results of the analyses as outlined in the chapter before are presented. It starts with the results from the hedonic regression analysis for both the renovation as a single measure as well as for the different park attributes. Second the results from the difference-in-difference analysis are discussed, followed by the sensitivity analysis.

The houses included in the hedonic regression method are defined according to their distance from the nearest park related urban renewal project and their transaction year. In the hedonic regression method, the catchment area of the renewal project is set to 1500 metres, which is a little less than 1.5 mile. The distance is set according to Livy and Klaiber (2016), who find that the external effect of park renovation reaches this far. It also makes it possible to compare results between this study and the one from Livy and Klaiber (2016). Other literature than Livy and Klaiber (2016) suggests that the external effect of parks reach around 700 metres from a park (Bolitzer & Netusil, 2000; Panduro & Veie, 2013). The 1500 metres set here are meant to give a baseline result. Later one the distance decay will be calculated to analyse how far the effect reaches. A house is included in the analysis if the transaction year lies after the completion year of the nearest renewal project. Time calculations are exact to the year of renovation and the transaction year, due to insufficient knowledge about the exact month of renovations.

For the difference-in-difference baseline specification the target area is set to 1500 metres and the control area is set to 1500 and 3000 metres based on previous literature (Van Duijn et al., 2016). Next the that, by setting the target area to 1500 metres it is equal to the catchment area of the hedonic regression method. By setting equal distances it is possible to compare between both methods. The 3000 radius for the control group might seem like a rather large one. This is set, because ideally, we want that the houses in the control group are not affected by the park renovation. Previous literature suggest that local park effects reach around 700 metres. By setting the control group to 1500 till 3000 metres, the chance that the control group is affected by the park is minimised, even when the park influence reaches over a wider distance than previous literature suggests. To test the assumption that the target and control group are similar in every way, except for the urban renewal, a graph is plotted of the average house price before the project of both groups. Three time periods are classified, namely before, between and after. Before is defined as the years before the year of start, between is defined as equal or later than the start year, but equal or lower than the completion year and after is defined as later than the completion year. To control the outcomes, the distance decay of the Target*After interaction variable is calculated. The difference-in-difference method is not used for the different park attributes due to complexity of the model.

Maps of the city of Amsterdam with the parks and their catchment areas of 0-1000 metre or target group of 0-1500 metre and control group of 1500-3000 metre are presented in appendix B due to the size of the maps. Map B1 presents the three park renovations in Amsterdam indicating which properties lie within the catchment area of 1500 metre. Map B2 presents the difference-in-difference method with all properties within 0-1500 metre from the park (target group) and those within 1500-3000 metre from the park (control group).

4.1 Hedonic regression models

Table 6 presents the results of the hedonic regression stated in equation 1. The model is built up with only year fixed effects (1), with property characteristics, but without location fixed effects (2), with place fixed effects (3) and with neighbourhood fixed effects (4). The increasing R^2 indicated that more variation is explained by the model. The results of table 6, specification 4 show a positive and significant effect of park renovations of house prices of 0,01149. The model employs a log-linear specification, which makes it necessary to transform the coefficient to get the growth rate. The percentage effect is $(exp^{0,01149}-1)*100\% = 1.156\%$. So, the external effect of the park renovation on house prices of houses within 1500 metre is 1.156%. The result is contrary whit the result of Livy and Klaiber (2016), who found negative or significant results. However, they suggest that park renovations should not be seen as a single measure, but consists of multiple attributes because of heterogeneity of parks. The results of the house characteristics can be found in the appendix C1. These results are similar to previous literature (Goh et al., 2012; Van Duijn et al., 2016; Livy & Klaiber, 2016).

Table 6: Results hedonic regression renovation single measure

	1		2		3		4	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Renovation (yes = 1)	-0,14226***	(0,003535)	-0,17255***	(0,002120)	0,01785***	(0,002058)	0,01149***	(0,001705)
Constant	11,05633***	(0,013822)	9,83899***	(0,010911)	9,64635***	(0,009599)	9,56573***	(0,008771)
Year fixed effects (26)	Yes		Yes		Yes		Yes	
House characteristics (17)	No		Yes		Yes		Yes	
Home type dummies (15)	No		Yes		Yes		Yes	
Building period dummies (8)	No		Yes		Yes		Yes	
Place fixed effects (5)	No		No		Yes		No	
Neighbourhood fixed effects (101)	No		No		No		Yes	
Observations	237.432		237.432		237.432		237.432	
R^2	22,95%		73,40%		80,05%		86,95%	
Adjusted R^2	22,94%		73,39%		80,05%		86,94%	

Note: Dependent variable is lnTransactionprice. The coefficients and standard errors of the control variables of column 4 can be found in table C1 in the appendix. * p<0,10, ** p<0,05, *** p<0,01.

Interesting to see in the above table (table 6) are the differences between specification 1 to 4. All renovation outcomes are significant at the 1% level, but the coefficients differ considerably (from - 13.3% to 1.156%). Moving from specification 1 to specification 2, house characteristics are added. From specification 2 to 3 and 4 more detailed spatial fixed effects are added. Here the potential for omitted variable bias decreases, because the spatial fixed effects become smaller (none in specification 1 and 2, place fixed effects in specification 3 and neighbourhood fixed effects in specification 4). The results suggest that controlling for such omitted variables plays an important role in getting unbiased results (Livy & Klaiber, 2016).

The model above uses a single measure that implicitly aggregates all park attributes. This approach does not capture the effect of specific features of parks and may have measurement error if the types of park features vary across parks. It also neglects the heterogeneity of parks and park renovations (Livy & Klaiber, 2016). The results of the regression model which differentiates between 7 park attributes (playground renovation, playground replacement, trail renovation, court renovation, new light, field renovation and other) (table 5 chapter 3.5) are shown in table 7. The model is built up in the same way as the single measure model. The model finds positive significant results of playground renovation and trail renovation. These effects are 8,784% and 6,876%. The positive effect of playground renovation is not found by Livy and Klaiber (2016), whereas the effect of trail renovation is in line with their research, although their effect (2,778) is smaller than the effect found by the model of this research. Negative and significant effects are found for playground replacement, court renovation, new lights and field renovation. The corresponding effects are -3.978%, -2.545%, -1.534% and -7.229%. Only the negative effect of new lighting corresponds with the results of Livy and Klaiber (2016). For the other attributes Livy and Klaiber (2016) found a positive effect of playground replacement, a positive effect of court renovation and no significant effect of field renovation. The results of the house characteristics can be found in appendix C2.

Again, the coefficients of specification 1 are much larger than the coefficients of specification 4. The is caused by the same reasons as for table 6 (hedonic regression single measure). The addition of spatial fixed effects lessen the coefficients and minimises omitted variable bias (Livy and Klaiber, 2016).

The correlation table (table 8) shows high correlation between playground replacement and trail renovation, between playground replacement and field renovation, between playground replacement and other, between trail renovation and field renovation and between field renovation and other. This correlation may be caused by the relatively small number of parks, making the variety of park attributes across the parks small. Additionally, the highly correlated attributes are the ones which are present in, almost, all renovations. The variance inflation factor (VIF) shows high correlation of trail renovation (44,23) and playground replacement (30,24) and moderate correlation of field renovation (8,79), other (8,64, new lights (2,65), playground renovation (1,97) and court renovation (1,81). The high VIF values are caused by the fact that these variables are dummy variables.

This multicollinearity can create some problems. First, R^2 will be high, but the individual coefficients may have high standard errors. This can create an effect where the regression looks good as a whole, but the variables are not significant. This is caused by the fact that the variables are so closely related it becomes difficult to observe the individual contribution of each variable (Brooks & Tsolacos, 2010). In this context the correlation is ignored, because it is assumed that the model is otherwise adequate. Livy and Klaiber (2016) suggests that these 7 attributes are a plausible magnitude and have an appropriate sign (Brooks & Tsolacos, 2010). Next to that multicollinearity creates the problem of a high R^2, but insignificant variables (Brooks & Tsolacos, 2010). As table 7 shows, this is not the case, since almost all variables are significant at the 1% level. Moreover, multicollinearity does not create inconsistent, biased or inefficient results (Brooks & Tsolacos, 2010).

Table 7: Results hedonic regression 7 park attributes

	1		2		3		4	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Playgroundrenovation (yes = 1)	0,16229***	(0,003912)	0,22144***	(0,002195)	0,09828***	(0,002606)	0,08419***	(0,002282)
Playgroundreplacement (yes = 1)	0,08741***	(0,011214)	-0,05545***	(0,006224)	-0,00605	(0,006013)	-0,04059***	(0,005359)
Trailrenovation (yes = 1)	0,04748***	(0,013870)	0,23718***	(0,007764)	-0,07604***	(0,007744)	0,06650***	(0,007251)
Courtrenovation (yes = 1)	-0,03105***	(0,004781)	-0,07054***	(0,002688)	0,07625***	(0,002756)	-0,02578***	(0,002676)
Newlight (yes = 1)	-0,05747***	(0,003904)	-0,08113***	(0,002193)	0,05338***	(0,002564)	-0,01546***	(0,002333)
Fieldrenovation (yes = 1)	-0,27487***	(0,006086)	-0,37737***	(0,003406)	-0,19062***	(0,003498)	-0,07504***	(0,003401)
Other (yes = 1)	0,00719	(0,006078)	0,00593***	(0,003522)	0,16478***	(0,003793)	0,00074	(0,003909)
Constant	11,05633***	(0,013639)	9,81557***	(0,010112)	9,69368***	(0,009606)	9,59388***	(0,008816)
Year fixed effects (26)	Yes		Yes		Yes		Yes	
House characteristics (17)	No		Yes		Yes		Yes	
Home type dummies (15)	No		Yes		Yes		Yes	
Building period dummies (8)	No		Yes		Yes		Yes	
Place fixed effects (5)	No		No		Yes		No	
Neighbourhood fixed effects (101)	No		No		No		Yes	
Observations	237.432		237.432		237.432		237.432	
R^2	24,99%		77,19%		80,54%		87,08%	
Adjusted R^2	24,98%		77,18%		80,54%		87,07%	

Note: Dependent variable is lnTransactionprice. The coefficients and standard errors of the control variables of column 4 can be found in table C2 in the appendix. * p<0,10, ** p<0,05, *** p<0,01.

Table 8: Correlation 7 park attributes

	Playground renovation	Playground replacement	Trail renovation	Court renovation	New light	Field renovation	Other
Playground renovation	1						
Playground replacement	0,4517	1					
Trail renovation	0,4434	0,9815	1				
Court renovatio	0,0417	0,3252	0,3191	1			
New light	-0,0205	0,592	0,581	0,1457	1		
Field renovation	0,4864	0,8912	0,9115	0,3501	0,6374	1	
Other	0,4908	0,883	0,9035	0,0644	0,4506	0,8046	1

Next to the distinction of 7 park attributes by Livy and Klaiber (2016) a distinction between 10 park attributes is made. There are two reasons for doing this. The first reason is that the category other is present in 11 of the 13 parks. This is too much for a remaining category. Second, when investigating the individual projects, some interesting attributes were found, which were not mentioned by Livy and Klaiber (2016), but can be seen as an attribute. The category other is divided into restaurant, monument, animals and other. The results can be found in table 9. The regression finds positive significant effects of playground renovation (23.5%), trail renovation (11%) and monuments (7%) and negative significant effects of playground replacement (-7.6%,) new lights (-1.6%), field renovation (-10.7), restaurant (-8.1%) and animals (-6.3%). The overlapping attributes of the model with 7 attributes and this model with 10 attributes show similar results, although the effects of this model are predominantly larger. The results of the rest of the model can be found in appendix C3.

The correlation table (table 10) presents the high correlation between playground renovation and restaurant, between playground replacement and trail renovation, between playground replacement and field renovation and between trail renovation and field renovation. This high correlation numbers may again be caused by the relative small number of cases. The attributes showing high correlation are the ones which are present in almost all parks. The VIF values of these variables are again high. There is high correlation for trail renovation (63,98), playground replacement (58,05), field renovation (25,80), restaurant (15,64) playground renovation (13,34) and monument (11,45) and moderately correlation for court renovation (8,07), animals (4,11), other (3,57) and new lights (3,06). This multicollinearity may give the problems stated before. Table 9 shows that the problem of insignificant variables does not occur, since almost all variables are significant at the 1% level (Brooks & Tsolacos, 2010). Moreover, multicollinearity does not create inconsistent, biased or inefficient results (Brooks & Tsolacos, 2010).

Table 9: Results hedonic regression 10 park attributes

	1		2		3		4	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Playgroundrenovation (yes = 1)	0,38924***	(0,010023)	0,55519***	(0,00566)	0,20307***	(0,006175)	0,21108***	(0,005653)
Playgroundreplacement (yes = 1)	-0,11913***	(0,015501)	-0,08179***	(0,00848)	-0,16282***	(0,008734)	-0,07870***	(0,009219)
Trailrenovation (yes = 1)	0,25810***	(0,016351)	0,28603***	(0,00894)	0,27086***	(0,008977)	0,10917***	(0,009369)
Courtrenovation (yes = 1)	0,10150***	(0,010012)	-0,08526***	(0,00556)	0,14550***	(0,006132)	0,00113	(0,006872)
Newlight (yes = 1)	-0,07066***	(0,004137)	-0,08918***	(0,00227)	0,04771***	(0,002707)	-0,01621***	(0,002509)
Fieldrenovation (yes = 1)	-0,39109***	(0,010402)	-0,41301***	(0,00571)	-0,38001***	(0,005663)	-0,11336***	(0,006588)
Restaurant (yes = 1)	-0,10214***	(0,011424)	-0,23855***	(0,00639)	-0,04768***	(0,006680)	-0,08442***	(0,007003)
Monument (yes = 1)	0,16217***	(0,007806)	0,06670***	(0,00427)	0,19123***	(0,004583)	0,06725***	(0,005164)
Animals (yes = 1)	-0,05473***	(0,006456)	-0,19819***	(0,00361)	0,02459***	(0,004049)	-0,06509***	(0,004119)
Other (yes = 1)	-0,09086***	(0,004926)	-0,01536***	(0,00273)	-0,00529***	(0,003133)	-0,02637***	(0,002849)
Constant	11,05633***	(0,013576)	9,82061***	(0,00989)	9,66145*	(0,009596)	9,61847***	(0,008860)
Year fixed effects (26)	Yes		Yes		Yes		Yes	
House characteristics (17)	No		Yes		Yes		Yes	
Home type dummies (15)	No		Yes		Yes		Yes	
Building period dummies (8)	No		Yes		Yes		Yes	
Place fixed effects (5)	No		No		Yes		No	
Neighbourhood fixed effects (101)	No		No		No		Yes	
Observations	237.432		237.432		237.432		237.432	
R^2	25,67%		70,35%		72,91%		81,59%	
Adjusted R^2	25,66%		70,34%		72,90%		81,58%	

Note: Dependent variable is lnTransactionprice. The coefficients and standard errors of the control variables of column 4 can be found in table C3 in the appendix. * p<0,10, ** p<0,05, *** p<0,01.

Table 10: Correlation 10 park attributes

	Playground renovation	Playground replacement	Trail renovation	Court renovation	New light	Field renovation	Restaurant	Monument	Animals	Other
Playground renovation	1									
Playground replacement	0,4517	1								
Trail renovation	0,4434	0,9815	1							
Court renovation	0,0417	0,3252	0,3191	1						
New light	-0,0205	0,5920	0,581	0,1457	1					
Field renovation	0,4864	0,8912	0,9115	0,3501	0,6374	1				
Restaurant	0,9275	0,419	0,4112	-0,1311	0,0108	0,4512	1			
Monument	0,1624	0,6187	0,6073	-0,1936	0,5431	0,6663	0,2049	1		
Animals	0,6144	0,3749	0,368	0,092	0,0572	0,4037	0,4955	-0,0432	1	
Other	0,663	0,4511	0,4892	0,2883	-0,0616	0,5367	0,5843	0,2448	0,4588	1

4.2 Difference-in-difference

The second method, the difference-in-difference method is used because it can distinguish between multiple moments in time. Second, it can account for possible anticipation effects. Moreover, it reduces the risk of omitted variable bias. Firstly, the assumption of a similar target and control group is tested. Figure 4 shows the average house price of the target and control group over time. By plotting this graph, it is tested if the average house of the target area is similar to the control area. Since the effect of the park related urban renewal projects influences house prices, only the transactions before the start of the project can be considered. As the graph shows, till 2003 the averages are almost identical. From 2004 onward the average house price of the target group is less than the average transaction price of the control group, but moves up again in 2007. An explanation for this is not found. However, based on the almost identical average from 1990 till 2003, it is assumed that the target and control group are identical.

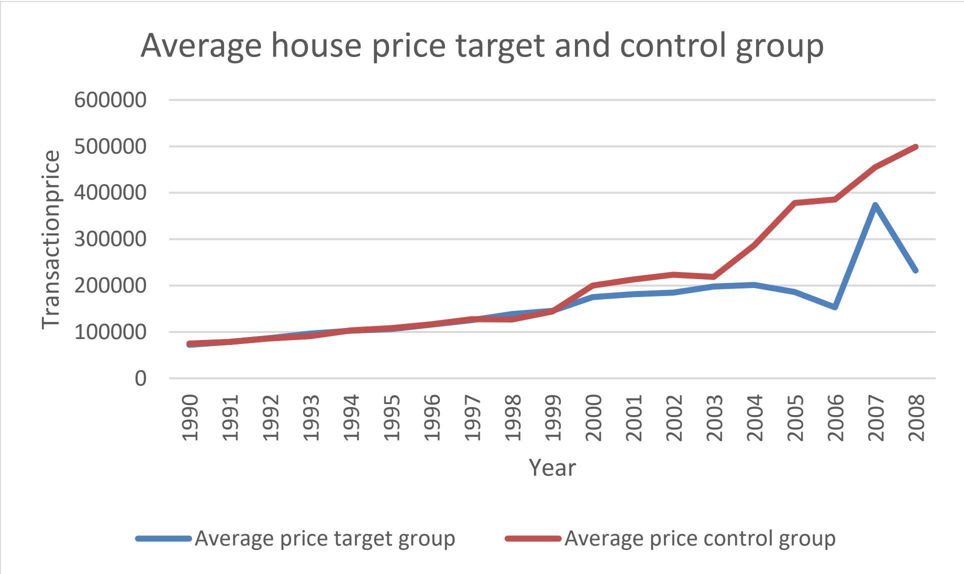

Figure 3: Average house price target and control group before the start of the project

Table 11 presents the results of the difference-in-difference method. The model is built up the same way as the hedonic regression method with firstly only year fixed effects (1), with property characteristics, but without location fixed effects (2), with place fixed effects (3) and with neighbourhood fixed effects (4). Again, an increasing R^2 indicated that more variation is explained by the model. The target variable indicated if a house is within 1500 metres from the project (yes) or within 1500 till 3000 metres (no). This variable is positive and significant indicating that houses closer to the park are sold for a higher price than houses further away. This effect is around 3.12%. This positive effect is in line with previous literature, which finds positive effects of parks and green areas on nearby house prices with a diminishing effect over space (Anderson & West, 2006; Bolitzer & Netusil, 2000; Daams et al., 2016). The variable Target*Between is positive and significant, indicating that during the start and completion of the project houses within 1500 metres are sold for 4.25% higher compared with houses within 1500

till 3000 metres from the project. The result of the Target*After variable, the variable of most interest for answering the hypothesis, shows a negative significant external effect of park renovations on nearby house prices of
-0,00750. This is equal to an effect of -0.747%. So, houses within 1500 metres from the project sold for 0.747% less compared with houses within 1500 till 3000 metres from the project after the completion of the project. The results of the complete model can be found in appendix C4. The result of the difference-in-difference method is contradicting with the findings of the hedonic regression model, which found a positive external effect. For both models, the influence radius is set to 1500 metres, so a difference in result is caused by the difference in methodology. Therefor the difference in both results is caused by the fact that the difference-in-difference method controls by using the control area. The hedonic regression method does not control for a control area. However, the results of the difference-in-difference method are in line with the results of Livy and Klaiber (2016) although they use a hedonic regression model instead of a difference-in-difference method. The results of both methods used in this thesis indicate that the external effect of park related urban renewal projects is not clear, because both negative and positive effects are found.

Table 11: Regression results difference-in-difference target area <1500

	1		2		3		4	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Target	-0,21303***	(0,006909)	-0,03550***	(0,004302)	-0,03741***	(0,003668)	0,03069***	(0,003837)
Target*D	0,00015***	(0,000061)	0,00007***	(0,000040)	0,00005***	(0,000031)	0,00000	(0,000030)
Target*Between	0,45303***	(0,012350)	0,25990***	(0,007545)	0,13138***	(0,006355)	0,04163***	(0,005555)
Target*Between*D	-0,00020***	(0,000013)	-0,00011***	(0,000071)	-0,00010***	(0,000060)	-0,00005***	(0,000051)
Target*After	0,05912***	(0,009561)	0,25990***	(0,005811)	0,00820***	(0,004854)	-0,00750*	(0,004285)
Target*After*D	-0,00007***	(0,000091)	-0,00002***	(0,000051)	-0,00002***	(0,000041)	0,00001***	(0,000040)
Constant	11,08160***	(0,016293)	9,75213***	(0,013522)	9,51137***	(0,011392)	9,49057***	(0,012045)
Year fixed effects (26)	Yes		Yes		Yes		Yes	
House characteristics (17)	No		Yes		Yes		Yes	
Home type dummies (15)	No		Yes		Yes		Yes	
Building period dummies (8)	No		Yes		Yes		Yes	
Place fixed effects (5)	No		No		Yes		No	
Neighbourhood fixed effects (101)	No		No		No		Yes	
Observations	140.205		140.205		140.205		140.205	
R^2	27,74%		73,70%		81,88%		87,78%	
Adjusted R^2	27,72%		73,69%		81,87%		87,77%	

Note: Dependent variable is lnTransactionprice. Target area defined as distance to nearest park <1500 metre, control area defined as distance to nearest park >=1500 metre and <3000 metre. The coefficients and standard errors of the control variables of column 4 can be found in table C4 in the appendix. * p<0,10, ** p<0,05, *** p<0,01.

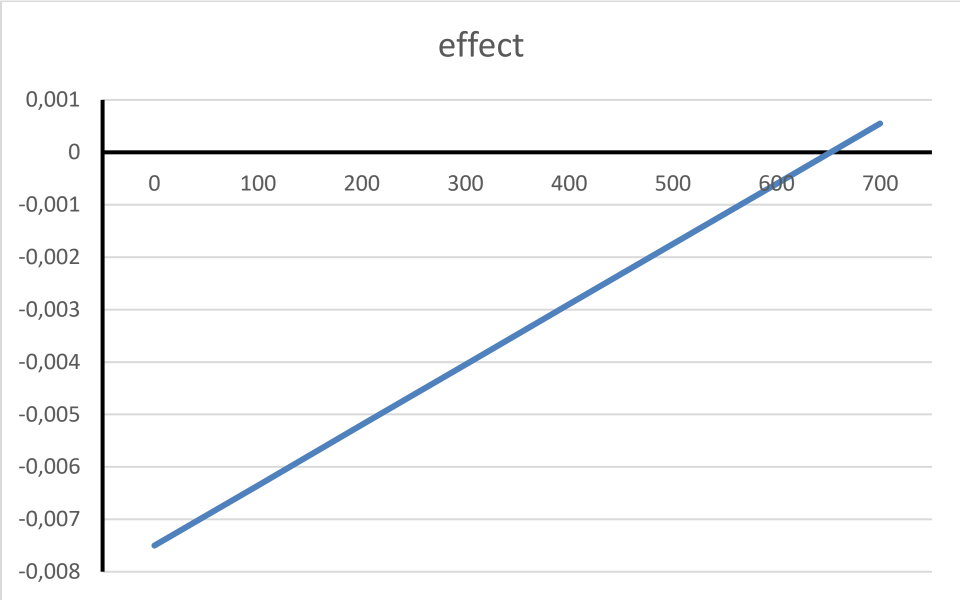

Figure 4: Distance decay effect after completion

The target area and control area of 1500 metres and 1500 till 3000 metres were set based on previous literature (Bolitzer & Netusil, 2002). The difference-in-difference model gives the possibility to calculate when the negative external effect of the Target*After variable is 0. By using the coefficients of the Target*After effect and its distance effect, the distance decay can be calculated. Assumed is that the effect diminishes over space linearly. This is graphically shown in figure 4. The graph shows that around 650 metres the negative external effect is 0, indicating that the target area could be set to 650 metres instead of 1500 metres. Table 12 presents the results of the regression where the target area is set to 700 metres and the control group is not changed. The results are similar to the ones with the target area of 1500 metres. The Target variable has an effect of 5.83%, the Target*Between variable has an effect of 6.65% and the Target*After variable an effect of -2.3%. The positive and negative signs are similar when the target area was set to 1500 metres, but the effects for the target area of 700 metres are larger. This is probably due to the fact that the target area is better defined now so the regression is better able to capture the external effect.

Table 12: Regression results difference-in-difference target area <700

	1		2		3		4	
Variable	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Target	-0,24787***	(0,010128)	-0,04613***	(0,006134)	-0,04328***	(0,005352)	0,05665***	(0,005707)
Target*D	0,00019***	(0,000024)	0,00010***	(0,000014)	0,00011***	(0,000012)	0,00002*	(0,000010)
Target*Between	0,53764***	(0,019054)	0,26148***	(0,011295)	0,15512***	(0,009529)	0,06435***	(0,007987)
Target*Between*D	-0,00039***	(0,000046)	-0,00013***	(0,000027)	-0,00020***	(0,000023)	-0,00019***	(0,000019)
Target*After	0,00655	(0,014156)	-0,04181***	(0,008359)	-0,02483***	(0,006982)	-0,02325***	(0,005831)
Target*After*D	0,00011***	(0,000034)	0,00006***	(0,000020)	0,00007***	(0,000017)	0,00004***	(0,000014)
Constant	11,17067***	(0,024330)	9,87048***	(0,019857)	9,64472***	(0,016791)	9,59162***	(0,015764)
Year fixed effects (26)	Yes		Yes		Yes		Yes	
House characteristics (17)	No		Yes		Yes		Yes	
Home type dummies (15)	No		Yes		Yes		Yes	
Building period dummies (8)	No		Yes		Yes		Yes	
Place fixed effects (5)	No		No		Yes		No	
Neighbourhood fixed effects (101)	No		No		No		Yes	
Observations	69.761		69.761		69.761		69.761	
R^2	27,15%		74,87%		82,83%		88,41%	
Adjusted R^2	27,12%		74,84%		82,52%		88,39%	

Note: Dependent variable is lnTransactionprice. Target area defined as distance to nearest park <700 metre, control area defined as distance to nearest park >=1500 metre and <3000 metre. The coefficients and standard errors of the control variables of column 4 can be found in table C4 in the appendix. * p<0,10, ** p<0,05, *** p<0,01.

4.3 Sensitivity analyses

To perform a Chow sensitivity test, the data set is split into two groups, one where the parks are larger than 20 hectares and one where the parks are smaller. Dy dividing by size the assumption of homogeneity between parks is released for a bit. The data is split according to table 13.

Table 13: Sample split

Group 1 (>20 ha)	Group 2 (<20 ha)
Vondelpark	Martin Luther King Park
Bijlmerpark/Nelson Mandelapark	Huijgenspark
Beatrixpark	Julianapark
	Park de Gagel
	Park de Watertoren
	Park Transwijk
	Den Uylpark
	Kronenburgerpark
	Park Presikhaaf
	Vechtzoompark

The Chow test is performed two times, one for the hedonic regression method where renovation is measured as a single measure and for the difference-in-difference method. The null hypothesis if the Chow test is that the intercept and slopes are identical for the two groups (Brooks & Tsolacos, 2010). The F-statistic for the hedonic regression method is 153,72 and the F-statistic for the difference-in-difference method is 242,96. For both Chow tests, the Chow F-statistic (169, 237064) and (174, 237084) do reject the null hypothesis, indicating that the model with the two groups performs better than the pooled model. The number of variables differs between the hedonic regression method and the difference-in-difference method because the hedonic regression method measures the effect as one variable called renovation, whereas the difference-in-difference method distinguishes between target, target between, target after and the distance decay of those three variables. So, the difference-in-difference method has 5 variables more than the hedonic regression method. Table 14 and 15 show the results for both groups of the two groups. As can be seen from the tables, the effects found by the pooled regressions are different from the ones found by the grouped models. For the hedonic regression method, the pooled results are largely driven by the larger parks. The effect for the larger parks is slightly higher than the results from the pooled model. The external effect of smaller parks is even negative. The larger parks in the difference-in-difference method have a positive significant external effect on house prices, whereas the pooled model and the smaller park show a negative significant effect. The positive results of the hedonic regression model are 1.728% and 3.17% for the difference-in-difference model. The negative effects found for the small parks is -0.0735% by the hedonic regression model and -4.09% by the difference-in-difference model.

Table 14: Grouped results hedonic regression model (specification 4 only)

	Large parks		Small parks	
Variable	Coef.	Std. Err.	Coef.	Std. Err.
Renovation	0,01714***	(0,003859)	-0,00706***	(0,002454)
Constant	10,17522***	(0,022973)	9,56837***	(0,010429)
Year fixed effects (26)	Yes		Yes	
House characteristics (17)	Yes		Yes	
Home type dummies (15)	Yes		Yes	
Building period dummies (8)	Yes		Yes	
Place fixed effects (5)	No		No	
Neighbourhood fixed effects (101)	Yes		Yes	
Observations	64.044		155.308	
R^2	87,70%		87,09%	
Adjusted R^2	87,68%		87,08%	

Table 15: Grouped results difference-in-difference model (specification 4 only)

	Large parks		Small parks	
Variable	Coef.	Std. Err.	Coef.	Std. Err.
Target	0,04647***	(0,008676)	0,02588***	(0,004782)
Target*D	0,00006	(0,000080)	-0,00009**	(0,000040)
Target*Between	0,06236***	(0,010198)	-0,01248	(0,007878)
Target*Between*D	-0,00008***	(0,000091)	0,00003***	(0,000080)
Target*After	0,03117***	(0,009958)	-0,04179***	(0,004994)
Target*After*D	-0,00003***	(0,000091)	0,00005***	(0,000041)
Constant	9,50246***	(0,067248)	9,53337***	(0,013801)
Year fixed effects (26)	Yes		Yes	
House characteristics (17)	Yes		Yes	
Home type dummies (15)	Yes		Yes	
Building period dummies (8)	Yes		Yes	
Place fixed effects (5)	No		No	
Neighbourhood fixed effects (101)	Yes		Yes	
Observations	37.207		86.447	37.207
R^2	88,84%		87,65%	88,84%
Adjusted R^2	88,82%		87,63%	88,82%

5. Conclusion & Discussion

This thesis studied the external effects of park related urban renewal projects by looking at 13 park renovations between 1999 and 2011 in six different Dutch cities. Two methods where used in order to compare with already existing studied and to compare the results found. Based on a hedonic regression method a positive external effect of park related urban renewal projects of 1.156% is found. Comparing this with the study of Livy and Klaiber (2016) shows that their results, a negative effect, is opposing with the results of this thesis. However, using park renovations as a single measure is just a way to compare with other studies. Livy and Klaiber argue that when using park renovations as a single measure the heterogeneity of parks and park renovations is ignored. Therefore, differentiating by park attributes is more important and provides more reliable results (Livy & Klaiber, 2016). When differentiating by park attributes, positive external effects of playground renovation and trail renovation is found. Negative external effects are found for playground replacement, court renovation, field renovation and new lights. These results are also different from Livy and Klaiber (2016), who finds positive results for playground replacement, trail renovation and court renovation, but a negative result of new lighting. The interesting attributes are playground replacement, which is found negative in this thesis, but positive by Livy and Klaiber (2016) and court renovation, which is found negative in this thesis and positive by Livy and Klaiber (2016). No clear answer why these differences between the paper of Livy and Klaiber (2016) and this thesis occur can be given. It might be caused by the fact that for certain parks the renovation is not an upgrade but a downgrade or the new attribute creates more nuisance.

To check the results of the hedonic regression method a difference-in-difference method is used. This method distinguishes between a target and a control area and by the timing period during the renovation and after the renovation. By using this method this thesis finds negative external effects of -0.747%, indicating that houses within 1500 metres from the park which are sold after the completion of the renovation are sold for 0.747% lower than houses within 1500 till 3000 metres from the renovation. This result contradicts with the findings of the hedonic regression method. The hedonic regression method finds a positive effect, while the difference-in-difference method finds a negative effect. By calculating the distance decay, it is found that around 650 metres from the park the effect is 0. When the target group is set to 700 metres and the control group remains the same the effect becomes larger with -2.3%. Because Livy and Klaiber (2016) used a hedonic regression, it is not possible to compare the results from the difference-in-difference method on-to-one to Livy and Klaiber (2016). But the results of the two methods can tell us something about the effects of park related urban renewal projects. The result of -2.3% by the difference-in-difference method where the target area is set to 700 metres contradicts the results of the hedonic regression, which found a positive result. Livy and Klaiber (2016) argued that the effect of park renovation is negative, which is supported by the results of the difference-in-difference method. The different results from the hedonic regression and the difference-in-difference may be

caused by the fact that the two methods are different. The results indicate that the true external effects of park related urban renewal projects are hard to measure and that the effects are debatable.
To check the robustness of both models the data is split in large parks and small parks. The Chow test indicated that the split model performs better than the pooled model. When performing both models again, but now for the large parks and small parks separately, positive external effect of larger parks are found by both methods. The hedonic regression method indicated an effect of 1.728% and the difference-in-difference method an effect of 3.17%. Both models found negative external effects of small parks, -0.0735% for the hedonic regression method and -4.09% for the difference-in-difference method. So positive effects are found for larger parks and negative effects for smaller parks. This result indicates that the pooled hedonic regression model is driven by the larger parks, whereas the difference-in-difference method is driven by the smaller parks.
Based on the results, the first hypothesis, park related urban renewal projects have a significant positive external effect on nearby house prices when the park related urban renewal project is treated as a single measure, cannot be clearly confirmed or rejected. Both positive effects, by the hedonic regression method, as well as negative effects, by the difference-in-difference method, are found. The Chow test and regressions which followed from the outcome of the Chow test indicate that the hypothesis can be confirmed for large parks and rejected for small parks. The second hypothesis, positive external effects of playground replacement, trail renovation and court renovation and a negative effect of new lighting on house prices, can be partly confirmed and partly rejected. In accordance with the hypothesis this thesis found a positive effect of trail renovation and a negative effect of new lighting. The positive effects of playground replacement and court renovation is not found, so this part of the hypothesis is rejected.

To understand the effects of park related urban renewal projects more studies are necessary. First of all, this study only covers the quantitative aspect, whereas qualitative aspects of parks also play a role. It may be that the way a neighbourhood feels about a renovation, if they like the renewed park or had more feeling with the old park, is represented in house prices. Second, catchment areas for the hedonic regression method and target and control areas for the difference-in-difference method may overlap when parks are located close to each other. In this thesis this is solved by only considering the effect of the nearest park renovation. It would be better if one is able to differentiate between the effects of multiple parks when these catchment areas or target and control areas overlap. Next to that, the methods used have assumptions which never holds in reality. Firstly, the 13 park related urban renewal projects are used as one, assuming that these projects are homogenous. In reality this is not true, because every project and every park is different. Second, for the difference-in-difference it is preferable that the target and control area are similar in every way, except for the park related urban renewal project. If the project did not happen, both areas should develop identically if this assumption holds. This is tested by graphing the average transaction price of the target and control group of those houses sold before the project started. Only those houses sold before the start of a project are considered, otherwise the renewal projects already plays a role. This graphing assumes that transaction prices are a representation of the situation of the location of the property and that by looking at the development of house prices the development of an area can be seen. This is not necessarily the case, because not everything is represented by a transaction price, but it gives an idea if both areas are similar in terms of the dependent variable of the hedonic regression and the difference-in-difference.

This thesis has a clear policy relevance. The results of this thesis show that park related urban renewal projects do not by definition have a positive external effect on nearby house prices. A positive effect is only demonstrated for large parks and not for small parks. This might influence policy makers in their decision about which parks receive money in order to perform a renovation. However, park renovation could have other effects which are positive on the vicinity but are not captured by house prices and therefor not studied in this thesis.

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APPENDIX A: Park related urban renewal projects

Almere

- Beatrixpark
- Den Uylpark

Amsterdam

- Martin Luther King Park
- Vondelpark
- Bijlmerpark/Nelson Mandelapark

Arnhem

- Park Presikhaaf

Nijmegen

- Kronenburgerpark

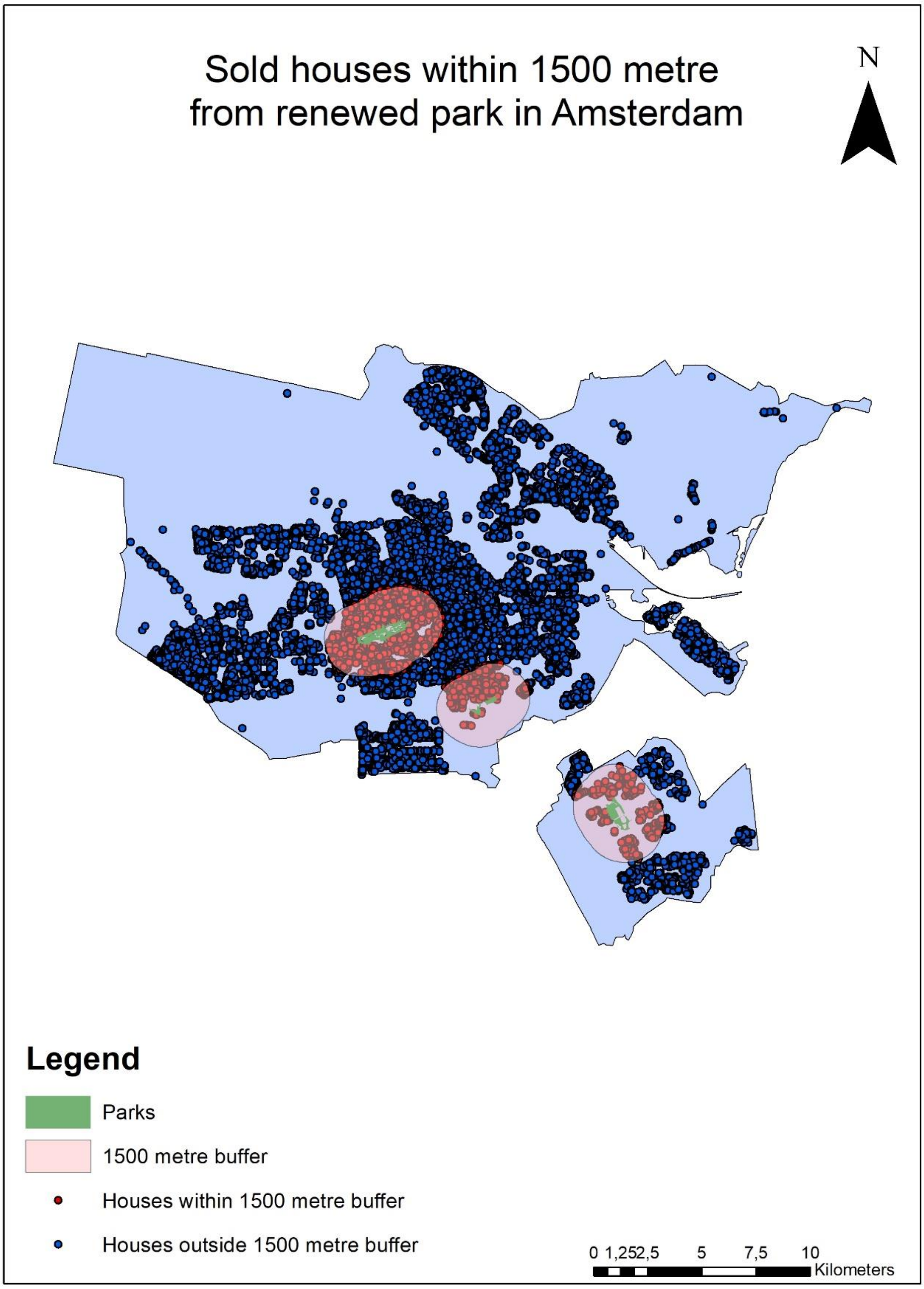
The Hague

- Huijgenspark

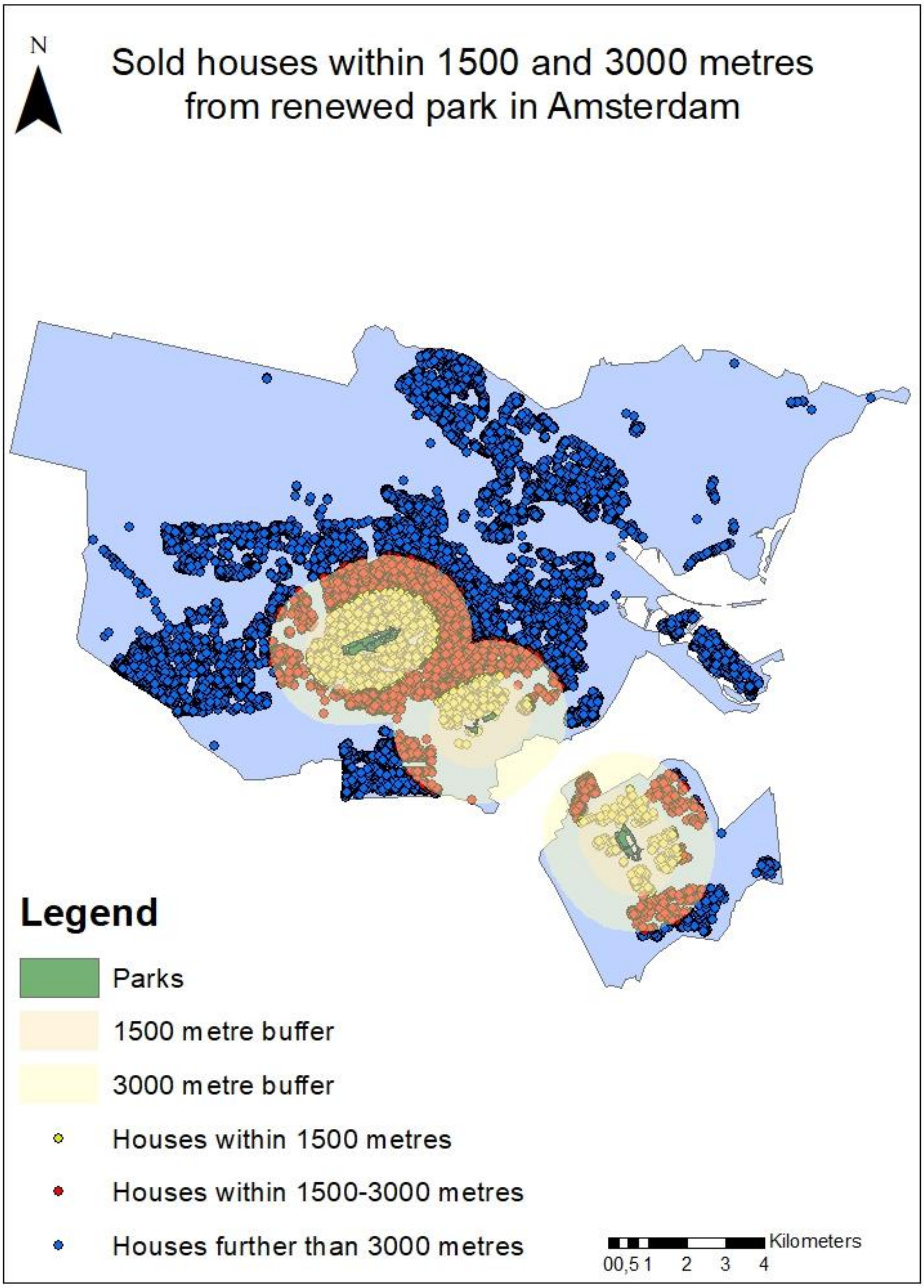
Utrecht

- Julianapark
- Park de Gagel
- Watertorenpark
- Park Transwijk
- Vechtzoompark

Appendix B: Maps of Amsterdam and



Map B1: Sold houses within 1500 metres from a renewed park in Amsterdam



Map B2: Sold houses within 1500 and 3000 metres for a renewed park in Amsterdam

Appendix C: Complete regression results

Table C1: Complete results hedonic regression renovation single measure (specification 4 only)

Variable	Coef.	Std. Err.	Variable	Coef.	Std. Err.
Renovation (yes = 1)	0,01149***	(0,001705)	Bathrooms	0,04145***	(0,001121)
Livingsize	0,00583***	(0,000018)	Indoorparking	0,07114***	(0,002367)
Elevators	0,08981***	(0,001536)	Qualityoutdoormainenance	0,01734***	(0,000613)
Floors	-0,00839***	(0,000959)	Qualityindoormaintenance	0,04352***	(0,000480)
Rooms	0,02569***	(0,000515)	Monument	0,08734***	(0,003640)
Attic	0,00066	(0,001552)	Hometype 5 (ref: Hometype 2)	0,04705***	(0,003261)
Loft	0,01139***	(0,002259)	Hometype 6	0,04705***	(0,009428)
Balconies	0,01471***	(0,001016)	Hometype 7	0,08823***	(0,003669)
Dormerwindow	0,04119***	(0,001637)	Hometype 8	0,12964***	(0,019316)
Roofterrace	0,04967***	(0,001478)	Hometype 9	0,28511***	(0,006324)
Kitchens	-0,02448***	(0,001121)	Hometype 10	0,27562***	(0,004977)
Sculleries	0,06113***	(0,001912)	Hometype 11	0,33937***	(0,018036)
Toilets	0,00396***	(0,000324)	Hometype 12	0,46402**	(0,207015)
Building period 2 (ref: Building period 1)	-0,03165***	(0,001885)	Hometype 21	0,00888*	(0,003604)
Building period 3	-0,03542***	(0,002233)	Hometype 22	-0,10040***	(0,003507)
Building period 4	-0,04436***	(0,002478)	Hometype 23	-0,07723***	(0,004013)
Building period 5	-0,14298***	(0,002460)	Hometype 24	-0,13829***	(0,003617)
Building period 6	-0,09009***	(0,002711)	Hometype 25	-0,17486***	(0,003786)
Building period 7	-0,02820***	(0,002329)	Hometype 26	-0,62509***	(0,015318)
Building period 8	0,06139***	(0,002228)	Hometype 27	0,03434***	(0,005718)
Building period 9	0,05861***	(0,002495)	Constant	9,56573***	(0,008771)
Observations	237.432				
R^2	86,95%				
Adjusted R^2	86,94%				

Note: Dependent variable is lnTransactionprice. * p<0,10, ** p<0,05, *** p<0,01.

Table C2: Complete results hedonic regression 7 park attributes (specification 4 only)

Variable	Coef.	Std. Err.	Variable	Coef.	Std. Err.
Playgroundrenovation (yes = 1)	0,21108***	(0,005653)	Kitchens	-0,020413***	(0,001121)
Playgroundreplacement (yes = 1)	-0,07870***	(0,009219)	Sculleries	0,061977***	(0,001902)
Trailrenovation (yes = 1)	0,10917***	(0,009369)	Toilets	0,003435***	(0,000323)
Courtrenovation (yes = 1)	0,00113***	(0,006872)	Bathrooms	0,041607***	(0,001116)
Newlight (yes = 1)	-0,01621***	(0,002509)	Indoorparking	0,070712***	(0,002355)
Fieldrenovation (yes = 1)	-0,11336***	(0,006588)	Qualityoutdoormainenance	0,017519***	(0,000610)
Other (yes = 1)	-0,08442	(0,007003)	Qualityindoormaintenance	0,043385***	(0,000478)
Livingsize	-0,03256***	(0,002310)	Monument	0,087510***	(0,003622)
Elevators	0,09020***	(0,001529)	Hometype 5 (ref: Hometype 2)	0,043689***	(0,003246)
Floors	-0,00735***	(0,000955)	Hometype 6	0,040024***	(0,009380)
Rooms	0,02539***	(0,000512)	Hometype 7	0,082325***	(0,003653)
Attic	-0,00254	(0,001547)	Hometype 8	0,125773***	(0,019216)
Loft	0,01232***	(0,002248)	Hometype 9	0,279843***	(0,006293)
Balconies	0,01517***	(0,001012)	Hometype 10	0,270377***	(0,004953)
Dormerwindow	0,04290***	(0,001629)	Hometype 11	0,336106***	(0,017943)
Roofterrace	0,04925***	(0,001471)	Hometype 12	0,480445**	(0,205991)
Building period 2 (ref: Building period 1)	0,06725***	(0,005164)	Hometype 21	0,004053	(0,003587)
Building period 3	-0,06509***	(0,004119)	Hometype 22	-0,106810***	(0,003492)
Building period 4	-0,02637***	(0,002849)	Hometype 23	-0,080920***	(0,003995)
Building period 5	-0,03171***	(0,001866)	Hometype 24	-0,141228***	(0,003601)
Building period 6	-0,03623***	(0,002211)	Hometype 25	-0,175842***	(0,003771)
Building period 7	-0,04650***	(0,002455)	Hometype 26	-0,628557***	(0,015243)
Building period 8	-0,14587***	(0,002440)	Hometype 27	0,029593***	(0,005690)
Building period 9	-0,09434***	(0,002686)	Constant	9,593876***	(0,008816)
Observations	237.432				
R^2	87,08%				
Adjusted R^2	87,07%				

Note: Dependent variable is lnTransactionprice. * p<0,10, ** p<0,05, *** p<0,01.

Table C3: Complete results hedonic regression 10 park attributes (specification 4 only)

Variable	Coef.	Std. Err.	Variable	Coef.	Std. Err.
Playgroundrenovation (yes = 1)	0,21108***	(0,005653)	Roofterrace	0,04828***	(0,001464)
Playgroundreplacement (yes = 1)	-0,07870***	(0,009219)	Kitchens	-0,02358***	(0,001118)
Trailrenovation (yes = 1)	0,10917***	(0,009369)	Sculleries	0,06172***	(0,001892)
Courtrenovation (yes = 1)	0,00113	(0,006872)	Toilets	0,00391***	(0,000322)
Newlight (yes = 1)	-0,01621***	(0,002509)	Bathrooms	0,04048***	(0,001111)
Fieldrenovation (yes = 1)	-0,11336***	(0,006588)	Indoorparking	0,07026***	(0,002344)
Restaurant (yes = 1)	-0,08442***	(0,007003)	Qualityoutdoormainenance	0,01792***	(0,000607)
Monument (yes = 1)	0,06725***	(0,005164)	Qualityindoormaintenance	0,04335***	(0,000475)
Animals (yes = 1)	-0,06509***	(0,004119)	Monument	0,08707***	(0,003604)
Other (yes = 1)	-0,02637***	(0,002849)	Hometype 5 (ref: Hometype 2)	0,03941***	(0,003234)
Livingsize	0,00584***	(0,000018)	Hometype 6	0,03542***	(0,009335)
Elevators	0,09016***	(0,001521)	Hometype 7	0,07580***	(0,003641)
Floors	-0,00623***	(0,000951)	Hometype 8	0,11756***	(0,019123)
Rooms	0,02620***	(0,000510)	Hometype 9	0,27544***	(0,006263)
Attic	-0,00782***	(0,001546)	Hometype 10	0,26533***	(0,004932)
Loft	0,01083***	(0,002237)	Hometype 11	0,32897***	(0,017856)
Balconies	0,01346***	(0,001007)	Hometype 12	0,45886**	(0,204977)
Dormerwindow	0,04285***	(0,001621)	Hometype 21	0,00104	(0,003572)
Building period 2 (ref: Building period 1)	-0,03171***	(0,001866)	Hometype 22	-0,11069***	(0,003478)
Building period 3	-0,03623***	(0,002211)	Hometype 23	-0,08197***	(0,003978)
Building period 4	-0,04650***	(0,002455)	Hometype 24	-0,13969***	(0,003586)
Building period 5	-0,14587***	(0,002440)	Hometype 25	-0,17290***	(0,003756)
Building period 6	-0,09434***	(0,002686)	Hometype 26	-0,62496***	(0,015170)
Building period 7	-0,03256***	(0,002310)	Hometype 27	0,02327***	(0,005664)
Building period 8	0,05989***	(0,002208)	Constant	9,61847***	(0,008860)
Building period 9	0,06158***	(0,002481)			
Observations	237.432				
R^2	81,59%				
Adjusted R^2	81,58%				

Note: Dependent variable is lnTransactionprice. * p<0,10, ** p<0,05, *** p<0,01.

Table C4: Complete results difference-in-difference (specification 4 only)

Variable	Coef.	Std. Err.	Variable	Coef.	Std. Err.
Target	0,03069***	(0,003837)	Kitchens	-0,03257***	(0,001453)
Target*D	0,00000	(0,000030)	Sculleries	0,04588***	(0,002554)
Target*Between	0,04163***	(0,005555)	Toilets	0,00576***	(0,000421)
Target*Between*D	-0,00005***	(0,000051)	Bathrooms	0,03988***	(0,001440)
Target*After	-0,00750*	(0,004285)	Indoorparking	0,07007***	(0,003570)
Target*After*D	0,00001***	(0,000040)	Qualityoutdoormainenance	0,02024***	(0,000782)
Livingsize	0,00583***	(0,000023)	Qualityindoormaintenance	0,04589***	(0,000616)
Elevators	0,07771***	(0,002076)	Monument	0,08401***	(0,004035)
Floors	-0,00482***	(0,001209)	Hometype 5 (ref: Hometype 2)	0,05490***	(0,004069)
Rooms	0,02767***	(0,000680)	Hometype 6	0,02440**	(0,010388)
Attic	-0,00325	(0,002139)	Hometype 7	0,06982***	(0,004658)
Loft	0,00941***	(0,002976)	Hometype 8	0,10786***	(0,030465)
Balconies	0,01908***	(0,001294)	Hometype 9	0,29718***	(0,010102)
Dormerwindow	0,03449***	(0,002181)	Hometype 10	0,31223***	(0,007534)
Roofterrace	0,05780***	(0,001901)	Hometype 11	0,39747***	(0,031702)
Building period 2 (ref: Building period 1)	-0,02989***	(0,002096)	Hometype 21	0,02232***	(0,004418)
Building period 3	-0,02815***	(0,002570)	Hometype 22	-0,07771***	(0,004308)
Building period 4	-0,03759***	(0,003024)	Hometype 23	-0,06607***	(0,005189)
Building period 5	-0,15743***	(0,003147)	Hometype 24	-0,11780***	(0,004468)
Building period 6	-0,10355***	(0,003820)	Hometype 25	-0,14781***	(0,004716)
Building period 7	-0,05066***	(0,002918)	Hometype 26	-0,66452***	(0,023845)
Building period 8	0,06100***	(0,002725)	Hometype 27	0,04204***	(0,007297)
Building period 9	0,06565***	(0,003274)	Constant	9,49057***	(0,012045)
Observations	140.205				
R^2	87,78%				
Adjusted R^2	87,77%				

Note: Dependent variable is lnTransactionprice. Target area defined as distance to nearest park <1500 metre, control area defined as distance to nearest park >=1500 metre and <3000 metre. * p<0,10, ** p<0,05, *** p<0,01.

Appendix D: Linear regression assumptions tested

Assumption 1: Average value of the errors is zero.

The hedonic regression model and the difference-in-difference model have a constant, so this assumption is never violated (Brooks & Tsolacos, 2010).

Assumption 2: The variance of the errors is constant; homoscedasticity.

Homoscedasticity is tested by the Breusch-Pagan / Cook-Weisberg test for heteroskedasticity with the command *estat hettest* in STATA. The null hypothesis is that the of a constant variance. The probability>chi2 is smaller than 0,01 which means there is evidence of heteroscedasticity in the hedonic regression model. For the difference-in-difference model also a probability>chi2 lower than 0,01 is found. This heteroscedasticity indicates that the coefficients are stull unbiased and consistent, but they no longer have the minimum variance among the class of unbiased estimators (Brooks & Tsolacos, 2010).

Assumption 3: The errors are statistically independent of one another.

To test this assumption the Breusch-Godfrey test is used, which is a more general test than the Durbin-Watson test which only looks at the first lag. The BG tests find no evidence of autocorrelation in the hedonic regression model and the difference-in-difference model.

Assumption 4: There is no relationship between the error and corresponding x variable.

Because assumption 1 hold for both the hedonic regression model and the difference-in-difference model, assumption 4 can be rewritten as the error and corresponding x variable have zero mean. Since this is the case for both model assumption 4 holds.

Assumption 5: u is normally distributed

By performing the Bera-Jarque test for normality, which uses the skewness and kurtosis, it is found that the hedonic regression model and the difference-in-difference model do not hold the normality assumption. However, Brooks and Tsolacos (2010) argue that this is not a big problem if the data set is sufficiently large, which it is in this case.

Appendix E: Bookkeeping data

drop if Buildingperiod==0	32.126 cases deleted
drop if Livingsize ==99999 & Livingsizecorrected ==0	12.819 cases deleted
drop if Livingsize ==1 & Livingsizecorrected ==0	475 cases deleted
copy data livingsize into livingsizecorrected if livingsizecorrected==0	
drop if Livingsizecorrected>8600	113 cases deleted
drop if Content>6400	4.714 cases deleted
drop if Lotsize>67950	981 cases deleted
drop if Lotsize==9999	489 cases deleted
gen lnlivingsize=ln(Livingsizecorrected)	
drop if lnlivingsize<3	654 cases deleted
drop if lnlivingsize>6	870 cases deleted
gen lntransactionprice=ln(Transactionprice)	
drop if lntransactionprice<9	0 cases deleted
drop if lntransactionprice>15	26 cases deleted
drop if Floors==0	1 case deleted
drop if Rooms==0	1.660 cases deleted
gen dup = cond(_N==1,0,_n)	
drop if dup>1	119.599 cases deleted
drop if transpm2>7500	417 cases deleted
drop if Livingsize==99999	15.094 cases deleted
drop if Livingsize==1	448 cases deleted
drop if Livingsize==999	33 cases deleted
drop if Originalaskingprice>2000000	114 cases deleted
drop if Transactionprice>2000000	5 cases deleted
drop if Rooms>20	6 cases deleted

Appendix F: Do file*

```
drop if Buildingperiod==0
drop if Livingsize ==99999 &  Livingsizecorrected ==0
drop if Livingsize ==1 &  Livingsizecorrected ==0
drop if Livingsizecorrected>8600
drop if Content>6400
drop if Lotsize>67950
drop if Lotsize==9999
gen lnlivingsize=ln(Livingsizecorrected)
drop if lnlivingsize<3
drop if lnlivingsize>6
replace Type=6 if Type==-1
replace House=7 if House==-1
replace Housesort=13 if Housesort==-1
replace Housecharacteristic=6 if Housecharacteristic==-1
gen lntransactionprice=ln(Transactionprice)
drop if lntransactionprice<9
drop if lntransactionprice>15
replace Openporch=0 if Openporch==-1
drop if Floors==0
drop if Rooms==0
replace Groundlease=0 if Groundlease==-1
unab vlist : Streetname Housenumber Housenumberaddition
sort `vlist' Streetname Housenumber Housenumberaddition
quietly by `vlist' Streetname Housenumber Housenumberaddition :  gen dup = cond(_N==1,0,_n)
drop if dup>1
gen transpm2=Transactionprice/Livingsizecorrected
drop if transpm2>7500
drop if Livingsize==99999
drop if Livingsize==1
drop if Livingsize==999
drop if Originalaskingprice>2000000
drop if Transactionprice>2000000
drop if Rooms>20
split Unsubscribedate, gen(date) ignore("-") parse("-") destring
gen Year1 = substr(date3, 1,4)
```

```
gen Year2 = substr(date1, 6,7)
gen Year3 = substr(Year2, 1,4)
replace Year3="1995" if Year3=="995 "
replace Year3="1996" if Year3=="996 "
replace Year3="1997" if Year3=="997 "
replace Year3="1998" if Year3=="998 "
replace Year3="1999" if Year3=="999 "
replace Year3="2016" if Year3=="016 "
replace Year3="2015" if Year3=="015 "
replace Year3="2014" if Year3=="014 "
replace Year3="2013" if Year3=="013 "
replace Year3="2012" if Year3=="012 "
replace Year3="2011" if Year3=="011 "
replace Year3="2010" if Year3=="010 "
replace Year3="2009" if Year3=="009 "
replace Year3="2008" if Year3=="008 "
replace Year3="2007" if Year3=="007 "
replace Year3="2006" if Year3=="006 "
replace Year3="2005" if Year3=="005 "
replace Year3="2004" if Year3=="004 "
replace Year3="2003" if Year3=="003 "
replace Year3="2002" if Year3=="002 "
replace Year3="2001" if Year3=="001 "
replace Year3="2000" if Year3=="000 "
replace Year3="1999" if Year3=="/199"
replace Year3="2000" if Year3=="/200"
replace Year3="2001" if Year3=="/201"
drop Year2
gen Year=Year1+Year2
drop Year1
drop Year2
gen month2 = substr(date1, 3,4)
gen Month3 = substr(month2, 1,3)
drop month2
gen month_num=month(date(Month3,"M"))
drop month_num
gen Month5 = substr(date1, 1,2)
```

```
replace Month5="1" if Month5=="1/"
replace Month5="2" if Month5=="2/"
replace Month5="3" if Month5=="3/"
replace Month5="4" if Month5=="4/"
replace Month5="5" if Month5=="5/"
replace Month5="6" if Month5=="6/"
replace Month5="7" if Month5=="7/"
replace Month5="8" if Month5=="8/"
replace Month5="9" if Month5=="9/"
drop Month3
drop Month5
replace Month1=0 if Month1==.
drop date1
drop Month1
destring (Month), gen (Month1)
destring (Year), gen (Year1)
drop Year
drop Month
drop Livingsize
rename Livingsizecorrected Livingsize
replace Place="UTRECHT" if Place=="DE MEERN"
replace Place="NIJMEGEN" if Place=="LENT"
replace Place="UTRECHT" if Place=="VLEUTEN"
replace Place="UTRECHT" if Place=="HAARZUILENS"
```

At this point the do* file is duplicated for both methods. This creates two do* files with a common base (the codes above) but different models.

Continuation do* file hedonic regression method

```
generate byte Renovation = NEAR_FC=="Kronenburgerpark" & Year>2006 & NEAR_DIST<= 1500 | NEAR_FC=="Park Presikhaaf" & Year>2007 & NEAR_DIST<= 1500 | NEAR_FC=="Beatrixpark" & Year>2002 & Year>2007 & NEAR_DIST<= 1500 | NEAR_FC=="Den_Uylpark" & Year>2004 & Year>2007 & NEAR_DIST<= 1500 | NEAR_FC=="Huijgenspark" & Year>2002 & Year>2007 & NEAR_DIST<= 1500 | NEAR_FC=="Julianapark" & Year>2004 & Year>2007 & NEAR_DIST<= 1500 | NEAR_FC=="Martin_Luther_King_Park" & Year>2005 & Year>2007 & NEAR_DIST<= 1500 | NEAR_FC=="Park_Tranwijk" & Year>2005 & Year>2007 & NEAR_DIST<= 1500 | NEAR_FC=="Park_de_Gagel" & Year>2005 & Year>2007 & NEAR_DIST<= 1500 | NEAR_FC=="Park_de_Watertoren" & Year>2006 & Year>2007 & NEAR_DIST<= 1500 |
```

NEAR_FC=="Vechtzoompark" & Year>2006 | NEAR_FC=="Vondelpark" & Year>2010 & Year>2007 & NEAR_DIST<= 1500 | NEAR_FC=="Nelson_Mandela_Park" & Year>2011 & Year>2007 & NEAR_DIST<= 1500

xi: reg lntransactionprice Renovation i.Year
xi: reg lntransactionprice Renovation i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.Year
xi: reg lntransactionprice Renovation i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.Place i.Year
xi: reg lntransactionprice Renovation i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.District i.Year

generate byte Playgroundrenovation1 = NEAR_FC=="Vondelpark" | NEAR_FC=="Julianapark" | NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Kronenburgerpark"
generate byte Playgroundreplacement1 = NEAR_FC=="Vondelpark" | NEAR_FC=="Julianapark" | NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Kronenburgerpark" | NEAR_FC=="Martin_Luther_King_Park" | NEAR_FC=="Nelson_Mandela_Park" | NEAR_FC=="Huijgenspark" | NEAR_FC=="Beatrixpark" | NEAR_FC=="Park_de_Gagel" | NEAR_FC=="Park_Transwijk" | NEAR_FC=="Den_Uylpark" | NEAR_FC=="Park Presikhaaf" | NEAR_FC=="Park_Transwijk"
generate byte Trailrenovation1 = NEAR_FC=="Vondelpark" | NEAR_FC=="Julianapark" | NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Kronenburgerpark" | NEAR_FC=="Martin_Luther_King_Park" | NEAR_FC=="Nelson_Mandela_Park" | NEAR_FC=="Huijgenspark" | NEAR_FC=="Beatrixpark" | NEAR_FC=="Park_de_Gagel" | NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Den_Uylpark" | NEAR_FC=="Park Presikhaaf" | NEAR_FC=="Vechtzoompark" | NEAR_FC=="Park_Transwijk"
generate byte Courtrenovation1 = NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Park_Transwijk" | NEAR_FC=="Beatrixpark" | NEAR_FC=="Park Presikhaaf"
generate byte Newlight1 = NEAR_FC=="Huijgenspark" | NEAR_FC=="Beatrixpark" | NEAR_FC=="Kronenburgerpark"
generate byte Fieldrenovation1 = NEAR_FC=="Vondelpark" | NEAR_FC=="Julianapark" | NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Kronenburgerpark" | NEAR_FC=="Nelson_Mandela_Park" | NEAR_FC=="Huijgenspark" | NEAR_FC=="Beatrixpark" |

```
NEAR_FC=="Park_de_Gagel" | NEAR_FC=="Park_Transwijk" | NEAR_FC=="Den_Uylpark" | NEAR_FC=="Park Presikhaaf" | NEAR_FC=="Vechtzoompark" | NEAR_FC=="Park_Transwijk"
generate byte Other1 = NEAR_FC=="Vondelpark" | NEAR_FC=="Julianapark" | NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Kronenburgerpark" | NEAR_FC=="Martin_Luther_King_Park" | NEAR_FC=="Huijgenspark" | NEAR_FC=="Park_de_Gagel" | NEAR_FC=="Park_Transwijk" | NEAR_FC=="Den_Uylpark" | NEAR_FC=="Park Presikhaaf" | NEAR_FC=="Vechtzoompark" | NEAR_FC=="Park_Transwijk"
generate byte Eventarea1 = NEAR_FC=="Martin_Luther_King_Park" | NEAR_FC=="Park_Transwijk"
generate byte Restaurant1 = NEAR_FC=="Vondelpark" | NEAR_FC=="Julianapark" | NEAR_FC=="Kronenburgerpark"
generate byte Monument12 = NEAR_FC=="Vondelpark" | NEAR_FC=="Huijgenspark" | NEAR_FC=="Park_de_Gagel" | NEAR_FC=="Den_Uylpark"
generate byte Animals1 = NEAR_FC=="Julianapark" | NEAR_FC=="Park_de_Gagel" | NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Den_Uylpark" | NEAR_FC=="Kronenburgerpark"
generate byte Other12 = NEAR_FC=="Vondelpark" | NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Vechtzoompark" | NEAR_FC=="Den_Uylpark" | NEAR_FC=="Kronenburgerpark" | NEAR_FC=="Park Presikhaaf"

gen Playgroundrenovation= Renovation*Playgroundrenovation1
gen Playgroundreplacement= Renovation*Playgroundreplacement1
gen Trailrenovation= Renovation*Trailrenovation1
gen Courtrenovation= Renovation*Courtrenovation1
gen Newlight= Renovation*Newlight1
gen Fieldrenovation= Renovation*Fieldrenovation1
gen Other= Renovation*Other1
gen Eventarea= Renovation*Eventarea1
gen Restaurant= Renovation*Restaurant1
gen Monument2= Renovation*Monument12
gen Animals= Renovation*Animals1
gen Other2= Renovation*Other12

xi: reg lntransactionprice Playgroundrenovation Playgroundreplacement Trailrenovation Courtrenovation Newlight Fieldrenovation Other i.Year
xi: reg lntransactionprice Playgroundrenovation Playgroundreplacement Trailrenovation Courtrenovation Newlight Fieldrenovation Other i.Buildingperiod Livingsize i.Homesort Elevators
```

Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.Year

xi: reg lntransactionprice Playgroundrenovation Playgroundreplacement Trailrenovation Courtrenovation Newlight Fieldrenovation Other i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.Place i.Year

xi: reg lntransactionprice Playgroundrenovation Playgroundreplacement Trailrenovation Courtrenovation Newlight Fieldrenovation Other i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.District i.Year

xi: reg lntransactionprice Playgroundrenovation Playgroundreplacement Trailrenovation Courtrenovation Newlight Fieldrenovation Restaurant Monument2 Animals Other2 i.Year

xi: reg lntransactionprice Playgroundrenovation Playgroundreplacement Trailrenovation Courtrenovation Newlight Fieldrenovation Restaurant Monument2 Animals Other2 i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.Year

xi: reg lntransactionprice Playgroundrenovation Playgroundreplacement Trailrenovation Courtrenovation Newlight Fieldrenovation Restaurant Monument2 Animals Other2 i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.Place i.Year

xi: reg lntransactionprice Playgroundrenovation Playgroundreplacement Trailrenovation Courtrenovation Newlight Fieldrenovation Restaurant Monument2 Animals Other2 i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.District i.Year

xi: reg lntransactionprice Renovation i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.District i.Year if NEAR_FC=="Vondelpark" | NEAR_FC=="Nelson_Mandela_Park" | NEAR_FC=="Beatrixpark"

xi: reg lntransactionprice Renovation i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.District i.Year if NEAR_FC=="Julianapark" | NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Kronenburgerpark" |

NEAR_FC=="Huijgenspark" | NEAR_FC=="Park_de_Gagel" | NEAR_FC=="Park_Transwijk" | NEAR_FC=="Den_Uylpark" | NEAR_FC=="Park Presikhaaf" | NEAR_FC=="Martin_Luther_King_Park" | NEAR_FC=="Vechtzoompark"

Continuation do* file difference-in-difference method

drop if NEAR_DIST>2000

generate Target=0

replace Target=1 if NEAR_DIST<=1500

generate Before=0

generate Between=0

generate After=0

replace Before=1 if NEAR_FC=="Martin_Luther_King_Park" & Year<2003 | NEAR_FC=="Vondelpark" & Year<1999 | NEAR_FC=="Nelson_Mandela_Park" & Year<2009| NEAR_FC=="Huijgenspark" & Year<2002| NEAR_FC=="Julianapark" & Year<2003| NEAR_FC=="Park_de_Gagel" & Year<2005 | NEAR_FC=="Park_de_Watertoren" & Year<2005 | NEAR_FC=="Park_Transwijk" & Year<2005| NEAR_FC=="Vechtzoompark" & Year<2006 | NEAR_FC=="Beatrixpark" & Year<2002 | NEAR_FC=="Den_Uylpark" & Year<2004 | NEAR_FC=="Kronenburgerpark" & Year<2004 | NEAR_FC=="Park Presikhaaf" & Year<2004

replace After=1 if NEAR_FC=="Martin_Luther_King_Park" & Year>2005 | NEAR_FC=="Vondelpark" & Year>2010 | NEAR_FC=="Nelson_Mandela_Park" & Year>2011 | NEAR_FC=="Huijgenspark" & Year>2002 | NEAR_FC=="Julianapark" & Year>2004 | NEAR_FC=="Park_de_Gagel" & Year>2005 | NEAR_FC=="Park_de_Watertoren" & Year>2006 | NEAR_FC=="Park_Transwijk" & Year>2005 | NEAR_FC=="Vechtzoompark" & Year>2006 | NEAR_FC=="Beatrixpark" & Year>2002 | NEAR_FC=="Den_Uylpark" & Year>2004 | NEAR_FC=="Kronenburgerpark" & Year>2006 | NEAR_FC=="Park Presikhaaf" & Year>2007

replace Between=1 if NEAR_FC=="Martin_Luther_King_Park" & Year>=2003 & Year<=2005 | NEAR_FC=="Vondelpark" & Year>=1999 & Year<=2010 | NEAR_FC=="Nelson_Mandela_Park" & Year>=2009 & Year<=2011 | NEAR_FC=="Huijgenspark" & Year==2002 | NEAR_FC=="Julianapark" & Year>=2003 & Year<=2004 | NEAR_FC=="Park_de_Gagel" & Year==2005 | NEAR_FC=="Park_de_Watertoren" & Year>=2005 & Year<=2006 | NEAR_FC=="Park_Transwijk" & Year==2005 | NEAR_FC=="Vechtzoompark" & Year==2006 | NEAR_FC=="Beatrixpark" & Year==2002 | NEAR_FC=="Den_Uylpark" & Year==2004 | NEAR_FC=="Kronenburgerpark" & Year>=2004 & Year<=2006 | NEAR_FC=="Park Presikhaaf" & Year>=2004 & Year<=2007

gen TargetBefore=Target*Before

gen TargetBetween=Target*Between

gen TargetAfter=Target*After

gen TargetDistance=Target*NEAR_DIST
gen TargetBeforeDistance=TargetBefore*NEAR_DIST
gen TargetBetweenDistance=TargetBetween*NEAR_DIST
gen TargetAfterDistance=TargetAfter*NEAR_DIST

xi: reg lntransactionprice Target TargetBetween TargetAfter i.Year
xi: reg lntransactionprice Target TargetBetween TargetAfter i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.Year
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xi: reg lntransactionprice Target TargetBetween TargetAfter TargetDistance TargetBetweenDistance TargetAfterDistance i.Buildingperiod Livingsize i.Homesort Elevators Floors Rooms Attic Loft Balconies Dormerwindow Roofterrace Kitchens Sculleries Toilets Bathrooms Indoorparking Qualityoutdoormaintenance Qualityindoormaintenance Monument i.District i.Year if NEAR_FC=="Julianapark" | NEAR_FC=="Park_de_Watertoren" | NEAR_FC=="Kronenburgerpark" | NEAR_FC=="Huijgenspark" | NEAR_FC=="Park_de_Gagel" | NEAR_FC=="Park_Transwijk" | NEAR_FC=="Den_Uylpark" | NEAR_FC=="Park Presikhaaf" | NEAR_FC=="Martin_Luther_King_Park" | NEAR_FC=="Vechtzoompark"