ERASMUS UNIVERSITEIT ROTTERDAM

Erasmus School of Economics

Master thesis Urban, Port & Transport economics

Neighborhood attractiveness and residential property prices; the impact of restaurants as consumer amenities

Abstract: This paper does research on the effect of restaurants, as local consumer related amenities, on the neighborhood attractiveness reflected through residential property prices in Amsterdam. Restaurant data from the Dutch review platform the Fork.nl is collected and transformed into useful measures using a geographical information system, QGIS. In addition, transaction data of residential properties is acquired from the Kadaster. The obtained results indicate a positive significant effect of the quantity of restaurants on the house prices. However, no robust and significant effects were found with respect to the quality and diversity of restaurants. This paper build upon the work of Wildeboer (2016) with several contributions, such as the use of multiple buffer radii and the use of price as an explicit variable. This study finds no robust and significant effects of the prices of restaurants with respect to the value of residential real estate.

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1. Introduction

Historically, a lot of empirical research has focused on identifying house price determinants and what factors contribute to an attractive neighborhood. There is an increasing awareness of the need to research the quality of our living environment and the effects of an improved quality of life in urban cities. Urban amenities are a crucial factor in determining willingness to pay for housing in cities (Glaeser et al. 2001). However, Gleaser et al. (2001) found an understudied aspect in the urban literature; the influence of a diverse variety of services and consumer goods on the desirability of locations. Gleaser, Kolko and Sainz (2001) discuss four critical amenities in their producer city versus consumer city debate. Accordingly, one of the four critical amenities is a rich variety of consumer goods and services. In this debate, the authors of the paper argue that the role of urban density in providing consumption is understudied and that there should be more focus on cities' role as centers of consumption. In recent decades, cities have experienced an urban revival which is closely associated with the shift from an industry to a service-based society in which face to face encounters have become increasingly important. Bathelt et al. (2004) researched the spatial clustering of economic activity and the relationship to the knowledge creation in social interactions. It was found that high levels of buzz in an area can be beneficial to firms that are in this area. These lively clusters cause for advantages that are not available to outsiders. This trend that has occurred, can manifest itself through rising land prices, especially in cities that are attractive to highly educated people. Gleaser et al. (2006) stated that the urban rent premium consists of two components, an urban wage premium and an urban amenity premium. Wage is still an important factor, but the urban amenities have become increasingly more important for explaining house price growth. Spatial policy should lay a foundation, to facilitate the transformation of trends, in which a healthy long-term economic development of the city is a central theme (Vermeulen et al., 2001; Stiglitz, 20011).

The aim of this paper is to analyze the four critical urban amenities of Gleaser et al. (2001) at a detailed level of analysis which is associated with real life interactions. This is be analyzed through the study of willingness to pay for residential real estate. Restaurants are iconic examples of urban amenities that facilitate real life encounters. A service-based society has several implications that can best be seen in the hospitality and restaurant business, where reviews are a significant factor in determining the profitability of the establishment (Negative Reviews' Impact on your Restaurant's Reputation, 2021). Following this logic, this paper answers the following central question; what is the effect of restaurants, as local urban amenities, on the neighborhood attractiveness indicated by the residential property prices? Both the quantity and quality of restaurants in the neighborhood is researched. Empirical studies in the past on this topic studied the relationship of a new Walmart store opening with respect to neighborhood sale prices (Pope & Pope, 2015). Other previous research that focused on the impact of neighborhood characteristics on real estate prices, was the study of Wildeboer (2016). More specifically, this work researched the influence of consumer related amenities, such as restaurants, on the house prices in the proximity in Amsterdam. This paper extends and improve the paper of Wildeboer (2016) by implementing several changes and additions. The diversity of cuisines and price levels is taken into consideration to analyze the diversity within restaurants. The cuisine diversity measure is calculated based on the Herfindahl-Hirschman Index, which indicates a measure of concentration and diversity (Rhoades, 1993). This is party done through a consumer-based restaurant review website called fork.nl. Restaurant data from the consumer review website is collected and converted into useful measures. This data includes information on restaurant name, address, average dining price, score, number of reviews, price of a bottle of water and cuisine. Amsterdam has the most restaurants in the Netherlands, has seen the steepest house price increase in percentages in recent years and is known for its consumer-friendly environment, thus making it an interesting case study for this Master thesis (Gemeente Amsterdam, 2022).

2. Literature study

2.1 How are house prices estimated?

Policy makers aim to gather as much information as possible about the supply and demand of environmental goods when formulating their policies. Engineers can provide insights regarding the costs associated with attaining specific levels of environmental quality. However, obtaining demand curves requires knowledge of the prices consumers are willing to pay for the good. Unlike environmental goods, the prices of market goods are observable. A hedonic estimation technique must be used to acquire the prices of environmental goods due to the non-marketed nature of them (Boyle & Kiel, 2001). This estimation technique assumes that when a consumer buys a marketed good, the consumer also implicitly buys some environmental good(s). For example, when somebody buys a house, they do not only acquire the physical structure, but they also obtain the features of the neighborhood and its environmental characteristics. According to Boyle & Kiel (2001), the contribution of the environmental goods to the price of the house can be extracted by regressing the characteristics of the house, including the environmental characteristics, on the observed price of the house.

2.2 How does the neighborhood affect real estate values?

The economic factors influencing real estate prices can be categorized into three main groups: microeconomic, mesoeconomic and macroeconomic factors. Among these, macroeconomic factors are related to socio-demographic, socio-economic and monetary market trends. In contrast, microeconomic factors are objective parameters of a specific transaction and thus refer to individual structural property characteristics. Mesoeconomic factors, on the other hand, refer to attributes that are related to the location of the property and neighborhood attributes (Ruza et al., 2014). Accordingly, the study of Ruza et al. (2014) mainly focusses on implications of their study on the mesoeconomic level. A house can be described as a combination of characteristics, such as location, quality, and size. Moreover, each house possesses a unique set of characteristics that affect the value of the home. Furthermore, the same set of characteristics can have varying influence in different geographic regions. Additionally, homeowners have unique utility functions and different preferences which result in diversification in how they value real estate. As a result, housing is not a homogenous good (Sirmans et al., (2005). The implicit land value of real estate is contingent on the market value of all amenities associated with the location of the house, such as neighborhood characteristics and the accessibility of the home (Dubin, 1992; Davis & Heathcote, 2007). As a result, desirability of locations is closely linked to the mesoeconomic factors affecting real estate valuations and is capitalized in the land component of house prices. Thus, this study aims to investigate the impact of local amenities, which reflect through desirability of locations, on residential property prices.

2.3 The role of amenities

Many empirical studies in the past have focused on what caused house price differentials due to a variation in amenity levels, in doing so, some studies found that statistically significant differences in wages and house prices are caused by a variation in amenities (Hoehn et al., 1987; Haurin & Brasington, 1996). A lot of empirical studies researched location specific characteristics that influence desirability of locations and thus drive real estate prices. The basic viewpoint in urban literature is that cities facilitate positive agglomeration effects on production and negative agglomeration effects on non-work-related consumption. This comes from the idea that in cities, residents often face longer commutes, higher crime rates, and pay higher rents. Gleaser et al. (2001) argue that too little attention is given to the role that cities play as centers of consumption. They argue that as individuals accumulate wealth, the quality of life becomes increasingly important in determining the desirability of living in specific areas. Gleaser et al. (2001) classify four critical urban amenities, namely aesthetics and physical setting, good public services, accessibility or speed and a diverse array of consumer goods and services. The four critical amenities have been developed through an urban perspective, where these amenities are recognized in terms of aggregated house price growth and population (Glaeser & Gottlieb, 2006). Next to this, it is worth mentioning that the framework of Gleaser et al. (2001) can also be useful on a more detailed level of analysis. Moreover, the first three critical urban amenities of Glaeser et al. (2001) have been researched extensively in the literature, while the last consumer related amenity is discussed later in this thesis. Initially, the literature on the first three urban amenities is briefly discussed.

The first critical urban amenity Gleaser et al. (2001) describe in their paper is speed or accessibility to the marketplace. One of the key findings of Muth's (1969) study of the spatial structure of housing market, is that there is a negative-exponential decline of residential population densities as one moves further from the city center. Moreover, real estate with a shorter distance to the city center has a higher price, in contrast to real estate located further away from the city center tends to have lower prices, ceteris paribus (Muth, 1969). These results stem from a monocentric city model where there is a trade-off between accessibility and transportation costs. Although it is widely accepted in urban literature that accessibility and neighborhood quality should influence house prices, some say empirical evidence is weak, however, monocentric models *can* perform well if the location-specific characteristics of housing are measured correctly (Dubin, 1992; Cheshire & Cheppard 1995). Furthermore, it is not just existing railways that have a positive effect on the real estate values in the neighborhood, but anticipated railway stations also have a positive effect which is proportional to the expected risks and uncertainties associated with the implementation of the project (Debrezion, Pels, & Rietveld, 2007; Agostini & Palmucci, 2008).

Another critical urban amenity that Gleaser et al. (2001) discuss is the importance of good public services. It has been widely accepted that good public schools and less crime increase the desirability of locations. At first, it was believed that crime levels and schools were important determinants of the location decision of residents; however, evidence was later provided that the quality of school is a crucial factor in determining house prices (Tiebout, 1956; Jud & Watts, 1981). More specifically, they found that an increase of one grade level in achievement of neighborhood schools is associated with an increase of around 5.7% in the value of the average house, ceteris paribus. Initially it was thought that there was a negative relationship between house prices and crime. Following this result, it was made clear in urban literature that school quality is the most important cause in explaining variation in constant-quality house prices, crime was found to be a less important factor (Thaler 1978; Haurin & Brasington, 1996). Furthermore, determinants such as distance from the city center and metro area accessibility – the first amenity of Gleaser et al. (2001) – were essential in explaining constant-quality house price differentials. Recent research has made a distinction between types of crimes and the impact of schooling on desirability of locations. Gibbons & Machin (2003) found that the quality level of primary schools is more important at neighborhood level because these schools have a smaller catchment area than secondary schools. Furthermore, Lynch & Rasmussen (2001) weighed crimes by their seriousness because they could result in very different measures for public safety for areas with identical crime rates. According to them, the most significant house price deductions was linked to violent crimes due to the added perception of safety of violent crimes.

The third critical urban amenity that Gleaser et al. (2001) describe, concerns the aesthetics and physical setting of real estate. Initially, it was stated that real estate located in desirable settings have an added value compared to less favorably located real estate. More specifically, factors such as having a garden with waterfront views, having access to pleasant views, or having open spaces significantly contribute to an increase in house price valuation. (Luttik, 2000). Moreover, other studies indicate that homes with beautiful urban landscapes have a premium over less appealing urban setting (Wen & Zhang, 2015). Open spaces, due to their recreational aspects, can increase the price of the real estate that it is associated with. However, Lutzenhiser & Netusil (2001) would like to highlight the potential drawbacks these open spaces can have, such as noise disturbance for residents or a sense of insecurity, especially for vulnerable individuals or elderly. On the contrary, Anderson & West (2006) emphasized the positive effects open spaces have on the sale prices of real estate. Accordingly, the value of being near open spaces is higher where space is scarce such as in denser populated areas like the CBD. Furthermore, other physical locational characteristics of the neighborhood concern the visual quality and built environment, in this setting historical cultural sites and urban monuments have a positive effect on the real estate value surrounding it (Baranzini & Schaerer, 2011; Lazrak et al., 2011). Their research provided evidence that home buyers are willing to pay a premium for a historical monument or for a home in the proximity of it.

From this overview of literature concerning local amenities that influence desirability of locations and thus affect residential property prices, it becomes clear that there is a shift in urban literature. In the beginning, it was believed that distance to the CBD and good public schools were the most important determinants in explaining house price differentials (Thibout, 1956; Muth's 1969). Thereafter, Luttik (2000) highlighted the relevance of physical setting and aesthetics of a home affecting its value positively. The shift that has been occurring in urban literature is driven by Gleaser et al. (2001), who introduced the concepts of production city versus consumption city. They observe two major ongoing trends, namely, rising incomes and improved transport technologies for ideas, goods, and people. Not only will the future of cities depend on the ability to attract high skilled labor, but also on the quality-of-life cities offer. People that are high skilled anticipate an ever-widening disparity across certain urban areas because some cities will successfully position themselves into consumer havens, while others will not. However, a diverse range of urban amenities, the last urban amenity, has received considerably less attention in literature. An exemption is the work of Pope & Pope (2015), this study researched whether the introduction of a new Walmart store had an influence on the real estate prices in the surrounding neighborhood. Their study provided evidence that, on average, a new Walmart store only will positively affect houses in proximity. The empirical study of Wildeboer (2016) researched local amenities that influence desirability of locations, thus driving house prices. Moreover, the study focused on whether local amenities, such as restaurants in Amsterdam between 2013 and 2016, influence neighborhood house sales prices. One key finding of that study was that only restaurants in the medium to upper quality spectrum are positively related to real estate prices. Since then, the landscape of the hospitality and restaurant business has seen a drastic change. Due to COVID-19, many restaurants have gone bankrupt or got replaced. Therefore, this paper recreates and improves the study of Wildeboer (2016) with more recent data, some changes, and additions to analyze whether the results of this study are still valid today. Wildeboer (2016) focused on a low, local level of analysis, where the study did not take the mobility of people into account. People in a city optimize their location with walking, cycling, public transport and private care use, this thesis accounts for this principle. Furthermore, this paper adds price as an explicit variable, where Wildeboer (2016) did not. Restaurants do not only compete on quality, ambience, and attractiveness of the surroundings, but also on price. This is an important characteristic that restaurant businesses compete on, moreover, it was not acknowledged in the study of Wildeboer (2016). Prices are an elusive concept in the hospitality industry, as consumption is not standardized. The consumers can choose between from a menu that provides a large set of potential combinations as well a great variety of quantities that can be consumed. This makes is very difficult to assess a singular price point to identify as 'price level' of a restaurant. I solve this problem with a novel measure of price, which is the price of standardized commodity; the price of one liter of mineral water. Although there exists variation in brand and packaging, this is in my view the most standardize measure of prices that relates to restaurants.

2.4 The role of restaurants as local amenities driving neighborhood attractiveness

In the last two decades there has been a noticeable trend regarding urban cities and growth. More specifically, urban cities with more restaurants and live performance venues per capita have grown quickly in France and the United States (Gleaser et al., 2001). Restaurants, theaters, and a diverse social scene is place specific, thus local, making it very hard to recreate elsewhere. In large metropolitan areas, consumers' welfare can be increased through reaching the potential of economies of scale that the city can provide. For citizens of urban areas, it is often a necessity to attend large entertainment venues like major league baseball games or the opera. Furthermore, the restaurant business can profit from the advantages of economies of scale in urban cities by providing a wide range of cuisines to its guests (Gleaser et al., 2001). One of the key findings of the study of Gleaser et al. (2001) was that they found a positive correlation between growth on a national scale and the number of restaurants. The fourth critical amenity of Gleaer et al. (2001), a diverse range of consumer products and services, is closely linked to the restaurants business as they are places where ideas arise and spread (Vermeulen et al., 2001). An important asset in today's technologically driven society is face-to-face encounters, restaurants can facilitate these by serving as attractive locations that can boost these. Furthermore, the cluster of amenities, such as restaurants and retail stores, has experienced a growth in importance reflected through real estate prices locally. The presence of several restaurants close to popular destinations, like train stations, can lead to spillover effects. The agglomeration of amenities such as restaurants can create both complementary and competing businesses (Hidalgo et al., 2020). In doing so, competitive clustering can emerge due to the need of consumers to compare quality, prices, and service before making a financial decision (Eaton & Lipsey, 1975; Scitovsky, 2013). Dining establishments within this competitive cluster can help their costumers make a dinner choice by providing them with the possibility to check the menu and prices beforehand. Many urban cities have specifically located areas in which the co-location of different restaurants is common. Although it is not expected for costumers in these areas to return to the same dining establishment twice, however it is expected that they come back to nearby alternatives on a future occasion due to the exposure of them (Hidalgo et al., 2020). Thus, a restaurant can serve as a proxy for other amenities located close by. Multiple studies found that there is a positive correlation between restaurants and grocery stores, also they often tend to co-locate next to each other. Beyond the catering ability that they provide to their clientele, restaurants also contribute to the overall liveliness and ambience of the local area, which is experienced by pedestrians and other people passing by (Clark, 2003; Hidalgo et al., (2020). Previous empirical studies on the effect of restaurants on real estate prices mainly have focused on an urban level analysis. For example, one of the key findings of the study of Garretsen & Marlet (2011) was that urban cities with a diverse array of urban amenities are better in attracting residents. The presence of a larger quantity and higher quality of dining establishments, among other amenities, have been a crucial factor in the location decision of residents. As a result, cities that provided these facilities have experienced higher and accelerated growth that translated into higher real estate prices. Moreover, empirical studies have shown that there is a positive relationship between land value and the proximity of amenities (Vermeulen et al., 2000). Not only did their study account for the quantity of amenities close by, but also the quality of restaurants.

However, the impact of restaurant characteristics on the residential property prices has not been researched extensively, therefore this paper adds to the scare body of literature on this topic. An exception is the empirical study of Kuang (2017), who researched the effect of amenity quality on the local consumption. According to Kuang (2017), prior research focused too much on the quantity of amenities within a geographical area, neglecting the quality of these amenities. This study introduced a quality-based dimension based on consumer price and ratings into her research, which was new at the time. These ratings were collected from Yelp.com, a consumer-based restaurant review website. One of the key findings of this study was that there was evidence suggesting a positive relationship between the quantity and quality of restaurants and the real estate prices in the neighborhood. Another finding of Kuang (2017) was that information on consumer amenities collected from review websites like Yelp.com, can influence sale prices of real estate in the neighborhood, making this an implicit market measure of the value of these amenities. From these reviews that are collected from websites like Yelp, a consistent measure of amenity values can be made that are useful for other private retail businesses or even local public goods.

2.5 Hypothesis

The previous paragraphs have made it clear that desirability of locations consists of several location-specific attributes that are included in the residential property prices. Furthermore, there has been a shift noticeable in literature from the concept of 'producer city' to 'consumer city'. This shift has been especially noticeable when discussing local amenities that influence desirability of locations and thus relevant for explaining house price differentials. This paper is an extension to the scarce body of literature that discusses the fourth critical urban amenity of Gleaser et al. (2001), namely a diverse array of consumer goods and services. Today's society is mostly dominated by digitalization of communication technologies, however face-to-face interactions and connections are becoming increasingly important. The focus of this paper is locations that enhance social connections and interactions, namely restaurants. Different studies have shown that restaurants can serve as a proxy for other consumer related amenities close by, such as grocery stores (Hidalgo et al., 2020). This study tests multiple hypotheses to analyze whether restaurants, as a local consumer related amenity that stimulates face-to-face interactions and meetings, affect desirability of locations and thus residential property prices. According to Clark (2003), restaurants add to local vibrancy and liveliness due to their presence. As a result, the first hypothesis does not differentiate between the quality of a restaurant, thus only regarding their presence.

> *Hypothesis 1:* The presence of local restaurants has a positive effect on the neighborhood attractiveness, as indicated by residential property prices.

Moreover, it has been widely accepted in urban literature that not only the quantity of amenities matters when discussing neighborhood attractiveness, but also the quality of the amenities in the proximity. Initially, it was believed that school quality was the most important factor in explaining differences in constant-quality houses (Haurin & Brasington, 1996). However, more recently a distinction was made between types of schooling in relationship to neighborhood real estate prices. More specifically, it was found that the quality of primary schools the most significant determinant in explaining house price differentials due to their smaller catchment area (Gibbons & Machin, 2003). Additionally, another study emphasized the importance of the amenity quality levels by explaining that a Michelin-starred restaurant has a greater impact on the neighborhood real estate prices than a fast-food restaurant (De Groot et al., 2010). This finding raises the possibility that a diverse selection of restaurants could be an important urban amenity. A diverse restaurant selection can be translated into restaurants with different cuisines and price-quality levels. As a result, two additional hypotheses can be formulated that account for the diversity within the restaurant industry.

> *Hypothesis 2:* The quality level of local restaurants has a positive effect on the neighborhood attractiveness, as indicated by residential property prices.

Hypothesis 3: The diversity of cuisines of local restaurants has a positive effect on the neighborhood attractiveness, as indicated by residential property prices.

One could say that restaurants that have the same cuisine sell homogenous goods, but they differentiate in other ways. Restaurant businesses compete on several factors such as ambience, attractiveness of surroundings and service, thus selling differentiated goods. These businesses compete in a monopolistic competition where there are low barriers to enter the market (Salop, 1979). Accordingly, these differentiated products allow the restaurants to act as price makers and set prices for these goods. Restaurants can raise their prices without initiating a price war with similar businesses. Due to the nature of these differentiated goods, consumers have a different willingness to pay for these goods. Intuitively this makes sense, as a consumer can have a higher willingness to pay for a Michelin starred restaurant compared to a fast-food restaurant. Furthermore, prices of a restaurant can reflect a signal to consumers to indicate the quality and service level. As a result, the price as explicit variable is included.

Hypothesis 4: The price level of local restaurants has a positive effect on the neighborhood attractiveness, as indicated by residential property prices.

3. Data

3.1 Restaurant data

This paper uses different datasets collected from several sources, more specifically, cross sectional datasets are used that contain information about restaurants, real estate, and Amsterdam's demographic. The restaurant data is collected from Fork.nl, a Dutch consumer-based restaurant review website. The retrieval process of the data collection of the website was automated by Webscraper.io, an online tool that allows for big data collection. On the Fork website only 20 restaurants are seen per page, therefore this online tool was helpful in this process. Fork.nl is an online review platform where consumers exclusively can leave a review on the restaurant following their actual visit. This selective approach increases the credibility of the site. Furthermore, it is not mandatory for a restaurant owner to register their establishment on Fork.nl, however it is common to do so. This restaurant data, that is collected on 15 august 2023 from the Fork.nl, contains 459 restaurants in Amsterdam. Next to their name, other variables like their address, the average price for a dinner, the price of a bottle of water and number of reviews are collected.

Differentials in price levels of dining establishments can be reflected through prices of water that is sold and average dinner price. To analyze the effects of all the restaurants that are based in Amsterdam, a free software program named QGIS is used. This is an intelligent geographical information software that allows us to generate useful measures for this restaurant data. Within this software, a specific strategy is applied to assign these restaurants to their corresponding neighborhood. After this data was collected, a unique restaurant ID was attached to each restaurant. It is empirically difficult to measure causal and significant estimates of the effect of restaurant prices on house prices. The first way to distinguish restaurants and research them by price is comparing the average dinner price, which has some drawbacks attached to it. At first, people can select many choices from a menu resulting in a great variability in the average price of a 3-course menu. Moreover, a 3-course menu is often the standard on the Fork website but can also be a promotional price that does not reflect the actual price level. The variability and unreliability in average menu price calls for an additional, more unbiased measure. Homogenous goods are goods that are the same in quality but differ in other factors like brand, price, or service (Ono, 1978). A bottle of water sold in a restaurant is a homogenous good because the water does not taste differently. This commodity removes a lot of the variance in the product but retains the variance with respect to service provision. The economic price people pay for a bottle of water in a restaurant often relates to the price of the service that is provided. Factors that play a role in this service are the temperature of water, the glass that is used, the packaging of the bottle and brand. The price of a large 1-liter bottle of water is collected for all restaurants that are included in the dataset. The data is collected through the website of the Fork or the website of the specific restaurant. This variable is standardized to one liter of water because some restaurants do not have a 1-liter water bottle for sale. This thesis uses both prices of a 3-course menu and the price of a bottle of water as explicit variables to research the effect on residential property prices. An omitted variable bias occurs when you do not include a variable in your model that has a correlation on both your dependent variable as your independent variable (Clarke, 2005). As mentioned earlier, restaurants compete in a monopolistic competition where prices can play an important role in the willingness to for consumers. The prices of restaurants could be correlated with house prices, as a result, an exclusion of prices would lead to an omitted variable bias. The inclusion of prices is an addition on the study of Wildeboer (2016) as this was not accounted for in this study.

3.2 The Herfindahl-Hirschman Index

To analyze the effect of restaurants, as consumer amenity, on the desirability of locations, and thus residential house prices, the diversity of cuisines must be considered. Appendix 2 displays the frequency of the number of restaurants in each cuisine. To properly analyze the effects of local restaurants as consumer related amenities, the cuisines are categorized in a manageable number of categories. Furthermore, certain cuisines were added together to create new categories, as a result the total number of cuisines changed from NC^{old} (42) to NC^{new} (17). A tool that is useful to measure the diversity of cuisines is the Herfindahl-Hirschman index. This is a measurement that contains information about the evenness and richness of an event under certain assumptions. Here, the *HHI* is operationalized by grouping restaurants together to create a manageable number of restaurant cuisines. There are a couple of steps to calculate the Herfindahl index. First, the number of restaurants in each cuisine category needs to be determined. Thereafter, the restaurant share per category is calculated. Once the calculated the *HHI* is calculated, it is inverted. The range is between 0 and 1, where 1 indicates very diverse restaurant cuisines and 0 a very homogenous one. This inverted Herfindahl-Hirschman index is calculated in the same way as described in Wildeboer (2016).

Figure 1 displays these 17 newly created cuisine categories (NC^{new}) in the city of Amsterdam. Also, for transparency reasons, these steps were taken to create the new cuisine categories:

1. Cuisines from Fork.nl that contain more than 6 restaurants in each category, were taken as the basis of diversification. These restaurant cuisines, along with the number of restaurants in each category, are found in Appendix 1.
2. The categorization of the remaining restaurants is defined as;

   European (36) = European (29) + Eastern European (1) + Spanish (6)

   African (4) = Moroccan (3) + Ethiopian (1)

   Asian (31) = Asian (18) + Vietnamese (2) + Indonesian (6) + Nepalese (5)

   South American (10) = South American (7) + Surinamese (2) + Brazilian (1)

   Middle Eastern (18) = Middle Eastern (4) + Syrian (4) + Iranian (2) + Lebanese (2) + Turkish (6)

   Steakhouse (10) = Steakhouse (8) + Grilled (6)

   Other (28) = Greek (5) + American (4) + Seafood (4) + Creperie (3) + Fusion (3) + Vegan Cuisine (3) + Belgian (2) + German (2) + Cantonese (1) + Vegetarian (1)

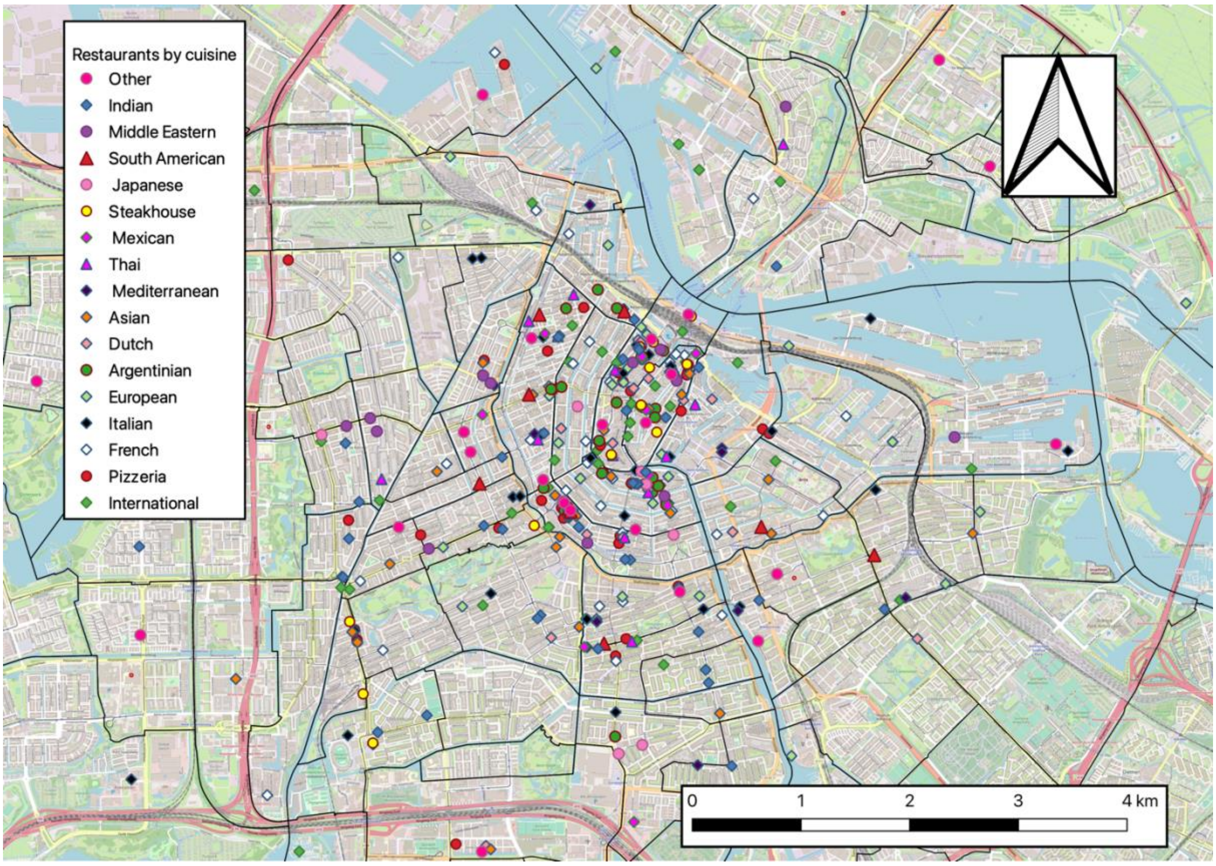

Figure 1: Cuisine categories in Amsterdam (NC^{new}), source: QGIS

3.3 Kadaster data

Furthermore, the other dataset contains information about Amsterdam's real estate market. The data set that is required for this paper, is not publicly available. Therefore, this information is obtained from the Kadaster, which is an official government-maintained public register that keeps track of all the properties in the Netherlands. This dataset contains 946 residential property transactions in Amsterdam between 1 January 2019 and 1 January 2023. The sale price, address, size, year of construction and date of sale of each transaction is included in this dataset. The raw dataset is thereafter transformed into useful measures. For instance, the dataset is transformed so that excel recognizes some as strings and some as numbers. Additionally, the dependent variable of this paper - price per square meter - is generated based on price divided by size. The sale price of each transaction is mapped in figure 2, also the price per square meter is mapped in figure 3. To analyze and map these transactions from the raw data set, these transactions are geocoded into GQIS.

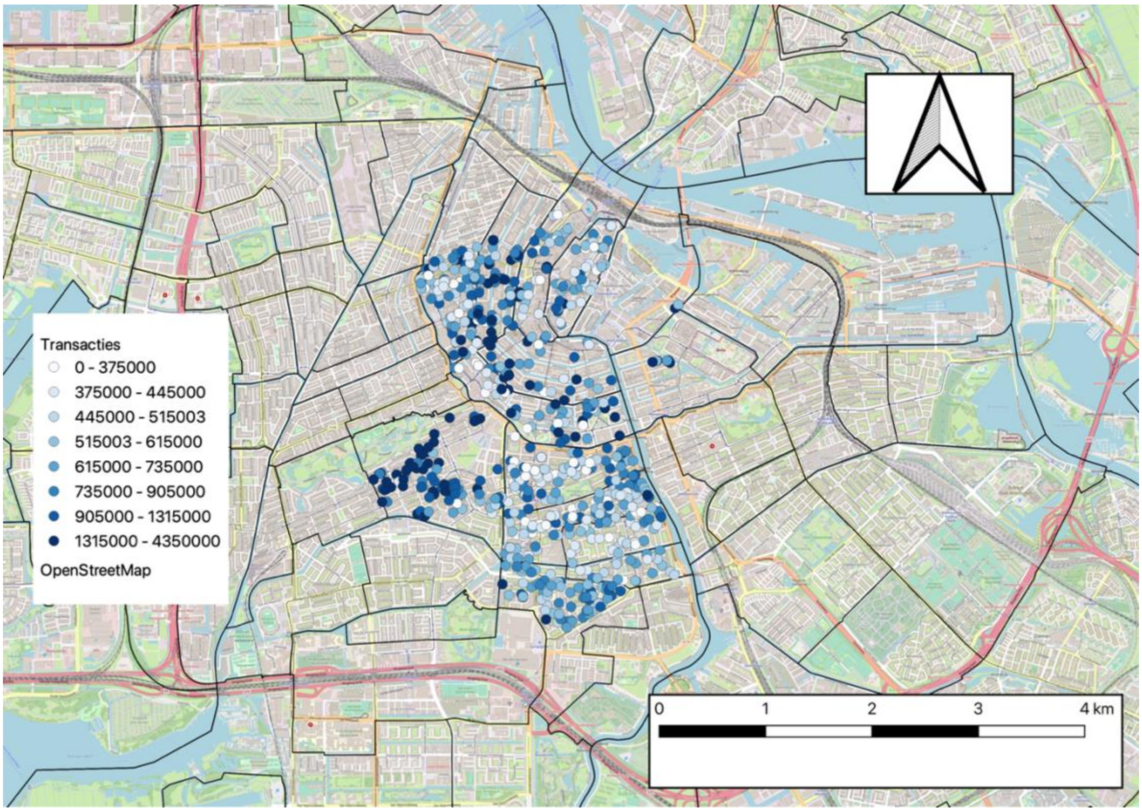

Figure 2: Transaction prices in Amsterdam, source: QGIS

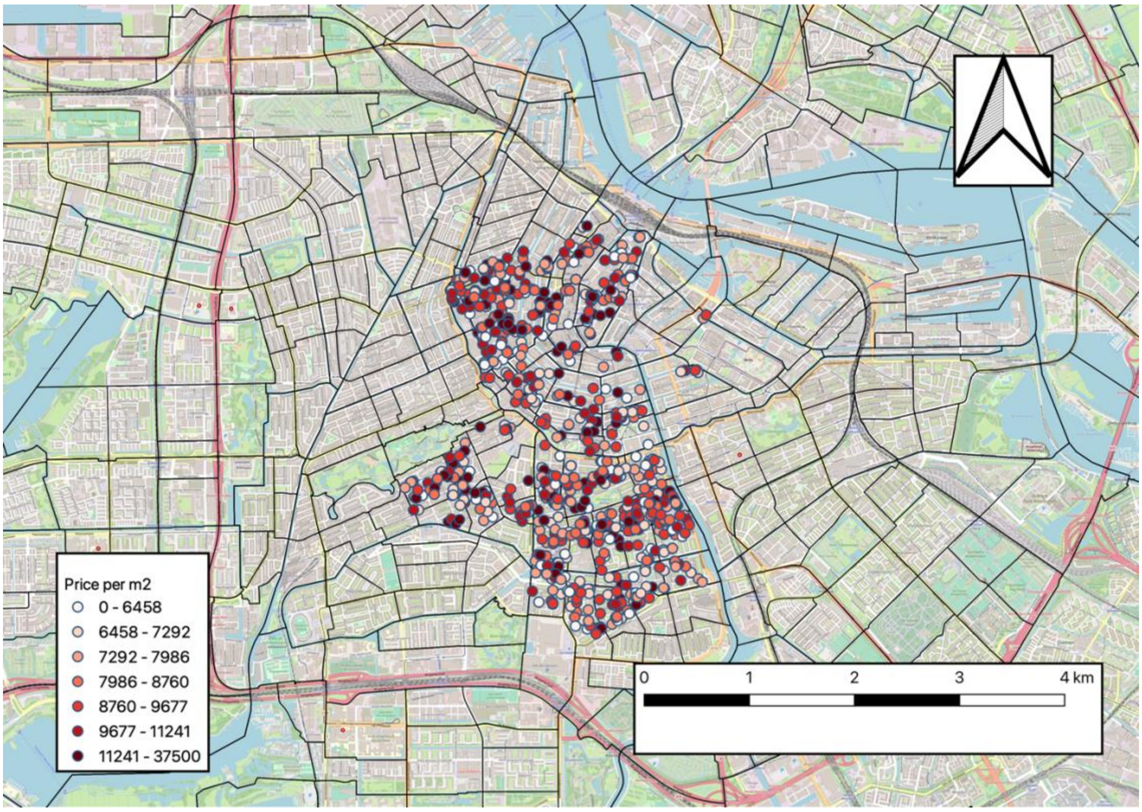

Figure 3: Price per square meter of each transaction, source: QGIS

3.4 Buffers

To analyze the effect of restaurants as consumer related amenities that affect residential real estate prices in Amsterdam, the restaurants can be seen as part of the neighborhood in which they operate in. An alternative perspective on evaluating restaurants involves a continuous spatial viewpoint. This approach changes the focus from the fixed neighborhood boundaries and focusses on the surroundings of each property. The surroundings of each property sale transaction determine the supply of consumer amenities. Therefore, the appropriate restaurant measures are aggregated per 6 different buffers around each of the 944 property sale transactions. As a result, property specific restaurant measures are generated, as well as neighborhood specified measures of restaurants.

Multiple buffers are considered due to the arbitrariness in the choice of size of these buffers. In doing so, 6 buffers are considered ranging from 500 meters up to 3000 meters, with steps of 500 meters in between. Amsterdam is a consumer-friendly city, that is known to be an attractive environment for pedestrians and cyclists. Figure 4 displays the percentages of walking trips for restaurants with the red dot. The range that people travel to restaurants by foot is mostly between 0 and 3km, which aligns with the chosen buffers. However, more than 50% of the walking trips are no further than 1500 meters, which hints to different radii up to 1500 meters. Furthermore, the average walking distance of a human is calculated to be around 5km/hour (Dorp & Groen, 2003). Also, the willingness to travel to restaurants by walking for most people is around 10 minutes (Iacono, Krizek & El-Geneidy, 2008), which corresponds to 833 meters by foot. However, due to the unconventional street pattern of Amsterdam, Arnott and Rowse (2009) describe a travel distance of $\sqrt{2}$ * radius, this equals a radius of 589 meters. These results provide evidence for the buffer radii of 500, 1000, and 1500 meters. Another popular mode of transportation in Amsterdam, is the bike. The daily commuters that travel by bike in the city equals to around 400.000 people, which is approximately the halve of inhabitants of Amsterdam (Amsterdam als fietsstad, 2006). Due to the popularity of this mode of transportation, it is wise to consider the bike as transportation mode in Amsterdam. Cyclists are willing to travel further than pedestrians due to their increased speed (Iacono, Krizek & El-Geneidy, 2008). The average speed of cyclist is around 12-14km/hour, which equals to a buffer radius of around 2200 meters, assuming a same willingness to travel to a restaurant as people who walk. Iacono et al. (2008) highlighted the increased travel distance to restaurants for pedestrians, which is displayed in figure 4, as well for bicycle trips, which is displayed in figure 5. One of the key findings of their empirical study was that more than 50% of all travel trips for entertainment purposes for cyclists are within 5 kilometers. The implication of this result is that people have an increased willingness to travel for restaurants when comparing bicycles with travelling by foot. However, figure 5 displays the travel time to restaurants for both walking and bicycle trips. Figures 4 and 5 together highlight that cyclists travel longer and further to restaurants compared to pedestrians. As a result, multiple buffer radii are considered. Figure 6 displays the 6 buffer radii of respectively 500m, 1000m, 1500m, 2000m, 2500m and 3000m.

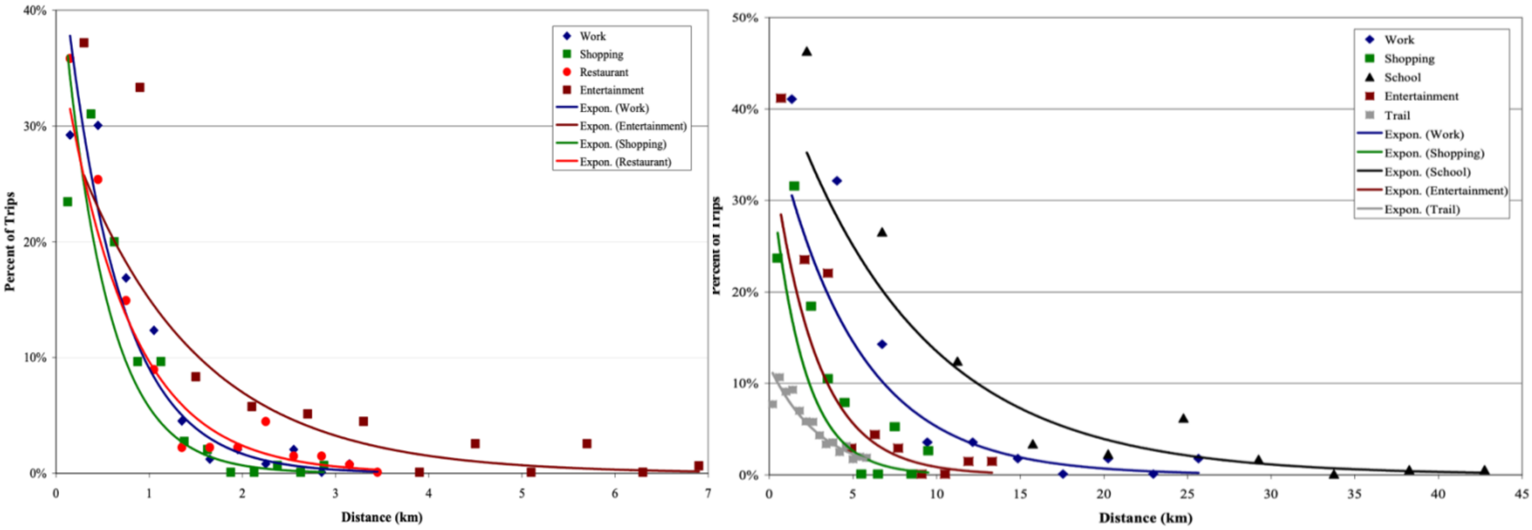

Figure 4: Distance decay in distance in km for walking trips (left) & bicycle trips (right), source: Iacono, Krizek & El-Geneidy (2008)

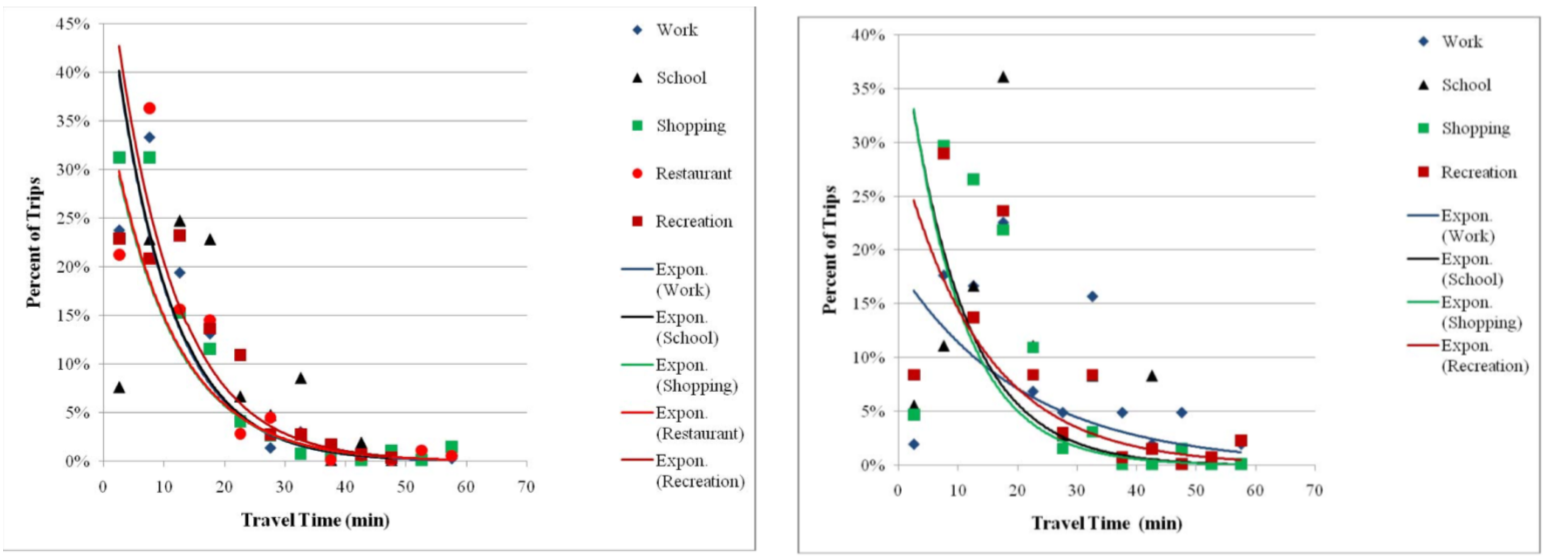

Figure 5: Distance decay in travel time for walking trips (left) & bicycle trips (right), source: Iacono, Krizek & El-Geneidy (2008)

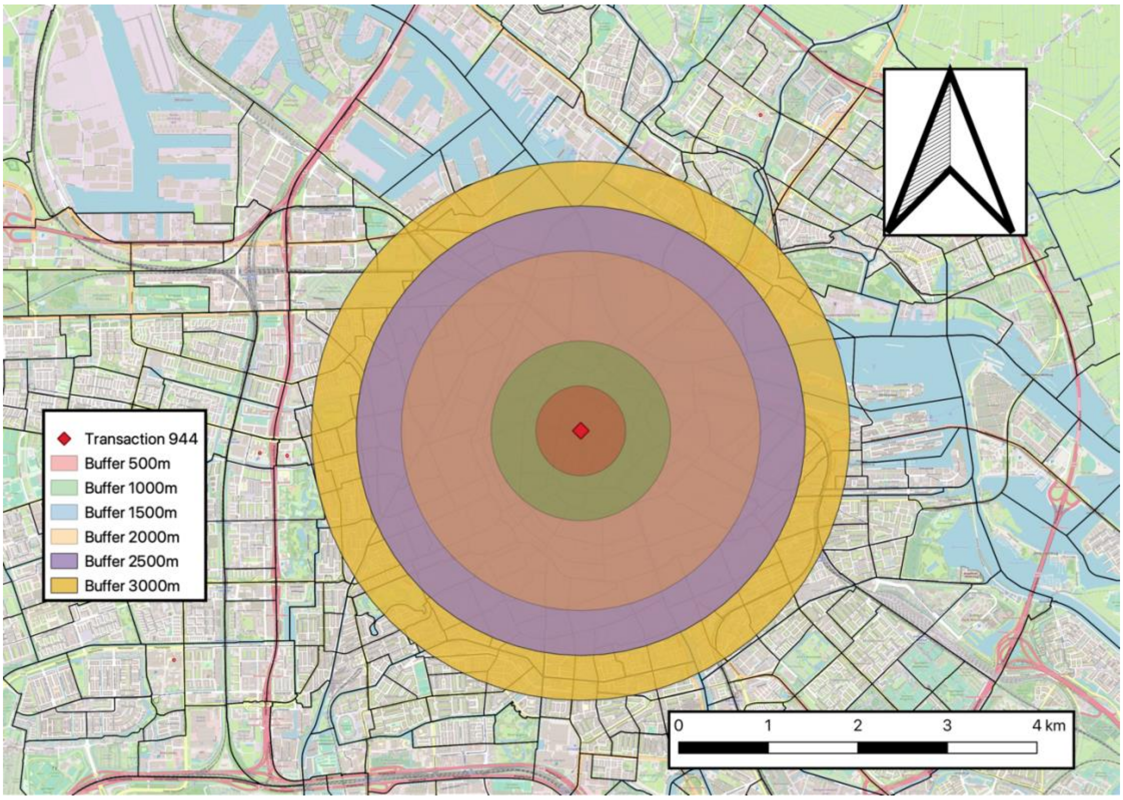

Figure 4: A visualization of the 6 buffers around transaction 944, source: QGIS

3.5 Building year

The transaction data of residential properties in Amsterdam that is collected from Kadaster, contains information about the building year of each property. The building years are categorized into building year cohorts to get a better overview and understanding of the relationship between house prices and building year of the property. These building year cohorts help to account for the nonlinearity relationship that exists within residential properties in Amsterdam (Vásquez et al, 2016). This nonlinearity relates to the nonlinear relationship between house prices and building year. Historical monuments and properties are regarded to have a higher value in the marketplace. After the second world war in the Netherlands, there was shortage of housing supply (Geschiedenis Zuid-Holland, 2021). The government was forced to develop a lot of houses in a short period of time. This resulted in a lot of terraced houses and multi staked apartments where the quality was not considered much. Therefore, these houses that were built after the second world war have relatively lower value today. Furthermore, new construction properties are considered to be of a high quality and therefore have a relatively higher market value today. In addition, the average building year of a residential property in Amsterdam is 1954 (*Amsterdam*, 2022). Ideally, I would like to have a finer granularity within the dataset, however this is not available. This limited data forces me to segment the data in groups. I have opted for three groups that capture the most important variation described in the literature. As a result, these building years can be categorized into three building year cohorts: <1945, 1945-1990, and 1990-2023.

3.6 Price per square meter

As mentioned earlier, the price per square meter is used as an explicit variable. Moreover, the price per square meter for all the residential property transactions is displayed in figure 3. The price per square meter is calculated by dividing the transaction sale price by the size of the property. Recently, it was recorded that the average price per square meter in Amsterdam is €7963 (Actuele huizenprijzen van Amsterdam, 2023). However, as seen in figure 3 and 5, some property transactions had a price per m2 higher than €20.000. For this master thesis, these transactions above €20.000, which are highlighted in red in figure 6, are treated as an outlier to obtain more valid results, however these outliers are kept in the analysis. These outliers are labelled as luxury apartments and represent high-end real estate properties. A separate intercept is estimated for these observations by using a dummy variable as these apartments may have unique characteristics that are not captured in the data.

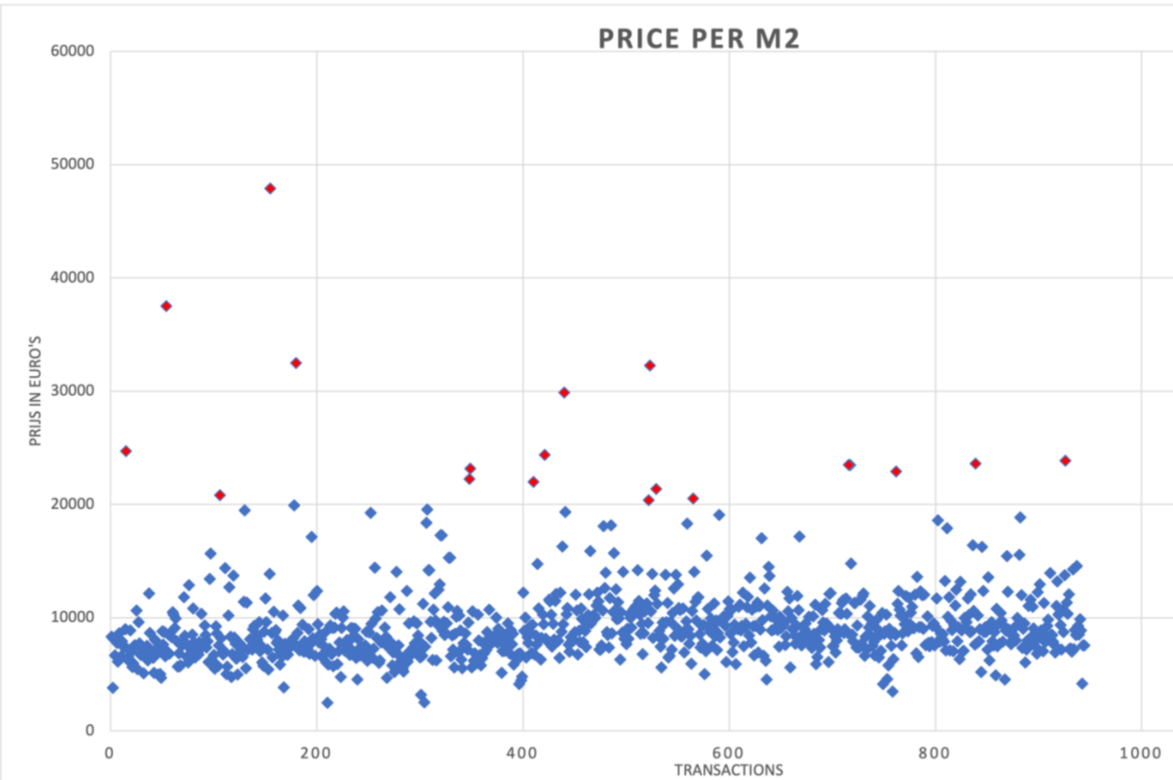

Figure 5: Scatterplot price per square meter, source: Excel

4. Methodology & empirical strategy

A substantial number of empirical studies that discuss house price differentials, originate from the work of Rosen (1974). He introduced the concept hedonic house price specification caused by implicit markets. His theoretical framework suggests that houses can be seen as a differentiated product composed from a bundle of characteristics. These characteristics are not separable from the house, thus sold together. As a result, the prices of these bundles can implicitly be calculated by looking at real estate transactions. A traditional hedonic house price model is based on an Ordinary Least Square (OLS) regression. This type of regression produces unbiased estimators if the estimates are equal to BLUE (Best Linear Unbiased Estimator), from the assumptions of the Gauss-Markov theorem (Harville, 1976; Hayes, 2007). This study follows the methodology and strategy as applied in Wildeboer (2016), however with a few additions.

Firstly, whereas the paper of Wildeboer (2016) did not use the price of restaurants as an explicit variable, this paper does so. As stated previously by Gleaser et al. (2001), consumer related amenities in the neighborhood can help in explaining house price differentials. Restaurant businesses compete in a monopolistic competition where there are low barriers to enter (Salop, 1979). In this market structure, firms are not price takers up to a certain degree because they produce differentiated goods. Restaurants compete on several factors such as quality of food, ambience, attractiveness of surroundings, and price. Restaurants who specialize in the same cuisines compete on prices. Furthermore, one can imagine that people have a higher willingness to pay for a Michelin starred restaurant compared to a fast-food restaurant. Therefore, a distinction can be made in the price levels of the restaurants. The inclusion of price as an explicit variable when explaining differentials in house prices, eliminates the omitted variable bias when this variable is not included.

Secondly, the study of Wildeboer (2017) implied three spatial aggregated buffers around each of the residential property transactions, these buffers had the size of 500m, 650m, and 800m, respectively. This empirical study of Wildeboer (2016) was done at a low, local level of analysis where only relatively small buffers were accounted for, considering the grid size of Amsterdam. As stated by Iacono et al. (2008), pedestrians have a lower willingness to travel to a restaurant than cyclists. The study of Wildeboer (2016) focusses on a local level of analysis and thus disregards the mobility of people. The bicycle is an important mode of transport in Amsterdam due to the large number of daily commuters. In addition, her study does not account for the fact that people optimize their location and have more modes of transport, which increases their mobility. Therefore, I extend her work by using 6 buffers around each transaction. A contribution and improvement to the work of Wildeboer (2016) is be made by implementing these changes.

A distinction can be made between the locational characteristics and structural characteristics of real estate. Locational characteristics are defined by attributes that are related to the geographical location of the property and the structural characteristics are defined by the physical attributes of the property. The structural characteristics can further be categorized into relative and absolute characteristics. Here, relative attributes relate to attributes that are common between properties in the neighborhood. The absolute locational characteristics of real estate are explained by the concepts of proximity, accessibility, or speed, one of the four critical urban amenities of Gleaser et al. (2001). Therefore, the accessibility of each residential property transaction in Amsterdam is also considered. More specifically, the distance from each property transaction to the nearest train station, highway entry/exit and Dam Square is calculated. A visual representation of this is displayed in figure 6 with the corresponding train stations- and highway names in table 1 and 2, respectively.

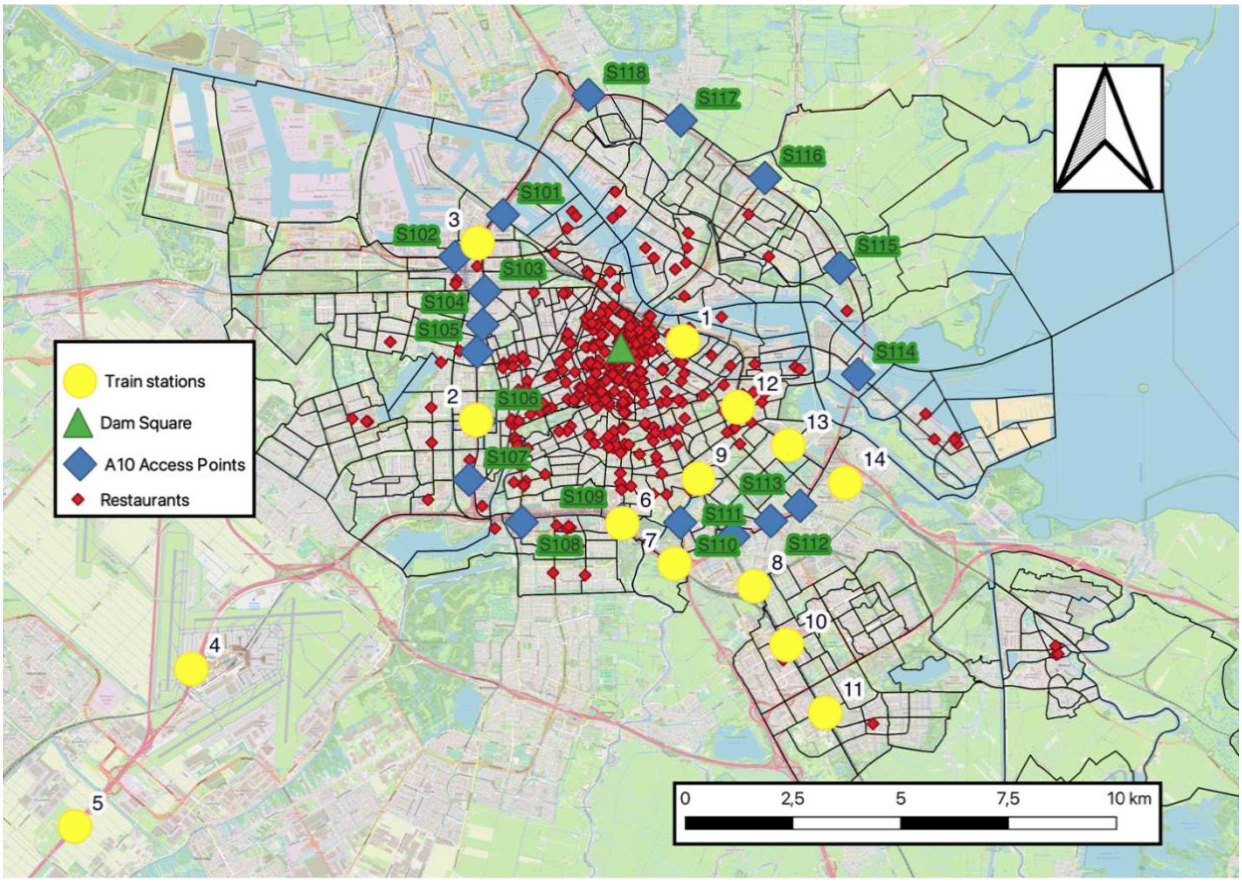

Figure 6: A visual representation of the train stations, highway access points and Dam Square with all the restaurants, source: QGIS

Table 1: A10 highway points

A10 Highway Access point	Name
S101	Hemhavens
S102	Sloterdijk
S103	Westerpark
S104	Bos en Lommer
S105	Geuzenveld
S106	Osdorp
S107	Slotervaart
S108	Oud Zuid
S109	Buitenveldert
S110	Rivierenbuurt
S111	Overamstel
S112	Centrum
S113	Watergraafsmeer
S114	Zeeburg
S115	Nieuwendam
S116	Noord
S117	Kadoelen
S118	Tuindorp Oostzaan

Table 2: Train stations

Number	Train station
1	Amsterdam Centraal
2	Amsterdam Lelylaan
3	Amsterdam Sloterdijk
4	Amsterdam Schiphol
5	Hoofdorp
6	Amsterdam Zuid
7	RAI
8	Duivendrecht
9	Amstel
10	Amsterdam Bijlmer-Arena
11	Holendrecht
12	Amsterdam Muiderpoort
13	Amsterdam Science Park
14	Diemen

5. Results

Table 3 represents the regression results for model 1 through model 4 for the 1500-meter buffer radius in Amsterdam. At first, this thesis estimates a base model (model 1) using a stepwise method of regression estimation. This stepwise regression estimations indicates that I added variables in steps to the regression, but I only included them in the model if they significantly increased the explaining power of my model, the R^2. This base model lays the foundation for the regression estimation for the different models. Model 1 displays trustworthy results due to the significance of the coefficients and the intuitive reasoning behind it. Here, a 1% increase in the size of a residential property in Amsterdam, indicates an increase of the property price of 0.94%, ceteris paribus. This coefficient is statistically significant at a 1% level. Also, the variable building year above 1990 indicates the difference compared to the reference group. In this case, the properties between 1945 and 1990 were taken as a reference category. Here, being constructed after 1990, increases the house price by 8.3% compared to a home that is built between 1945 and 1990, this effect is statistically significant at a 1% level, ceteris paribus. The indicator luxury apartments (dummy variable) are 104% more expensive compared to properties with a price per square meter of less than €20.000, ceteris paribus, this effect is statistically significant at a 1% level. Furthermore, having a train station one meter closer to your home, decreases the value of the house by 0.01%, ceteris paribus, this is significant at a 1% level. This is in line with the negative externalities generated by rail infrastructure. It is likely that these negative effects will dominate the positive effects in Amsterdam where the connectivity is generally good.

If we look at model 2, we see similar results for the variables that were also in the base model. For example, the variable size and distance to the closest train station still have a positive significant effect on house prices. All the variables that were in model 1 still display positive significant coefficients in model 2. Two variables that are added in the second model and indicate certain restaurant characteristics, are restaurants and number of reviews. Here, restaurants display the number of restaurants located in that buffer and number of reviews display the amount of consumer reviews on the website of Fork. We see that the coefficient of building year above 1990 decreases a bit when these two variables are added, however a positive significant coefficient is still the case. This indicates that omitting the restaurant variables generate a small degree of omitted variable bias. An extra restaurant in the buffer radius of 1500 meter increases the property price by 0.03%, ceteris paribus. This effect is statistically significant at a 1% level, though modest in size. Furthermore, the number of reviews a restaurant has is negatively correlated with the house price. An extra review decreases the price of a residential property by 0.7%, ceteris paribus. This effect is statistically significant at a 1% level.

Table 3: Buffer of 1500m

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Ln (size)	0.936***	0.929***	0.926***	0.926***
	(0.017)	(0.017)	(0.0173)	(0.0174)
Building year >1990	0.083***	0.0734***	0.074***	0.074***
	(0.025)	(0.025)	(0.025)	(0.025)
Luxury apartments	1.040***	1.031***	1.028***	1.028***
	(0.062)	(0.062)	(0.062)	(0.062)
Distance train	0.0001***	0.0001***	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Restaurants		0.0003***	0.0005***	0.0005***
		(0.0001)	(0.0001)	(0.0002)
Number of reviews		-0.0007*	-0.001**	-0.001*
		(0.0004)	(0.0005)	(0.0005)
HHI			-1.248*	-1.219*
			(0.655)	(0.681)
Attractiveness neighborhood			0.027**	0.027**
			(0.013)	(0.013)
Price bottle of water				-0.101
				(0.199)
Price restaurant				0.012
				(0.021)
Constant	9.225***	9.494***	10.559***	10.761***
	(0.080)	(0.183)	(0.706)	(1.05)
Observations	944	944	944	944

R-squared	0.776	0.778	0.779	0.779

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The third model builds upon the previous models with two additional variables that include restaurant characteristics as well as neighborhood characteristics. The Herfindahl Hirschman index (HHI) indicates the concentration of restaurants, additionally, the HHI is inverted for the purpose of this thesis making it reflect diversity. The neighborhood characteristic that has been added in model 3 relates to the attractiveness of the neighborhood. The variables of the first two models are also relevant in model 3. For these coefficients, we see the same positive and negative significant correlation with price as in the previous models, which indicate the relevance of these variables. However, the variable distance to the closest train station lost its significance and explaining power in this model. We also see an increase in the coefficient of the number of reviews compared to the second model. Here, an extra review, significantly decreases the house price by 0.1%, ceteris paribus (significant at a 5% level). The HHI has a statistically significant negative impact on the residential property prices at a 10% level. An increase of one in the Herfindahl Hirschman index decreases the house price by 124.8%, ceteris paribus. This effect is statistically significant at a 10% significance level. On the contrary, the attractiveness of the neighborhood has a positive significant impact on the residential property price. More specifically, an increase of one unit in neighborhood attractiveness, results in a 2.7% higher house price, ceteris paribus (significant at a 5% level).

One of the main critique points on the study of Wildeboer (2016) was that the effect of restaurant prices on house prices was neglected. Therefore, this thesis tried to implement these critique points by adding both the average price of a dinner and the price of a bottle of water as explanatory variables. These changes are represented through model four. If we look at the coefficients of the base model in model 4, we see that these still are positive significantly correlated with house prices, except for distance to train station. Also, the restaurant characteristics and neighborhood characteristics do not change in model 4 compared to the previous models when adding these price variables. Accordingly, the addition of a restaurant in the neighborhood increases the residential house price with 0.05%, ceteris paribus. This coefficient is statistically significant at a 1% level. However, both the variables that represent price are not statistically significant, indicating that price is not an omitted variable in determining the effect of restaurants on house prices in Amsterdam.

6. Robustness

The obtained results in the previous section are evaluated by varying the buffer radius with the same observations. The robustness of the results in table 3 are determined by comparing the same models in different buffer radii. The buffers which are used to compare these obtained results have the size of 500m, 1000m, 2000m, 2500m, and 3000m. The regression output tables for all the different buffers are displayed in Appendix 1, respectively.

Looking at the first explanatory variable, size, we see constant positive significant results in all the 6 buffer radii. As a result, the size of a residential property is an important determinant in explaining the price of a property. Moreover, the coefficient of size holds similar positive significant values through all the buffers, which means that this variable is robust.

The second variable in the dataset accounts for residential properties that are built after the year 1990. Comparing the positive significant results of this variable in table 3 to the several buffers stated in Appendix 1, we see similar results. Building year after 1990 seems to hold its positive significance impact on house prices through all four models in the 6 buffer radii, making this a robust result.

The variable luxury apartments are defined as residential properties that have a price per square meter higher than €20.000. The positive significant results that are displayed in figure 3 can also be found through the 6 different specifications stated in Appendix 1. The robustness of this coefficient is clear due to the consistent positive significant measures.

In table 3, the coefficient of distance to the closest train station goes from positive and significant in the first two models to insignificant and no effect in the last two models. Comparing this result to the different buffers, we see mixed results. For example, the buffers of 500m and 1000m display a small positive significant coefficient through all the four models. Additionally, the buffers of 2000m and 2500m display the same results positive significant results for the first two models as stated in table 3. However, the coefficient of distance to closest train station in the buffer of 3000m holds a negative value and is significant at a 10% level in models 2, 3 and 4. The relatively small magnitude of the coefficient and ambiguous result through the different buffers, make it difficult to assume the robustness of this variable. Train stations generate positive network effects in terms of the increased mobility of its users in the neighborhood. However, train stations also have negative externalities that are not included in the price of the good. An example of these negative externalities generated by rail infrastructure is noise (Sandholm, 2005).

The base model is expanded with two restaurant characteristics, namely the number of restaurants and reviews. Comparing the results of the variable restaurants with the buffers, we see indications of the robustness of this variable. More restaurants have almost always a positive significant impact on residential property prices throughout the robustness checks, making the variable robust. However, the number of reviews has an ambiguous effect throughout the buffers. More specifically, this variable has a negative significant effect on house prices in table 3, but this effect is not seen in the other buffers stated in Appendix 1. Here, we see negative as well as positive coefficients, therefore this variable is not as robust as the number of restaurants.

The only significant results of the HHI in all the buffers are displayed in table 3. Here, diversity is negatively associated with house prices, which is not in line with the theory as well as previous research. However, the HHI positively associated with the residential price in the buffer of 500m, this coefficient is not statistically significant, so we cannot interpret this. The different magnitudes and significance of this variable in the several buffers do not make this variable trustful to interpret. The other variable that is added in model 3 is the attractiveness of the neighborhood, which holds a positive significant effect (on a 5% level) in table 3. However, this variable is consistently negative in the other buffers but not statistically significant in any of them (at a 10% level). The small sample size could hinder the measure of diversity of cuisines, as this an information intensive measure. This means that the variation requires for a distribution over various cuisine. Some of these cuisines are in specific and scarce areas.

The fourth and complete model includes the price variables of restaurants, more specifically, the price of an average dinner and the price of a bottle of water. The coefficient of average dinner price is, like in table 3, not statistically significant in any of the buffers. The coefficient in of this variable is positive in table 3 but negative in the buffers of 500m and 100m. In the bigger buffers, 2000m up until 3000m, this coefficient becomes positive. These ambiguous results make it difficult to assume the robustness of it. Furthermore, the coefficient of the price of a bottle of water in table 3 has a negative value. Moreover, this coefficient is also negative, and significant (on a 5% level), in the buffers of 2000m and 2500m. On the contrary, the price of a bottle of water has a positive significant impact on residential property prices in the smallest buffer of 500m. The variability in significance and magnitude of the coefficients of the price of a water bottle between the buffers make it difficult to assume the robustness of it.

7. Discussion

This section forms a synthesis between the obtained results, robustness checks and hypothesis. Moreover, the validity of each of the four hypotheses is analyzed. From the results of model 1, it becomes clear that these variables have significant explaining power when discussing residential property prices in Amsterdam. Several studies have highlighted the role that restaurants play as a proxy for other consumer related amenities in the neighborhood, like grocery stores (Hidalgo et al., 2020). Furthermore, restaurants add to local buzz and liveliness due to their presence (Clark, 2003). Following these results, the first hypothesis was formulated. This hypothesis states the presence of local restaurants has a positive effect on the neighborhood attractiveness, as indicated by residential property prices.

Through the six different specifications of buffer radii, I find robust results for the variable restaurant, indicating a positive significant impact. Thus, we reject the null hypothesis that the quantity of restaurants has no effect on residential property prices. These findings are in line with the literature.

Additionally, it is widely accepted in urban literature that, next to quantity, the quality of amenities matters when discussing neighborhood attractiveness and thus house prices. According to Haurin & Brasington (1996), school quality was the most important factor in explaining house price differentials. Therefore, the second hypothesis emphasizes the quality aspect of restaurants, and stated that the quality of a restaurant has a positive influence on house prices. When we look at the results and the robustness of the variable number of reviews, we see an ambiguous result. Table 3 suggests a negative significant impact of the number of reviews a restaurant has on the residential property. However, there are mixed results when we compare this to the coefficients stated in Appendix 1. For example, a positive significant result is found in model two of the buffer of 2500m. Here, an extra review, significantly (at a 5% level) increases the house price by 0.21%, ceteris paribus. The variance of this variable is great, which causes the variable not to be robust. Therefore, I fail to reject the null hypothesis that the quality has no influence on the house prices. The limited data set and sample size could obscure significant differences that become apparent when using a larger, rich dataset. I did not find evidence to support this hypothesis, however, the positive coefficients that are found in the other buffer radii, are in line with the literature, thus could be an indication towards this hypothesis and should be further researched.

Furthermore, the third critical amenity of Gleaser et al. (2001) was the aesthetics and physical setting of real estate. Luttik (2000) argued that factors such as a garden with waterfront views, having access to pleasant views, or having open spaces significantly contribute to an increase in house price valuation. Additionally, Wen & Zhang (2015) stated that homes with beautiful urban landscapes have a premium over less appealing urban settings. The variable attractiveness of neighborhood tried to analyze these empirical findings. Here, an increase of one in neighborhood attractiveness, increases the residential property price by 2.7%, ceteris paribus. This effect is statistically significant at a 5% significance level and is in line with the literature.

The third hypothesis considers the diversity of cuisines and stated that this had a positive impact on the neighborhood and thus residential property prices. Accordingly, a Michelin starred restaurant has a greater positive influence on the neighborhood compared to a fast-food restaurant (De Groot et al., 2010). The results in table 3 imply a significant negative effect of diversity on residential property prices. In model 4, an increase of one unit in diversity, significantly (at a 10% level) decreases the house price by 21.9%, ceteris paribus. As mentioned earlier, the robustness of these coefficients in table three can be questioned. As a result, I did not find any evidence to support the third hypothesis of a positive correlation between diversity of cuisines and house prices.

One of the main points of critique of the study of Wildeboer (2016) was that this study neglected the prices of restaurants. The fourth hypothesis tried to implement this feedback based on several studies. Restaurants try to sell differentiated goods due to the market environment that they compete in (Salop, 1979). In doing so, they compete on factors such as service, ambience, and price. Differentiated goods can result in an increased gap in willingness to pay of consumers for these goods. Higher prices within restaurants can act as a proxy for other factors such as good quality or service. Therefore, the fourth hypothesis states that prices have a positive impact on the residential property price. Due to the insignificant results, we can not interpret these. In addition, the lack of robustness of the price variables throughout the buffers do not make these coefficients reliable. Therefore, I did not find any support for the fourth hypothesis. As a result, this study does not suggest that price is an omitted variable in determining the impact of restaurant on residential property prices. The consistent significant result for the quantity of restaurants is unaffected when adding price to the model. This suggest that price is not an omitted variable when excluded from the model. Nevertheless, restaurant prices can still impact house prices through other mechanisms that is obscured in this small dataset. These results suggest, through variance, that these mechanisms are not necessarily shared simultaneously with the number of restaurant and house prices.

8. Limitations & recommendations

Unfortunately, this study is more explorative than initially anticipated. The study stated out with the objective to use a large-scale data set on the Dutch housing market. The permission to use this data set was denied at a late stage due to circumstances that were out of my control. To still be able to complete an informative and interesting study, I decided to invest in purchasing a commercially available dataset. The number of observations made available as an academic study was limited by the data provider Kadaster. In addition, the costs per observation were prohibitive in terms of securing a large dataset. As a result, the sample size was maximized within the available options and stratified over the center of Amsterdam. This means that this dataset is small compared to other studies who had the advantage of using large datasets that sometimes make these publicly free of charge. Therefore, the study is vulnerable to having otherwise significant effects remaining obscured due to the limited information that is contained in the dataset. This means that the data leads to frequent insignificant results, nevertheless, the results have been interpreted as well as possible, and proved to be informative on several points as elaborated in the results and discussion sections.

Furthermore, the data set of all the restaurants in Amsterdam captured a significant part of the restaurant study, but not all. Also, there could be selection bias in the restaurants available for this study. The Fork switched from a free page for restauranteurs to a monthly paid subscription a few years ago. This resulted in a loss of restaurants on the website of the Fork. As of today, the number of restaurants that are listed on this website are 464, however the most recent calculation was there are 1888[1] restaurants in the city of Amsterdam. The assumption is made that these 464 restaurants are a representative sample of all the restaurants, this also could not be the case. However, my recommendation would be to repeat this study with a larger dataset of the transaction data as well as the restaurant data, if these become available.

This study researched the effect of local consumer amenities that affect the neighborhood and thus house prices. More specifically, restaurants were taken as a consumer related amenity to research the effect on house prices. However, a possible bias that arises in this type of study, is the problem of reverse causality. In this thesis, I tried to find causal effects of the relationship between restaurant characteristics and residential property prices. However, this relationship could also be reversed. Reverse causality bias arises when your dependent variable causes your independent variable (Leszczensky & Wolbring, 2022). Related to this context, this translates to that restaurants could follow properties. This could imply that more expensive and higher quality restaurants will base their location decision on house prices. For example, more and higher quality restaurants could be found in expensive neighborhoods. This thesis did not account for this type of causality; therefore, future research could improve this type of study by accounting for this potential bias. Potential improvements in this respect could be by tracking restaurants and house prices over a longer time. The potential bias that arises in an endogenous variable can be addressed by using an instrumental variable. This instrument must be correlated with the endogenous variable and uncorrelated with any (unobserved) determinants of the dependent variable house prices (Baiocchi et al., 2014). Another way to improve this study is to exploit shocks to the access to restaurants in a local setting, for example, new bridges or road works.

9. Conclusion

This master thesis researched the relationship between consumer related amenities and residential property prices in Amsterdam. More specifically, the role of restaurants was studied as local consumer related amenity that enhances face-to-face interactions. These social interactions are discussed in the light of the 'consumer city' versus 'producer city' debate of Gleaser et al. (2001). Today's society is dominated by digitalization of communication technologies. However, these face-to-face interactions have an increasingly important impact on society. Therefore, the main research question was formulated as follows; what is the effect of consumer related amenity, namely restaurants that stimulate face-to-face encounters, on desirability of locations and thus residential property prices?

To analyze this research question, several data sets have been used that relate to real estate transactions and restaurant data from the Fork. These datasets are transformed into QGIS, a geographic information system that allows for the creation of useful measures to analyze this effect. The results and robustness checks indicate a positive significant effect of the quantity of restaurants on the residential property prices. However, no significant and robust effects were found in the hypothesis that considers the diversification and quality aspect of restaurants. The central research question can only be answered with the evidence that is provided for the quantity aspect of restaurants.

This master thesis has several contributions. At first, this study recreated the study of Wildeboer (2016) in a new timeframe, with more recent data. This data was collected after COVID-19, which had a big impact on the hospitality industry. Furthermore, this study addressed one of the main points of critique on the study of Wildeboer (2016), namely that this study neglected the effect of restaurant prices. In doing so, the average price of a dinner and price of a bottle of water were used as explicit variables to analyze the effect of restaurants on house prices. However, no significant and robust results were found that prices do have an effect. In other words, the main points of critique in the previous work are, at least partially, rebuked by this. This study does not find evidence that people do not optimize their location decision based on restaurant prices.

Another contribution is found in the light of the buffer radii choices. The study of Wildeboer (2016) used relatively small buffers of 500m up until 800m. This study tried to improve and extend her work by using more and bigger buffers of 500m up to 3000m. Thereafter, the results between different buffers were analyzed to indicate the robustness of the results. The results are unfortunately inconclusive on this respect for the most part. However, the robust, and consistent effect of the quantity of restaurants is at least in partial support of the study of Wildeboer (2016).

Overall, this thesis gives a first indication into potential improvements upon the previous work. Therefore, my recommendations would be to analyze these effects with a larger data set for the real estate properties as well as the restaurant data. In addition, future research could account for the potential reverse causality bias that arises in this type of spatial study. This study could be interesting for policy makers because it emphasizes the importance of consumer related amenities. Homeowners exhibit a willingness to pay for nearby restaurants, which may extend their interest in various other amenities in the proximity of their residence. An important realization is that willingness to pay is reflexive of an underlying economic concept: utility. These findings imply that homeowners in urban areas derive utility from having access to restaurants, essentially making cities more appealing as places to live by promoting consumer amenities.

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Appendix 1 – Buffers

*Table 5: Buffer 500m Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Ln (size)	0.9363***	0.9319***	0.9304***	0.9299***
	(0.0171)	(0.0172)	(0.0175)	(0.0175)
Building year >1990	0.0834***	0.0736***	0.0746***	0.0730***
	(0.0246)	(0.0250)	(0.0251)	(0.0251)
Luxury apartments	1.0397***	1.0312***	1.0319***	1.0320***
	(0.0625)	(0.0625)	(0.0626)	(0.0625)
Distance Train	0.0001***	0.0001***	0.0001***	0.0001***
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Restaurants		0.0010**	0.0010*	0.0006
		(0.0004)	(0.0006)	(0.0006)
Number of reviews		0.0001	0.0001	0.0000
		(0.0001)	(0.0001)	(0.0001)
HHI			0.0032	0.1816
			(0.1211)	(0.1592)
Attractiveness neighborhood			-0.0045	-0.0039
			(0.0046)	(0.0046)
Price restaurant				-0.0053
				(0.0048)
Price bottle of water				0.0935*
				(0.0486)
Constant	9.2254***	9.2029***	9.2304***	8.6918***
	(0.0800)	(0.0842)	(0.1286)	(0.2905)
Observations	944	944	944	944
R-squared	0.7761	0.7774	0.7763	0.7774

*Table 6: Buffer 1000m Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Ln (size)	0.9363***	0.9313***	0.9289***	0.9294***
	(0.0171)	(0.0173)	(0.0175)	(0.0175)
Building year >1990	0.0834***	0.0689***	0.0693***	0.0696***
	(0.0246)	(0.0250)	(0.0251)	(0.0251)
Luxury apartments	1.0397***	1.0290***	1.0284***	1.0291***
	(0.0625)	(0.0624)	(0.0625)	(0.0626)
Distance Train	0.0001***	0.0001***	0.0001***	0.0000**

	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Restaurants		0.0005***	0.0005***	0.0006***
		(0.0002)	(0.0002)	(0.0002)
Number of reviews		0.0000	0.0001	0.0001
		(0.0002)	(0.0003)	(0.0003)
HHI			-0.3684	-0.4122
			(0.4734)	(0.4878)
Attractiveness neighborhood			-0.0034	-0.0035
			(0.0045)	(0.0045)
Price restaurant				-0.0025
				(0.0115)
Price bottle of water				-0.0237
				(0.1064)
Constant	9.2254***	9.2068***	9.5620***	9.8006***
	(0.0800)	(0.1191)	(0.4540)	(0.6771)
Observations	944	944	944	944
R-squared	0.7761	0.7783	0.7773	0.7774

*Table 7: Buffer 2000m Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Ln (size)	0.9363***	0.9339***	0.9308***	0.9269***
	(0.0171)	(0.0171)	(0.0172)	(0.0173)
Building year >1990	0.0834***	0.0743***	0.0733***	0.0742***
	(0.0246)	(0.0249)	(0.0250)	(0.0250)
Luxury apartments	1.0397***	1.0349***	1.0347***	1.0328***
	(0.0625)	(0.0625)	(0.0625)	(0.0624)
DistanceTrain	0.0001***	0.0000**	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Restaurants		0.0003**	0.0003**	0.0004**
		(0.0001)	(0.0001)	(0.0001)
Number of reviews		0.0001	-0.0006	-0.0005
		(0.0007)	(0.0010)	(0.0010)
HHI			-0.4826	-0.8124
			(0.4738)	(0.5215)
Attractiveness neighborhood			-0.0043	-0.0039
			(0.0045)	(0.0045)
Price restaurant				0.0354
				(0.0252)
Price bottle of water				-0.5651**
				(0.2277)
Constant	9.2254***	9.1563***	9.8990***	12.4012***
	(0.0800)	(0.2753)	(0.7511)	(1.3298)
Observations	944	944	944	944
R-squared	0.7761	0.7774	0.7766	0.7782

*Table 8: Buffer 2500m Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Ln (size)	0.9320***	0.9324***	0.9314***	0.9268***
	(0.0171)	(0.0171)	(0.0173)	(0.0176)
Building year >1990	0.0918***	0.0781***	0.0758***	0.0683***
	(0.0247)	(0.0258)	(0.0259)	(0.0261)
Luxury apartments	1.0281***	1.0225***	1.0215***	1.0128***
	(0.0624)	(0.0622)	(0.0622)	(0.0623)
DistanceTrain	0.0001***	0.0001***	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Restaurants		0.0004**	0.0005**	0.0004*
		(0.0002)	(0.0002)	(0.0002)
Number of reviews		-0.0005	-0.0016	-0.0015
		(0.0007)	(0.0012)	(0.0012)
HHI			-1.2861	-1.5817
			(1.1603)	(1.3817)
Attractiveness neighborhood			-0.0049	-0.0036
			(0.0045)	(0.0045)
Price restaurant				0.0492
				(0.0338)
Price bottle of water				-0.7004**
				(0.3105)
Constant	9.2224***	9.3094***	10.9389***	13.7410***
	(0.0786)	(0.2689)	(1.4377)	(2.4275)
Observations	944	944	944	944
R-squared	0.7773	0.7791	0.7781	0.7793

*Table 9: Buffer 3000m Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1*

VARIABLES	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4
Ln (size)	0.9367***	0.9395***	0.9377***	0.9363***
	(0.0172)	(0.0172)	(0.0173)	(0.0174)
Building year >1990	0.0818***	0.0837***	0.0832***	0.0836***
	(0.0248)	(0.0248)	(0.0249)	(0.0250)
Luxury apartments	1.0347***	1.0305***	1.0317***	1.0314***
	(0.0631)	(0.0630)	(0.0631)	(0.0631)
DistanceT	-0.0000	-0.0000*	-0.0000*	-0.0001*
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Restaurants		0.0003	0.0005	0.0004
		(0.0002)	(0.0003)	(0.0004)
Number of reviews		0.0021**	0.0016	0.0016
		(0.0009)	(0.0016)	(0.0016)
HHI			-0.7280	-0.4911

			(1.4937)	(1.7462)
Attractiveness neighborhood			-0.0046	-0.0045
			(0.0044)	(0.0044)
Price restaurant				0.0257
				(0.0448)
Waterfles_				-0.1630
				(0.4077)
Constant	9.3375***	8.4971***	9.3853***	9.3000**
	(0.0801)	(0.3477)	(1.8547)	(4.1030)
Observations	944	944	944	944
R-squared	0.7730	0.7745	0.7734	0.7735

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Appendix 2 – Frequency restaurant categories

Table 10: The frequency of each cuisine category

Keuken2	Freq.	Percent	Cum.
International	58	12.64	12.64
Indian	46	10.02	22.66
Pizzeria	43	9.37	32.03
French	40	8.71	40.74
Italian	37	8.06	48.80
European	29	6.32	55.12
Argentinian	24	5.23	60.35
Dutch	20	4.36	64.71
Asian	18	3.92	68.63
Mediterranean	16	3.49	72.11
Thai	14	3.05	75.16
Mexican	11	2.40	77.56
Steakhouse	8	1.74	79.30
Japanese	7	1.53	80.83
South American	7	1.53	82.35
Grilled	6	1.31	83.66
Indonesian	6	1.31	84.97
Spanish	6	1.31	86.27
Turkish	6	1.31	87.58
Greek	5	1.09	88.67
Nepalese	5	1.09	89.76
American	4	0.87	90.63
Middle Eastern	4	0.87	91.50
Seafood	4	0.87	92.37
Syrian	4	0.87	93.25
Crêperie	3	0.65	93.90
Fusion	3	0.65	94.55
Moroccan	3	0.65	95.21
Vegan cuisine	3	0.65	95.86
Belgian	2	0.44	96.30
German	2	0.44	96.73
Iranian	2	0.44	97.17
Lebanese	2	0.44	97.60
Surinamese	2	0.44	98.04
Vietnamese	2	0.44	98.47
Brazilian	1	0.22	98.69
Cantonese	1	0.22	98.91
Caribbean	1	0.22	99.13
Eastern Europe	1	0.22	99.35
Ethiopian	1	0.22	99.56
Local	1	0.22	99.78
Vegetarian	1	0.22	100.00
Total	459	100.00	