ERASMUS UNIVERSITY
ERASMUS SCHOOL OF ECONOMICS
URBAN, PORT AND TRANSPORT ECONOMICS

MASTER THESIS

Car use,quality of parking and retail performance

A study on the Randstad agglomeration

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Rotterdam
28-7-2014

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Executive summary

The importance of the car on retail performance (turnover per square meter) is generally overestimated in literature. This is mainly due to a lack of differentiation between different types of retail areas with visitors who have different requirements for parking. On top of that most literature is focussing on the quantity and price of parking and neglect the effect of quality of parking. Therefore this thesis will research these two subjects. At first a differentiation between different type of retail areas, such as city centres and rural areas, will give an insight in the modal split of retail areas in the Randstad agglomeration. This differentiation will show that the car has only a minority stake in the modal split for city centres of bigger cities in the Randstad agglomeration. The car has a higher share in the modal split for rural areas. However, when the modal share of the car is compared with retail performance there is no evidence of a relation. A second focus in this thesis is the quality of parking. The quality of parking does have an influence on the performance of retail areas. This thesis finds evidence that the quantity of parking has no substantial influence on the performance of retail areas where the quality of parking does have a substantial influence.

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1. Introduction

In the last century the world changed dramatically with a substantial population growth (United Nations, 1999) and a growth in the number of cars which was relatively even larger (Dargay, Gately, & Sommer, 2007). Old city centres which have been built before this era do not have the infrastructure to cope with congestion occurred by these developments. It is however important to keep these cities accessible and assure economic growth but also account for sustainability, congestion and pollution (Mingardo, 2008).

In this thesis the focus will be on the Randstad agglomeration. The Randstad agglomeration consists out of the four biggest Dutch cities with their surrounding cities which can be seen as one big agglomeration with 7.8 million inhabitants (2012) making it one of the top 20 metropolitan areas in Europe (Netherland Ministry of Infrastructure and environment, 2014). On top of the already highly agglomerated position of the Randstad agglomeration it is expected that until 2025 population in this region will grow with another 700.000 inhabitants (CBS, 2011). A growing problem, and a threat for the future, is the congestion and pollution (Valk, 2002). Congestion has a negative impact on the development of the Randstad because it slows down economic growth. There is a high correlation between agglomeration and congestion, implying that there is more congestion in highly agglomerated cities and regions (Marlet & Woerkens, 2004).The four largest Dutch cities, Amsterdam, Rotterdam, The Hague and Utrecht, are the largest agglomerations in the Netherlands (CBS, 2014). This implies that the highest amount of congestion occurs in these four cities. The TomTom Traffic Index confirms this assumption where The Hague is the most congested city followed by Amsterdam, Rotterdam and Utrecht. The Hague, Amsterdam and Rotterdam are in the top 60 of most congested cities (TomTom, 2014) (Verkeerskunde, 2013).

Transport is a derived demand. There is no actual demand for travelling itself but there is demand for moving from A to B. The actual demand is the goal of the travel such as commuting, shopping and leisure. This derived demand implies that the normal rules for demand and supply does not hold for transport. For instance, people don't buy petrol because they have a demand for petrol, but because they want to move somewhere. Also the normal demand assumption that more is better doesn't hold. A longer journey time is not better than a shorter one (Mallard & Glaister, 2008).

Because the actual demand for travelling is in many occasions shopping (RAC Foundation, 2006) (Shimazaki, Kazunori, & Shihana, 1994; Ibrahim, 2005) this goal of travelling is important to understand. Changing the behaviour of shoppers can help with changing the modal split for a certain

area where needed. For instance congestion problems in the city centres of older, bigger cities with many retail venues can be decreased by reducing the use of the car for shopping trips. However, before doing so it is important to understand the reason of choosing a mode for a shopping trip and the effect of changing the possibilities for shoppers to choose a certain mode on the environment of that area. It is especially important to understand the effect of a changing policy in this field on the retail performance in the cities involved. Retail is important for a cities economic growth as well as the economic sustainability (Lowe, 2005).

A well known measure of reducing the percentage of car usage in the model split is introducing parking tariffs. This is no different for the Netherlands. Parking policies in the Netherland vary between cities. Some cities focus on the accessibility of their city by car with providing parking facilities while other cities emphasize on keeping cars as much as possible outside their city centres by making their city centre only accessible by walking, cycling and public transport. This choice in policy is, partly, dependent on the infrastructure of that particular city. Some cities are less accessible than others due to their historical growth, this occurs mostly in older cities. However, on overall most Dutch cities cope with congestion and pollution issues with different policies to regulate this.

Among shop owners, retail managers and branch organisation general consensus is that parking plays a crucial role in the performance of retail areas. However, literature is divided in its opinion about this. In many papers evidence is found that percentage of the car in the modal split for shopping trips does not directly influence the performance of retail in that area. Other factors like the quantity and quality of shops play a more important role on the choice of shopping areas by shoppers. On top of that the atmosphere of a shopping area, like safety and completeness in the supply of different shops in that area, and closest to home/work play a vital role (Mingardo & Meerkerk, 2012) (CBRE, 2014). The importance of the car as a predominant way of travel for shopping is often overestimated.

1.1 Goal of this thesis

Because of the need to reduce traffic in many congested areas many congested cities have taken measures to reduce car usage. Because the high amount of trips conducted with a car have shopping as a purpose the focus will be on shopping trips in this thesis. Reducing the share of the car in the modal split of retail areas can be achieved by implementing parking restrictions such as parking tariffs. However, reduce the share of the car in the modal split of retail areas can have implications for the retail performance of that retail area. The goal of this thesis is to provide an understanding on the effect the quantity and quality of parking has on retail performance. This understanding of the

effect parking has on retail performance will be used to evaluate the effectiveness of parking restrictions in the Randstad agglomeration.

Parking can be seen in a quantitative and a qualitative way. At this moment most papers written on the subject of parking and retail performance focus on the quantity of parking. However, on this subject literature is not consistent. Some scholars argue that the quantity of parking is of great importance for retail areas while others contradict this thought, at first this thesis will test the importance of the quantity of parking on retail performance for the Randstad agglomeration. Modal splits of different types of retail areas and the correlation between the percentage of car usage in these modal splits and retail performance will be reviewed in order to give an insight of the retail environment of the tested retail areas.

The effect of the quality of parking on retail performance is often neglected by scholars. Therefore this thesis will also review the effect of the quality of parking on retail performance. Decoupling the quantitative and qualitative effects of parking gives a more detailed insight in how parking policies affect the performance of retail areas in order to see how parking tariffs can be implemented in the most efficient way.

The research question in this thesis will be: *What is the importance of the car as the mode of travel for shopping trips and does the quality of parking influences the retail performance in the Randstad agglomeration?*

This research question will be answered with the help of four different sub-questions. The following sub-questions have been formulated:

- *What is de modal split of the different type of retail areas for daily and non daily goods in the Randstad agglomeration?*
- *How do parking tariffs correlate with the modal split of different type of retail areas in the Randstad agglomeration?*
- *How does the share of the car in the modal split correlate with the turnover of a retail area in the Randstad agglomeration?*
- *How does the quality of parking in a retail area influence the retail performance in the Randstad agglomeration?*

1.2 Methodology

A literature review will has been conducted in order to formulate the different sub-questions which will be answered later on in this thesis. In this literature review the need for parking policies will be explained by reviewing the congestion problems which are present in most western cities. After that the effect of these parking policies on congestion will be reviewed. Because of the focus of this thesis on retail performance and to understand the retail environment the modal split of shopping trips will be explained. At last the different views in literature on how the modal split influence the retail performance will be explained.

In order to interpret the effect the quantity of parking has on retail areas the first three sub-questions will be tested with descriptive statistics. With the use of the database tables will be made in order to review the modal split of the different type retail areas. The correlation between different variables will also be displayed in tables but with the help of scatter plots in order to give a more detailed view on these correlations. The last sub-question, on the effect of the quality of parking on retail performance, will be answered with a regression analysis. The effect of the perceived quality of parking on the turnover per square meter of a retail area will be reviewed.

1.3 Structure of this thesis

This thesis will begin, after this introduction, with a literature review in chapter 2. In chapter 3 a framework, with the different sub-questions, will be created. The methodology which explains how the different sub-questions will be answered is described in chapter 4. In this chapter the different variables will be explained as well as the methods used. In chapter 5 and 6 the actual research is performed and the results are described. On top of that in chapter 6 the different tests for the Ordinary Least Squares (OLS) assumptions are performed. The conclusion will be given in chapter 7 where the results are interpreted and the sub-questions and research question will be answered. The policy implications for the conclusion of this thesis together with the limitations of this thesis and the suggestions for future research can also be found in this chapter.

2. Literature review

2.1 Congestion in cities.

Many cities have to cope with congestion and pollution problems in their inner cities. City centres are most of the time designed before the booming of the car which gives implications in managing traffic flows nowadays causes congestion problems (Verhoef et all, 1995). These congestion problems are caused by different reasons. At first cities, metropolitan areas, grew disproportionally fast in the last century. In the 19th century the biggest disamenity of a city was the risk of diseases. Because people lived closer to each other than in rural areas diseases could spread easily. With the improvement of sewage systems and providing clean water these disamenities disappeared and positive amenities became predominant. Examples of these positive amenities are interaction with other people, better job opportunities and living nearby restaurants and theatres, basically everything that is a positive incentive for somebody to live in a city (Glaeser & Gottlieb, 2006). Cities in the United States and Europe grew faster than the nationwide growth of the population. In the United States urban growth surpassed the nationwide growth with 5,3 percentage points between 1920 and 2010, in France with 2 percentage points between 1920 and 2010 and in Spain with even 9,2 percentage points between 1936 and 2007 (Duranton & Puga, 2013). This growth is on top of the nationwide population growth which, dependable on which country, is exceeding an annual rate of 10%. These numbers imply a migration from rural towards urban areas in the 20th century, an effect called urbanization. Together with nationwide growth this had many implications for a cities´ infrastructure.

Not only the bigger cities, and their metropolitan area, grew in the last century, but also surrounding municipalities grew in that time. These municipalities often don't have the amenities and facilities bigger cities can offer. These smaller municipalities are therefore dependent on the bigger cities in the region for these amenities and facilities (Glaeser, Kolko, & Saiz, 2001). For this reason a growing number of inhabitants of surrounding municipalities have an influence on the congestion of the bigger city. Overall urbanization has a huge impact on the accessibility of cities (Antrop, 2004).

Besides the population growth of cities also the number of cars relatively grew with a rapid pace in the last half a century changing the urban environment dramatically (Glaeser & Gottlieb, 2006). The number of cars per 1000 population increased in OECD countries with annual growth rates between 1.6 and 13.1 percent, mainly depending on the state of development in 1960. Countries which were less developed in 1960 a higher growth rate than more developed countries at that time. It is expected that the growth of the number of cars per 1000 population will sustain in the near future.

However, OECD countries are expected to have lower annual growth rates than non OECD countries, this again due to the phase of development at this moment. In the non OECD countries there is in general a lower car penetration and therefore more possibilities for growth (Dargay, Gately, & Sommer, 2007).

Natural population growth and the growth of the number of cars per 1000 population all add up to a growth in the absolute number of cars on the road nowadays. However, Dargay, Gately, & Sommer (2007) find evidence that more urbanized countries have a lower car ownership rate per 1000 population than others. Also the effect of good public transport, like intercity train connection and metropolitan transit systems, decrease the car ownership rate compared with countries who didn't have these public transport connections. Still, all countries have a positive growth in this car ownership rate. Therefore all factors combined urbanbized areas have to cope with a growing absloute ammount of cars.

Despite of the fact that in the last century public transport has been improved still most of all people travelling travel by car (O'Toole, 2009). In the United States, with an urbanization rate of 80.7% in 2010 (United States Census Bureau, 2012) and Europe with an urbanization rate of 72% (Uhel, 2008) respectively 84% in 2008 (BTS, 2008) and 88.3% in 2012 (Eurostat, 2012) of all travel is done by car. These numbers are representative for the whole United States and Europe so it plausible that these percentages are lower in more urbanized areas, but still of substantial size. A research conducted by the European Metropolitan Transport Authorities in 2000 among 9 big European cities in 9 different countries is showed that 66% of all trips in these metropolitan areas were made by car.

Older, compact, cities face the problems with congestion and pollution nowadays and have to make sure that there will be an equilibrium between accessibility and the quality of the urban environment. Transport is an important driver for economic growth. However, transport causes many negative externalities such as congestion, pollution and accidents (Mingardo G. , 2008). These negative externalities can cause serious problems for the sustainability of economic growth and a cities' accessibility.

2.2 Parking policies

As literature shows general consensus is that a trade-off has to be made between accessibility and sustainability in cities. Parking is an important factor in determining congestion policy in cities (Golias, Yannis, & Harvatis, 2002). Parking policies are widely used in order to change the mode used

by people who travel towards city centres. It is therefore an important aid for policy makers to regulate traffic in their city centres (Marsden, 2006).

Cruising for parking, looking for a parking space, adds a substantial amount of traffic in metropolitan areas. Therefore cruising for parking adds to the congestion and pollution in this city, especially in the urban areas (Arnott & Inci, 2006) (Anderson & de Palma, 2004). The total effect of cruising for parking is not exactly known, but there are some estimations. A research conducted by Shoup (2005) on different European and American literature showed that about 30% of all traffic in a city is caused by cars cruising for parking. Newspapers argue that this percentage is even higher up to 50% (Arnott & Inci, 2006). Because of the high percentage of traffic in a city is caused by people cruising for parking it is important for congested cities to allocate parking in the most efficient way. Searching for parking is caused because the demand for parking is higher than the supply (Shoup, 2005). The negative externalities of cruising for parking, such as congestion and pollution, can be decreased by an effective parking policy. Implementing parking tariffs (demand side) and changing the supply of parking (supply side) are two ways of parking policy. It is however quite difficult to find an optimum number of parking supply due to the different and changing characteristics of areas where parking is demanded. A change in the use of an area can change the demand for parking completely. The demand for parking is dependent on the characteristics of the environment where the parking demand is. Shops have another demand for parking than offices and schools. Even within these categories there are differences in the demand for parking (Shoup, 1997). Therefore the most used parking policy is implementing parking tariffs in order to change the demand for parking.

Parking tariffs can be found all over the world in congested cities. Because of the high portion of traffic in a city that can be allocated to parking (Shoup, 2005) (Arnott & Inci, 2006) these parking policies can be effective for reducing congestion and pollution in a city. The effect of parking tariffs is widely discussed in literature. David W. Gillen (1978) was one of the first scholars to discuss the effect of parking tariffs. Introducing the effect of time costs and parking tariffs where parking tariffs are more effective where the time costs are lower. People who have a lower income are likely to value time to a lower extend than people with a higher income. People with a lower income will relocate earlier when a parking tariff is introduced. Introducing parking tariffs causes less traffic in a city because less people will visit a shopping area by car (Hess, 2001). Parking tariffs influence the costs of travelling by car and therefore the convenience of travelling by car. This can cause a change in mode and time of travelling (Still & Simmonds, 2000). Setting parking tariffs can result in the elimination of unnecessary cruising for parking and can therefore be a policy measure in decreasing

congestion. The most efficient tariff is a tariff where there is still saturation of parking, but there is no unnecessary cruising for parking (Anderson & de Palma, 2004) (Arnott & Inci, 2006).

Besides setting tariffs cities can choose for regulating the allocation of parking. A possibility is to change parking behaviour and try to move parking from on-street parking to off-street parking. An example of off-street parking are parking garages. When searching time increases for on-street parking, especially due to limited free parking places, people are more willing to look for alternatives like off-street parking. However, the choice between off-street and on-street parking is still affected by the costs of parking and walking distance from the parking place to the final destination (Golias, Yannis, & Harvatis, 2002). It is important to have an integrated parking policy that involves on-street and off-street parking together. This because otherwise one of the two options will be preferred by car drivers resulting in an inefficient distribution of parking. People like to park on on-street parking facilities because of the convenience of parking nearby their final destination. Pricing of off-street parking have to involve the resource costs of off-street parking, for instance a longer walking distance to the final destination and the resource costs of on-street parking, such as searching time for an available parking space. (Calthrop & Proost, 2002). In order to incorporate these costs in the different options for parking an overarching parking policy is needed.

Both Golias et all (2002) and Calthrop and Proost (2002) acknowledge the issue of searching time for an available on-street parking place. This is consistent with researches of Arnott and Inci (2006) and Shoup (2005) where searching for on-street parking places has a substantial impact on congestion in a city centre. For this reason effective parking policy for on-street and off-street parking is important in order to manage cruising for parking and reduce the total amount of traffic. An effective parking policy is a policy where parking tariffs are aligned in order to set the demand for parking to the most efficient level and to allocate parking between on-street en off-street parking in the most efficient way. Both demand and allocation efficiency can help a city decrease congestion in their city centre.

2.3 Shopping trips

Travelling by car can have many purposes. In a research conducted by the RAC Foundation in 2005 in the UK found that 30% of all trips with all different modes had the purpose of shopping activities. Commuting and business purposes do, for example, only account for 21% of all trips by any mode. Most people, 63%, choose the car as their mode of transport for these shopping activities in the UK. Also in the rest of Europe, Asia and the United states shopping trips conducted by car have a predominant position (Ibrahim, 2005) (Shimazaki, Kazunori, & Shihana, 1994). However, the amount of kilometres covered in these trips is much high for commuting and business purposes than for

shopping (RAC Foundation, 2006). This implies that shopping trips involve shorter trips and therefore the time needed for parking, for instance time spend on cruising for parking, has a relatively high share in the total trip time of these shopping trips. Parking is therefore a substantial part of the travel time for shopping trips

The car is chosen by a substantial part of shopper mostly out of convenience. For instance the ability of transporting big and large amounts of goods plays a role in choosing the car as the mode to shop (RAC Foundation, 2006) (Ibrahim, 2005). Because a substantial amount of trips incur shopping and many of those trips are done with a car shopping trips have a substantial influence on the negative externalities of car usage.

Shopping trips involve more complex choices, such as destination choices, route, frequency and mode, than other trips like business trips (Jones, 1978). People who plan a shopping trip often do not have a fixed destination. The effort of determining the location choice has influence on the eventual choice of a shopping destination (Hensher & McLeod, 1977). This implies that shopping trips can be influenced to a larger extend than commuting and business trips. Destination choices and the choice of the mode of transport can be affected by external effects, such as the quality of public transport and parking policies. Accessibility is an important factor for the destination choice of shoppers (CBRE, 2014). Hensher and King (2001) did a research on parking behaviour in the Sydney business district and found that shoppers are more flexible in the parking destination, but still park close to the retail area even when parking tariffs are implemented.

Because of the fact that shopping trips account for a big share in the total number of trips conducted with a car and parking has a substantial share in the travel time of these trips and the fact that shopping trips are quite different from other trips like commuting and family visits because of multiple location choices (Jones, 1978) it is an important goal of transport to focus on in traffic regulating policies, like parking policies. The modal splits of these kind of trips are more easily to influence than other kind of trips like business trips. The fact that shopping trips involve a location choice which have multiple outcomes results in more flexibility for shoppers. Changes in parking policy will affect the modal split of an area or the location choice in a much further extent than commuting, family visits and business appointments where the destination is most of the time fixed. In a research, conducted by the RAC foundation in 2006 in the UK it shows that people, using cars for shopping trips, 55% of all people indicated that they would be shopping somewhere else if parking tariffs would rise.

Congestion has an influence on the time that is involved in shopping trips. Because shoppers chose their mode on a set of different determinants, delay that is caused by congestion is influencing this choice (Bhat, 1998). The most agglomerated areas have the most congestion problems (Marlet & Woerkens, 2004). Because congestion is most likely to occur in city centres it is assumable that city centres have the lowest rate of shoppers that choice the car as the mode to travel.

2.4 The effect of parking on retail

As mentioned in the previous chapter reducing congestion can be achieved by reducing the demand for parking with parking tariffs. Because of the nature of shopping trips conducted with a car, short distances and substantial part of travel time spend on parking, it is likely that shopping trips are most affected by restricting parking policies. It is therefore important to understand the effect of parking on retail performance in order to understand the effect of implementing parking policies, such as parking tariffs, on retail performance.

Retail is of great importance for cities. Shopping is the motive behind many trips to cities (Warnaby & Davies, 1997) and creates economic growth and helps sustaining this growth. There are characteristics that attract shoppers such as amenities that are only offered in a certain cities (Glaeser, Kolko, & Saiz, 2001), and on the other side there are characteristics which can repel shoppers, such as a bad accessibility of cities (CBRE, 2014). It is therefore important to equilibrium between the quality and diversity of retail and accessibility that retail area. While the quality and diversity is a responsibility of the retail owners and their branch organizations accessibility can be influenced by parking policies.

Parking is an important subject for urban planners. The right supply and effective pricing of parking is important in order to keep a city centre accessible, but also in order to account for sustainability and sustain economic growth. Urban planners have to make decisions such as the number of parking places, but also regulate the demand of parking with parking tariffs and time restrictions for parking (Mingardo & Meerkerk, 2012). Because of the importance of retail for cities it is important to understand the effect of regulation of parking.

Literature is not consistent about the importance of the car for retail performance. Some scholars argue that parking is important for retail. The availability of parking is an important factor for the choice of a shopping location. Timmermans et all (1992) argue that parking facilities, among other factors such floor space and distance from departure, is a measure of attractiveness of a retail area. Still and Simmonds (2000) reviewed, with the help of different frameworks, that reducing parking in

an area can cause a decrease in economic growth. The report of RAC (2006) confirms this where 55% of all shoppers who use the car as mode will change shopping destination and 31% will change shopping destination if there will be a congestion charge. This view is mainly adopted by retailers and branch organizations with a main believe “no parking, no business”. Also a more recent research conducted by the CBRE (2014) in different European countries concluded that parking is still an important determinant of attractiveness of a retail area. Local authorities are often influenced by this view in order to offer more parking spaces and reduce or limit parking tariffs (Mingardo & Meerkerk, 2012).

Mingardo and Meerkerk (2012) reviewed three assumptions which have been used in the decision making on parking policies by local authorities. These assumptions have been contradicted in multiple papers and reports and are basically misconceptions of policy makers. The first assumption is: most shoppers reach a shopping area by car. A research performed by an organization called Sustrans in 2003 and 2006 contradicts this assumption. Retailers were asked which percentage of their customers they think visits the shopping area where they are located by car. In Graz (Austria) retailers estimated the percentage of shopper that visited by car at 58% while actually only 32% of all shopping trips is conducted with a car (Sustrans, 2003). A similar research was conducted in Bristol (UK) where the percentage of shopping trips conducted by car was estimated at 41% while actually only 22% of all shopper came by car (Sustrans, 2006).

The contradiction between the papers that suggest that most shoppers visit a shopping area with a car is the fact that these papers (RAC Foundation, 2006) (Ibrahim, 2005) (Shimazaki, Kazunori, & Shihana, 1994) don’t differentiate between urban and suburban shopping trips. As shown by the reports of Sustrans in 2003 and 2006 the percentage of shopping trips conducted with a car in urban areas is substantially lower. Also Mingardo and Meerkerk (2012) find a difference where overall there is no relation between parking availability and tariffs and the performance of a retail area while for regional, suburban, shopping areas there is a small positive relation between parking availability and retail performance.

The second assumption is: Shoppers that visit a retail area by car spent more money than shoppers who use another mode for their shopping trips. Also this assumption does not hold in literature. Mingardo et all (2009) conducted a research on the amount that supermarket customers spent on a weekly which showed that there is no significant difference in spending for different modes of transport. Other scholars concluded similar findings in other Dutch cities. Visitors that come by car to a retail area spend more per visit, but customers that use a bike or walk will visit more frequent and

therefore spend more overall (Christiaens, 2000) (Verhoek, 2000). Overall there is misconception in the view of retailers and branch organization about the amount spent by customers.

The third assumption is: the availability of parking influences the destination decision choice of customers who travel by car. Also this assumption is contradicted in literature. Mingardo and Meerkerk (2012) find evidence that parking tariffs and availability of parking have no effect on the decision choice of a certain shopping area. Shoppers are more likely to choose a retail area because of its quantity and quality of parking, visitor friendliness and location. Shoppers accept that parking is scarce at the most popular shopping areas and that because of this scarcity parking comes with a price. Marsden (2006) argues that the overall attractiveness of a city centre is not influenced by parking restraints. Shoppers who normally visit a retail area, city centre, by car will adept these parking restraints by changing modes or park further away of the destination.

However, the mode of a shopping trip might be changed due to these parking limitations. On top of that shoppers have a limited time available for shopping. Because of this time limitation the number of shopping areas which are available as a shopping location is limited (Landau, Prashker, & Alpern, 1982). Therefore the location decision for shoppers may not be influenced when the availability of parking decreases because travelling to another shopping area is exceeding the time available for shopping. Shoppers are limited in their location choices.

3. Framework

As reviewed in the literature review congestion is a problem in numerous cities around the world, including the Netherlands. Due to the relatively high share of shopping trips in the total number of trips conducted with a car it might be effective to reduce these shopping trips conducted with a car and force shoppers to change their mode of travel. However, because of the importance of retail it is important to understand what the impact is of implementing parking policies with the aim of reducing the demand of parking is on the retail performance.

In this thesis the focus will be on the Randstad agglomeration and therefore the different assumptions provided by the literature will be tested for this region. Literature is divided on the modal share of the car in shopping trips. Some scholars argue that shopping trips account for the majority of shopping trips (RAC Foundation, 2006) (Ibrahim, 2005) (Shimazaki, Kazunori, & Shihana, 1994), while others argue that this is an overestimation (Sustrans, 2006) (Sustrans, 2003) (Mingardo & Meerkerk, 2012). The main difference between these researches is the shopping area researched. The papers which argue that the car has a predominant role in the modal split of shopping trips focus on a country, or at least regional, level. Papers and reports which argue that the car is not that dominant in the modal split of shopping trips focus on an urban level, for instance a city centre. Because of the lack of consistency in the type of retail area researched these differences occur. Therefore it is interesting to review the modal split of different types of retail areas in the Randstad agglomeration.

Besides the differences in the type of retail area there can be made a differentiation between daily and non daily goods. There is little literature available on the differentiation of daily and non daily goods. Daily and non daily goods have different characteristics. Where daily goods involve groceries and personal care do non-daily goods involve more incidental purchases like clothing and electronics (KSO, 2011). Daily goods are less sensitive for economic cycle than non daily goods. This because daily goods involve many goods which are basic needs (Rabobank, 2013).

Because of these different trip characteristics it is plausible to expect a different modal split for these different shopping purposes. The first sub-question that will be answered in this thesis will be therefore:

> *"What is the modal split for the different type of retail areas for daily and non daily goods in the Randstad agglomeration?"*

Parking policy is implemented in order to regulate the demand for parking in an area. The most well known parking policy that local governments can take is introducing parking tariffs. Paid parking has been implemented in all major city centres in the Randstad agglomeration. Also in many other retail areas, such as shopping centres on the outskirts of a city, parking tariffs have been implemented in order to regulate the demand for parking. For local governments it is important to understand the effect of parking policy. Introducing parking tariffs will reduce the demand for parking (RAC Foundation, 2006) (Hess, 2001) (Still & Simmonds, 2000). Because shopping trips are more flexible in terms of modal choice it is expected that implementing parking tariffs gives shoppers an incentive to change their mode of travel. This assumption found in the literature will be tested for the different retail areas in the Randstad agglomeration by comparing parking tariffs with the modal split of these retail areas. The sub-question created is therefore:

> *"How do parking tariffs correlate with the modal split of different type of retail areas in the Randstad agglomeration?"*

As mentioned by Mingardo and Meerkerk (2012) there is a misconception that shoppers who use their car as the mode of travel spent more than shopper who use another mode of travel for their shopping trip. Literature reviewed that shoppers who use their car do not spent more in total. Per trip there is a positive link between shopping trips conducted by car and the amount that is spent on this shopping trip, but shopper who use another mode are more frequent shoppers (Mingardo, Mouter, & Talens, 2009) (Christiaens, 2000) (Verhoek, 2000). However, other papers and reports argue that the car is an important mode of travel because of the convenience, for instance transporting high volumes of goods (RAC Foundation, 2006) (Ibrahim, 2005). For this reason the correlation between the percentage of shopping trips conducted with a car and the turnover for different type of retail areas in the Randstad agglomeration will be tested with the following sub-question:

> *"How does the share of the car in the modal split correlate with the turnover of a retail area in the Randstad agglomeration?"*

The previous sub-questions focus on the quantitative side of parking. The modal split and how parking policies affect this modal split will be reviewed with these sub-questions. The focus in literature about parking and retail performance also has been mainly on the quantity of parking. As seen in the different papers reviewed in this thesis scholars argue that either that the amount of parking is an important for retail performance or that there is no direct connection between the quantity of parking and retail performance. Parking policy is mostly focussed on implementing and

setting parking tariffs with an aim on decreasing the demand for parking. Besides the quantity of parking there is the quality of parking. The quality of parking is in the most papers on parking and retail performance neglected. Shoup (2006) emphasize on the aesthetic part of parking policies. In order to increase the attractiveness of an environment it is important to regulate the quality of parking. Unattractive parking facilities decrease the attractiveness of such an environment. The quality of parking is quite a broad concept. In this thesis the focus will be on the perceived quality of parking possibilities near the shopping destination.

It is interesting to review the effect of the quality of parking on retail performance. Shoppers might valuate quality of parking more than they do like the quantity or price of parking. The quality of parking might be therefore important on the retail performance. When shoppers have a higher perceived quality of parking in one retail area than in another it is possible that this influence the destination choice and therefore the retail performance of that chosen shopping area. In order to test this for the different retail areas in the Randstad agglomeration the following sub-question has been created:

> *"How does the quality of parking in a retail area influence the retail performance in the Randstad agglomeration?"*

The results from the first three sub-questions will be used to determine the share of the car in the modal split and therefore the importance of the car as a mode for shopping trips. The information of the modal split can be used in order to determine the total effect of parking policy measures. The quality of parking will be researched in order to make a first attempt to decouple quantity and quality of parking in order to give a more detailed view on parking policies. Parking policies can influence both the quality and quantity of parking in an area at the same time. It is therefore important to understand both the effect of changing the quantity and quality of parking.

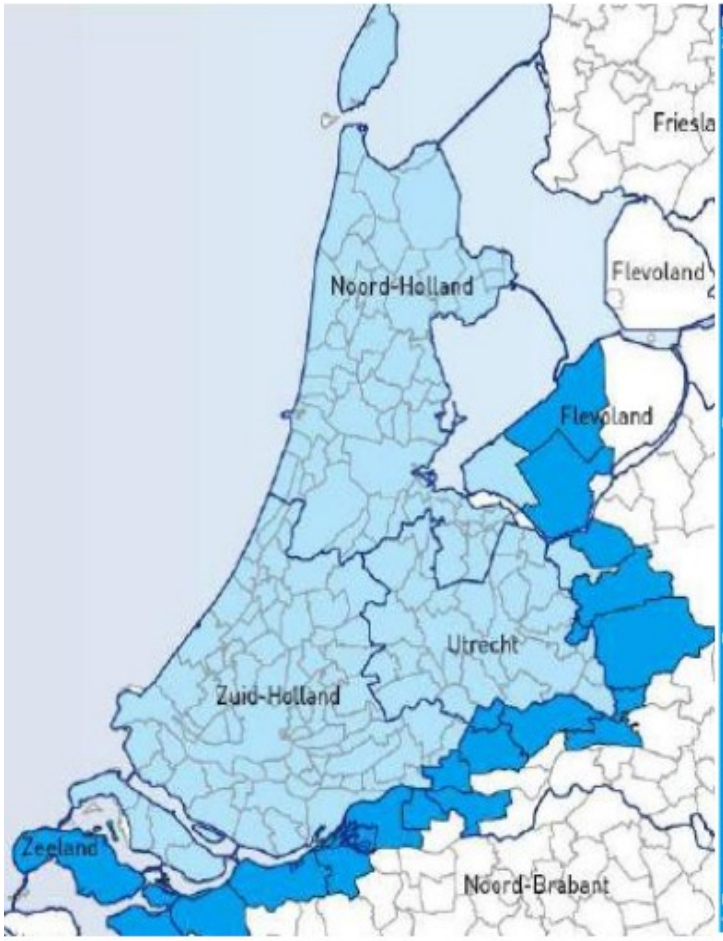
4. Methodology

In this chapter the methodology used will be described. In order to interpret the later results the database used will be described and explained. These databases will be used for two different methods. At first descriptive statistics will be generated in order to answer the first three sub-questions which have been created in the framework. On top of that a regression analyses will be conducted in order to test the last sub-question. This chapter will describe which variables will be used and why these variables have been chosen.

4.1 Database

In order to answer the different sub-questions a database has been created with information from different sources. The most important source is a report called “Randstad Koopstromen Onderzoek 2011”, abbreviated as KSO2011. This report consists out of research conducted by a company called I&O research and is commissioned by the three provinces in the Randstad agglomeration, Noord-Holland, Zuid-Holland and Utrecht, different municipalities in these provinces and a retail branch organisation. The aim of this research was to understand the different determinants that influence the behaviour and location choice of shoppers for 217 retail areas in the Randstad agglomeration. For the retail areas included in this research retail performance, satisfaction scores of shoppers on different characteristics of that retail area, location choice determinants, modal split of retail areas and parking characteristics are described. Most of these indicators are divided between daily and non-daily goods. The KSO2011 research included 158 municipalities (38% of all Dutch municipalities) with 7.621.255 inhabitants (46% of total Dutch inhabitants). Figure 1 shows the geographical coverage of the KSO2011 report. The Research was conducted by taking 69400 surveys. KSO researches are conducted every 5-7 years with the KSO2011 research being the fifth edition.

Figure 1: Geographical coverage of the KSO2011 report



provincie	regio	enquêtes
Zuid-Holland	Alblasserwaard	702
	Alphen aan den Rijn e.o.	855
	Bollenstreek	1.699
	Delft/Westland	5.156
	Den Haag / Wassenaar	3.456
	Drechtsteden	1.859
	Goeree Overflakkee	838
	Hoekse waard	429
	Leiden e.o.	1.789
	Midden Holland	3.172
	Ridderkerk e.o.	1.948
	Rotterdam	2.977
	Schiedam/Vlaardingen	1.438
	Voorne Putten	2.757
	Zoetermeer/Rijswijk	1.812
	Totaal	**30.887**
Utrecht	Eemland Noordwest	1.325
	Eemland Zuidoost	1.273
	SG Utrecht Noord	2.756
	SG Utrecht oost	1.035
	SG Utrecht Zuid	1.198
	Utrecht Noordwest	2.475
	Utrecht Zuidoost	1.967
	Utrecht Zuidwest	1.154
	Totaal	**13.183**
Noord-Holland	Amstel- en Meerlanden	3.915
	Amsterdam	1.775
	Gooi- en Vechtstreek	1.974
	IJmond	1.353
	Kop NH	1.739
	Noord-Kennemerland	2.317
	Waterland	1.156
	West-Friesland	3.889
	Zaanstreek	1.165
	Zuid-Kennemerland	2.246
	Totaal	**21.529**
Randgebied		3.908
Totaal		**69.507**

Source: KSO2011

A second source that is used is a report from the CBS. CBS conducts a yearly demographic research for all different municipalities in the Netherlands. For this thesis information from 2011 is used because the information in the KSO2011 research is also covering 2011. This research includes, among other things, total population and population density numbers for these municipalities. This source will be used in order to check for a relation between population density and the size of a city in order to test literature which claim that agglomerated cities are more congested.

After matching information from the KSO2011 report and the information from the CBS there are 166 retail areas left in the dataset. There are some differences between these reports on how municipalities are defined. The difference between the definitions of municipalities is mainly because of restructuring in the Netherlands where some municipalities are joined together. The KSO2011 research mainly approach most municipalities as in the situation before they were joined together while CBS uses the merged municipalities. As a result this will give implications with the definition of

local and regional shoppers. Because there is a difference in the definition of municipalities between the KSO2011 database and the CBS municipalities which don't match cannot be used.

4.2 Descriptive statistics

The constructed database will be used to obtain information about modal choice, retail area characteristics and parking characteristics for different retail areas in order to provide descriptive statistics on these retail areas in order to answer the first three sub-question. The modal choice of customers will be linked to different characteristics of different shopping areas and the different type of shopping trips. Information used from the CBS and KSO2011 reports will give an insight in the effect of retail area characteristics on the modal choice for that retail area. Also the effect of the type of good, daily or non daily, involved in a shopping trip on the modal choice will be reviewed.

In order to answer the first sub-question the modal split for will give an insight in modal split of five different types of retail areas in the Randstad agglomeration. For this reason different retail areas are categorized in five different categories. These categories are: inner cities of bigger cities, big retail concentrations (big shopping malls for example), shopping areas in small and medium municipalities, regional shopping areas (shopping areas which serve relatively many surrounding municipalities) and suburban shopping areas. Table 1 shows the type retail areas which have been created with the number of observations.

Table 1: Description of the different type of retail areas

Type of retail area	Frequency	Percentage
City centre	10	11.76
Big retail concentration	5	5.88
Regional shopping areas	25	29.41
Shopping areas in small and medium sized municipalities	25	29.41
Suburban shopping area	20	23.53

Source: Own elaboration/KSO2011

Despite of the fact that this categorization does not involve all retail areas which are available in the KSO2011 research it still gives a good insight between the role a retail area has and the modal split of that retail area. Where city centres often have an important role in providing amenities which are not present in smaller municipalities, such as movie theatres, specialized restaurants and specialized

shops (Glaeser, Kolko, & Saiz, 2001), other retail areas have another role in their region. Regional retail areas also serve a surrounding region with certain amenities, but on a smaller scale. However, suburban areas are more likely to serve more local shoppers. For the different types of retail areas the modal choice will be researched.

In order to test the assumption that more agglomerated cities have a higher level of congestion (Marlet & Woerkens, 2004) the population density will be reviewed for these three different sizes of cities, implying that a higher number of people per square meter results in more congestion problems. With information from the CBS (2011) population size and population density has been derived from different municipalities in the Netherlands are derived. In the constructed database population sizes vary from 6499 inhabitants up to 779808 inhabitants. Despite the wide spread in the data sample there are only nine municipalities which have more than 100.000 inhabitants. Municipalities are categorized in three different categories, small, medium and large cities. Small cities are defined as cities which have less than 50.000 inhabitants, medium sized cities are cities which have between 50.000 and 100.000 inhabitants and large cities are defined as cities which have more than 100.000 cities. On top of that the modal split of the four biggest cities in the Randstad agglomeration will be reviewed with the highest population density.

Table 2: Categorization of city sizes

Category	Size
Small sized municipalities	<50.000 inhabitants
Medium sized municipalities	>50.000 but < 100.000 inhabitants
Large sized municipalities	> 100.000 inhabitants

Source: Own elaboration

The KSO2011 research makes a differentiation between daily and non daily goods presented in table 3. The effect both type of goods have on the modal split for shopping trips will be reviewed for the 5 different types of retail areas. This will result in a more in-depth insight is modal choices made by shoppers.

Table 3: Categorization of daily and non daily goods

Daily	Non daily
Grocery shopping	Clothing
Personal care	Electronics and jewellery
	Household items, furnishings and garden decorations
	Leisure products

Source: Own elaboration/KSO2011

At first the different parking tariffs will be reviewed. This will be done with reviewing the level of the parking tariffs in the retail areas where parking tariffs are implemented and the implementation rate of paid parking per type of retail area.

In order to test the correlation between parking tariffs and the percentage of shopping trips conducted with a car a comparison of the modal split of all retail areas will be made. There will be no specification by type of retail area due to the lack of data, all city centres of the biggest cities have paid parking implemented so there is no comparison possible for this category. Reviewing all the retail areas in the database show that some of those retail areas have implemented paid parking and some don't. A comparison will be made which will show the effect of paid parking on the modal choice without concerning about the level of this tariff. On top of that a scatter plot will indicate if there is a link between the level of the tariff for paid parking and the share of the car in the modal split of retail areas.

The last sub-question that will be tested descriptive statistics is the correlation between the modal share of the car in shopping trips and the turnover per square meter for a retail area. This test will be performed for the total turnover per square meter, the turnover per square meter for daily goods and the turnover per square meter for non daily goods. This test will give an insight in the correlation between the share of the car in the model split of shopping trips and the turnover per square meter for different type of goods.

All these descriptive tests can be used to find correlations between different variables in our dataset. Descriptive statistics cannot say something about how the variables affect each other. It is however a useful tool to give an insight in the data in the dataset and tests the different assumptions formulated by literature. In order to review the real effects between the different variables a regression will be performed.

4.3 Regression

In order to answer the last sub-question: *What is the influence of the quality of parking on retail performance?* a regression analysis will be conducted. In this regression analysis the effect of the quality of parking, with control variables, will be tested on three different dependent variables. All observations in the dataset will be used. In contrast with the descriptive statistics there will be no subdivision of the different types of retail areas due to the decrease in observations with this subdivision. Other control variables will be used to compensate for these effects.

4.3.1 Dependent variables

There will be three different dependent variables which will be tested on how they are affected by the quality of parking. The three dependent variables which will be tested all measure the turnover per square meter. Measuring productivity in terms of turnover per square meter is a widely used way of measuring (Rabobank, 2013). It gives a fair indication of the performance of a retail area because it gives the opportunity to compare retail areas with the most diverse sizes. In order to organize the results of the regression natural logarithms will be generated for these dependent variables creating a log-level regression model. The natural logarithm transformation will result in a regression where the effect of the different independent and control variables on the dependent variables will be displayed in a percentage. Due to the difference between the levels of the different results in the regression this transformation to natural logarithms will make the results more organized. Another reason for transforming these independent variables to natural logarithm is to exclude outliers in the data.

The natural logarithm of the total turnover per square meter will be used as the first dependent variable in the regression. The total turnover per square meter will give a good indication on the effect the different independent variables have on the turnover per square meters. With the results of this regression in mind a differentiation will be made between daily and non daily goods. As mentioned in the researches of Rabobank (2013) and CBRE (2014) the performance of daily and non daily goods is influenced in different ways. On top of that, as will be reviewed later on in this thesis, there is a substantial difference in the average turnover per square meter between daily and non daily goods. For this reason it is interesting to test if, and how, shoppers shopping for either daily or non daily goods react on the quality of parking. Therefore two extra dependent variables will be tested, the natural logarithm of the turnover per square meter of daily goods and the natural logarithm of the turnover per square meter for non daily goods. Table 4 will provide a summary of the dependent variables.

Table 4: Description of the dependent variables

Variable	Obs	Mean	Std. Dev.	Min	Max
ln_product~l	188	8.45553	.4486354	6.690842	9.423191
ln_pr~_daily	189	9.072081	.3395028	7.566311	10.06036
ln_pr~ndaily	216	7.74029	.5357656	5.888878	8.915701

Source: Own elaboration/KSO2011

4.3.2 Independent variables

The focus in this regression analysis will be on the quality of parking facilities. Despite of the fact that the quality has been neglected in most researches about the effect of parking on retail performance it might be an important indicator for the retail performance. The quality of parking is measured in the KSO2011 research by the quality of parking possibilities near the final (shopping) destination. The perceived quality of parking in a retail area is measured on a scale from 1 to 10 for all different retail areas. The grade, 1 to 10, shoppers give to the quality of parking gives an indication on how shoppers perceive the parking facilities in a shopping area. This grade, and the grades for other characteristics of retail areas, has been obtained with a survey held among shoppers. Because the focus on the quality of parking in this thesis the first independent variable is:

- Perceived quality of shopping (Ranking 1 to 10)

The KSO2011 research also provides six other variables which measure the perceived quality of other characteristics of retail areas. Also these characteristics have been grades by shoppers from 1 to 10. The perceived quality of these characteristics gives an insight how shoppers evaluate the different retail areas in this report. It is therefore important to include the scores for the different characteristics in order to test if they have an explanatory power on the turnover per square meter.

- Completeness of the retail area (Ranking 1 to 10)
- Atmosphere (Ranking 1 to 10)
- Safety (Ranking 1 to 10)
- Daytime bars and restaurants (Ranking 1 to 10)
- Accessibility car (Ranking 1 to 10)
- Accessibility transit (Ranking 1 to 10)

As will show in the next chapter due to multicollinearity issues the variables *atmosphere* and *accessibility by car* will be excluded from the regression analysis.

Table 5: Description of the independent variables

Variable	Obs	Mean	Std. Dev.	Min	Max
completeness	192	7.583854	.437149	6.2	8.4
atmosphere	192	7.232813	.5716848	5.1	8.3
safety	191	7.550785	.3823568	6.1	8.4
parking	191	7.446597	.7015595	4.3	9.1
daytime_ba~s	191	6.717801	.9339206	3.6	8.2
accessibil~r	191	7.691623	.5860959	4.7	8.7
accessibli~t	190	6.928947	.8990612	3.9	8.8

Source: Own elaboration/KSO2011

4.3.3 Control variables

There will be controlled for several external effects in this regression with control variables. This will be done in order to increase the explanatory power of the regression by including external factors which affect the dependent variable.

The first control variable which will be used is the size of the retail area. A research conducted by the Rabobank in 2013 concluded that different sizes of retail areas perform in a different way. Small (<10000 m^2) and big (>40000 m^2) retail areas showed an increase in turnover per square meter, while medium (between 10000 m^2 and 40000 m^2) sized retail areas showed a decrease (CBRE, 2014) (Rabobank, 2013). Shoppers often chose for small and big retail areas because of the accessibility of these areas (CBRE, 2014). The following control variables are created in order to control for the effect of the size of retail area:

- Small Retail Areas (Retail areas with less than 10000 square meters)
- Medium Retail Areas (Retail areas between 10000 and 40000 square meters)
- Big Retail Areas (Retail areas with more than 40000 square meters)

As will be reviewed in the next chapter there is a substantial difference in turnover per square meter between daily and non daily goods the effect on the total turnover per square meter. Daily and non daily goods have different characteristics wherefore both type of goods react different to economic cycles (Rabobank, 2013). On top of that the KSO2011 research indicates that shoppers for daily goods have a higher evaluation of the perceived quality of parking. These differences between both goods can result in a different reaction on the perceived quality of parking. For instance, people who shop for luxury goods may be more influenced by the perceived quality of parking when deciding a shopping trip destination. For this reason there will be controlled for daily goods with a control variable when testing the total turnover per square meter. In the regression of daily and non daily

goods this variable will be neglected because the effect of daily and non daily goods is already covered in the dependent variable. This control variable is constructed by dividing the daily goods turnover of a retail area by the total turnover of that retail area. This leaves a variable which indicates percentage of daily goods for that shopping area:

- Percentage Daily (Daily goods turnover/Total turnover of a retail area)

Parking tariffs have a negative impact on the share of the car in the modal split. Parking tariffs makes a trip by car more expensive and are therefore less attractive (Arnott & Inci, 2006) (Hess, 2001) (Still & Simmonds, 2000). This can have implications on the perceived quality of parking because shoppers can relate parking tariffs to less attractive parking possibilities. In order to exclude this effect from the independent variable parking this regression will control for the presence of paid parking. Because the actual tariff has a high negative correlation with the variable parking resulting in multicollinearity issues a dummy variable has been constructed to test if there is paid parking present in a retail area while neglecting the level of this tariff.

- Paid parking (0 = no, 1 = yes)

Table 6: Description of the independent variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Big_retail~a	217	.1843318	.3886511	0	1
Medium_ret~a	217	.4884793	.501023	0	1
Small_reta~a	217	.3271889	.4702717	0	1
Percentage~e	217	62.45499	25.77268	0	100
popdensity	166	2577.512	1593.076	191	6046

Source: Own elaboration/KSO2011

4.4 OLS model

The regression analysis will be conducted with the variables described in the previous paragraph. Three dependent variables will be tested on how they are influence by the different independent variables. These dependent variables are transformed to the natural logarithm of the original variables in order to create a log linear model. There are 7 independent variables, 5 will be used in the regression model, which give an insight in the perceived quality of characteristics of a retail area. On top of that 5 control variables will control for external effects which influence the dependent variables.

The following log linear equation has been created:

- $\mathbf{Ln\ (Y) = \alpha + \beta_i X_i + u_i \quad i = 1,2,.....,217}$

There are different requirements which have to be fulfilled in order to conduct an OLS regression. When one or more requirements are not fulfilled the results of the regression can be biased.

It is important that the independent variables used in the regression model have a linear relationship with the dependent variable otherwise there will be problems with estimating the regression model. The variables used all have linear relations with the dependent variables. The regression model is constructed with data that directly relates to the retail areas involved as showed in the log linear equation reviewed above.

Multicollinearity will be tested with a correlation matrix and VIF scores. This will be done in order to test for correlations between the independent variables. The VIF scores will be used in order to give an overall insight in the correlation between the different independent and control variables. VIF scores above 5 will be reviewed in more detail with the correlation matrix in order to review the impact of the correlation between the different independent variables. Normality is tested with a histogram of the different observations of the different continuous dependent and independent variables in order to compare the distribution with a normal distribution. On top of that the Shapiro-Wilk test will be used to mathematically test this assumption. The Shapiro-Wilk test has a null hypothesis which assumes that the observations are normally distributed. A p-value lower than 0.05 will reject this hypothesis.

Homoscedasticity, constant variance of the dependent variables, is tested with the Breusch-Pagan test. The null hypothesis of this test assumes that the variance of the dependent variables is constant. A p-value lower than 0.05 will reject this assumption. A rejection of this assumption will be controlled for with robust standard errors. The last test which will be conducted is the Ramsey Rest test. The Ramsey Reset test will test if there are omitted variables in the model. The null hypothesis assumes that there are no omitted variables. A p-value lower than 0.05 will reject the null hypothesis.

For both the regression model as the different tests to test the OLS assumptions a significance level of 0.05 will be used. Ceteris paribus, keeping all other factors constant, is assumed.

5 Results of the descriptive statistics

5.1 The modal split for retail areas in the Randstad agglomeration

The most agglomerated areas have the highest congestion in the Netherlands (Marlet & Woerkens, 2004). It can be assumed that congestion can be linked to population density. Testing the link between the level of agglomeration, measured in city size, and population density for the Randstad agglomeration results in a similar conclusion. When the different municipalities are sorted in the three different sizes it shows that population density increases with the size of the municipality. The municipalities which have been defined as large have the highest population density with an average of 4070.16 inhabitants per square kilometre. Medium sized municipalities have an average population density of 2957.89 inhabitants per square kilometre and small municipalities have a population density of 1428.23 inhabitants per square kilometre.

Table 7: Population density in inhabitants per square kilometre, specified per city size

Category	Average population	Average population density (inhabitants per square kilometre)
Small municipalities	29317	1428
Medium municipalities	72349	2958
Large municipalities	357116	4070

Source: Own elaboration/CBS

The modal split of shopping areas will be reviewed for 5 different types of retail areas. The city centres category includes the biggest cities while regional shopping areas are mostly medium sized cities. The link between city size and population density found in the previous table is linked to the modal split of these different types of retail areas. The modal share of the car for retail areas in the biggest cities is the lowest of all retail areas.

Table 8: Modal split of the tested retail areas

Type of retail area	Car (%)	Bike (%)	Public transit (%)	Walking (%)
City centre	25.7	34.55	16.4	23.3
Big retail concentration	48.25	28.5	10.25	13
Regional shopping areas	50.5	30.88	3.5	15.17
Shopping areas in small and medium sized municipalities	54.2	30.42	1.1	14.14
Suburban shopping area	49.13	26.03	5.37	19.47
Average	48.18	29.98	4.98	16.83

Source: Own elaboration/KSO2011

These results confirm the finding that literature is not consistent in the type of retail area researched. It is clear that the car has no dominant role for in the modal split for city centres, while for more rural areas the car has a dominant role.

When the modal split is reviewed on a micro level for the city centres of the four biggest cities it can be concluded that in the biggest four cities of the Netherlands the modal share of the car is even lower. This is in line with the assumption that the correlation between congestion and the percentage of the car in the modal split of retail areas is negative.

Table 9: Modal split of the city centres of the four biggest Dutch cities in percentage

City centre of:	Car (%)	Bike (%)	Public transit (%)	Walking (%)
Amsterdam	6	34	30	31
Rotterdam	17	24	34.5	24.5
The Hague	20.5	23.5	31.5	24.5
Utrecht	16	29	32.5	22.5
Average	14.88	27.63	32.13	25.63

Source: Own elaboration/KSO2011

In the KSO2011 report shoppers indicate how important different determinants of the shopping location are in their location choice. Table 10 shows the importance of the different location choice characteristics for the five different types of retail areas. This table clearly shows that shoppers find parking capacity and parking tariffs less important for city centres than for other type of retail areas. However, the accessibility by public transport is of a greater importance than for most other retail areas, only for regional shopping areas the accessibility by public transport is more important. This implies a change of mode for city centres.

Table 10: Importance of the determinants for the shopping area choice in percentage

Type_of_retail_area	dichttot	complw-t	compltot	prijstot	uitsttot	bar-vtot	bar-ttot	parktot	parkta-t	routew-t	routea-t	combitot
Binnenstad	37.7	54.1	31.1	10.6	23.9	12	8	6.5	1	4.9	5.5	4.1
Grootschalige conce	24.66667	44	36.33333	29	12	17.33333	20	13.66667	4	8	6	4.333333
Hoofdwinkelgebied	50.28	48	27.08	10.12	18.96	3.76	17.2	16.04	4.96	2.96	4.08	3.24
Kernverzorgend cent	59.56	36.84	24.69	10.08	12.4	1.6	14.64	16.6	4.6	3.6	4.44	3.52
Stadsdeelcentrum	65.65	39.9	25	13.75	12.9	5.15	17.45	19.1	5.75	4.2	4.3	2.75
Total	54.33735	43.27711	26.6747	11.72289	15.86747	4.927711	15.48193	15.71084	4.53012	3.86747	4.481928	3.349398

Source: Own elaboration/KSO2011

Despite of the fact that there is little literature available about the differentiation between daily and non daily goods on the modal split of retail areas it is interesting to review the effect of a differentiation between these goods. The reason for performing this test is the substantial difference between the turnover per square meter of daily and non daily goods as shown in table 11 and table 12. In total as well as for each specified type of retail area daily goods have a higher turnover per square meter.

Table 11: Turnover per square meter in Euro for daily and non daily goods

	Daily goods	Non daily goods
Turnover per square meter (In Euro)	9190.40	2598.51

Source: Own elaboration/KSO2011

Table 12: Turnover per square meter in Euro for daily and non daily goods, specified per type of retail area

Type of retail area	Daily goods	Non daily goods
City centre	8908.40	2543.30
Big retail concentration	5284	1287.80
Regional shopping areas	8099.28	2738.48
Retail areas in small and medium sized municipalities	9123.60	2717.28
Suburban retail area	11989.60	3096

Source: Own elaboration/KSO2011

Daily goods have a lower percentage of car usage in its modal split than non daily goods. This result applies for every type of retail area. However, the difference in modal split is the highest for big retail concentrations and city centres. However, big retail concentrations have a relatively low number of

square meters for daily goods and can therefore not completely be interpreted. Still these findings implies that shoppers valuate travelling with the different available modes in a different way for shopping trips involving daily goods than shopping trips which involve non daily goods.

Table 13: Modal split for daily goods, specified per type of retail area

Type of retail area	Car (%)	Bike (%)	Public transit (%)	Walking (%)
City centre	18.6	37.9	8.3	35.3
Big retail concentration	25	42.5	12	20.5
Regional shopping areas	45.76	32.36	1.68	20.28
shopping areas in small and medium sized municipalities	53.24	30.8	0.56	15.28
Suburban shopping area	46.9	27.35	3.4	22.4
Average	44.5	31.59	2.82	21.11

Source: Own elaboration/KSO2011

Table 14: Modal split for non Daily goods, specified per type of retail area

Type of retail area	Car (%)	Bike (%)	Public transit (%)	Walking (%)
City centre	32.8	31.2	24.5	11.3
Big retail concentration	62	14.33	19.67	4
Regional shopping areas	56.17	28.96	5.25	9.63
Shopping areas in small and medium sized municipalities	55.16	30.04	1.64	13
Suburban shopping area	50.21	24.84	7.32	17.53
Average	51.79	28.06	7.53	12.52

Source: Own elaboration/KSO2011

It shows that the share of the car in the modal split of the different retail areas is quite different. There is also a difference between daily and non daily goods. However, the car is overall not the dominant mode of travel for shopping trips with a city centre of a bigger city as the shopping destination. The only exception is the modal split for shopping trips involving non daily goods. There the car has a slight majority in the modal split. In the other type of retail areas the cars has a dominant role in the modal split. Therefore the modal split is highly dependent on the type of retail area.

5.2 The correlation between parking tariffs and the modal split in retail areas in the Randstad agglomeration

Parking tariffs have been widely implemented in different type of retail areas in the Randstad agglomeration. When the tariffs are reviewed it is no surprise that parking tariffs are the highest in city centres of the bigger cities. This is in line with the assumption that congestion is the highest in these city centres. In order to reduce the number of shopping trips conducted with a car setting parking tariffs is effective (Hess, 2001) (Still & Simmonds, 2000).

Table 15: Parking tariffs in Euro, specified per type of retail area

Type of retail area	Average parking tariff (in Euro/Hour)
City centre	2.82
Big retail concentration	1.53
Regional shopping areas	1.48
shopping areas in small and medium sized municipalities	1.28
Suburban shopping area	1.28
Average	1.71

Source: Own elaboration/KSO2011

The implementation rate of paid parking also confirms this assumption. While in all city centres of the biggest cities in the Randstad agglomeration paid parking is implemented this is only in 12% of all small en medium retail areas the case.

Table 16: Implementation rate of paid parking in percentage, specified per type of retail area

Type of retail area	Parking implemented (in % of total number of retail areas)
City centre	100
Big retail concentration	60
Regional shopping areas	68
shopping areas in small and medium sized municipalities	12
Suburban shopping area	50
Average	50.59

Source: Own elaboration/KSO2011

There is a negative correlation between the percentage of shoppers who use a car for their shopping trip and the presence of parking tariffs in a retail area. The average percentage of shoppers who use their car for a shopping trip without the presence of parking tariffs is 52.16% while retail areas with the presence of parking tariffs have a modal share of the car of 41.51%. This difference is only moderate. A single variable regression for this model only gives an R-square of 0.1728 resulting in an explanatory power of 17.28%. This implies that there are other factors which explain the difference in modal share between these retail areas. A differentiation for the different types of retail areas would have been an addition to the explanatory power of the model. However, the number of observations is too small to review this effect in more detail.

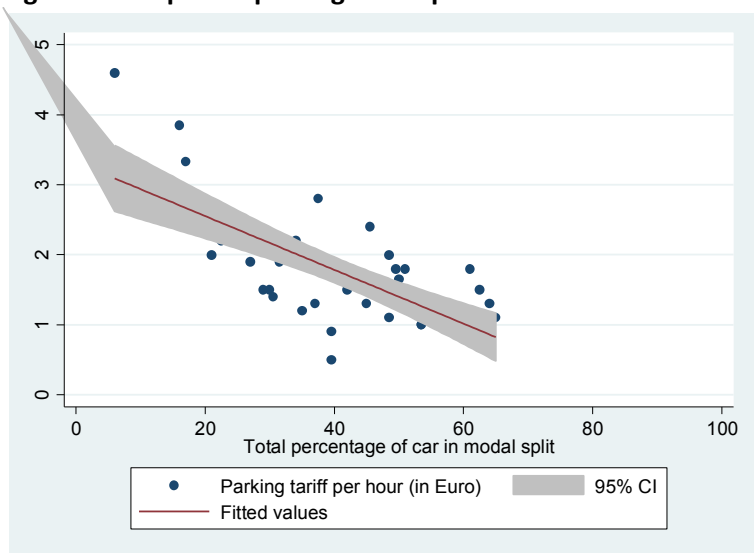
Table 17: Modal share of the car for retail areas with and without parking in percentage of total modal split

	Parking tariffs	No parking tariffs
Modal share of the car (in %)	41.51	52.16

Source: Own elaboration/KSO2011

When the level of the parking tariff is considered it becomes clear that there is strict negative correlation between the level of the parking tariff and the percentage of shopping trips conducted with a car, as shown by figure 2. The corresponding regression model shows a significant relation. With an R-square of 0.4470 this model has an explanatory power of 44.7%, which is quite high for a single variable regression.

Fig 2: Scatter plot of parking tariffs per hour and modal share of the car



Source: Own elaboration

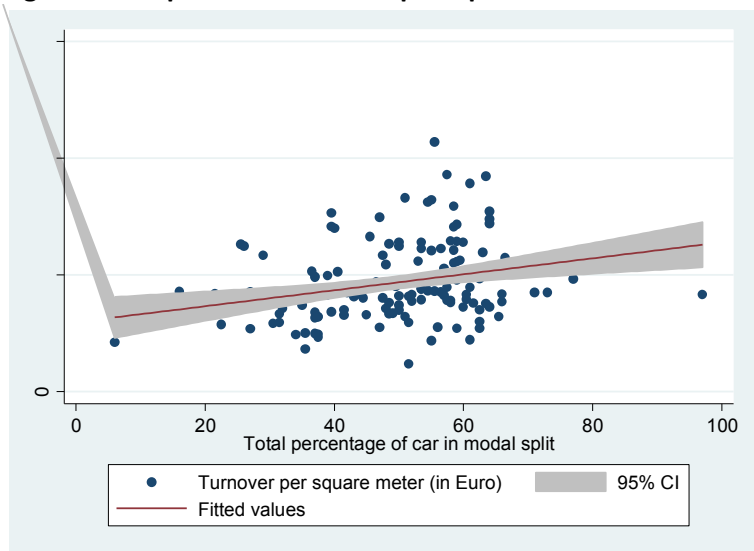
In this model there are some outliers. The parking tariffs in the city centres of Amsterdam, Rotterdam and Utrecht are substantially higher than the other reviewed retail areas. Removing these outliers does not result in a different outcome. Also without these outliers there is a negative relation between the parking tariffs and the modal share of the car.

This correlation is in line with the correlation between the type of retail area, city centre of a bigger city, and the share of the car in the modal split with the assumption that these city centres have a higher level of congestion and therefore the modal choice is influence by more than only parking tariffs. This result only shows the correlation between these two variables. In the regression that will be conducted the effect of parking tariffs will be research somewhat more thoroughly.

5.3 The correlation between the modal split and the turnover of retail areas in the Randstad agglomeration

In order to review the importance of the car for retail performance the correlation between the turnover of shopping areas and the modal share of the car for shopping trips will be reviewed. In order to do so the modal share of the car will be compared with the turnover per square metre.

Fig 3: Scatter plot total turnover per square meter and the modal share of the car



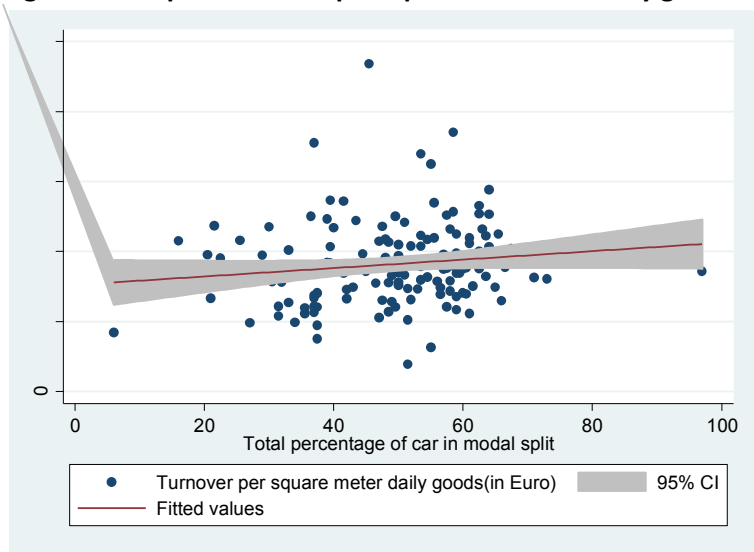
Source: Own elaboration

This graph shows the share of shopping trips conducted with a car in the modal split for all shopping areas in the database. This graph indicated that the turnover of a retail area is only slightly positively

influenced by the share of the car in their modal split. With an R-square of only 0.0790 there is only an explanatory power of 7.9%. This low level of explanatory power indicates that the modal share of the car by itself has only a little influence on turnover per square meter and that there are other variables which have an influence on the this turnover per square meter.

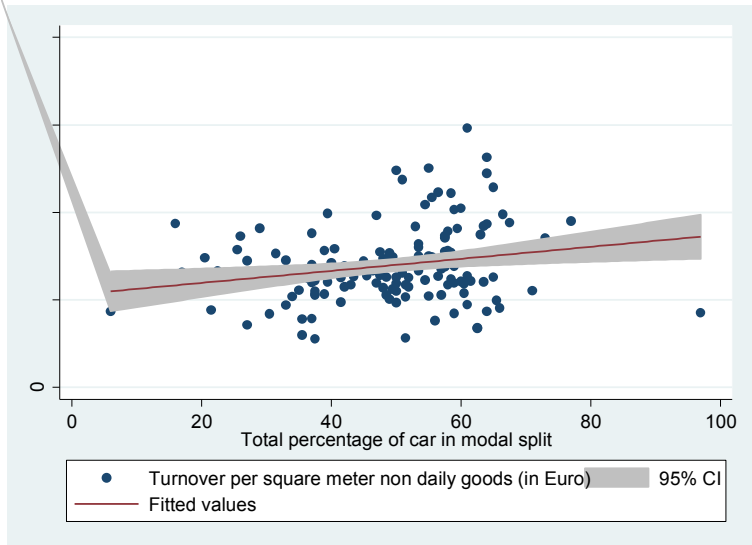
This graph shows the total effect of the percentage of shopping trips conducted with a car for both daily and non daily goods. Because of the difference in the modal split between daily and non daily goods this can have an impact on the relation between car as the mode of shopping trips and the turnover. Therefore this test will also be conducted for both types of goods separately.

Fig 4: Scatter plot turnover per square meter for daily goods and the modal share of the car



Source: Own elaboration

Fig 5: Scatter plot turnover per square meter for non daily goods and the modal share of the car



Source: Own elaboration/KSO2011

These graphs show that there is a stronger correlation between the share of the car in the modal split and the turnover per square meter for non daily than for daily goods. This is in line with the earlier observation that non daily goods have a higher share of the car in the modal split of shopping trips. However, the correlations found in the three different scatter plots are small. Together with the low explanatory power of the models it can be concluded that there is no direct evidence that there is a correlation between the modals share of the car in shopping trips and retail performance. This result is in line with literature that argues that there is no direct relation between car usage and retail performance (Christiaens, 2000)(Verhoek, 2000)(Mingardo, Mouter, & Talens, 2009).

6 Results of the regression

6.1 Tests for OLS assumptions

Three dependent variables, the natural logarithm of total turnover per square meter, turnover per square meter for daily goods and turnover per square meter for non daily goods, and the continuous independent variables will be tested on how they are affected by the quality of parking. This is done with a regression analysis. At first the tests for the OLS assumption will be tested whereupon the regression outcomes will be described.

6.1.1 Multicollinearity

Multicollinearity can be a problem in a regression analysis. It would be ideal to have a high correlation between the independent and dependent variables. However, if the independent variables correlate with each other problems can arise with shared variance between different independent variables. Shared variance can result in an, unintended, influence on the outcome of the regression. In order to test for multicollinearity the correlation matrix has been created for all three dependent variables.

Table 18a: Correlation matrix natural logarithm of the total turnover per square meter model

(obs=142)

	ln_pro~l	comple~s	atmosp~e	safety	parking	daytim~s	access~r	access~t	Big_re~a	Medium~a	popden~y	paidpa~g	Percen~e
ln_product~l	1.0000												
completeness	-0.2033	1.0000											
atmosphere	-0.3046	0.7881	1.0000										
safety	-0.1187	0.4878	0.7516	1.0000									
parking	0.3879	0.0377	-0.0413	0.2356	1.0000								
daytime_ba~s	-0.5137	0.5921	0.7067	0.4479	-0.2705	1.0000							
accessibil~r	0.4530	-0.0386	-0.1090	0.1858	0.9048	-0.3534	1.0000						
accessibli~t	0.0505	0.3287	0.0904	-0.1842	-0.0491	0.2653	-0.0476	1.0000					
Big_retail~a	-0.4493	0.3564	0.1948	-0.1244	-0.2998	0.4051	-0.4187	0.3875	1.0000				
Medium_ret~a	-0.1871	0.1434	0.2097	0.2556	0.1143	0.2530	0.1314	-0.0998	-0.5066	1.0000			
popdensity	0.1309	0.0215	-0.1019	-0.2957	-0.1480	-0.0655	-0.1356	0.5298	0.2150	-0.1404	1.0000		
paidparking	-0.3115	0.3361	0.1908	-0.1702	-0.3205	0.3787	-0.4219	0.3745	0.5661	-0.1441	0.3036	1.0000	
Percentage~e	0.7446	-0.4521	-0.4081	-0.0389	0.3766	-0.6678	0.4661	-0.3130	-0.7134	-0.0385	-0.0927	-0.6076	1.0000

Source: Own elaboration/KSO2011/CBS

In the correlation matrix a few high correlations can be found. Safety and completeness are highly positively correlated (0.7516 and 0.7881) with the atmosphere of a retail area. This is not surprising. It is plausible that the grade shoppers give for the atmosphere of a retail area is influenced by the completeness of shops and safety of that retail area. A second high positive correlation (0.9048) can be found between the perceived quality of parking and accessibility by car. This correlation is also no surprise, the perceived quality of parking is likely to be influenced by congestion. Shoppers might

have a lower evaluation of parking when the trip to the final destination, parking place, is congested. Accessibility by car is also likely to be influenced by the amount of congestion. A congested city will get a lower grade on accessibility by car. A third negative correlation appears between the percentage of daily goods and the dummy variable big shopping area (-0.7134). Big shopping areas tend to have a lower number of daily goods according to data. The bigger shopping malls and designated retail areas on the outskirts of cities in this dataset focus mostly on home decoration. Also the city centres of bigger cities are assigned to the variable big retail area. In these city centres it is likely that there are more shops which focus on non daily goods like clothing and household electronics.

Table 18b: Correlation matrix natural logarithm of the turnover per square meter for daily goods model

(obs=143)

	l~_daily	comple~s	atmosp~e	safety	parking	daytim~s	access~r	access~t	Big_re~a	Medium~a	popden~y	paidpa~g
ln_pr~_daily	1.0000											
completeness	0.0471	1.0000										
atmosphere	-0.0407	0.7877	1.0000									
safety	-0.0009	0.4871	0.7516	1.0000								
parking	0.2951	0.0459	-0.0373	0.2368	1.0000							
daytime_ba~s	-0.1999	0.5992	0.7065	0.4471	-0.2575	1.0000						
accessibil~r	0.3212	-0.0321	-0.1059	0.1868	0.9049	-0.3426	1.0000					
accessibli~t	0.1599	0.3360	0.0949	-0.1811	-0.0426	0.2741	-0.0430	1.0000				
Big_retail~a	-0.2749	0.3588	0.1967	-0.1230	-0.2958	0.4069	-0.4156	0.3895	1.0000			
Medium_ret~a	-0.0088	0.1518	0.2131	0.2568	0.1192	0.2609	0.1347	-0.0920	-0.5010	1.0000		
popdensity	0.1028	0.0348	-0.0951	-0.2910	-0.1393	-0.0492	-0.1293	0.5343	0.2184	-0.1305	1.0000	
paidparking	-0.1576	0.3396	0.1932	-0.1685	-0.3157	0.3819	-0.4182	0.3772	0.5671	-0.1392	0.3071	1.0000

Source: Own elaboration/KSO2011/CBS

Table 18c: Correlation matrix natural logarithm of the turnover per square meter for non daily goods model

	l~ndaily	comple~s	atmosp~e	safety	parking	daytim~s	access~r	access~t	Big_re~a	Medium~a	popden~y	paidpa~g
ln_pr~ndaily	1.0000											
completeness	0.0205	1.0000										
atmosphere	-0.1258	0.7898	1.0000									
safety	-0.1713	0.4862	0.7501	1.0000								
parking	0.1360	0.0282	-0.0522	0.2273	1.0000							
daytime_ba~s	-0.1509	0.5968	0.7107	0.4483	-0.2818	1.0000						
accessibil~r	0.1768	-0.0410	-0.1127	0.1818	0.9035	-0.3558	1.0000					
accessibli~t	0.2861	0.3379	0.1066	-0.1735	-0.0685	0.2834	-0.0559	1.0000				
Big_retail~a	-0.0961	0.3644	0.2009	-0.1246	-0.2958	0.4071	-0.4102	0.3870	1.0000			
Medium_ret~a	-0.1674	0.1283	0.1955	0.2514	0.1215	0.2336	0.1327	-0.1141	-0.5127	1.0000		
popdensity	0.2186	0.0246	-0.1016	-0.2982	-0.1386	-0.0671	-0.1291	0.5126	0.2248	-0.1429	1.0000	
paidparking	0.0571	0.3339	0.1927	-0.1656	-0.3247	0.3793	-0.4244	0.3759	0.5511	-0.1431	0.2931	1.0000

Source: Own elaboration/KSO2011/CBS

The correlation matrixes for daily and non daily goods give similar results. For this reason two variables will be dropped. Accessibility by car and atmosphere will be excluded from the model in order to avoid multicollinearity problems. Because these variables have shared explanatory power excluding these two variables solve the problem of multicollinearity. The variables big shopping area and percentage daily goods are correlated, but are less likely to have a shared explanatory power. Both variables measure something completely different. On top of that both variables are control variables and are therefore not interpreted in depth. The VIF scores are consistent with the correlation matrices. After excluding the variables atmosphere and accessibility the VIF scores of the independent variables are presented below this section. Only the scores for the variable big retail areas show a VIF score above 5. According to variable which score above 5 need to be looked into in more detail. The correlation between the variable big retail areas and most other independent variables is not substantial (<-0.5 or >0.5). Only for the variables medium retail areas and paidparking correlation is slightly larger. For this reason no multicollinearity problems are expected.

Table 19a: VIF scores for the total turnover per square meter model

Variable	VIF	1/VIF
Big_retail~a	5.72	0.174770
Percentage~e	4.74	0.210795
daytime_ba~s	3.61	0.276802
Medium_ret~a	2.92	0.342737
safety	2.56	0.390772
completeness	2.34	0.427440
accessibli~t	2.03	0.493584
paidparking	1.98	0.504021
popdensity	1.64	0.608033
parking	1.52	0.659003
Mean VIF	2.91	

Source: Own elaboration/KSO2011/CBS

Table 19b: VIF scores for the turnover per square meter for daily goods model

Variable	VIF	1/VIF
daytime_ba~s	3.39	0.294643
Big_retail~a	3.26	0.306689
safety	2.53	0.394779
completeness	2.37	0.422553
Medium_ret~a	2.23	0.448372
accessibli~t	2.03	0.492230
paidparking	1.85	0.541318
popdensity	1.62	0.617514
parking	1.45	0.687731
Mean VIF	2.30	

Source: Own elaboration/KSO2011/CBS

Table 19c: VIF scores for the turnover per square meter for non daily goods model:

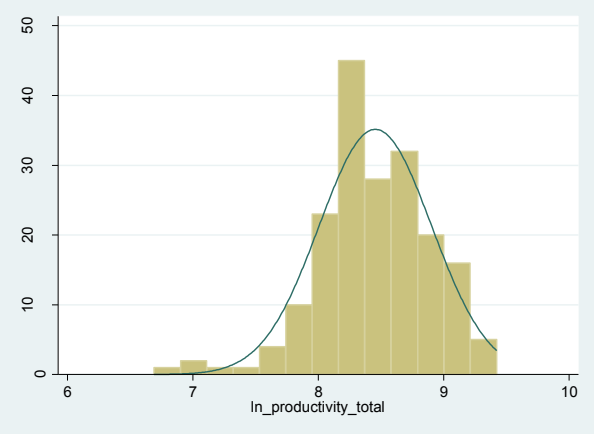
Variable	VIF	1/VIF
daytime_ba~s	3.44	0.290775
Big_retail~a	3.21	0.311380
safety	2.54	0.393266
completeness	2.35	0.425354
Medium_ret~a	2.19	0.457111
accessibli~t	1.97	0.506900
paidparking	1.79	0.559992
popdensity	1.58	0.631387
parking	1.47	0.680840
Mean VIF	2.28	

Source: Own elaboration/KSO2011/CBS

6.1.2 Normality

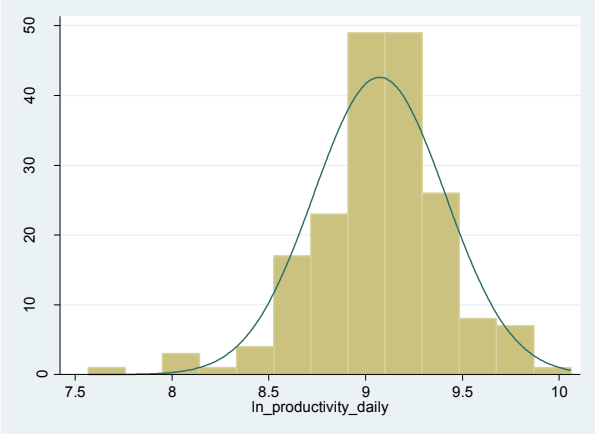
The normality of the dependent and independent variables will be tested in this paragraph. Significance levels and confidence intervals of the results of a regression can become biased when the assumption of normality does not hold. Outliers can affect the result for this reason and can therefore wrongfully influence the significance of a result. Normality will be tested graphically and mathematically. In the graph which will be created for each variable the distribution of the variable is compared with a normal distribution. A Shapiro-Wilk test will be conducted in order to test the normality assumption in a mathematical way.

Fig 6a: Distribution of the natural logarithm of the total turnover per square meter



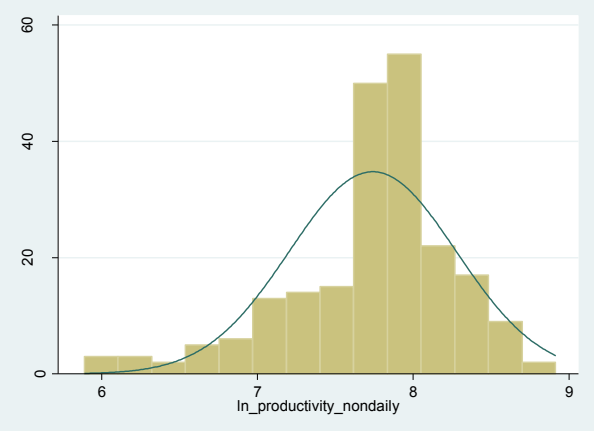
Source: own elaboration

Fig 6b: Distribution of the natural logarithm of of the turnover per square meter for daily goods



Source: own elaboration

Fig 6c: Distribution of the natural logarithm of turnover per square meter for non daily goods



Source: own elaboration

These graphs show that the distribution is left skewed and therefore do not follow the normal distribution. This observation is in line with the results of the Shapiro-Wilk test.

Table 20a: Shapiro-Wilk test for the dependent variables

Shapiro-Wilk W test for normal data

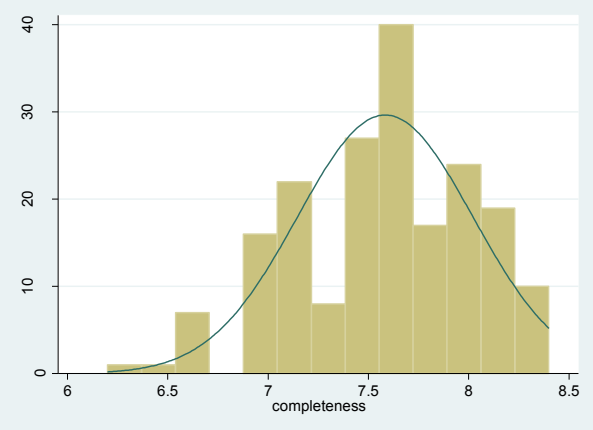
Variable	Obs	W	V	z	Prob>z
ln_product~l	188	0.97306	3.808	3.067	0.00108
ln_pr~_daily	189	0.96259	5.313	3.832	0.00006
ln_pr~ndaily	216	0.93648	10.134	5.349	0.00000

Source: own elaboration

These graphs and Shapiro-Wilk tests conclude that the normality assumption is not fulfilled for all of the dependent variables.

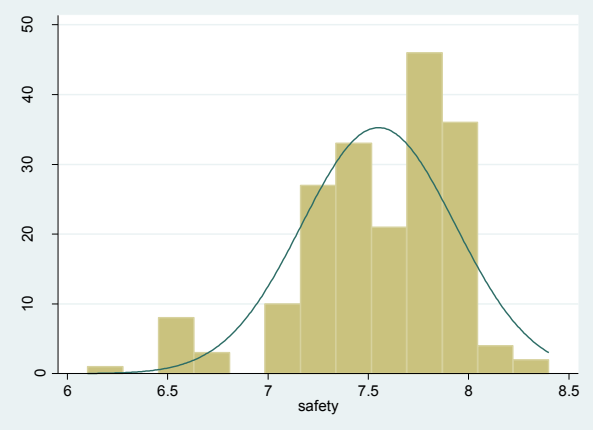
In the set of independent variables there are also variables which don't follow a normal distribution. The graphs show that all scores for the characteristics of retail areas, except the completeness score, show a left skewed distribution.

Figure 7a: Distribution of completeness



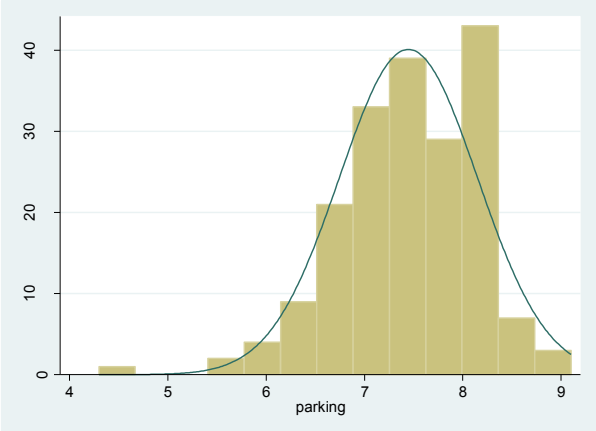
Source: own elaboration

Figure 7b: Distribution of safety



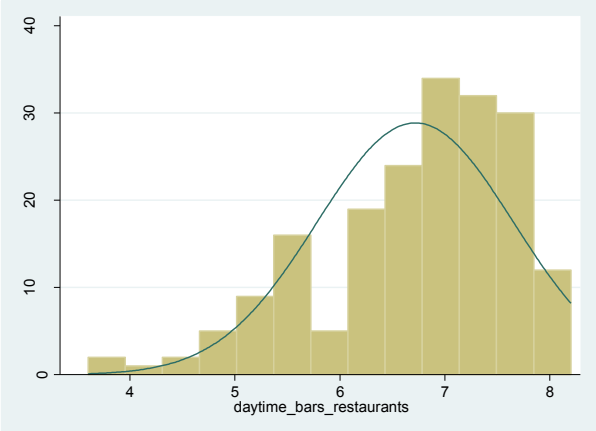
Source: own elaboration

Figure 7c: Distribution of Parking



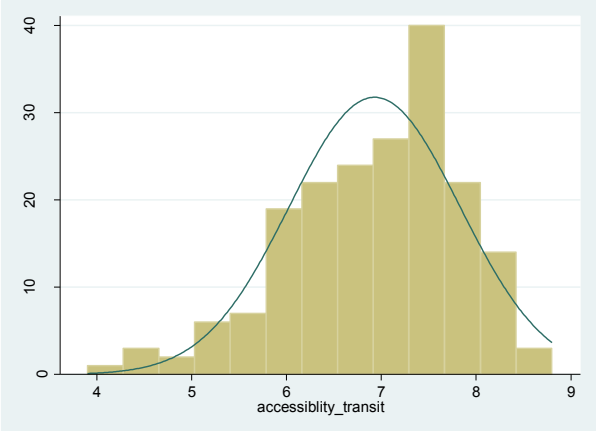
Source: own elaboration

Figure 7d: Distribution of daytime restaurant/bars



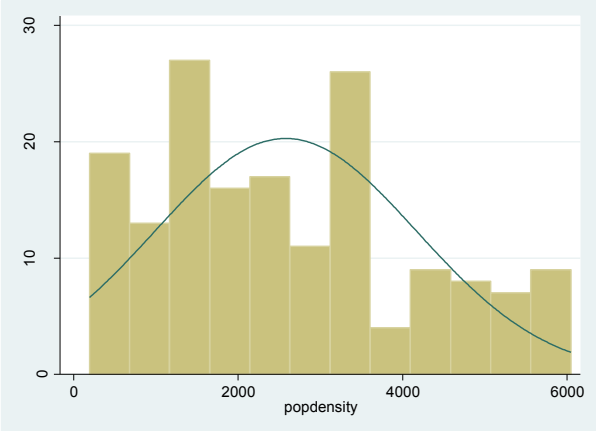
Source: own elaboration

Figure 7a: Distribution of accessibility transit



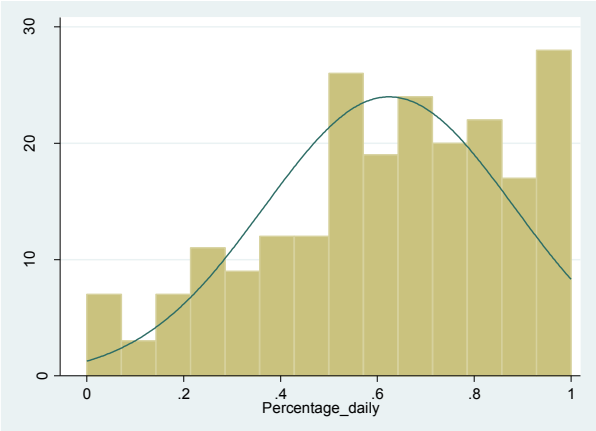
Source: own elaboration

Figure 7a: Distribution of population density



Source: own elaboration

Figure 7a: Distribution of percentage daily



Source: own elaboration

The Shapiro-Wilk test confirms these findings where only the completeness score is following a normal distribution.

Table 20b: Shapiro-Wilk test for the independent variables

Shapiro-Wilk W test for normal data

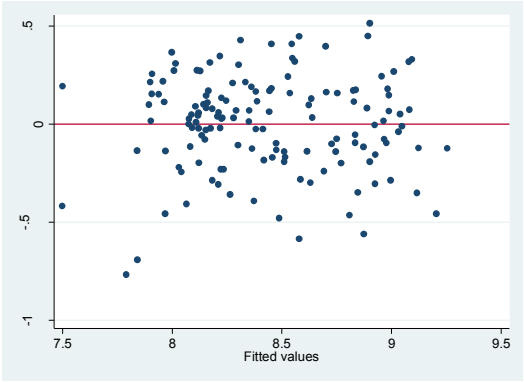
Variable	Obs	W	V	z	Prob>z
completeness	192	0.98691	1.885	1.455	0.07278
safety	191	0.95061	7.079	4.492	0.00000
parking	191	0.96764	4.638	3.522	0.00021
daytime_ba~s	191	0.94763	7.506	4.627	0.00000
accessibli~t	190	0.97195	4.002	3.183	0.00073
popdensity	166	0.96908	3.926	3.117	0.00091
Percentage~e	217	0.98225	2.843	2.414	0.00789

Source: own elaboration

6.1.3 Homoscedasticity

The variance of the residuals of the model have to be constant in order to estimate an efficient model. The homoscedasticity of all three models will be tested. Two tests will be performed. At first the scatter plot of the fitted values will be reviewed where the residuals are compared with the fitted residuals. In this scatter plot the distribution has to behave in a non divergent and non convergent pattern. As a second test the Breusch-Pagan / Cook-Weisberg test will be performed. When the homoscedasticity assumption does not hold the standard errors will be replaced with robust standard errors in order to control for the error in the residuals.

Figure 8a: Scatter plot homoscedasticity total turnover per square meter model



Source: Own elaboration

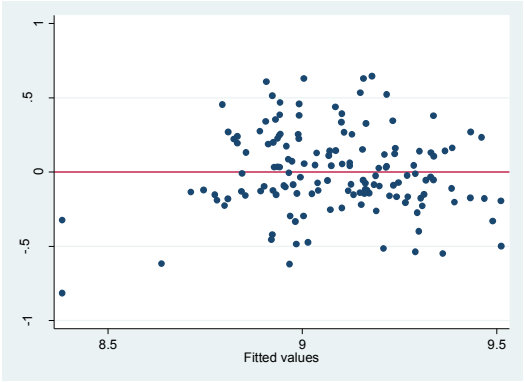
Table 21a: Breusch-Pagan test for heteroskedasticity total turnover per square meter model

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ln_productivity_total

         chi2(1)      =     0.30
         Prob > chi2  =   0.5833
```

Source: Own elaboration

The homoscedasticity assumption for the total turnover per square meter does hold. The variance of the residuals doesn't show a clear divergent or convergent pattern. The Breusch-Pagan / Cook-Weisberg test confirms this with a p-value of 0.5833 not rejecting the null hypothesis that there is a constant variance.

Figure 8b: Scatter plot homoscedasticity turnover per square meter for daily goods model



Source: Own elaboration

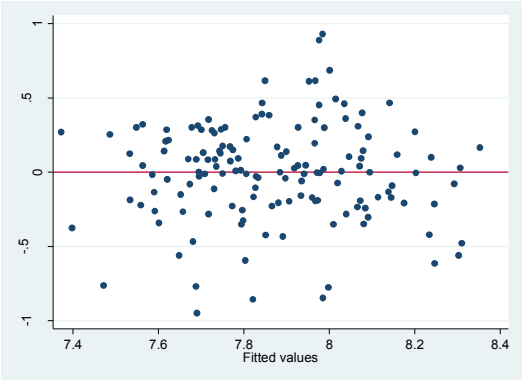
Table 21b: Breusch-Pagan test for heteroskedasticity turnover per square meter daily goods model

```
. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ln_productivity_daily

         chi2(1)      =     9.20
         Prob > chi2  =   0.0024
```

Source: Own elaboration

The variances of the residuals of the model where total turnover per square meter for daily goods is included show only a little sign of convergence. This scatter plot does not show a clear pattern. However, the Breusch-Pagan / Cook-Weisberg test conclude that the homoscedasticity assumption does not hold with a p-value of 0.0024. The null hypothesis is rejected.

Figure 8c: Scatter plot homoscedasticity turnover per square meter for non daily goods model



Source: Own elaboration

Table 21c: Breusch-Pagan test for heteroskedasticity turnover per square meter daily goods model

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of ln_productivity_nondaily

         chi2(1)      =     0.26
         Prob > chi2  =   0.6101
```

Source: Own elaboration

The variance of the residuals of the model for non daily goods shows no clear divergent or convergent pattern. The Breusch-Pagan / Cook-Weisberg test confirms this finding with a p-value of 0.6101 resulting in not rejecting of the null hypothesis that the variance of the residuals are constant.

Because the homoscedasticity assumption does not hold for the turnover per square meter and the daily turnover per square meter for daily goods the regression have to control for this. This will be done with robust standard errors.

6.1.4 Ramsey Reset test

The Ramsey Reset test will be used in order to estimate if the models are correctly specified without omitted variables. The model for the total turnover per square meter and the model for the turnover per square meter for daily goods have no indication for omitted variables. However, there is a strong indication that there are omitted variables in the model for turnover per square meter for non daily goods. In order to have the models equally specified, and the fact that the Ramsey RESET test will not reveal which variables are omitted, the omitted variables are accepted.

Table 22a: Ramsey RESET test for omitted variables total turnover per square meter model

```
Ramsey RESET test using powers of the fitted values of ln_productivity_total
       Ho:  model has no omitted variables
                 F(3, 128) =      1.45
                  Prob > F =      0.2306
```

Source: Own elaboration

Table 22b: Ramsey RESET test for omitted variables turnover per square meter for daily goods model

```
Ramsey RESET test using powers of the fitted values of ln_productivity_daily
       Ho:  model has no omitted variables
                 F(3, 130) =      8.73
                  Prob > F =      0.0000
```

Source: Own elaboration

Table 22c: Ramsey RESET test for omitted variables turnover per square meter for non daily goods model

```
Ramsey RESET test using powers of the fitted values of ln_productivity_nondaily
       Ho:  model has no omitted variables
                 F(3, 131) =      2.22
                  Prob > F =      0.0887
```

Source: Own elaboration

6.2 Results of the regression

Three different regressions analyses on the total turnover per square meter, turnover per square meter for daily goods and the turnover per square meter for non daily goods have been conducted.

In this chapter the outcomes of the three different will be discussed. The dependent variables are the natural logarithms of the original variables. Therefore it is possible to explain the effects of the independent variables as a percentage of the dependent variables.

6.2.1 Total turnover per square meter

The following model has been generated:

Table 23a: Regression analysis on the natural logarithm of the total turnover per square meter

```
Linear regression                               Number of obs =     142
                                                F( 10,   131) =   30.84
                                                Prob > F      =  0.0000
                                                R-squared     =  0.7126
                                                Root MSE      =  .25307
```

ln_productivity_total	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
completeness	.2160462	.0899058	2.40	0.018	.0381912	.3939013
safety	-.1706272	.0896897	-1.90	0.059	-.3480548	.0068005
parking	.0978618	.0417494	2.34	0.021	.0152715	.180452
daytime_bars_restaurants	.0388955	.0678118	0.57	0.567	-.0952523	.1730433
accessiblity_transit	.1055463	.0494577	2.13	0.035	.0077071	.2033855
Big_retail_area	-.3404188	.141543	-2.41	0.018	-.6204245	-.060413
Medium_retail_area	-.2753615	.081123	-3.39	0.001	-.4358421	-.1148809
popdensity	.0000213	.0000177	1.20	0.231	-.0000137	.0000564
paidparking	.0850867	.0574096	1.48	0.141	-.0284832	.1986566
Percentage_daily_percentage	.0145047	.0029017	5.00	0.000	.0087644	.0202449
_cons	5.606769	.7104503	7.89	0.000	4.201329	7.012209

Source: Own elaboration/KSO2011/CBS

The regression model has an R-square of 0.7126 resulting in an explanatory power of 71.26% on the natural logarithm of the total turnover per square meter of retail areas in the Randstad agglomeration with the independent variable used.

The perceived quality of parking in a retail area has a significant positive relation with the turnover per square meter of that retail area. When the valuation, the grade given by shoppers, of parking of a retail area increases with 1 point the turnover per square meter will increase with 9.78%, ceteris paribus.

The perceived completeness of a retail area has a significant positive relation with the total turnover per square meter of that retail area. When the valuation, the grade given by shoppers, of the completeness of a retail area increases with 1 point the turnover per square meter will increase with 21.60%, ceteris paribus.

The perceived accessibility of a retail area by public transit has a significant positive relation with the turnover per square meter of that retail area. When the valuation, the grade given by shoppers, of the accessibility of a retail area by public transit increases with 1 the turnover per square meter will increase with 10.55%, ceteris paribus.

Three different control variables are significant in this regression model. When a retail area is determined as a big retail area the turnover per square meter will decrease with 34.04%, ceteris paribus. A similar result can be found for medium retail areas. When a retail area is determined as being a medium retail area the turnover per square meter will decrease with 27.54%, ceteris paribus. Both compared with small retail areas. The percentage of daily goods also has a positive relation. When the percentage of daily goods increase with 1 the turnover per square meter is increased with 1.45%. This result is confirming the findings in the descriptive statistics.

The difference in the level of influence is partly due to the ranges used in the observations. Where the perceived valuations of shoppers, the grades given by shoppers, are ranked from 1 to 10 the percentage of daily goods is measured in a ranking from 1 to 100. The dummy variables can be either 1 or 0.

The perceived valuation of safety and daytime bars and restaurants are not significant. Also the population density and the whether or not there is paid parking are not significant in this model.

6.2.2 Turnover per square meter for daily goods

The following regression model for the turnover per square meter for daily goods has been generated:

Table 23b: Regression analysis on the natural logarithm of the turnover per square meter for daily goods

Linear regression

Number of obs = 143
F(9, 133) = 5.60
Prob > F = 0.0000
R-squared = 0.2755
Root MSE = .30308

ln_productivity_daily	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
completeness	.2288404	.1098239	2.08	0.039	.0116129	.4460679
safety	-.1046065	.1063025	-0.98	0.327	-.3148688	.1056557
parking	.0845677	.0456546	1.85	0.066	-.0057353	.1748707
daytime_bars_restaurants	-.0014314	.0765916	-0.02	0.985	-.1529266	.1500639
accessiblity_transit	.1009791	.0386874	2.61	0.010	.024457	.1775012
Big_retail_area	-.4721023	.1746015	-2.70	0.008	-.8174573	-.1267473
Medium_retail_area	-.2079528	.1043085	-1.99	0.048	-.4142709	-.0016347
popdensity	.0000118	.0000194	0.61	0.544	-.0000266	.0000503
paidparking	-.030364	.0878726	-0.35	0.730	-.2041726	.1434447
_cons	6.966033	.7241644	9.62	0.000	5.533664	8.398402

Source: Own elaboration/KSO2011/CBS

The regression model has an R-square of 0.2755 resulting in an explanatory power of 27.55% of the natural logarithm of the turnover per square meter for daily goods of retail areas in the Randstad agglomeration with the independent variables used. This is lower than the regression model of the total turnover per square meter implying that other, not included, variables have an explanatory power on the turnover per square meter for daily goods.

For daily goods the perceived quality of parking is not significant anymore. This result implies that the quality of parking does not have an influence on the turnover per square meter for daily goods in contradiction with the effect of parking on the total turnover per square meter.

The perceived accessibility of a retail area by public transport has a significant positive effect on the turnover per square meter for daily goods for that retail area. When the evaluation, the grade given by shoppers, increases with 1 the turnover per square meter for non daily goods will increase with 10.10%, ceteris paribus.

The control variables big retail area and medium retail area still have a significant negative effect on the turnover per square meter for daily goods. Retail areas determined as a big retail area or a medium retail area have respectively a 47.21% and 20.80% lower turnover per square meter for daily goods compared with small retail areas, ceteris paribus.

The perceived evaluation of completeness, safety daytime bars and restaurants are insignificant as well as population density and whether or not there is paid parking.

6.2.3 Turnover per square meter for non daily goods

The following regression model for the turnover per square meter for non daily goods has been generated:

Table 23c: Regression analysis on the natural logarithm of the turnover per square meter for non daily goods

Linear regression

Number of obs = 144
F(9, 134) = 8.10
Prob > F = 0.0000
R-squared = 0.2762
Root MSE = .3448

ln_productivity_nondaily	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
completeness	.206743	.1350557	1.53	0.128	-.0603737	.4738597
safety	-.2415044	.1376358	-1.75	0.082	-.5137241	.0307152
parking	.0802631	.0501406	1.60	0.112	-.0189064	.1794325
daytime_bars_restaurants	.0510023	.0852541	0.60	0.551	-.1176153	.21962
accessiblity_transit	.1239974	.0716366	1.73	0.086	-.0176873	.2656822
Big_retail_area	-.5646641	.138889	-4.07	0.000	-.8393624	-.2899658
Medium_retail_area	-.3381742	.0935284	-3.62	0.000	-.5231571	-.1531913
popdensity	.00002	.0000256	0.78	0.435	-.0000306	.0000707
paidparking	.0861888	.0771453	1.12	0.266	-.0663912	.2387687
_cons	6.491355	.918191	7.07	0.000	4.675334	8.307377

Source: Own elaboration/KSO2011/CBS

The regression model has an R-square of 0.2762 resulting in an explanatory power of 27.62% of the natural logarithm of the turnover per square meter for daily goods of retail areas in the Randstad agglomeration with the independent variables used. This is lower than the regression model of the total turnover per square meter implying that other, not included, variables have an explanatory power on the turnover per square meter for daily goods.

In this regression model the evaluation of the quality of parking by shoppers is also not significant implying that the quality of parking does not have a significant effect on the turnover per square meter for non daily goods.

Only the control variables big retail area and medium retail area still have a significant negative effect on the turnover per square meter for daily goods. Retail areas determined as a big retail area or a

medium retail area have respectively a 56.47% and 33.82% lower turnover per square meter for daily goods compared with small retail areas, ceteris paribus.

Differences between these three regression models appear in each variable. Sign and significance as well as the magnitude are different for the three separate models. A part of this difference can be assigned to the difference in the effect of the independent variables on the three different dependent variable. However, the difference in the R-squares between the regression model of the total turnover per square meter and the fact that the regression model for the turnover per square meter of daily has omitted variables may be accountable for a part of these differences. Therefore the most complete model, the total turnover per square meter, will be used in order to draw conclusion in the next chapter. This model does also accounts for the difference between daily and non daily goods, not for the turnover per square meter but for the total surface of daily and non daily goods in a retail area.

7 Conclusion and discussion

In this chapter the results found in this thesis will be discussed. At first the different sub-questions and the research question of this thesis will be answered with the results of the descriptive statistics and regression provided in chapter 5 and 6. In chapter 7.2 the policy implications will be reviewed followed by a review of the limitations of this research in chapter 7.3. In chapter 7.4 some possibilities for future research will be suggested.

7.1 Conclusions

7.1 What is the modal split of the different type of retail areas for daily and non daily goods in the Randstad agglomeration?

As reviewed by the first set of descriptive statistics the bigger cities have a higher population density in de Randstad agglomeration. This result is in line with the literature (Marlet & Woerkens, 2004). Congestion can influence the modal split of a retail area by influencing the convenience and time factor of shopping trips (Gillen, 1978).

In the Randstad agglomeration the share of the car in the modal split for shopping trips is substantially lower for city centres of the bigger cities. This result is found for shopping trips which involve daily and non daily goods. For the four biggest cities in the Netherlands the car has even a lower share in the modal split for shopping trips. This conclusion is confirming the finding that literature is not consistent in the way shopping trips are defined in literature. Literature which found high percentages of shopping trips conducted with a car focus on country or regional level (Ibrahim, 2005) (RAC Foundation, 2006) (Shimazaki, Kazunori, & Shihana, 1994) while literature which found lower percentage of the car in the modal split focus on urban areas (Sustrans, 2003) (Sustrans, 2006). It is clear in these results that the urban area of a city centre has a lower percentage of the car in their modal split.

These results imply that the car is not the dominant mode of travel for shopping purposes in city centres. This finding confirms that the assumption, formulated by Mingardo and Meerkerk (2012), that most shoppers reach a shopping area by car, is indeed a misconception, at least for the Randstad agglomeration. This finding can have implications for retail policies implemented in these bigger city centres. The use of the car for shopping trips to city centres of bigger cities is overestimated by urban planners and retail branch organization which argue that most shoppers reach a shopping area are by car.

7.1.2 How do parking tariffs correlate with the modal split of different type of retail areas in the Randstad agglomeration?

Parking tariffs are an important instrument for the regulation of traffic in a city because the demand for traffic can be influenced with parking tariffs (Still & Simmonds, 2000) (Hess, 2001) (Anderson & de Palma, 2004) (Arnott & Inci, 2006). Reviewing the implementation of paid parking in the Randstad agglomeration shows that all the city centres of the biggest cities have implemented paid parking. Not only the implementation rate of paid parking, 100%, is the highest for city centres of the bigger cities, also the level of the parking tariff is the highest for these retail areas. These results imply that the parking policies in these city centres are the most restrictive on car usage. This finding is in line with the finding that the level of congestion is the highest in the city centres of these bigger cities compared with other retail areas and with the modal split found in the first sub-question.

However, the modal split shows only a small difference between shopping areas which have paid parking implemented and those who offer free parking. This small difference implies that whether or not parking tariffs have been implemented doesn't play a big role in the modal choice of people. This finding can imply that shoppers are used to pay for parking in the area where implemented. This finding is contradictory with literature that argues that parking tariffs lower the demand for parking. However, when there are parking tariffs implemented the level of these parking tariffs do have a strong correlation with the modal share of the car in a retail area.

7.1.3 How does the share of the car in the modal split correlate with the turnover of a retail area in the Randstad agglomeration?

The share of the modal split has only a very limited effect on the turnover per square meter. The level of negative correlation found in chapter 5 is not only very limited, the explanatory power of the model is also very low. Similar effects can be found for daily and non daily goods. Therefore it can be concluded that the share of the car is not of a big importance for the performance of retail areas. The low explanatory power found for these models imply that other factors are more important for the turnover per square meter for this retail area.

These results confirm the findings of literature which argue that the modal share of the car is not important for the turnover of a retail area (Mingardo & Meerkerk, 2012) (Van Meerkerk, Mingardo, & Bosch, 2008) (Verhoek, 2000) (Christiaens, 2000). This finding is contradictory with the general conception of many urban planners and retail branch organizations who focus on the availability of parking. Focussing on the supply of high levels of cheap, or free, parking space is, in general, not

improving the performance of retail areas in the Randstad agglomeration. It might be better to focus on other characteristics of a retail area in order to increase the turnover per square meter.

7.1.4 How does the quality of parking in a retail area influence the retail performance in the Randstad agglomeration?

This sub-question reviews the quality in parking in contract to the previous sub-questions. Where the test for the quantity of parking doesn't show a significant correlation with the performance of retail areas the test for the quality of parking does show a significant relation. It can be concluded that despite of the fact that the quantity of parking has no direct effect on the turnover per square meter the quality of parking does have a positive effect on retail performance. The high correlation between perceived accessibility of a retail area by car and the perceived quality of parking implies that shoppers also appreciate the accessibility of a retail area.

This result implies that shoppers appreciate retail areas which have high quality parking spaces available near the final destination of shoppers and, on top of that, due to the high correlation with the accessibility of retail area by car routes to these retail areas which have low volumes of congestion. The time effect plays a significant role in this. Accessibility is key in this matter. With restrictive parking policies, such as implementing parking tariffs, the quality of parking can be increased. Parking tariffs can decrease the demand of parking.

To an even further extend this result can be used to optimize off-street and on-street parking. As noted in the literature review parking policies are most efficient when on-street and off-street parking policies are aligned with each other. Promoting off-street parking could reduce demand for on-parking and therefore increase the perceived quality of parking in a retail area. However, this assumption has to be research more thoroughly in order to draw conclusions on this matter.

7.1.5 What is the importance of the car as the mode of travel for shopping trips and does the quality of parking influences the retail performance in the Randstad agglomeration?

As the descriptive statistics showed the car has a different share in the modal split for the different types of retail areas. In the city centres of the bigger cities the percentage of shopping trips conducted with a car is substantially lower than for other retail areas. Implementing parking tariffs will decrease the use of the car for shopping trips, but not to big extend. The regression analysis revealed that implementing a parking tariff has no significant effect on the turnover per square meter of a retail area. However, there is no evidence that the percentage of shopping trips conducted with a car is positively related with the turnover per square meter of a retail area. The

quality of parking, however, is significantly positively related with the turnover per square meter of a retail area. All these findings involve the Randstad agglomeration.

These findings result in the conclusion that the quantity of parking is not that important for the performance of retail areas while the quality of parking has a positive effect on the performance of retail areas. This conclusion is not in line with the perception most retail branch organizations and urban planners have. Retail branch organizations and urban planners still emphasize on the quantity of parking. For instance the KSO2011 report as well as the Nationale Parkeertest 2011, both reports commissioned by retail branch organizations, emphasize on the availability of enough parking space.

7.2 Policy implications

The main finding in this thesis that the quantity of parking is of no significant importance for the performance of retail areas while the quality of parking does have a significant relation with the performance of retail areas has some implications for the implementation of parking policies. The importance of the car for retail areas is often overestimated in terms of the of the car share in the modal split of retail areas. In the most dense retail areas the car only has a minor share in the modal split. On top of that most of the retail branch organizations and urban planners still focus on the role of the car in a quantitative way focussing on the availability of high amounts of (free) parking for the future. The main recommendation for retail branch organizations and urban planners is to change scope from a focus on the quantity of parking to the quality of parking. Offering a higher quality of parking in a retail area can increase the performance of that retail area. As showed in the results of the research conducted the price of parking doesn't play a significant role in the performance of retail areas. It can be concluded that shoppers don't mind to pay for parking as long as the quality is good.

The price of parking is not related to the performance of a retail area, but the quality of parking has a positive effect on the performance of a retail area. Shoppers are willing to pay for parking as long as the quality of parking is good. Making parking in a retail area cheaper or free can even have a reverse effect. Decreasing parking tariffs or remove these tariffs at all can increase the number of shoppers who use a car for their shopping trips resulting in increasing demand for parking and therefore cruising for parking. This will have a negative effect on the accessibility and can have a negative effect on the perceived quality if parking.

As reviewed in the literature review implementing paid parking will decrease the demand for parking. The research conducted revealed no significant negative relation between the share of the

car in the modal split of a retail area and retail performance. However, implementing parking tariffs can have two positive effects on retail areas. At first the perceived quality of parking can be increased by decreasing the level of cruising for parking in a retail area because more parking spaces will be available due to a lower demand. This can have a positive effect on the retail performance of that retail area. Also the accessibility of a retail area will increase with lowering demand for parking and therefore decrease the level of cruising for parking. Because the evaluation of the accessibility of a retail area is highly related with the perceived quality of parking this can result in a positive effect on the performance of retail areas. A second positive effect of reducing cruising for parking by implementing parking tariffs is a general reduction in traffic with its negative external effects such as congestion, pollution and accidents.

It is important that policy makers are aware of the effect that parking policy has on retail performance in a certain shopping area. Results found in this thesis indicate that the perceptions at this moment by retail branch organizations and urban planners have the reverse effect of what they try to perceive, namely increasing retail performance. Despite of the fact that the results in this thesis only cover the Randstad agglomeration it is assumable that similar results can be found in urban areas with similar characteristics such as the quality of public transport and the distribution of local and regional shoppers.

7.3 Limitations

The biggest limitation of this thesis is the limited number of observations for the different type of retail areas. It is therefore not possible to control for the different type of retail areas in the regression analysis. This limitation is inherent to the limited number of retail areas in the Randstad agglomeration. An increase in retail areas would give an opportunity to include this characteristic in the regression model. However, including other retail areas from other parts of the Netherlands, or even surrounding countries, gives implications for the comparability of retail areas and would require more control variables. A retail area in a more rural area may have a different modal split and performance might be influenced in a different way on parking. A strength in comparing only retail areas in the Randstad agglomeration is the strong resemblance of the different retail areas.

In the KSO2011 dataset the performance of retail areas is measured as the turnover per square meter for the different retail areas. There is a big downside on measuring performance in terms of turnover. Turnover cannot tell anything about the profitability of a retail area. An insight in the profitability could give a more detailed view on the difference in turnovers between the different retail areas and the difference between daily and non daily goods.

In this thesis shopping trips are divided in shopping trips for daily and non daily goods. In this thesis the modal split of both categories have been reviewed. However, many shopping trips involve both daily and non daily goods. Therefore shopping trips which had the purpose of shopping for daily goods can also involve non daily goods and vice versa. These multipurpose shopping trips can affect the modal split and therefore the analysis.

The percentage of shopping trips conducted with a car has been measured in the KSO2011 report. However, the average spending per shopping trip for these different modes have been neglected, just as the frequency of conducting a shopping trip. It is interesting to have this data available in order to review the average spending per mode with the frequency of these shopping trips in order to find a more detailed effect of the modal split on retail performance.

7.4 Future research

As mentioned in the literature review there are two different types of parking, on-street and off-street. Off-street parking is easier to allocate and might be a solution for congestion caused by cruising for on-street parking. However, different determinants determine the choice of a car driver whether or not to use on-street parking. It is therefore interesting to see if off-street parking, like parking garages, can attract more car drivers when the quality increases. When shoppers will be incentivized to change from on-street to off-street parking this also can have a positive effect on the perceived quality of on-street parking. A decrease in the demand for on-street parking will lead to a better availability of on-street parking. As mentioned by Calthrop et all (2002) resource costs are determined by car drivers and shoppers in order to make a location choice. It is interesting to review whether or not the quality of off-street parking can compensate for the extra resource costs of off-street parking, such as walking distance to the final destination.

In order to conduct such a research more data has be available. The quality of parking is measured by the Nationale Parkeertest, but the number of retail area researched is very limited. On top of that only city centres and main retail areas are researched. In order to have a more balanced view on the effect of the quality of off-street parking it is important that different types of retail areas are reviewed. The Koopstromen reports can also play a role in collecting this data. Now there is only the general perceived quality of parking measured in a grade given by shoppers. The quality of parking could be measured for on-street as well as off-street parking in order to understand the importance of parking for retail performance in a more in-depth level.

According to the regression model specified in chapter 6 the perceived quality of public transport is positively related to the total turnover per square meter. It might be interesting to have a more detailed view on the different types of public transport. The quality of different types of public transport might have a different effect on the total turnover per square meter. It is assumable that local and regional shoppers have a different demand for public transport for instance. A more detailed view can give an insight in which type of public transport is most valuable for a retail area. On top of that the KSO2011 dataset doesn't consider shoppers who use two or more different modes of transport for a shopping trip. An example of using different modes of transport is using a car and public transport in a park and ride construction. If a substantial part of the shoppers of a retail area uses this construction, the quality of park and ride facilities could have an influence on the performance these retail areas.

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