ERASMUS UNIVERSITY ROTTERDAM

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The effect of amateur sport clubs on the value of properties

Empirical evidence from Rotterdam and Amsterdam

Abstract

In this paper we researched the effect of amateur sports clubs on the value of properties. This research is based on data of the two biggest municipalities in the Netherlands, Rotterdam and Amsterdam. Using a hedonic regression model, we studied multiple pathways through which sport can influence house prices. Several distance buffers, diversity in supply of sports and types of sports have been researched. Based on our models, we found partial evidence of sport clubs having a negative effect on house prices. We suggest that this is caused by high correlations with land prices and reverse causality. Especially since as the distance buffer decreases, this effect becomes more negative. Effects on diversity are also mixed, it seems to have a positive effect in Rotterdam and a negative effect in Amsterdam. The analysis of types of sports was inconclusive, but we found partial proof that outdoor sport clubs are perceived as a positive amenity, while indoor sport clubs are not. The analysis shows strong indication of endogeneity, which potentially can be solved by a longitudinal approach using quasi-experimental data, which is the main recommendation for future research.

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I. Introduction

Research on what affects house prices has become relatively popular over the last decades. Various topics like the characteristics of a home (e.g. number of rooms) and neighbourhood characteristics (e.g. schools and train stations) all have been studied widely. The research methods used in these papers are all related to hedonic pricing models. This method lets you value one specific attribute of a good which consists out of multiple attributes. But what is interesting in the existing literature, is that not much has been written on the effect of sport clubs on house prices. Sport, which always has been a popular topic, is a relatively important leisure activity for people. It helps us to stay in shape but next to that it is an important factor in our social relations with other people. So sport is not only an amenity where you can spend time and benefit your health, it also has a social aspect which can have an effect of people's perception towards sports. But the main question is whether people are willing to pay a premium to have a sport clubs in their proximity/neighbourhood. Using a hedonic pricing model this paper will try to give an answer on this question.

The social relevance of this topic is related to both house prices and sports. In the last decades we started to understand the impact of sports on our body more and more. Staying fit is not only an appearance measure but also leads to a healthy body with a longer life expectancy (Rijnbeek, 2016). Excess weight leads to less functioning organs, such as your heart. So sport can be seen as a social amenity which helps to keep the population in shape. But it also has a social side, where sport brings people together. Take for example a football team for kids, where you get in a team based on your skills. This means that all kinds of different cultures can be in one team and play together. In this way, kids learn at a young age to play and interact with other people which all have different backgrounds. For adults the same theory applies. But maybe adults play sports because their friends play that sports too. This means they are socially active but do not necessary interact outside of their standard social group. As for house prices, it is of social importance to research what exactly are people willing to pay a premium for. Is sports valued as such an amenity that people want to live in a certain distance from it? Or are people willing to travel a certain distance to a sport club, which makes it less of an issue whether the sport club is located near their house.

It is clear that house prices and hedonic pricing models are of academic relevance, because it has been researched a lot. As for sports and house prices, this topic has had less academic attention. The most well-known papers, using a hedonic pricing model, are focussed on what the impact is of a new (or existing) sports stadium on house prices. Sport clubs, as in amateur sport clubs, has to my knowledge not been researched before. This makes it more relevant in my opinion, because both house price and sports are such relevant topics in today's society.

So this paper will research what the effect is of amateur sport clubs on property values. As mentioned before, there is not a lot of scientific papers which studied this topic. To our knowledge there is no proof whether amateur sport clubs do have an effect on house prices. This paper does believe that the topics are connected and that this effect is positive. First off, a sport club can be seen as a neighbourhood characteristic. It characterizes a neighbourhood, the same as a school or train station does. Every one living inside or even outside the neighbourhood can use these amenities in return for a monetary transaction. A lot of studies have researched neighbourhood characteristics, such as schools, stations and even crime statistics. Some well-known examples are (Jud & Watts, 1981), (Bowes & Ihlanfeldt, 2001) and (Gibbons & Machin, 2008). Based on Hummel (2017), research shows that neighbourhood characteristics do affect house prices (positively or negatively). So what is it that sport clubs bring to a neighbourhood, which leads to an increase in house prices? Well, sport clubs are an amenity where people not only can exercise to stay in shape, but also can socialize with other people. These characteristics of sport clubs can lead to an increase in house prices, because people value living in the proximity of such an amenity. However, if this proximity to a sports club becomes too small it will lead to negative externalities. These negative externalities, such as noise pollution, lead to a negative effect on property values. So people are willing to pay a premium to live in the proximity of sport clubs. But when this proximity is too small, it will lead to a negative effect on property values. These are all assumptions and thus need to be proven by this research. In order to give a proper answer, we first state our research question.

'What is the effect of amateur sport clubs on property values?'

In order to state a solid answer on our research question, our paper will use the following hypotheses. But before we will discuss these, an explanation will be given why we base our research on the markets of Amsterdam and Rotterdam. There are several reasons why these cities were chosen. First off, Amsterdam is the biggest municipality in the Netherlands and Rotterdam the second biggest, based on number of residents (respectively 859,732 and 641,326) (CBS, 2018). Next to that, Amsterdam has a total different morphology than Rotterdam. Amsterdam has an old centre with a lot of canals, whereas Rotterdam has the aesthetics of an industrial city. Rotterdam was bombed during the second World War, which destroyed the old centre of the city. This lead to a relatively new city centre compared to other Dutch cities, such as Amsterdam. Another interesting fact about Rotterdam is that it is formed by the river Maas. Basically there are two parts of Rotterdam, the north side of the river and the south side of the river. The north is mostly perceived as the wealthy part of the city, because here also lays the city centre. Whereas the south is perceived as the poor part, because here live relatively much minorities and it has a low perceived security (Gemeente Rotterdam, 2018). Amsterdam on the other hand has a more traditional composition, with a typical city centre. The history of the city is still easy to notice in the city centre, with the canal houses. It is interesting to see whether these different morphologies between cities can potentially lead to different outcomes. Another reason why Amsterdam and Rotterdam are chosen is because of their difference in type of city. Amsterdam is characterized by its service industry, whereas Rotterdam has a more industrial image. Because of the Port of Rotterdam, people associate Rotterdam with industry related business. The difference in industries leads to a difference in working class living in both cities. This difference can potentially lead to different outcomes for both cities, because people from a certain working class can value sport differently.

Hypotheses

As assumed in the beginning of this paper, there are two main aspects people value of a sport club (health and social aspect). These aspects of sport are positively valued by people. So with other words, people value sport as a positive amenity, which gives the opportunity to socialize and at the same time stay in shape. This paper expects that people do not want to travel too far to use this amenity, thus meaning they value to live in a certain distance from a sport club. This leads to the first hypothesis of this paper:

> ***Hypothesis 1:*** *An additional sports club in the range of 800 meters has a positive effect on house prices.*

The null hypothesis is that an additional sport club in the range of 800 meters has no effect or a negative effect on house prices.

So expectations are that sport clubs in a range of 800 meters has a positive effect on the house prices. However, this effect will turn negative once the distance buffer decreases to a certain distance. The reason for this is negative externalities, such as noise pollution and populated parking spots in the neighbourhood. This leads to the following hypothesis:

> ***Hypothesis 2:*** *An additional sports club in the range of 350 meters has a negative effect on house prices.*

The null hypothesis is that an additional sport club in the range of 350 meters has no effect house prices.

Another hypothesis based on distance focusses on the multiple distance buffers. Our study will consider four different distance buffers, namely 800, 650, 500 and 350 meters. We will discuss the reasoning behind these distance buffers later on in the paper. As for why these distances are important to house prices, we expect that as the distance becomes smaller, the effect on house prices becomes also smaller. Thus going from a positive effect at 800 meters to eventually a negative effect at 350 meters. This leads to the third hypothesis:

> ***Hypothesis 3:*** *As the distance buffer becomes smaller, the effect of sport clubs on house prices becomes more negative.*

The null hypothesis is that there is no difference in effect between all distance buffers.

There are a considerable amount of different sports. All these different sports can be sorted under certain sport groups. An example of such a group is ball sport, where almost all sports using a ball are subject to. Football, the most popular sport in the Netherlands, is a prime example of this sport group (NOC*NSF, 2017). But how is diversity in sport related to house prices? A possible relationship could be that a higher diversity leads to more choice for the homeowners. This increase in choice is positively valued by the homeowner, what can lead to an increased willingness-to-pay to live close to such a diversity in sport offerings. The increased willingness-to-pay is then reflected into the house price. This leads to the first hypothesis:

> ***Hypothesis 4:*** *A higher diversity in sport offerings has a positive effect on the value of houses.*

The null hypothesis is that a higher diversity in sport offerings has no effect on the value of houses.

In sports you can separate two types of sports, namely team sports versus individual sports. A good example of this is football versus swimming. We expect that people value living close to a team sports club more positively than an individual sports club. This is because of the social aspect which is related with team sports. When you sport in a team, it is easy to socialize with other people. You train with each other and play matches together. People might even only go to the sport club because of the social relations they have with their team mates. This aspect is less present at individual sport clubs, where in most cases the emphasis lays on exercising. Because of this social aspect that plays a bigger role in team sport clubs we expect the following:

> ***Hypothesis 5:*** *Team sports have a stronger effect on house prices compared to individual sports*.

The null hypothesis is that there is no difference in effect on house prices between team sports and individual sports.

As for our last hypothesis, we expect that there is a difference in effect between sport clubs which offer outdoor sports and sport clubs which offer indoor sports. The reasoning behind this is that outdoor sports require relatively more space than an indoor sport clubs. In compact neighbourhoods there is no space for such sport clubs, so outdoor sport clubs will locate in areas where it is relatively less dense. For indoor sport clubs, it is quite common to locate in dense neighbourhoods because they only require a gymnasium in most cases. Thus indoor sport clubs have a relatively higher chance to be located closer to houses, and thus the negative externalities such as noise pollution can play a bigger role for these sport clubs. This leads us to the following hypothesis:

> ***Hypothesis 6:*** *Outdoor sports have a stronger effect on house prices compared to indoor sports.*

The null hypothesis is that there is no difference between outdoor and indoor sports on house prices.

To study these hypotheses we will use a hedonic pricing model. The basics of this model are that it uses a regression method with control variables such as the living space in square meters. In this way our model can give solid estimations of what the effect will be of sport clubs on house prices.

The lay-out for the rest of this paper will be as followed. First we will discuss the existing literature relevant to our research. After that the conceptual model will be discussed. This will be followed by the methodology and data description. In section six the empirical model will be reviewed. This section will be followed by the results and after that the discussion will be discussed. As last the conclusion is given, containing also the limitations and recommendations.

II. Literature review

Hedonic pricing models in real estate has always been a popular topic for scientific papers. That is why most topics have already been extensively researched. Sirmans et al. (2005) wrote a review article on hedonic pricing models in real estate, in which they categorized the different contributions. A review of in total 125 different articles led to eight main categories, namely *construction & structure*; *House internal features*; *House external amenities*; *Environmental – Natural*; *Environmental – Neighbourhood & location*; *Environmental – Pubic service*; *Marketing, occupancy & selling* and as last *Financial issues* (Sirmans, Macpherson, & Zietz, 2005) Based on Sirmans' et al. (2005) overview, it follows that especially the first three categories have been widely researched. These categories contain topics such as *lot size, bedrooms, fireplace* and *garage spaces*. As mentioned, this paper will research the effect of sport clubs on house prices. What is unexpected is that the effect of sport clubs on house prices has never been researched before. Even in Sirmans' overview there is no mention about sport clubs. Only one type of sport is mentioned, which is golf. Sirmans et al. (2005) classifies the topic 'golf course' under the category '*Environmental – Neighbourhood & location'*. The influence of a golf course on house prices has appeared nine times in scientific papers and has a positive effect in all nine papers (Sirmans, Macpherson, & Zietz, 2005).

So following from Sirmans' et al. (2005), sport clubs can be divided under the category '*Environmental – Neighbourhood & location'* (*Neighbourhood characteristics* called from now on). Examples of neighbourhood characteristics are stations (e.g. train or metro), schools, crime and neighbourhood density. These topics have been widely researched, however the effect of amateur sport clubs on house prices is never researched before. This makes it unclear about what the effect will be. But based on the assumption that people value sport as a positive amenity, you could argue that people are willing to pay for such an amenity in their neighbourhood. Glaeser (2004) states in his paper 'Consumer city' that a city has four critical urban amenities. One of these critical amenities is 'the presence and variety of services and consumer goods'. Cities with more of these services and consumer goods, such as restaurants and theatres, have grown more quickly in the last twenty years in the United States and France, so-called 'Consumer cities' (Glaeser, Kolko, & Saiz, 2001). This outcome suggests that people value living in dense areas in order to profit from its urban amenities. So this leads to the assumption that amateur sport clubs are also positively valued, because sport clubs can be seen as an urban amenity. Next to that, the public perception about sport has also positively changed the last years. Especially in the Netherlands where the government stimulates people to stay healthy by hosting sport events (Rijksoverheid, 2018).

This change in the public perception about sport has led to an increase in sport participants over the last decade (Hover, 2018). So sport has grown in popularity and thus it is assumable that people value sport positively. This paper expects that this positive view could possibly lead to a different perception where homeowners wish to live close to sport facilities and resulting in a rise of property values.

Earlier on this paper stated that we could not find any papers on amateur sport clubs and house prices, however there has been several researches on sports and property values. These papers tend to focus on what the effect will be when a pro sports club is building a new stadium. For example, Tu (2005) researched what the effect is of the new FedEx Field, an American football stadium, on the houses in the surrounding area. He found that the new stadium improved the housing values. The closer a house is located to the new FedEx stadium, the greater the price improvement. The impact tends to be minimal when the distance increases to 2.5 miles away from the stadium. These results are in contradiction to 'neighbourhood activists' concern that sport venues adversely affect property values because of negative externalities (Tu, 2005). Feng and Humphreys (2008) found somewhat similar results to that of Tu (2005). They studied what the effect is of two different sport facilities in Columbus, Ohio on residential property values. On the one hand they studied the effect of a National hockey league stadium and on the other hand a Major league soccer stadium. Their results show that both stadiums have a positive effect on the value of surrounding houses. The value of closely located houses is higher than further located houses. The only difference between the two stadia is that the rate of decline is faster for the hockey stadium because it is located in the downtown area, while the soccer stadium is located in the suburban area (Feng & Humphreys, 2016). Dehring et.al (2007) studied the effect of an announcement of an American football stadium on the surrounding property values. Turns out that the announcement leads to an increase of property values for the nearby houses, but other neighbourhoods in the same county experienced a decrease in value. These patterns reversed when the announcement was cancelled. The research also found that the amenity effect was not significantly different from zero for when a publicly subsidized stadium was built in Arlington (Dehring, Depken, & Ward, 2007).

What is striking is that all studies discussed above are focussed on the American housing market. There is little research done on 'sports and property values' in Europe and especially in the Netherlands. However, there are some papers, such as Ahlfeldt and Maennig (2008) who studied the impact of sport arenas on property values in Berlin. Using a hedonic pricing model, including distance variables, they found that within a 3 kilometre radius, sport arenas have a significant positive effect on house values (Ahlfeldt & Maennig, 2008). This is line with studies from the United states, as discussed before. One other research from Europe is that by Kavetsos (2012), who analysed the impact of the London Olympics announcement on property prices. This is slightly different to the research of Dehring et al. (2007), who studied the impact of an announcement of a new stadium. However, the results are quite similar. Kavetsos (2012) found that the hosting boroughs have a price increase of around 3.3 percent. An alternative specification lead to the conclusion that property prices decrease with around 0.4 percent when the distance to the main Olympic stadium increases with one mile. This suggests that prices tend to be higher when located closer to the stadium (Kavetsos, 2011).

So far several papers have been discussed, however none of the papers seem to research what the willingness to pay is to have an amateur sport club in the neighbourhood. Although, some papers briefly touch this topic. Such as, Nicholls and Crompton (2007) who studied the effect of a golf course on property values. They found that houses located relatively close to the country club experienced a premium, which represented 25.8% of the average sales price of the homes. Another finding is that property prices seem to fall when the distance to the country club increases (Nicholls & Crompton, 2007). So et al. (1997) studied the impact of transport mobility on house prices. However, in their model they also included sports facilities which had a positive effect on house prices (So, Tse, & Ganesan, 1997). Worth noticing is that sports facilities is not further specified in their paper, so it is hard to tell what exactly are the sports facilities they include.

So concluding from the existing literature sport stadiums and announcements of new sport stadiums seem to have a positive effect on the value of properties. However, there seems to be little to no research on what the effect of amateur sport clubs on property values. It is even questionable whether there is an effect at all. This paper expects that there must be an effect, because people rate sport as an important leisure activity. This paper already discussed this topic briefly about what possible explanations could be. These two assumptions led to the reasonable expectation that that people are willing to pay extra to live in the proximity of a sport club or even a wide diversity of sport clubs. But to have a better understanding to why sport clubs are important amenities to people, we have to dive deeper in the economic theory behind it.

III. Conceptual model

As discussed prior in this paper, an amateur sport club can be seen as an amenity where people can do activities with one another. A sport club is not only a place where people can carry out their hobby, but it also can function as a place where one can socialize with other people. Taylor et al. (2015) have made a summary of the social impacts of sport. At the end of this summary they state several benefits of sport, namely health benefits, crime benefits, education benefits and social capital benefits. These four benefits lead to exchequer benefits, which means that eventually sport will save the government money (Taylor, Davies, Wells, Gilbertson, & Tayleur, 2015). So it is not only the people who benefit from sport, but also the government.

Based on Mill's theory 'Utilitarianism' (Mill, 2007), we argue that every human being has a utility function. This utility function reflects how much utility is derived from a certain activity or product for instance. The basic theory is that every person wants to maximize its own utility function, because this leads to the maximum happiness for this person. So for example a person derives utility from being healthy, living in a home, and doing leisure activities. However, in order to maximize someone's utility, a person needs to give something in return. This is mostly expressed in monetary values. So in order to eat to stay healthy, you have to buy food. The basic understanding is that people always try to act in a way where their utility is maximized, but in order to do so they have to spend money. Sometimes the monetary value of a certain characteristic is hard to define. For instance a composite good, such as a house, is traded for a specific value at a specific time. However, a house consists out of multiple characteristics, which together define a house. The number of rooms, a garden, a kitchen, a garage and location factors all have an influence on the monetary value of that specific house. The reasoning behind this is that all these characteristics have a certain utility to the person buying the house. So altogether these characteristics lead to the price the person is willing to pay. By using a hedonic price model, it is possible to determine how much a person is willing to pay for a certain characteristic. So far, a lot of research has been done on amenities, such as schools, metro/train stations and retail. But sport facilities, as in where people can spend their leisure time doing sports, has not been researched. If we look at the utility function, it is reasonable to expect that sport is something where people extract utility from. It does not only helps you to stay fit, but it also has a social aspect as mentioned before by (Taylor, Davies, Wells, Gilbertson, & Tayleur, 2015). So as sport contributes to maximizing an individual's utility, it is reasonable to assume that people are willing to pay extra in order to live in a certain range from sport facilities. Another possible explanation for the positive effect is that sport clubs enhance the attractiveness of a neighbourhood.

Amenities such as schools, grocery shops and metro stations have a positive effect on house prices and are perceived as attractive amenities for a neighbourhood (Haurin & Brasington, 1996), (Blayney, 1979), (Song & Knaap, 2004). We expect that sport clubs can be perceived as amenities with the same level of importance to people and thus can have the same results as these amenities.

However, it is expectable that when a sport facility is located right next to your home you will actually perceive negative consequences. For instance, a football club attracts a lot of visitors in the weekend. In the Netherlands there are a lot of different competitions based on age and quality. So when you live close to such a facility it is logical that you experience negative consequences. Examples are noise pollution, high car usage in the neighbourhood, and less privacy. High car usage can lead to full park spaces, which for a resident is perceived as unpleasant. We assume that people are not willing to pay extra to live too close to sport clubs, which means that the prices of houses located near sport clubs tend to be lower than 'normal' houses. The negative externalities lead to such a discomfort for people's utility function that they do not wish to pay a premium to live next to a sport club.

So, people are willing to pay extra to live in a certain range from sport clubs. But when the range becomes too small people perceive it as such a discomfort that the house prices tend to be lower. But how about the different kinds of sports? Is it logical to expect that every type of sports has the same effect on house prices? We believe that this is not the case. Sports is such a broad concept with lots of different categories. For instance, hockey and judo are both popular sports but differ completely from each other in multiple ways. Where hockey is played mostly outdoors, judo is done indoors. Next to that, judo is a sport done as an individual. Hockey on the other hand is a real team sport. These differences between types of sport can possibly have a different outcome on house prices. Not in a way that the effect is completely opposite from each other, but that one type of sport has a stronger effect than the other type of sport. By type of sport is a collection of sports meant. So for example ball sport is a type of sport which consists of football, basketball, volleyball and many more sports. We assume that these type of sports differ on two levels. On the one hand we have team sport versus individual sport and on the other hand there is outdoor sports versus indoor sports.

We expect that team sport has a stronger positive effect than individual sports, because team sport is in overall more popular and thus are people willing to pay more for these sport clubs. In the Netherlands, football, tennis and hockey have a combined membership number of around two million (NOC*NSF, 2017).

Next to that, our expectations are that outdoor sports have a stronger positive effect than indoor sports. The reasoning behind this is that indoor sports require less space than outdoor sports. This means that indoor sports have a higher likelihood to be located in dense areas. Outdoor sports like football and hockey require relatively much space. This makes it hard for these sport clubs to be located in a residential area. Because these sports clubs tend to be relatively further away from residential areas, the negative effects will be less an issue. So this leads to the conclusion that outdoor sports tend to lead to less negative externalities to homeowners and are thus perceived as more positive than indoor sports.

IV. Methodology

In this paper a hedonic pricing model is used to understand what the effect is of sport clubs on house prices. In order to do so, distance-variables were created which reflect the accessibility and proximity of sport clubs. But, before the methodology behind these variables are discussed, the theory behind the hedonic pricing model will be reviewed.

When you read a lot of papers about house prices and factors that influence it, than you can see that almost all papers use a hedonic pricing model to capture this effect. The origins of this theory states from 1974, when Sherwin Rosen published his paper '*Hedonic Prices and Implicit Markets: Product Differentiation in Pure Competition*'. In this paper he wrote the foundations for the hedonic pricing theory, where later research mostly based their models on. Rosen (1974) states in his paper that hedonic prices can be defined as the implicit prices of attributes, which can be observed from prices of differentiated products and the specific amounts of characteristics associated with them (Rosen, 1974). In his paper, Rosen does not exclusively base his theory on one specific market, but the housing market is a well-suited example. Basically, what the hedonic pricing model does is to value one specific variable of a good which is composed out of multiple variables, a so-called composite good. So if we take a house as an example, it is clear that multiple variables are part of one house. Sheppard (1999) wrote a paper about the hedonic analysis in the housing market. The housing market can be seen as an implicit market, which means that all goods (houses) are traded in 'bundles'. The demand for these goods are based on the characteristics the good embodies (Sheppard, 1999). Each characteristic bears utility to the consumer and that results in a price for each characteristic of the good. So the hedonic pricing model decomposes the attributes of the composite good into implicit prices for each attribute. In this paper the composite good is a house and its attributes are for example an additional bedroom or the year a building is constructed (Van Haaren, van Oort, & Wildeboer, 2017), cited from (Hummel, 2017).

The empirical strategy used in this paper follows Ahlfeldt and Maennig (2008), where it consists out of two steps. The first step is developing a hedonic pricing model which explains the present house value pattern, the so-called base model. It is important to have a reliable base model, because it allows us to make conclusions about what the effect will be of sport clubs on house prices in the later models. The base model is extended in the second step, in which several distance variables are added. These variables are used to capture the impact of sport clubs on house prices. The base model follows the assumption that the value of properties can be described by their structural attributes (S), a set of attributes capturing the effect of the neighbourhood (N) and the period in which a house was sold (T), following (Malpezzi, 2003). This leads to the following regression equation

$$\ln(P) = \alpha + \beta_1 S_1 + \ldots + \beta_i S_i + \gamma_1 N_1 + \ldots + \gamma_j N_j + \delta_1 T_1 + \ldots + \delta_k T_k + \varepsilon$$

where i, j and k represent the number of attributes, β,γ and δ are coefficients and ε is an error term. The log price is used for interpretation reasons. When interpreting regression results in log-linear specifications, the attribute coefficient gives the percentage impact of changes in attribute value on property value (Ahlfeldt & Maennig, 2008). The actual model which contains the distance-variables (D) and the type of sports (K) follows from the base model. This leads to the following regression equation

$$\ln(P) = \alpha + \beta_1 S_1 + \ldots + \beta_i S_i + \gamma_1 N_1 + \ldots + \gamma_j N_j + \delta_1 T_1 + \ldots + \delta_k T_k + \theta_1 D_1 + \ldots + \theta_l D_l + \rho_1 K_1 + \ldots + \rho_f K_f + \varepsilon$$

where l and f represent the number of attributes and θ and ρ are the coefficients. As this research is based on the house market of Rotterdam and Amsterdam, two identical models will be used. This means that Rotterdam and Amsterdam will be modelled apart but the variables used in the models will be the same. The reasons for this are to eventually compare results between the two cities and to keep the models accessible.

As to the structural attributes, these are essential in a hedonic pricing model on properties. We include several structural attributes, based on Sirmans' et al. (2005) overview. The surface of the living space in square meters is the main structural attribute and also one of the most researched. Next to that the number of rooms, the type of house and the construction year of a dwelling are all included in the model as structural attributes. We followed the example of influential papers such as (Kain & Quigley, 1970), (Can, 1990) and (Follain & Jimenez, 1985).

The effect of different attributes tends to vary across different geographical location. If each neighbourhood has its own effect, than the ideal hedonic model would need to include each neighbourhood as a separate variable (Tse, 2002). We include such 'neighbourhood fixed effects' in our model. This allows to control for fixed effects by clustering the different neighbourhoods. Without this cluster correction the standard error can easily be too small and the coefficients can too easily be significant. The last part of the basic model is the attribute of time. This variable shows in what year a certain transaction has taken place. So this allows our model to capture any effects of possible interruptions in the market conditions. Because the data used in this research covers the time period 2003 to 2016, the time variable allows us to control for the effects of the financial crisis starting from 2007.

As for the distance-variables, this paper expects that the effect of a sport club on dwelling prices differs with distance. Several papers such as Kain (1962) and Tu (2005) use this method to value the effect of neighbourhood amenities on house prices. The range consists out of four rings each representing a certain distance. The smallest range is 350 meters and the largest is 800 meters. The other two ranges are 500 and 650 meters. The reason why four different ranges are taken is to see whether there is a change in effect between the four distances. One possible outcome could be that the effect goes from positive to negative when the distance decreases. Meaning that people value extra sport opportunities positively on a higher scale, but when the number of clubs increase on a low scale then they experience negative externalities from it. Negative externalities such as noise pollution or sport visitors taking all the parking spots, this follows the argument of Li & Brown (1980) on micro-neighbourhood externalities. Furthermore, the actual model will also contain variables that measure for diversity. These diversity variables are calculated for each distance-range and show how much diversity there is for a specific point on the map. This will be further explained in the section *data description*.

V. Data description

The main source of data used in this paper is from the Nederlandse Vereniging van Makelaars (NVM). They provided a file of all house transactions in the period of 2003 to 2016. For Amsterdam, this resulted in 111,846 observations and Rotterdam has 57,221 observations. Each observation has a list of variables which characterizes this specific observation. Some examples of these variables are size in square meters, number of rooms, address and the year it was sold. The other data used in this thesis are the locations of all sport clubs in Amsterdam and Rotterdam. These locations were collected from the sports database, both provided by each municipality. Amsterdam has 896 different amateur sports clubs and Rotterdam has 923 amateur sports clubs. All sports clubs were divided into different categories, which led to sixteen different categories. So, the category 'ball games' for example consisted out of American football, basketball, volleyball and several more (see the appendix for the full overview). In order to use these sport observations in our research, the observations have to be geographically coded. This allows us to eventually calculate the number of sport clubs in a particular radius from each specific house point on the map. In the appendix you can find several maps, which show where sport clubs and properties are located. Based on these maps, we see that in Amsterdam there are relatively few sport clubs located in the centre. While in Rotterdam, the amount of sport clubs in the city centre is relatively high. A possible explanation could be that Rotterdam has relatively more indoor sport clubs which require less space. For example the category 'dance' for which Rotterdam has 93 active sport clubs and Amsterdam 22.

The radius this paper examines are 350 meters, 500 meters, 650 meters and 800 meters. The reasoning is that 800 meters is the distance one can travel in ten minutes with a walking speed of five kilometres per hour. However, this is when you walk in a straight line without interruptions of traffic lights and other factors. So the 500 meter radius is what you can actually walk in ten minutes in a populated area, the so-called spherical walking distance. 650 meter is the equivalent of the average neighbourhood size in Amsterdam (Wildeboer, 2017), so this distance is also applied to Rotterdam to keep the data equivalent for both cities. The last distance, 350 meter, is added to see what the effect is of a relatively closely located sport club (within 10 minutes walking distance). Once these distances were coded, the diversity was calculated. The rate of diversity is calculated by using the Herfindahl-Hirschman-index. This index gives an insight in what the rate is of diversity for each specific house in the dataset. The index can be between zero and one. If the diversity index is closer to one, than this implies that this specific point/neighbourhood has little to no diversity, with one being no diversity at all. The opposite means that a diversity index more situated towards zero means that this specific point/neighbourhood has relatively much diversity. The Herfindahl-Hirschman index is calculated as follows:

$$HHI = \sum_{i=1}^{n} M_i^2$$

With M being the ‘market share’ of a specific sport category and n is the total number of sporting categories. The market share M is calculated as follows:

$$M = \left(\frac{K}{Z}\right)$$

K is the share of a specific sport category and Z is total sum of all sport categories combined. However, to make it easier to interpret, we adjust the Herfindahl-index for our model. We create the variable *diversity*, which is the inverse of the Herfindhal-index. This means that a 0 now indicates that there is no diversity, while a one indicates there is relatively a lot of diversity.

Types of sports

As mentioned before in the introduction, this paper hypothesizes that there is a difference in effect between team sport and individual sport. To test this two variables were made, namely ‘team sports’ and ‘individual sports’. Both variables consist out of certain sport categories which are mentioned before in this chapter. For some sport categories it is hard to say whether it is a team sport or individual sport. This is because some sport categories consist out of a substantial number of sports, which all have a different set up. An example of this is the sport category ‘mind games’, where bridge and chess both are subject to. Bridge is a card game where you play in duos against each other. Chess on the other hand is a boards game where you play one on one. So basically, bridge can be seen as an team sport and chess as an individual sport. However, bridge is represented more in the data than chess so we named mind games a team sport. This reasoning is applied to every sports category.

As last we examine the difference in indoor sports and outdoor sports. In order to research whether there is a difference in effect on house prices, we first need to determine what indoor sports are and what outdoor sports are. Indoor sports are characterized by the fact that it is done indoors, such as in a sports hall. Earlier on we discussed how we made the distinction for team sports and individual sports. We took here the actual sport categories and arranged them under the group which was most compatible. For indoor and outdoor we used a different approach. We looked at all the different sports subcategories, such as football, tennis and rowing, and arranged these subcategories one by one to their most compatible group (indoor or outdoor). The reason why we used this way of sorting is because most sports categories contained controversial subcategories if we look at indoor and outdoor. Take for example ball sports where you have football, a typical outdoor sports, and basketball. It is impossible for us to sort them under the same category. However, there are some types of sports which are still hard to sort under one specific group. Tennis is most known to be played outside in the Netherlands, however there are lots of indoor sport facilities which have tennis courts. But because of tennis being a typical outdoor sports, we sorted it under outdoor sports. We used the same specific analysis on all sports.

In the appendix you can find a full overview of all types of sports. In this overview each sport or sport category is sorted under a certain type of sport (team, individual, indoor and outdoor).

VI. Empirical model

As stated in the section 'Methodology', this paper follows the empirical strategy used in Ahlfeldt and Maennig (2010). In the following part of this paper we will give a further explanation of the variables used in our research and the underlying thoughts of our models.

The first model is purely focussed on giving a good explanation about what exactly influences house prices. As discussed before, our base model will not use any variables about sport clubs, but only the base variables. It is important to have a solid base model, because it allows us to make conclusions about what the effect will be of sport clubs on house prices in the later models. For each city there will be a separate model, however the variables used in both models are similar. This is purely done to have a good understanding of what the effect is in both cities without having any effect on each other.

For our model we use the logarithm of price as our dependent variable. This gives us a so-called log-level model, where an increase of one of an independent variable leads to an X percentages change of the dependent variable. However, it is hard to say anything about the mean, minimum and maximum of log prices (lnprice called from now on). So to give a better understanding of how the dependent variable lnprice is composed, the mean, minimum and maximum of the variable price are stated. For Rotterdam the mean price is €195,558, which is a reasonable number. The minimum and maximum are respectively €50,100 and €1,000,000. These numbers were handpicked because there were some outliers which could influence the results. For Amsterdam the price range is also manually picked, because of the same reason for Rotterdam. The minimum price was two and the maximum price was around one billion. These are both unrealistic numbers so we chose the same minimum price as for Rotterdam which is €50,000. However this resulted in an actual minimum price of €52,000 because there is no property sold for €50,000 in our data. The maximum price was set slightly higher than in Rotterdam, to €2,000,000. The reason for this is because Amsterdam has a booming housing market at the moment. Houses are sold way beyond their asking price, especially near the centre of Amsterdam. The mean price in Amsterdam is €300,479. In comparison to Rotterdam (€195,558) this is quite a substantial difference and thus shows how different the housing market in both cities is.

For the following section on independent variables, we will first discuss the Rotterdam and after that Amsterdam.

Rotterdam

The independent variables which will be used in this research were already mentioned briefly in the 'methodology'. However, in this section they will be discussed more in depth. The first variable which we will discuss is the living space in square meters. The mean of this variable is 103.7, which means that on average a property in Rotterdam has a living space area of approximately 104 square meters. The minimum is adjusted because the data contained values of one. This is an unrealistic number for a living space area, so we set the minimum to twenty. The maximum is 400, which is plausible for the mansions located in Kralingen and penthouses in Rotterdam. The next variable is the number of rooms a dwelling unit has. The mean is 3.9, which means that an average home in Rotterdam has approximately four rooms. The minimum number of rooms in a home is one and the maximum number of rooms is 26. The number of rooms is a categorical variable where each number represents a category. So for one room, there is a separate category, up to nine number of rooms. All numbers from ten and above are set under the same category, namely 'ten and more'. The reference category is four because this the average number of rooms in our dataset. The third variable used is 'type of dwelling', which is also a categorical variable. The variable type indicates what type of home it is. So for example, category one represents all intermediate houses and category five the detached houses. Note that when none of these categories are applicable on the dwelling unit in question, then this means that the dwelling is an apartment. With other words, when the variable type is zero than we can speak of an apartment. This makes apartments our reference category. The mean of the variable type is 0.58, which means that the average type of house in Rotterdam is an apartment. As mentioned before in the section data, there are around 39,618 apartments versus 17,194 in Rotterdam. The next variable used in our model is the construction year of a dwelling unit. The same as type and number of rooms, this variable is also categorical. Each category represents a certain time range. Category one represents the minimum time range, which is 1500 to 1905. And category nine represents the maximum time range, which is 2001 and more. The mean of construction year is 4.9, which means that category 5 is the average construction period of our dataset. For this reason it is also the reference category in our model. Category five represents 1960 to 1970, which is a logical period for Rotterdam. Most buildings were destroyed during the second world war, so this means that most buildings in Rotterdam had to be rebuild. The next variable used in our model is year of sale. The minimum year of sale is 2003 and the maximum is 2016. The mean is not worth interpreting, because it does not give us anything of value. We use the year 2003 as the reference year. As last, our model contains the identity of all neighbourhoods in Rotterdam. The minimum, maximum and the mean of this variable are not really interesting to discuss. We used the neighbourhood identity of Rotterdam centre as a reference category.

These variables discussed above are the “base” variables, which means that they are used to give a solid estimation of what influences house prices in Rotterdam. The following variables are all related to the actual research. First off, the distance variables will be discussed. After that the variables related to types of sport will be discussed.

The distance variable 800 meters shows the number of sport clubs are present in a 800 meter radius. The minimum number of sport clubs is zero and the maximum number is 66. The mean is 20.2, which implies that on average there are twenty sport clubs in a 800 meter range of a home. For all distance variables the minimum is zero, so this will not be further discussed. Next to that, we look at the diversity in sport clubs that is present in a neighbourhood. As earlier mentioned, this diversity is calculated using the Hirschman-Herfindahl-index and shows on a scale from zero to one how much diversity there is present. For ease of interpretation we calculated the inverse of the Herfindahl-index and named it diversity. This means that as the number comes closer to one, the diversity is higher. As for the opposite, a number close to zero indicates that there is little diversity and thus more specialisation. For the distance 800 meters the mean of diversity is 0.78 and the maximum is 0.90. These are relatively high numbers, thus indicates that on average a property in Rotterdam has to a certain extent diversity of sport clubs in their proximity. The minimum is for all ‘diversity variables’ zero so this will not be further discussed. The distance 650 meters has a maximum of 55 sport clubs and has a mean of 14.1. The mean and maximum of the diversity variable are respectively 0.72 and 0.90. For the distance 500 meters the maximum and mean are respectively 44 and 8.8. The corresponding mean and maximum for the diversity on 500 meters are 0.63 and 0.89. As last, the smallest distance, 350 meters, has a maximum of 24 and mean of 4.4. The diversity mean and maximum are respectively 0.48 and 0.88. If we look at the mean of all diversity distances than we see that the mean goes down as the distance decreases. This has a logical explanation, because when the distance decreases, the number of sport clubs also decreases and thus the chance on a diversified supply of sport clubs lowers. Sport facilities, such as a swimming pool, sports hall or ice-rink, attract the same types of sport. This means that multiple sport clubs use this facility for their sport activities and thus be located on the same location. So once the distance decreases, this cluster of sport clubs have a higher impact because the total number of sport clubs decreases.

This paper examines four different variables related to type of sport. All four variables are based on the 800 meters distance variable. The same as for the distance variables is that all variables related to type of sport have a minimum of zero. Team sports has a maximum of 29 and a mean of 9.4. This implies that an average dwelling unit in Rotterdam has nine team sports related sport clubs in a range of 800 meters. For individual sports the numbers are slightly different. The maximum is 38 and the mean is 10.8, which means that on average a dwelling unit in Rotterdam has more individual sports than team sports in their proximity. For outdoor sports and indoor sports, the difference is quite substantial. Where indoor sports have a maximum and mean of respectively 62 and 16.2, outdoor sports have a maximum and a mean of 24 and 4.1. One reason for this difference is due to the fact that indoor sports require less space and multiple sport clubs use the same facility.

Amsterdam

The first variable which will be discussed is the living space area in square meters. The mean for this variable is 88, which means that on average a property in Amsterdam has a living space of 88 square meters. What is interesting to see is that this is lower than in Rotterdam, where the average is around 103. However, as discussed earlier, the average price of a property is €100,000 more expensive in Amsterdam than in Rotterdam (respectively €300,479 and €195,558). So the price per square meter is way higher in Amsterdam than in Rotterdam. This supports the argument that Amsterdam currently has a booming real estate market. The next variable, number of rooms, has a mean of 3.3. To have no difference between Rotterdam and Amsterdam, we choose to use the same reference category used for the model of Rotterdam (reference category of 4 rooms). For the rest all categories are the same as for Rotterdam, with ten and more rooms as a separate category. The minimum and maximum are respectively 1 and 25, which is similar to Rotterdam. The type of building has the same setup as for Rotterdam, so there are no differences between minimum and maximum (range from zero to five). The mean in Amsterdam is 0.23, which is even more situated to zero than the mean of Rotterdam (0.58). This means that the apartment and house ratio in Amsterdam is heavily situated towards the apartments side. There are 96,480 apartments in our dataset versus ‘only’ 14,190 houses. The year of construction shows that in Amsterdam the properties are on average older than in Rotterdam. The means are respectively 4.01 and 4.92. As earlier discussed, this is due to the fact that most of Rotterdam older centre was bombed during the second World War. Whereas the centre of Amsterdam still has relatively old properties, like the famous canal houses. The variable year of sale does not show any differences between the two cities. Amsterdam has a mean of 2009.97, which does not differ much with Rotterdam (2009.52). As for the last base variable ‘neighbourhood identity’ only the reference category is interesting to discuss, which is a neighbourhood in the centre of Amsterdam (Burgwallen-oude zijde).

Following the discussed base variables, we will now continue with the distance variables and the type of sport variables. The same as for Rotterdam, the minimum is in all cases zero so will not be mentioned. A minimum of zero means that some properties have no sport facilities in their neighbourhood, looking at a maximum range of 800 meters. For the longest range, 800 meters, the mean is 21.2 and the maximum is 55. The diversity on 800 meters shows a mean of 0.74 and a maximum of 0.89. This does not differ much with Rotterdam. The variable 650 meters has a mean of 14.1 and a maximum of 43. The mean and minimum of the corresponding diversity are respectively 0.68 and 0.90. For the last two distances, 500 and 350 meters, there seems to be no real differences with Rotterdam. Both distances have an almost identical mean with that of Rotterdam. For the distance 500 meters the difference is only 0.4 (8.4 for Amsterdam and 8.8 for Rotterdam). The distance 350 meters has the same difference of 0.4 for the means (4.0 in Amsterdam 4.4 in Rotterdam). The maximum for both distances in Amsterdam are 36 for 500 meters and 27 for 350 meters. The diversity variables for 500 and 350 meters do also not differ much from Rotterdam. The mean for both distances in Amsterdam are 0.58 for 500 meters and 0.44 for 350 meters. The minimum of both distances are respectively 0.88 and 0.86.

As last the type of sport variables will be discussed for Amsterdam. For team sports and individual sports the difference in mean is bigger than the difference for Rotterdam. The mean of individual sports for Amsterdam is 13.4 and 7.8 for team sports. This is quite a difference compared to Rotterdam (10.8 individual versus 9.4 team). The maximum number of team sports and individual sports is almost the same for Amsterdam and Rotterdam. In Amsterdam the maximum is 28 for team sports and 38 for individual, whereas Rotterdam has a maximum of respectively 29 and 38. As earlier discussed, the difference between indoor and outdoor sports in Rotterdam was proportional. We gave some explanations for this. For Amsterdam the difference is even bigger, with a mean of 18.0 for indoor sports and 2.6 for outdoor sports. This means that the difference in number of indoor sports and outdoor sports is quite substantial in Amsterdam.

Table 1 – Overview Rotterdam

Variable	*Observations*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
Base variables					
Price	56,108	195558.8	123965.6	50100	1000000
Log price	56,108	12.04138	0.5068702	10.82178	13.81551
Living space m^2	56,641	103.67	44.14314	21	400
Number of rooms	56,737	3.874315	1.451442	1	26
Type	56,812	0.5812152	1.127351	0	5
Construction year	56,812	4.922411	2.395774	1	9
Year of sale	56,705	2009.515	4.182235	2003	2016
Neighbourhood identity	56.812	5990875	491.4192	5990110	5992540
Distance variables					
800 meters	57,221	20.20118	12.52758	0	66
Diversity 800m	56,724	0.777063	0.1395927	0	0.8960302
650 meters	57,221	14.08763	9.662717	0	55
Diversity 650m	56,222	0.723581	0.1915233	0	0.9030471
500 meters	57,221	8.822268	7.157863	0	44
Diversity 500m	54,233	0.6279981	0.2513834	0	0.8864266
350 meters	57,221	4.425718	4.756922	0	24
Diversity 350m	46,918	0.4768583	0.3041816	0	0.8765432
Type of sport					
Team sports	57,221	9.359029	6.181958	0	29
Individual sports	57,221	10.84216	7.078775	0	38
Outdoor sports	57,221	4.069258	3.336883	0	24
Indoor sports	57,221	16.16753	11.12557	0	62

Table 2 – Overview Amsterdam

Variable	*Observations*	*Mean*	*Standard deviation*	*Minimum*	*Maximum*
Base variables					
Price	109,718	300479.5	216065.4	52000	2000000
Log price	109,718	12.44934	0.5312837	10.859	14.50866
Living space m^2	109,957	88.02306	45.80422	20	400
Number of rooms	109,760	3.33514	1.522903	1	25
Type	110,670	0.2321496	0.7615749	0	5
Construction year	110,670	4.007003	2.713548	1	9
Year of sale	110,259	2009.966	4.115264	2003	2016
Neighbourhood identity	110,670	3630795	496.5645	3630000	3631491
Distance variables					
800 meters	111,816	21.19182	13.16521	0	55
Diversity 800m	111,309	0.7410924	0.1469987	0	0.8934911
650 meters	111,816	14.0724	9.694234	0	43
Diversity 650m	111,116	0.6825597	0.1920668	0	0.8960302
500 meters	111,816	8.388996	6.834551	0	36
Diversity 500m	109,541	0.5752637	0.2573707	0	0.8788927
350 meters	111,816	4.032679	4.323429	0	27
Diversity 350m	94,370	0.4377436	0.2901215	0	0.8639053
Type of sport					
Team sports	111,816	7.815778	5.307127	0	28
Individual sports	111,816	13.37604	9.275808	0	38
Outdoor sports	111,816	2.554751	2.89518	0	30
Indoor sports	111,816	17.97168	12.30519	0	52

VII. Results

As mentioned before in this paper we examine multiple models. The first model, called the base model, is used to give a solid indication of what affects house prices. In this model we do not consider distances towards sport facilities and type of sports. We find that the base hedonic model performs satisfactory with all coefficients showing logical signs. This is the case for both cities. For the surface in square meters we see that there is a significant positive effect as expected and that this effect is bigger in Amsterdam than in Rotterdam. This amplifies the theory that in Amsterdam the space of living is valued higher than in Rotterdam. For the number of rooms we find that the reference category in Rotterdam, which is four number of rooms, is valued as highest. We also see that as the number of rooms go up, this will lead to a lower house price. This is the case for both Amsterdam and Rotterdam. In Amsterdam it is not the average number of rooms which has the highest price effect, but it is five rooms. For the type of building we find that all categories have a positive effect in both cities. This in relation towards the reference category which are all apartments in the data. This means that every type of house has a higher effect on price than an apartment, with a detached house having the highest effect (as well in Amsterdam as in Rotterdam). Next to that, the coefficients for type of buildings seem to differ between cities, however they do follow the same pattern. As for the period a dwelling unit was build, there seems to be no striking results. We can argue that the period of 1960 to 1970 has the lowest effect on house prices in both cities. As for the rest of the periods, we find that newer dwellings have the highest effect on price. This effect is even higher than that of historical type buildings (period of 1500 to 1905). For the year a dwelling unit is sold we find that in relation to the reference year (2003), all other years seem to have a more positive effect. This is the case for as well Rotterdam as Amsterdam. Our data also shows that the price effect is going up from 2004 to 2008 and then starts to go down. In 2014 the effect finally goes up again. This shows the impact of the financial crisis on the housing market. As last, our model accounts for neighbourhood fixed effects by including all neighbourhood identities.

Base model M0	**Rotterdam**		**Amsterdam**	
Independent:	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Logarithm of price				
Surface in square meters	0.006984***	29.17	0.0075667***	38.96
Number of rooms				
1 room	-0.1218559***	-3.24	-0.3048277***	-13.10
2 rooms	-0.0944831***	-7.09	-0.1476744***	-11.39
3 rooms	-0.0359405***	-4.89	-0.0432409***	-6.84
4 rooms	-	-	-	-
5 rooms	-0.0019314	-0.28	0.0173941**	2.43
6 rooms	-0.0074104	-0.43	-0.0339215***	-3.04
7 rooms	-0.0263868	-1.15	-0.1092093***	-7.36
8 rooms	-0.0829092***	-3.11	-0.2114358***	-7.98
9 rooms	-0.1646299***	-3.76	-0.3374579***	-10.00
10 rooms	-0.2784396***	-5.31	-0.5470093***	-10.40
More than 10 rooms	-0.443178***	-6.98	-0.6948415***	-12.77
Type of building				
(ref) Apartments (0)	-	-	-	-
Intermediate house (1)	0.1199622***	6.00	0.0593871***	4.47
Semi-detached house (2)	0.1780045***	7.18	0.1496804***	6.28
Corner house (3)	0.1807807***	6.97	0.1066708***	8.07
Half double house (4)	0.3030631***	10.49	0.231835***	10.49
Detached house (5)	0.4040469***	12.27	0.2828485***	7.12
Construction year				
Period of 1500 - 1905	0.1073394***	4.02	0.1729744***	8.84
Period of 1906 - 1930	0.0984251***	4.37	0.147677***	6.84
Period of 1931 - 1944	0.0847457***	2.93	0.1224051***	5.78
Period of 1945 - 1959	0.0468127**	2.29	0.0421522**	2.12
(ref) Period of 1960 – 1970	-	-	-	-
Period of 1971 - 1980	0.0484215***	3.07	0.069579**	2.48
Period of 1981 - 1990	0.0816969***	3.25	0.0939891***	5.13
Period of 1991 - 2000	0.2577766***	14.37	0.2095383***	11.61
Period of 2001 and later	0.3650286***	19.23	0.2397594***	11.47
Year of sale of a dwelling unit				
(ref) 2003	-	-	-	-
2004	0.0250426***	2.99	0.0158762**	2.58
2005	0.0587898***	10.12	0.0692533***	8.65
2006	0.0952036***	13.86	0.1395583***	13.24
2007	0.1287719***	18.47	0.2433076***	16.78

2008	0.1514264***	18.08	0.2981198***	19.12
2009	0.1290719***	14.75	0.2345989***	18.27
2010	0.1228606***	12.30	0.2434323***	17.91
2011	0.1095459***	10.15	0.2318496***	16.36
2012	0.0692636***	6.32	0.1719337***	11.49
2013	0.0212477*	1.76	0.14722***	9.20
2014	0.0491017***	3.44	0.2269234***	12.38
2015	0.0874617***	5.12	0.34327***	15.71
2016	0.1850808***	9.32	0.4980076***	21.74
Neighbourhood fixed effect	Yes		Yes	
Constant	11.32991***	448.19	11.64606***	426.05
Adjusted R-squared	0.8277		0.8811	
Number of observations (N)	55,830		108,204	

Significance: ***=1%, **=5%, *=10%. This measurement standard will be used for all models.

As shown above, our base model performs satisfactory with all coefficients showing logical signs. In the next part we will actually examine whether sport clubs have an effect on house prices. First off we will start with model one, which examines the impact of sport clubs for the distance buffer 800 meters. We will also include the diversity index of this particular distance into our model. The results are shown in table model one. Firstly, we check whether there are drastic changes in the signs of our base variables' coefficients. This seems to be not the case for as well Rotterdam as Amsterdam. So all base variables stayed quite similar. For the distance variables we find some interesting results. In Rotterdam there is a negative effect of the variable '800 meters distance range'. This effect is significant on a one percent level. However the sign of this coefficient is so small that it navigates to zero. If we had to translate it into numbers, an increase of one extra sport club in a range of 800 meters leads to a price decrease of 0.19 percent. For an average dwelling unit in Rotterdam, this would mean a price decrease of €371.56. The coefficient of the distance variable '800 meters range' is also negative in Amsterdam but even smaller (more situated towards zero). However this coefficient is not significant and thus means we cannot say anything about its effect. Both coefficients of the diversity variables are significant on a five percent level. However the coefficients are complete opposite of each other. In Rotterdam there seems to be a positive effect of diversity on house price, while in Amsterdam there is a negative effect. So in Rotterdam more diversity in sport clubs leads to a higher dwelling unit price, while in Amsterdam more diversity leads to a lower sale price.

Model 1 (M1): Distance 800 meters and diversity index	**Rotterdam**		**Amsterdam**	
Independent variable:	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Logarithm of price				
Dependent variables:				
Distance variables				
800 meters distance range sport clubs	-0.0019308***	-2.69	-0.0005699	-0.88
Diversity index for 800 meters	0.1098627**	2.19	-0.065244**	-2.04
Constant	11.40745***	345.22	11.62554	362.04
Adjusted R-squared	0.8267		0.8815	
Number of observations (N)	55,335		107,699	

See appendix table 2.1 for full model

In our second model we try to capitalize the effect of negative externalities on short distance range. This is done by using our base model plus the distance variable for 350 meters and the corresponding diversity index. Before we argue anything about the effect of these variables, we first examine whether our base model still performs as expected. This is the case for both Rotterdam and Amsterdam. The results for the distance range 350 meters are not as expected. First off, none of the coefficients for Amsterdam are significant and thus we cannot interpret their effects. For Rotterdam the diversity index is positive, however the same as for Amsterdam, this variable is not significant on any of the three levels. The only variable we can interpret is the distance variable for Rotterdam. This shows a negative effect and is significant on a five percent level. If we compare this coefficient with that of the 800 meters variable, we see that as the distance becomes smaller, the negative impact becomes bigger. However, this difference is relatively small and both coefficients are leaning to zero.

Model 2 (M2): Distance 350 meters and diversity index	**Rotterdam**		**Amsterdam**	
Independent variable:	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Logarithm of price				
Dependent variables:				
Distance variables				
350 meters distance range sport clubs	-0.0036844**	-2.54	-0.0007195	-1.06
Diversity index for 350 meters	-0.0018912	-0.11	0.0054823	0.42
Constant	11.3318***	378.70	11.62346	445.01
Adjusted R-squared	0.8117		0.8787	
Number of observations (N)	45,817		91,412	

See appendix table 2.2 for full model

We tested also the distances 500 and 650 meters and their corresponding diversity index variables for Amsterdam. All of the coefficients for Amsterdam are insignificant and thus are not possible to be interpreted. For Rotterdam the distance variables 650 and 500 meters both are significant. However, the corresponding diversity indices are not and thus are not eligible to be interpreted. When we interpret the coefficients of 650 and 500 meters for Rotterdam, we find that both variables are negatively related to house prices. Comparing the signs of the coefficients of all distances for Rotterdam, we find that as the distance becomes smaller the negative impact on house prices increases. This means that people value an extra sport club on 800 meters distance range as less negative than an extra sport club on 650 meters distance and so on. However, take in mind that these differences are all relatively small.

Independent: **Log of price**	**Model 3 - 650 meters**				**Model 4 - 500 meters**			
	Rotterdam		**Amsterdam**		**Rotterdam**		**Amsterdam**	
Dependent:	*Coefficient*	*T-value*	*Coefficient*	*T-value*	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Distance variables								
650 meters distance range	-0.0028167***	-3.10	-0.0009149	-1.31	-	-	-	-
Diversity index 650 meters	0.0537707	1.33	-0.0176286	-0.70	-	-	-	-
500 meters distance range	-	-	-	-	-0.0030525***	-2.74	-0.0007326	-1.05
Diversity index 500 meters	-	-	-	-	-0.0016081	-0.06	0.0080022	0.55
Constant	11.39523***	325.20	11.64672***	396.14	11.35848***	380.83	11.65013***	439.27
Adjusted R-squared	0.8252		0.8816		0.8206		0.8817	
Number of observations	54,846		107,510		52,929		105,986	

See appendix tables 2.3 & 2.4 for full models

In the last section of the results we will analyse whether different types of sports have different effects on house prices. First, model 5 will be discussed which analyses the effect of team sports and individual sports on house prices. The base variables for both Rotterdam as Amsterdam do not perform differently as in the other models. As for the variables team sports and individual sports the results are not what we expected. None of the variables for both cities are significant, which means that we cannot say anything about the effect it has on house prices. In other words, we cannot prove that team sports and individual sport differ in effect on house prices. For model 6 we examined what the effect is of indoor and outdoor sports on house prices. For Rotterdam there is a difference and most important, both variables are significant. Indoor sports seem to have a negative effect on house price, while outdoor sports have a positive effect on house prices. As stated earlier in this paper, we expected that outdoor sports would have a stronger, as in more positive, effect on house prices than indoor sports. These results seem to support this statement. As for Amsterdam however, the results are not significant which means we cannot say anything about the effect of both variables.

Independent: **Log of price**	**Model 5 - Team & individual**				**Model 6 - Indoor & outdoor**			
	Rotterdam		**Amsterdam**		**Rotterdam**		**Amsterdam**	
Dependent:	*Coefficient*	*T-value*	*Coefficient*	*T-value*	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Type of sports variables								
Team sports	-0.0020595	-1.16	-0.0002158	-0.17	-	-	-	-
Individual sports	-0.0005917	-0.30	-0.0014075	-1.29	-	-	-	-
Indoor sports	-	-	-	-	-0.0021835*	-1.95	-0.0003401	-0.44
Outdoor sports	-	-	-	-	0.0061071**	2.02	-0.0012641	-0.70
Constant	11.36891***	342.84	11.65925***	376.05	11.37564***	326.61	11.64987***	369.80
Adjusted R-squared	0.8280		0.8813		0.8291		0.8812	
Number of observations	55,815		108,175		55,815		108,175	

See appendix tables 2.5 & 2.6 for full models

VIII. Discussion

In the previous section we stated the results of our research. In this part of our paper we will reflect on these results and discuss possible reasons for the outcomes. Furthermore, we will reflect the hypotheses which are stated earlier in this paper For the first model, we examined what the effect is of sport clubs on house prices, considering a 800 meter distance range. Next to that, we included the impact of diversity of sport clubs on house prices. Our model showed that for Rotterdam there is a negative impact of sports clubs located in a 800 meter distance range on house prices. This result is also supported by the model of Amsterdam. However, Amsterdam's coefficient is not significant. We hypothesized at the beginning of this paper that 'an additional sport club in the range of 800 meters has a positive effect on house prices.' The null hypothesis is that a higher diversity in sport offerings has no effect or a negative effect on the value of houses. As our results show, we found negative effects. This means we cannot reject our null hypothesis.

So a negative coefficient means that people value an extra sport club in their neighbour negatively. But what could be possible reasons for this? You could argue that the negative externalities, which we expected to happen when the distance buffer is only 350 meters, could already have an impact on a 800 meter distance range. However, noise pollution and no parking space are not realistic reasons. 800 meters is quite a substantial distance so it is not practical to argue that negative externalities are the reason for this effect. A more realistic reason could be the morphology of urban areas. As sport clubs require relatively much space, mainly outdoor sport clubs, it is hard for them to locate near busy areas. They are bound to locate on places where there is enough space. These spacious areas are not located in the city centre, but more in outer areas of the cities. Outer areas are relatively cheaper than city centre areas, when you look at the price of land. Next to that, a reasonable assumption is that sport clubs are endogenous. So sport clubs might influence house prices, but house prices also influence sport clubs. As sport clubs are space intensive, it is optimal for them to pay a minimum land rent. So expensive houses, which are located near the city centre, indicate that the price of land in these neighbourhoods are relatively high. Thus, sport clubs choose locations with low land prices, which are also the neighbourhoods with relatively cheap houses. However, we do include neighbourhood effects in our model, which should eliminate the impact of morphology on our results.

As for the second hypothesis 'an additional sport club in the range of 350 meters has a negative effect on house prices', we found partially supportive results. For Rotterdam the coefficient is negative and significant (at a five percent level). For Amsterdam the coefficient is also negative, however it is not significant. This does not allow us to say anything about the results for Amsterdam. So the hypothesis is partially supported. As mentioned before in the conceptual model, possible reasons for a negative effect on a relatively short distance range (350 meters) are negative externalities.

In our third hypothesis we stated that 'as the distance buffer becomes smaller, the effect of sports clubs on house prices becomes more negative'. If we analyse the results for both Rotterdam and Amsterdam, we see that this is partially supported. For Amsterdam most coefficients are not significant, which means we cannot say anything about the effect. However, Rotterdam does show significant coefficients for all four buffer distances. These coefficients show that as the distance becomes smaller, the effect of sport clubs on house prices becomes more negative. This means that as the distance becomes smaller, an extra sport club will lead to a higher negative effect on the price of properties. Reasons for this result could be that negative externalities have a bigger impact on smaller distances. So as the distance decreases, the effect of negative externalities increases.

Not only did this paper research the effect of an extra sport club on house prices for a certain distance buffer. It also examined whether diversity in sport clubs has an impact on the value of properties. For each distance we included a diversity index which had a value between one and zero. One indicates a lot of sport diversity, while zero means a specialisation of one certain type of sport. Our results show that only the coefficients of the 800 meter diversity index variable are significant (for both Rotterdam as Amsterdam). This means we cannot say anything about the effect of the other distances. At the beginning of this paper we hypothesized that 'a higher diversity in sport offerings has a positive effect on the value of houses'. This hypothesis is partially supported, because we found contradicted results from Rotterdam and Amsterdam. The diversity index in Rotterdam shows a positive coefficient, which is in line with our hypothesis. More diversity in sport clubs is valued positively by the people and thus translates in a positive effect on property prices. As for Amsterdam the coefficient is negative, which implies that people value more diversity negatively and thus results in a negative effect on property prices. A possible explanation for a negative coefficient in Amsterdam could be related to freedom of choice. As earlier mentioned, Amsterdam has a tight housing market which means that demand exceeds supply. This is a reason for why the prices are relatively high in Amsterdam at the moment. But the non-equilibrium also implies that people who look for a house do not have much options to choose from. We expect that for this reason people prioritize the basic characteristics of a house and do not take in mind other characteristics of a home such as neighbourhood amenities. Especially sport which can be seen as a secondary or even a tertiary necessity.

To see whether the city centre does have a different impact of sport clubs on house prices, we created an extra variable for our model. This variable, called 'centre', consists out of all neighbourhoods that are part of the city centre. As for Rotterdam there are six neighbourhoods (Gemeente Rotterdam, 2018) and Amsterdam has ten neighbourhoods in the city centre (Wikipedia, 2018) This left us with 4,847 observations for Rotterdam and 14,825 for Amsterdam. We used the same regression method as used in prior models and analysed whether the effect of 800 meters distance buffer and diversity changed using only the data of the city centre neighbourhoods. Our model shows that there are no different effects for Rotterdam. However, for Amsterdam does show a change in coefficients. Especially the diversity variable shows a relatively big change from -0.065 to -0.122 and still being significant at a ten percent level. This indicates that in the city centre there is an even bigger negative effect of sport diversity on house prices. However, this is only partially supported, because our model for Rotterdam does not support this.

Distance 800 meters and diversity index for city centre	**Rotterdam**		**Amsterdam**	
Independent variable:	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Logarithm of price				
Dependent variables:				
Distance variables				
800 meters distance range sport clubs	-0.0022662	-1.44	-0.0028774	-1.70
Diversity index for 800 meters	0.0869668	0.12	-0.1221089*	-2.20
Constant	11.20978***	20.44	11.86684***	247.59
Adjusted R-squared	0.8109		0.8502	
Number of observations (N)	4,785		14,155	

See appendix table 2.7 for full model

The last two hypotheses concern the types of sports. We hypothesized that 'team sports have a stronger effect on house prices compared to individual sports'. Based on our results we cannot conclude anything about the effects of both type of sports. For as well Rotterdam as Amsterdam all coefficients are negative but insignificant. This leaves us to conclude that there is no proof for a difference between the two type of sports and thus the effect could be equal. This means we found no proof whether more social sport clubs (team sports) are valued more positive than sport clubs which focus more on the health aspect (individual sports). As for indoor and outdoor sports we hypothesized that 'outdoor sports have a stronger effect on house prices compared to individual sports'. This is partially supported by our models. For Amsterdam the coefficients are both negative but insignificant. However, for Rotterdam the coefficients are both significant, indoor sports on a ten percent level and outdoor sports on a five percent level. Furthermore, the coefficient for indoor is negative while outdoor shows a positive coefficient. This means that an indoor sport club is perceived as a negative amenity and thus resulting in a negative effect on house prices. Outdoor sports clubs are perceived as a positive amenity and thus results in a positive effect on house prices. This result is in line with what we assumed at the beginning of our paper. However, it does contradict with what we stated earlier on in our discussion. We assumed that sport clubs need relatively much space, especially outdoor sports clubs. For this reason they tend to locate on places where the price of land is relatively cheap and where land is abundant. That is why the effect of sports clubs is negative, because it is related to relatively cheap properties. Our results show that outdoor sports clubs have a positive effect on house prices and thus contradicts this assumption. Further research is needed to test what is the definite reason for these contradicting results.

IX. Conclusion

In this part of the paper we will try to answer the research question. The research question, mentioned at the beginning of this paper, is ‘What is the effect of amateur sport clubs on property values?’. Based on the hypotheses we tried to give an answer of how sport clubs could affect property prices. Well, as discussed in the previous section of this paper, we found some expected and unexpected results. However, most results are partially supported because of the insignificant coefficients found for Amsterdam. This means we can give an indication of the price effects, but there is still enough room for further research.

So what is the effect of amateur sport clubs on property values? Well, based on our results you could argue that sport clubs in general are negatively associated with property values. During the course of the study, it became clear that endogeneity plays an important role. This effect becomes more negatively once the distance buffer decreases. This means that people experience a discomfort from sport clubs in their neighbourhood which leads to a decrease in house prices. This negative effect is mostly due to the presence of indoor sport clubs, which have a negative effect on house prices, corresponding with the overall coefficient of all sport clubs together. Outdoor sport clubs however show a positive effect on property values, which means that people value outdoor sport clubs as a positive amenity. But because this result is only supported by our model for Rotterdam, this still leaves much to discuss. This research project at the very least describes a research agenda for the future. Our model could not show whether team sports have a different or bigger effect on house prices than individual sports. This means that the social aspect of sports remains inconclusive in whether it affects house prices.

Recommendations & limitations

As this paper is one of the first which researches the effect of amateur sport clubs on house prices with a hedonic price model, a lot of further research has to be done to come to solid conclusions. This paper recommends further research to include longitudinal data. This allows the model to include the effect of movement of sport clubs. One other researcher, verbally, suggested that most sport clubs in Rotterdam and Amsterdam had to move in the past because of property development. This led to sport clubs locating on places where the price of land was relatively low. If a model can capture this effect, than this will lead to a better understanding of how sport clubs affect house prices. Testing this potential explanation would require additional research in a quasi-experimental setting. Another recommendation is accounting for endogeneity in your model. This could be achieved by including one or multiple instrumental variables. These variables affect sport clubs but do not influence the price of properties.

As for the limitations in this paper, we found during our research process that there are some limitations in the data. Some locations of sport clubs are not the actual locations where the sport is performed. Examples of these sports are diving, running and boot camp. Other limitations are linked to the discussed recommendations. We expect that the inconclusive results are caused by the absence of longitudinal data and the presence of endogeneity.

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XI. Appendix

Appendix 1: Sport categories an types of sport

Table 1.1 – Overview of different sporting categories and the number of observations per city

Sports categories	**Number of observations** (Amsterdam; Rotterdam)
Athletics	12;9
Ball games	195;175
Physical condition	12;40
Dance	22;93
Mind games	52;28
Fitness	112;113
Gymnastics	56;76
Remaining sports	39;76
Equestrian sport	9;9
Racket sport	80;68
Combat sport/Defence sport	167;145
Gun sport	22;8
Water sport	58;31
Bicycling sport	9;5
Winter sport	11;3
Swimming sport	40;44
Total	*896;923*

Table 1.2 – Overview of all sport categories and corresponding subcategories

Category	**Subcategories**
Athletics	- Athletics
Ball games	- American Football - Basketball - Beach volleyball - Bowling - Cricket - Golf - Hand ball - Hockey - Baseball/Softball - Jeu de boules - Korfball - Lacrosse - Rugby - Football - Volleyball - Indoor football

Physical condition	- Bootcamp - Cardio training - Running - Nordic walking
Dance	- Ballet - Breakdance - Cheerleading - Country dance - Dance - Hip-hop - Indian dance - Line dance - Pole dance - Ballroom dance - Street dance - Urban dance - Folk dance - Zumba
Mind games	- Bridge - Draughts/checkers - Play jass - Chess
Fitness	- Aerobics - Body pump - Body shape - CrossFit - Fitness - Personal training - Pilates - Fit Gym
Gymnastics	- Gymnastics
Remaining sports	- Billiards - Body & mind - Climbing - Kombi fit - Scouting - Yoga
Equestrian sport	- Equestrian sport
Racket sport	- Badminton - Squash - Table tennis - Tennis
Combat sport/ Defence sport	- Aikibudo - Aikido - Boccia - Boxing - Jiu-jitsu - Budo - Capoeira - Hapkido - Iaido - Judo - Karate - Kickboxing - Krav maga - Kung-Fu - MMA - Fencing - Taekwondo - Tai chi
Gun sport	- Archery - Shooting
Water sport	- Canoeing - Diving

	- Rowing - Surfing - Water sport - Sailing
Bicycling sport	- Rollerblading - Cycling
Winter sport	- Ice skating
Swimming sport	- Swimming sport - Water polo

Note These subcategories are in line with the categories used by the municipality of Rotterdam. This paper followed their structure in where to classify each type of sport.

Table 1.3 – Team sport versus Individual sport

Team sports	Individual sports
Ball sport	Athletics
Racket sport	Physical condition
Water sport	Bicycling sport
Swimming sport	Winter sport
Mind games	Fitness
Dance	Gymnastics
	Remaining sports
	Equestrian sport
	Combat sport/Defence sport
	Gun sport

Table 1.4 – Indoor sports versus outdoor sports

Indoor sports	Outdoor sports
Basketball	Athletics
Bowling	American Football & Rugby
Handball	Cricket & Lacrosse
Volleyball	Golf
Indoor Football	Baseball and Softball
Cardio training	Jeu de boules
All dance types	Korfball
All mind games	Football
All fitness types	Bootcamp
Gymnastics	Running & Nordic walking
All remaining sports (except scouting)	Scouting
Badminton	Equestrian sports
Squash	Tennis
Table tennis	All water sports
All Combat/Defence sports	All bicycling sports

All Gun sports
All swimming sports

Appendix 2: Stata output

Table 2.1: Model 1; 800 meters distance buffer and diversity index

Model 1 (M1): Distance 800 meters and diversity index	**Rotterdam**		**Amsterdam**	
Independent: **Logarithm of price**	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Surface in square meters	.0069911	29.52	.0075772	39.00
Number of rooms				
1 room	-.1187559	-3.19	-.3035266	-13.07
2 rooms	-.0941889	-7.17	-.1468027	-11.32
3 rooms	-.0362825	-4.89	-.0426045	-6.77
4 rooms	-	-	-	-
5 rooms	-.0011491	-0.17	.0169589	2.36
6 rooms	-.0064034	-0.38	-.0327712	-2.99
7 rooms	-.0252133	-1.11	-.1084347	-7.35
8 rooms	-.083834	-3.12	-.2129153	-7.97
9 rooms	-.1567249	-3.73	-.3389591	-10.03
10 rooms	-.2805952	-5.47	-.5458694	-10.39
More than 10 rooms	-.4437625	-7.00	-.695239	-12.72
Distance variables				
800 meters distance range sport clubs	-.0019308	-2.69	-.0005699	-0.88
Diversity index for 800 meters	.1098627	2.19	-.0652441	-2.04
Type of building				
(ref) Apartments (0)	-	-	-	-
Intermediate house (1)	.1188625	5.75	.0574953	4.44
Semi-detached house (2)	.1759269	7.02	.1471906	6.17
Corner house (3)	.1796679	6.74	.1047265	8.11
Half double house (4)	.3059684	10.17	.2340223	10.50
Detached house (5)	.4098625	11.71	.2753526	6.72
Construction year				
Period of 1500 - 1905	.1055483	3.98	.1752565	9.09
Period of 1906 - 1930	.09556	4.31	.1495716	7.01
Period of 1931 - 1944	.0820578	2.88	.1238022	5.89

Period of 1945 - 1959	.0463884	2.44	.0427483	2.15
(ref) Period of 1960 – 1970	-	-	-	-
Period of 1971 - 1980	.0477038	3.14	.072793	2.55
Period of 1981 - 1990	.0784571	3.21	.0954345	5.29
Period of 1991 - 2000	.2560035	15.24	.2097338	11.65
Period of 2001 and later	.3645261	20.41	.2411801	11.46
Year of sale of a dwelling unit				
(ref) 2003	-	-	-	-
2004	.0251201	2.93	.0155142	2.54
2005	.0592511	10.00	.0691677	8.58
2006	.096064	13.66	.1396808	13.24
2007	.1298128	18.33	.2431953	16.71
2008	.1522293	17.70	.2983893	19.12
2009	.1307191	14.69	.2347013	18.30
2010	.1238004	12.21	.2439156	17.91
2011	.1107967	10.13	.2319705	16.36
2012	.0700149	6.27	.1721855	11.46
2013	.0213162	1.72	.147711	9.21
2014	.0498772	3.42	.2279628	12.54
2015	.0878208	5.05	.3446909	15.93
2016	.1857787	9.26	.4997106	22.07
Neighbourhood fixed effect	Yes		Yes	
Constant	11.29758	239.51	11.69064	342.01
Adjusted R-squared	0.8267		0.8815	
Number of observations (N)	55,335		107,699	

Table 2.2: Model 2; 350 meters distance buffer and diversity index

Model 2 (M2): Distance 350 meters and diversity index	**Rotterdam**		**Amsterdam**	
Independent:	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Logarithm of price				
Surface in square meters	0.0071318	31.05	.0076445	39.60
Number of rooms				
1 room	-.112775	-2.52	-.3102056	-13.08
2 rooms	-.0870045	-6.74	-.1475339	-11.23
3 rooms	-.0334113	-4.43	-.0425573	-6.70
4 rooms	-	-	-	-
5 rooms	.0023626	0.34	.0197093	2.59

6 rooms	-.0047436	-0.26	-.0380653	-3.23
7 rooms	-.0186867	-0.77	-.1143877	-6.94
8 rooms	-.1037752	-3.97	-.2278944	-8.30
9 rooms	-.1989973	-4.78	-.3320649	-8.01
10 rooms	-.290813	-4.12	-.509993	-10.91
More than 10 rooms	-.4619741	-6.92	-.7007502	-11.80
Distance variables				
350 meters distance range	-.0036844	-2.54		
sport clubs			-.0007195	-1.06
Diversity index for 350 meters	-.0018912	-0.11	.0054823	0.42
Type of building				
(ref) Apartments (0)	-	-	-	-
Intermediate house (1)	.121572	5.67	.048543	3.40
Semi-detached house (2)	.1460793	6.11	.1346603	4.71
Corner house (3)	.1861682	6.36	.0979559	7.72
Half double house (4)	.3139912	8.43	.2156476	10.13
Detached house (5)	.404538	9.04	.2535341	6.26
Construction year				
Period of 1500 - 1905	.1017473	3.60	.1776732	8.42
Period of 1906 - 1930	.1024671	4.21	.1563505	6.93
Period of 1931 - 1944	.0879531	3.10	.1261924	5.74
Period of 1945 - 1959	.0508867	2.55	.0365646	1.85
(ref) Period of 1960 – 1970	-	-	-	-
Period of 1971 - 1980	.0512083	3.12	.0780813	2.35
Period of 1981 - 1990	.0767619	2.89	.0930743	4.51
Period of 1991 - 2000	.2730026	13.62	.2112759	10.71
Period of 2001 and later	.3663684	21.10	.240168	10.68
Year of sale of a dwelling unit				
(ref) 2003	-	-	-	-
2004	.0196341	2.07	.0205745	3.45
2005	.0583232	9.54	.0727435	9.33
2006	.0924286	13.13	.1471044	14.51
2007	.1266075	18.10	.2565909	19.25
2008	.1498236	18.46	.3134617	22.28
2009	.1276624	15.92	.2469428	21.25
2010	.1214587	12.26	.2562133	20.33
2011	.1075921	9.64	.2464914	19.78
2012	.0657556	5.82	.1879363	13.98
2013	.0177503	1.50	.162858	11.20
2014	.0449544	3.07	.2461549	14.86

2015	.0855967	5.08	.3647186	18.31
2016	.184922	9.36	.5216971	25.27
Neighbourhood fixed effect	Yes		Yes	
Constant	11.33369***	413.79	11.62397	403.29
Adjusted R-squared	0.8117		0.8787	
Number of observations (N)	45,817		91,412	

Table 2.3: Model 3; 650 meters distance buffer and diversity index

Model 3 (M3): Distance 650 meters and diversity index	**Rotterdam**		**Amsterdam**	
Independent: **Logarithm of price**	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Surface in square meters	.0070164	30.21	.0075776	39.11
Number of rooms				
1 room	-.1181944	-3.15	-.3033402	-13.00
2 rooms	-.0928811	-7.03	-.1467211	-11.35
3 rooms	-.0355046	-4.79	-.0423395	-6.75
4 rooms	-	-	.0176754	2.47
5 rooms	-.0015586	-0.23	-.0323511	-2.98
6 rooms	-.0063294	-0.37	-.1088356	-7.33
7 rooms	-.0246205	-1.08	-.2124577	-7.95
8 rooms	-.0853057	-3.25	-.3401625	-10.02
9 rooms	-.158118	-3.83	-.5459507	-10.37
10 rooms	-.280335	-5.42	-.6955862	-12.73
More than 10 rooms	-.4454734	-6.97		
Distance variables				
650 meters distance range sport clubs	-.0028167	-3.10	-.0009149	-1.31
Diversity index for 650 meters	.0537707	1.33	-.0176286	-0.70
Type of building				
(ref) Apartments (0)	-	-	-	-
Intermediate house (1)	.117324	5.55	.0593969	4.51
Semi-detached house (2)	.1664215	6.69	.1484645	6.20
Corner house (3)	.1789026	6.58	.1075596	8.38
Half double house (4)	.3008809	9.47	.2318779	10.28
Detached house (5)	.4082189	10.93	.2746816	6.75
Construction year				
Period of 1500 - 1905	.1051736	4.05	.1740985	9.03

Period of 1906 - 1930	.097466	4.42	.1490903	7.03
Period of 1931 - 1944	.0841939	2.99	.1231529	5.90
Period of 1945 - 1959	.0488228	2.59	.0433419	2.21
(ref) Period of 1960 – 1970	-	-	-	-
Period of 1971 - 1980	.0488499	3.19	.0706512	2.52
Period of 1981 - 1990	.0788372	3.17	.0954358	5.32
Period of 1991 - 2000	.2604289	15.61	.2099761	11.71
Period of 2001 and later	.366835	20.12	.2390695	11.61
Year of sale of a dwelling unit				
(ref) 2003	-	-	-	-
2004	.0253001	2.93	.0155818	2.52
2005	.0594958	9.95	.0694151	8.60
2006	.0958234	13.46	.1398075	13.23
2007	.1298628	18.24	.2436673	16.82
2008	.1509526	17.64	.2987756	19.22
2009	.1302729	14.70	.2350258	18.42
2010	.123757	12.10	.2442672	18.03
2011	.1117121	10.14	.2322854	16.43
2012	.0699451	6.15	.1724092	11.52
2013	.0220089	1.77	.1478561	9.25
2014	.0498299	3.40	.2277176	12.49
2015	.087375	5.03	.3443733	15.88
2016	.1857432	9.21	.499535	21.99
Neighbourhood fixed effect	Yes		Yes	
Constant	11.34146***	357.27	11.66335	363.40
Adjusted R-squared	0.8252		0.8816	
Number of observations (N)	54,846		107,510	

Table 2.4: Model 4; 500 meters distance buffer and diversity index

Model 4 (M4): Distance 500 meters and diversity index	**Rotterdam**		**Amsterdam**	
Independent:	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Logarithm of price				
Surface in square meters	.0070687	30.11	.0075651	38.73
Number of rooms				
1 room	-.1191419	-3.02	-.3043997	-12.98
2 rooms	-.0904158	-6.74	-.1471143	-11.33
3 rooms	-.0348758	-4.70	-.04244	-6.71

4 rooms	-	-	-	-
5 rooms	-.001516	-0.22	.0189482	2.66
6 rooms	-.0078226	-0.45	-.0316977	-2.89
7 rooms	-.0289055	-1.24	-.1078736	-7.16
8 rooms	-.0884212	-3.46	-.2142389	-7.84
9 rooms	-.1668281	-4.07	-.3435164	-10.01
10 rooms	-.2891577	-4.90	-.5450661	-10.32
More than 10 rooms	-.4581395	-7.07	-.702989	-12.43
Distance variables				
500 meters distance range sport clubs	-.0030525	-2.74	-.0007326	-1.05
Diversity index for 500 meters	-.0016081	-0.06	.0080022	0.55
Type of building				
(ref) Apartments (0)	-	-	-	-
Intermediate house (1)	.1163172	5.36	.0593252	4.39
Semi-detached house (2)	.1496748	5.92	.1459811	5.86
Corner house (3)	.1780047	6.38	.10796	8.41
Half double house (4)	.2992985	8.82	.2373438	10.95
Detached house (5)	.4063087	10.42	.2662926	6.64
Construction year				
Period of 1500 - 1905	.1015098	3.92	.1716556	8.77
Period of 1906 - 1930	.095131	4.26	.1463613	6.83
Period of 1931 - 1944	.0823627	2.94	.1198032	5.73
Period of 1945 - 1959	.0485272	2.65	.0393425	2.10
(ref) Period of 1960 – 1970	-	-	-	-
Period of 1971 - 1980	.04708	3.13	.0685884	2.44
Period of 1981 - 1990	.0770132	3.04	.092591	5.00
Period of 1991 - 2000	.2645221	16.19	.2090315	11.51
Period of 2001 and later	.364951	20.58	.2358117	11.26
Year of sale of a dwelling unit				
(ref) 2003	-	-	-	-
2004	.0245125	2.78	.0171238	2.74
2005	.0593917	9.95	.0710483	8.84
2006	.0960787	13.11	.1421142	13.47
2007	.1299843	18.17	.2465575	17.20
2008	.1513975	17.34	.3014641	19.65
2009	.1300996	14.72	.2373317	18.80
2010	.1236656	12.22	.2465356	18.42
2011	.1094795	9.94	.2347109	16.77
2012	.0690466	6.16	.1744167	11.71

2013	.0221445	1.84	.1500924	9.48
2014	.0497084	3.41	.2302846	12.68
2015	.0871344	5.12	.3469432	16.10
2016	.1846627	9.22	.5024707	22.39
Neighbourhood fixed effect	Yes		Yes	
Constant	11.36009	428.23	11.64523	406.26
Adjusted R-squared	0.8206		0.8817	
Number of observations (N)	52,929		105,986	

Table 2.5: Model 5; Team and individual sports

Model 5 (M5): Team & individual sports	**Rotterdam**		**Amsterdam**	
Independent:	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Logarithm of price				
Surface in square meters	.0069761	29.33	.0075689	39.28
Number of rooms				
1 room	-.122288	-3.26	-.303541	-13.06
2 rooms	-.0950832	-7.18	-.1473162	-11.42
3 rooms	-.0366382	-4.96	-.043126	-6.87
4 rooms	-	-	-	-
5 rooms	-.0014801	-0.22	.0170744	2.38
6 rooms	-.0061841	-0.37	-.034274	-3.06
7 rooms	-.0251061	-1.11	-.1094054	-7.41
8 rooms	-.0816217	-3.08	-.2121379	-8.01
9 rooms	-.1613205	-3.75	-.3376305	-10.08
10 rooms	-.2760868	-5.31	-.5465787	-10.42
More than 10 rooms	-.4399192	-6.99	-.6949011	-12.80
Types of sport				
Team sports	-.0020595	-1.16	-.0002158	-0.17
Individual sports	-.0005917	-0.30	-.0014075	-1.29
Type of building				
(ref) Apartments (0)	-	-	-	-
Intermediate house (1)	.1181766	5.73	.0589436	4.45
Semi-detached house (2)	.1747713	6.96	.1495108	6.31
Corner house (3)	.1789906	6.74	.1061211	8.02
Half double house (4)	.2997846	10.12	.2313594	10.41
Detached house (5)	.4009246	11.99	.2819377	7.09
Construction year				

Period of 1500 - 1905	.1067626	4.02	.1743746	9.06
Period of 1906 - 1930	.0976245	4.27	.1488875	7.00
Period of 1931 - 1944	.0837943	2.90	.1227309	5.80
Period of 1945 - 1959	.046793	2.40	.0436199	2.19
(ref) Period of 1960 – 1970	-	-	-	-
Period of 1971 - 1980	.0481138	3.06	.0709564	2.53
Period of 1981 - 1990	.0804964	3.23	.0952874	5.28
Period of 1991 - 2000	.2557163	14.81	.209719	11.82
Period of 2001 and later	.3632425	19.55	.2400648	11.53
Year of sale of a dwelling unit				
(ref) 2003	-	-	-	-
2004	.0250458	2.99	.0160108	2.61
2005	.0588197	10.09	.0693312	8.65
2006	.0952824	13.88	.1395447	13.23
2007	.1288424	18.55	.2432181	16.77
2008	.1517514	18.10	.2981753	19.13
2009	.1292598	14.67	.2346969	18.35
2010	.1230157	12.34	.2436262	17.98
2011	.1097578	10.18	.2322582	16.42
2012	.0693741	6.28	.1720616	11.49
2013	.0212055	1.73	.1474429	9.24
2014	.0492309	3.43	.2270352	12.43
2015	.0873168	5.10	.3435622	15.79
2016	.1850226	9.31	.4983507	21.87
Neighbourhood fixed effect	Yes		Yes	
Constant	11.36891***	342.84	11.65876	404.62
Adjusted R-squared	0.8280		0.8813	
Number of observations (N)	55,815		108,175	

Table 2.6: Model 6; Indoor and outdoor sports

Model 6 (M6): Indoor & outdoor sports	**Rotterdam**		**Amsterdam**	
Independent:	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Logarithm of price				
Surface in square meters	.0069651	30.09	.0075718	39.20
Number of rooms				
1 room	-.1174672	-3.10	-.3039876	-13.09
2 rooms	-.0946296	-7.15	-.1474334	-11.41

3 rooms	-.036995	-4.91	-.0431348	-6.85
4 rooms	-	-	-	-
5 rooms	-.0003713	-0.05	.017183	2.39
6 rooms	-.0051543	-0.31	-.0343407	-3.08
7 rooms	-.0222767	-1.03	-.1096214	-7.47
8 rooms	-.0792129	-3.05	-.2124132	-8.02
9 rooms	-.1608532	-3.77	-.3381935	-10.09
10 rooms	-.2712445	-5.32	-.5480309	-10.43
More than 10 rooms	-.436654	-6.90	-.6958807	-12.83
Type of sports variables				
Indoor sports	-.0021835	-1.95	-.0003401	-0.44
Outdoor sports	.0061071	2.02	-.0012641	-0.70
Type of building				
(ref) Apartments (0)	-	-	-	-
Intermediate house (1)	.1162512	5.58	.0595279	4.47
Semi-detached house (2)	.1717038	6.75	.150653	6.42
Corner house (3)	.1772369	6.60	.1068806	8.07
Half double house (4)	.297889	9.99	.2323574	10.50
Detached house (5)	.3995426	11.93	.2832067	7.15
Construction year				
Period of 1500 - 1905	.1037643	3.88	.1744632	9.23
Period of 1906 - 1930	.0945789	4.19	.1493051	7.18
Period of 1931 - 1944	.0776859	2.88	.1237613	6.01
Period of 1945 - 1959	.0507093	2.54	.0438909	2.22
(ref) Period of 1960 – 1970	-	-	-	-
Period of 1971 - 1980	.0495873	3.10	.0708081	2.53
Period of 1981 - 1990	.0818241	3.33	.0955839	5.34
Period of 1991 - 2000	.2513965	14.49	.2104171	11.73
Period of 2001 and later	.3635692	19.40	.2405917	11.46
Year of sale of a dwelling unit				
(ref) 2003	-	-	-	-
2004	.0244376	2.95	.0160309	2.62
2005	.0586926	10.19	.06939	8.68
2006	.0951852	13.99	.139647	13.27
2007	.1287454	18.69	.2432851	16.78
2008	.152069	18.60	.2982165	19.15
2009	.1293703	14.83	.2346927	18.34
2010	.1227008	12.36	.2436395	17.99
2011	.1101752	10.39	.2322552	16.43

2012	.0688852	6.27	.1721119	11.52
2013	.0219859	1.81	.147442	9.24
2014	.0486966	3.42	.2271124	12.43
2015	.0866124	5.12	.3436573	15.80
2016	.1845898	9.23	.4984759	21.92
Neighbourhood fixed effect	Yes		Yes	
Constant	11.37564	326.61	11.64911	396.50
Adjusted R-squared	0.8291		0.8812	
Number of observations (N)	55,815		108,175	

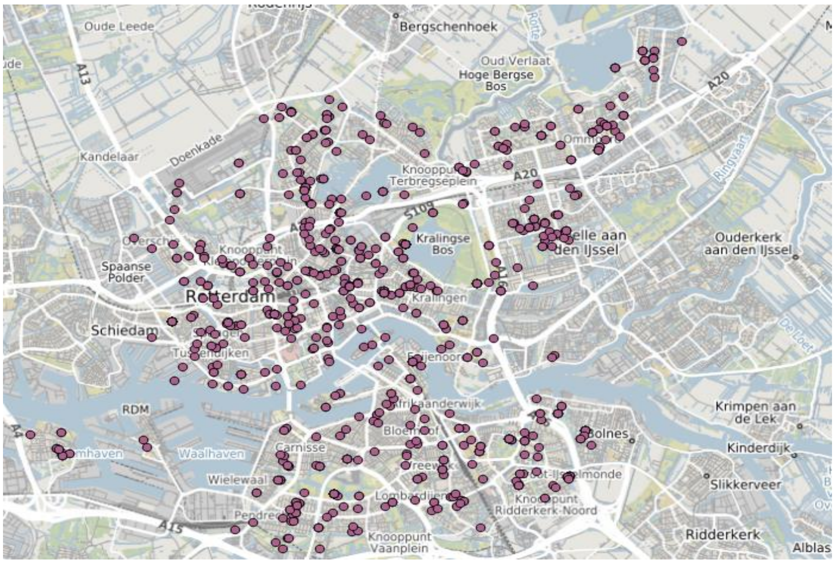
Table 2.7: Model 7; 800 meters distance buffer and diversity index for the city centre

Model 7 (M7): Distance 800 meters and diversity index for city centre	**Rotterdam**		**Amsterdam**	
Independent: **Logarithm of price**	*Coefficient*	*T-value*	*Coefficient*	*T-value*
Surface in square meters	.0091404	39.78	.0071785	25.13
Number of rooms				
1 room	-.0696968	-0.54	-.4284486	-16.30
2 rooms	-.0231033	-1.26	-.2180095	-14.72
3 rooms	.0071402	0.38	-.051561	-4.00
4 rooms	-	-	-	-
5 rooms	-.0559284	-2.74	.0007835	0.07
6 rooms	-.0624824	-0.88	-.0721411	-4.66
7 rooms	-.2311249	-4.81	-.1338858	-7.07
8 rooms	-.3551677	-6.81	-.2229782	-4.78
9 rooms	-.4730998	-2.89	-.4113147	-8.25
10 rooms	-.7794189	-6.35	-.5851794	-12.77
More than 10 rooms	-1.050.151	-6.41	-.7014079	-11.00
Distance variables				
800 meters distance range sport clubs	-.0022662	-1.44	-.0028774	-1.70
Diversity index for 800 meters	.0869668	0.12	-.1221089	-2.20
Type of building				
(ref) Apartments (0)	-	-	-	-
Intermediate house (1)	-.1589276	-1.55	.001899	0.11
Semi-detached house (2)	-.0508425	-0.98	.196233	2.34
Corner house (3)	-.0073125	-0.06	.0951457	2.88

Half double house (4)	-.0076113	-0.03	-.0552743	-0.55
Detached house (5)			-.0317364	-0.94
Construction year				
Period of 1500 - 1905	.0150211	0.17	.0947784	3.56
Period of 1906 - 1930	.0924184	1.12	.0352079	1.63
Period of 1931 - 1944	.2068272	3.09	.0160002	0.63
Period of 1945 - 1959	-.0791718	-2.91	.0123325	0.46
(ref) Period of 1960 – 1970	-	-	-	-
Period of 1971 - 1980	-.0696905	-2.14	-.0186303	-0.43
Period of 1981 - 1990	-.0648008	-1.36	-.0051768	-0.17
Period of 1991 - 2000	.1472249	3.16	.1257498	8.43
Period of 2001 and later	.2429611	6.52	.1522453	4.64
Year of sale of a dwelling unit				
(ref) 2003	-	-	-	-
2004	.0357983	2.61	.0267512	1.89
2005	.0500345	4.45	.0979298	8.73
2006	.0797948	3.37	.1773772	11.49
2007	.1393013	6.95	.2824447	15.17
2008	.1397935	9.01	.3536085	17.01
2009	.1431529	4.97	.2644304	14.52
2010	.1281287	3.94	.2954857	18.69
2011	.1057598	3.58	.2868449	15.03
2012	.0591503	2.04	.2364676	12.65
2013	.0861627	2.04	.2270938	8.76
2014	.0998717	6.51	.3131949	12.66
2015	.1480611	5.74	.4194415	14.61
2016	.293324	12.93	.5788902	24.52
Neighbourhood fixed effect	Yes		Yes	
Constant	11.20978	20.44	11.87202	421.70
Adjusted R-squared	0.8109		0.8502	
Number of observations (N)	4,785		14,155	

Appendix 3: QGIS output

Figures 3.1 & 3.2: all sport clubs in Rotterdam



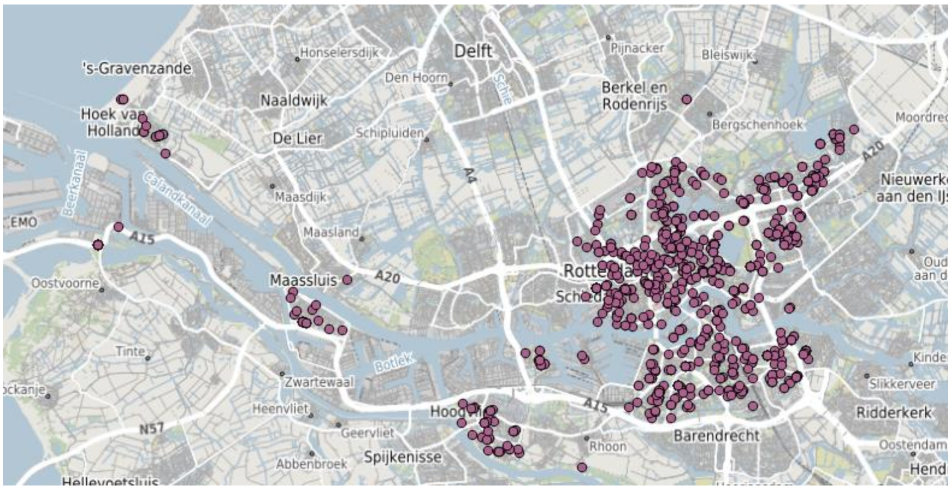
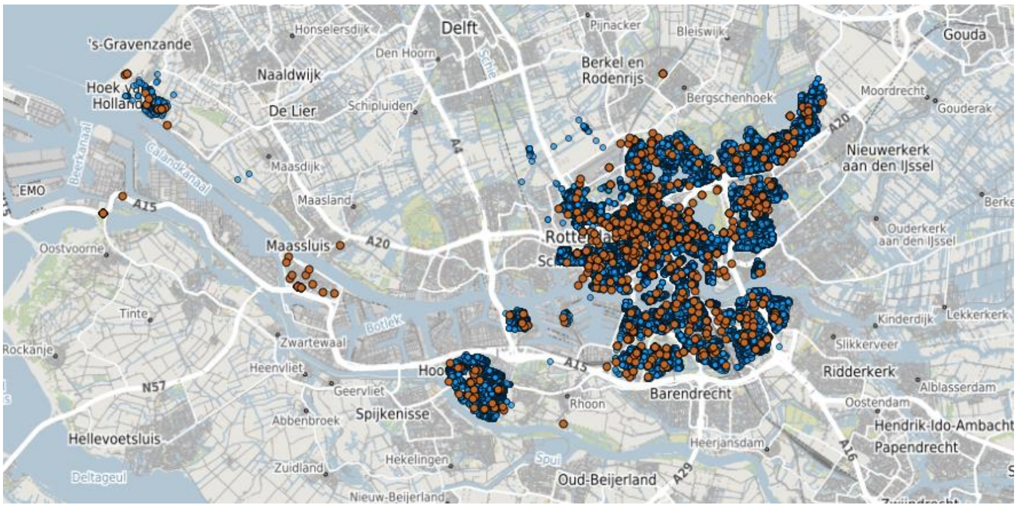


Figure 3.3: Location of sport clubs and properties for Rotterdam



Orange represents all sport clubs, while blue represents all properties.

Figure 3.4: all sport clubs in Amsterdam

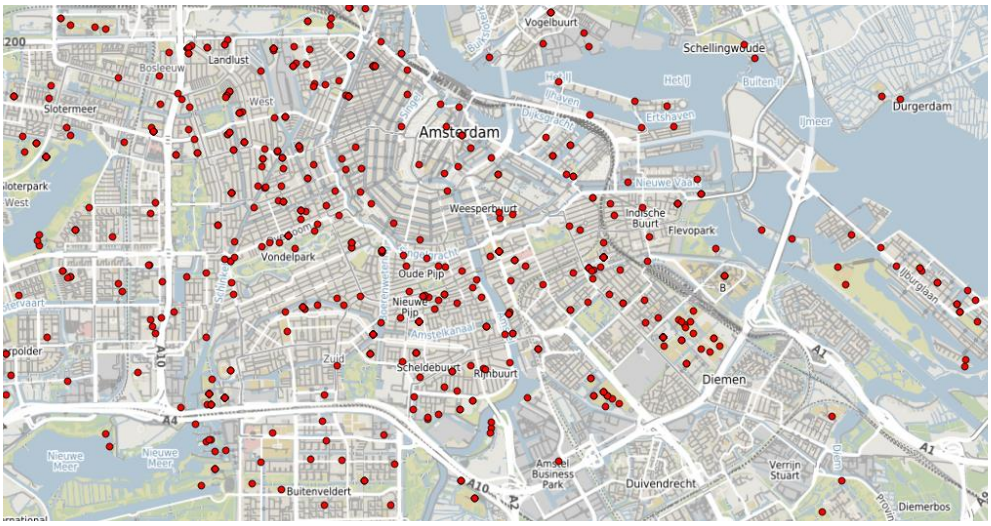
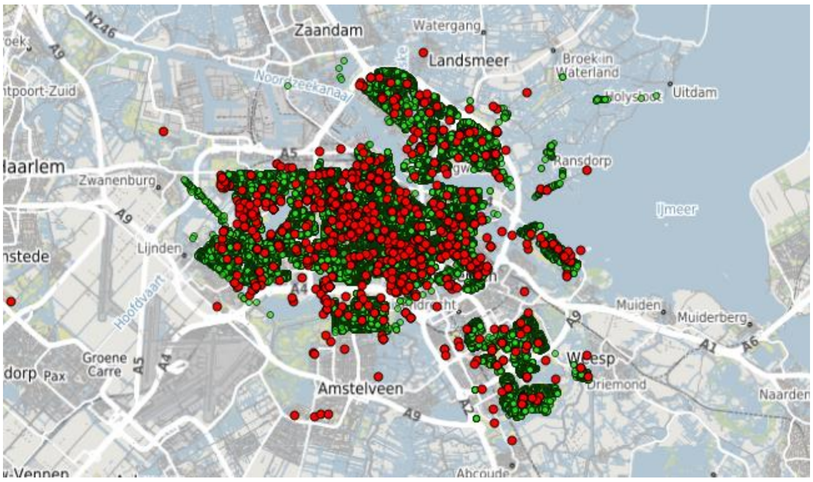


Figure 3.5: Location of sport clubs and properties in Amsterdam



Red represents all sport clubs, while green represents all properties.