


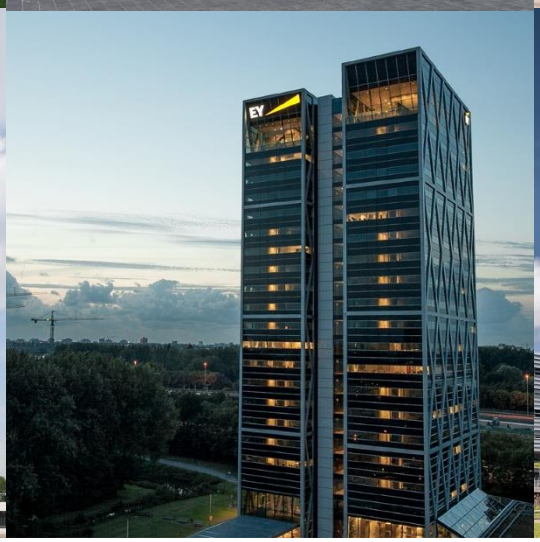


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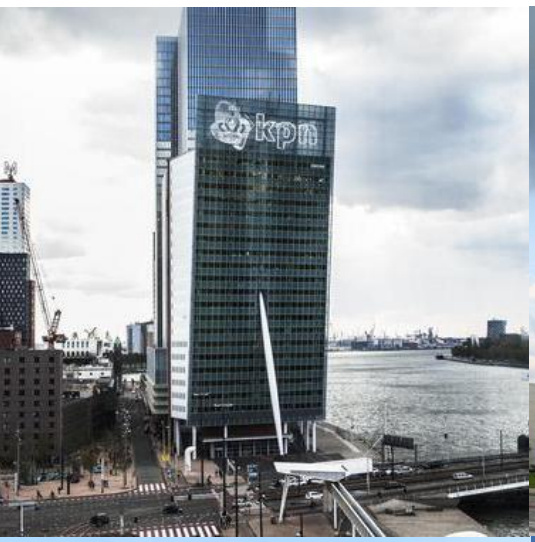
A quantitative approach



Willingness to pay for single- vs. multi-tenant office properties in the Randstad Metropolitan Area

A quantitative approach

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Preface

In September 2013, almost four years ago, I continued my study career after achieving a Bachelor of Applied Science couple of months earlier. I thought that I could combine a full-time Master program in Groningen with the start of a career in Amsterdam. While I finished the pre-master in the timeframe given, I lacked in discipline, energy and time to keep track of the actual Master program.

I started working a Spring Real Estate at the same time I have started the Master-program. Being a capital market advisor at Spring Real Estate, I noticed that there was something specific about single-tenant office properties. On the one hand, I noticed that investors that specifically invested in single-tenant office properties before 2008 had distressed portfolios. Much of the former tenants left, the investor had no clue of the local user market and eventually decides to dispose the assets with high discounts. On the other hand, there was much appetite from new investors that were looking for single-tenant long-leased office investment. The developments on the market were the underlying thought of my thesis topic.

After being pushed by family, friends and colleagues, I finally started writing this thesis and almost a year later I am writing this preface. There were moments that I wanted to give up. I had to give up my free time in evenings and in weekends. I am happy that I made it through.

Amsterdam, 16 september 2016
Sjors van Iersel

Executive summary

Real estate investors can be specific in determining whether to invest in a single-tenant or multi-tenant property. Both a single-tenant and multi-tenant investment strategies have their advantages and disadvantages. A single-tenant investment could be seen as a passive investment. Single-tenant properties are fully leased for relatively longer terms and thus generate a steady cash-flow. The management of a multi-tenant property is much more intensive. An owner of a multi-tenant property needs to get involved in the local market in order to make various decisions about whom to lease to, even when a local professional is appointed for property- and asset management. In this study we investigate whether there is a pricing difference between an office property being single- or multi-tenant.

Prior research suggests that there is a significant difference between single-tenant and multi-tenant properties. As single-tenant properties are not able to diversify risk across multiple tenants, the tenant creditworthiness becomes increasingly important in valuing a single-tenant office property (Lammert, 1996; Mooney et al, 1998). For multi-tenant properties, risk associated with the cash-flow quality are diversified among multiple tenants. If one tenant is not capable of paying its rent, the owner of a property will still receive income from other tenants in the property. Therefore, the creditworthiness of individual tenants plays a less important role in valuing a multi-tenant property. In addition, literature concludes that, contrary to single-tenant properties, multi-tenant properties experience a stronger rental growth in an upwards real estate market (Patel, 2000) – or a weaker rental depreciation in a downwards real estate market (Baum and Turner, 2004). This is supported by the fact the multi-tenant properties are more likely to experience a higher reinvestment rate than single-tenant offices and therefore are better maintained during the holding period. Liu et al. (2013) found that non-local buyers are more likely to acquire single-tenant offices than multi-tenant offices and significantly overpay on acquisition by an estimated 13.8 percent premium relative to similar assets. In addition, Liu et al. (2013) found that nonlocal sellers are significantly more likely to divest properties that are single-tenant and upon exit sell offices at a discount of 7 percent relative to similar assets.

This research is an explanatory research which is quantitatively conducted by a regression analysis. Our model has been applied to a dataset of investment transactions of office properties that took place in the Randstad office market. The data set consists of 420 investment transactions that took place during the period 2012 – 2017. Characteristic for this study is that it has made use of Investment Memoranda as their main data source, a selling document that a company presents to potential investors to explain the investment objectives

and terms. Therefore, this study tackles the problem of the transparency of the office market and the difficulty to collect reliable data.

Results presented in this study provide evidence that there is a significant willingness from investors to pay for office properties that have one tenant (single-tenant) rather than office properties that have multiple tenants. We found evidence that single-tenant office properties transact with an estimated premium of 17.9% relative to multi-tenant office properties. The premium paid for single-tenant properties relative to multi-tenant properties could be explained by the fact that a single-tenant investment strategy is considered to be an 'investor friendly' investment due to the limited management that is needed. In contrast, owners of multi-tenant office buildings have higher costs on management and maintenance that comes on top of financial loses on any vacancy and non-recoverable service costs.

We have also found evidence that multi-tenant office properties transact at an estimated premium of 27.1% relative to vacant properties. This results supports the fact that having any tenants in an office building in general is valuable.

1 Introduction

Real estate investors can be specific in determining whether to invest in a single-tenant or a multi-tenant property. Both a single and multi-tenant investment strategies have their advantages and disadvantages. Since a single-tenant property is fully leased and single-tenant leases are generally written for longer terms than multi-tenant leases (Graff and Web, 1990), there are minimal responsibilities for the owner. This is especially the case when the property is recently constructed or renovated and therefore defects on the property are not likely to happen. In contrast to single-tenant investments, investing in a multi-tenant property is considered to be much more active. An owner of a multi-tenant property needs to get involved in the local market in order to make various decisions about whom to lease to. Even when a local professional is appointed for property- and asset management, the management of multi-tenant properties can be very intensive.

Lease terms in multi-tenant office properties in the Netherlands are typically 5 years with a tenant's option to renew for a further five years (Lofstedt and Baum, 1993). Single-tenants generally sign upon longer lease agreements for 10 – 15 years. Graff and Webb (1990) considers a leased single-tenant property as a low risk investment, since single-tenant leases are generally written for longer terms than multi-leases and therefore are a stable and income producing assets, more akin to corporate bonds. All a single-tenant property owner needs to do is collect the rent for the lease term agreed upon and negotiate a new lease term with the tenant a year or two before expiration of the current lease term. While a single-tenant property owner still needs to know much regarding the business of the tenant, a single-tenant investment strategy is an outcome for investors with little knowledge and understanding of the local market dynamics.

Yet, investing in single-tenant properties can be a risky business compared to investing in multi-tenant properties. For multi-tenant properties, risk regarding occupancy is relatively less than with single-tenant properties. If one tenant does not renew the lease or goes bankrupt, the investor will lose just a fraction of the total expected rental income. A substantial cash flow remains to pay the financial liabilities that comes with owning a real estate investment. For single-tenant properties, the termination of the rental agreement is about the biggest fiasco that can happen to the owner. An owner will lose a 100 percent of its income. It could be very challenging for a vacant (former single-tenant) property to find a new occupier for the entire property; the number of companies that are looking for large office space in the area at that specific moment in time could be very limited. In contrast, smaller tenant looking for office space are more numerous and therefore it can be easier for an owner to find a new tenant for

a smaller unit. In addition, the property might not suit those companies. This could be especially the case for properties that have been built to suit the previous tenant. Remodeling the vacant property could be expensive for a company.

The question rises if there is a difference in the pricing of single-tenant and multi-tenant office property. Smith (2009) advocates that a “property is only as strong as its tenant”. This is especially the case for single-tenant properties. Investors ‘put all their eggs in one basket’ by acquiring single-tenant properties. After all, a single-tenant office property generates a steady stream of cashflow as long as it has a tenant, but does not generate any income at all when a tenant vacates the property. By investing in multi-tenant offices, an investor is able to diversify risk of income loss among multiple tenants. Therefore the risk factor of an office property becoming completely vacant is less shared by multi-tenant properties.

Literature suggests that there is a significant difference between single- and multi-tenant properties on multiple levels. Since a single-tenant property owner is not able to diversify cash flow risk among multiple tenants, the tenant creditworthiness becomes increasingly important in valuing a single-tenant property (Lammert, 1996; Mooney et al. 1998). Contrary, risk associated with the cash-flow for multi-tenant properties has much more to do with re-letting potential (Griffiths, 2006). The differences between single and multi-tenant properties indicate that there could be a significant pricing difference. To the authors knowledge, the pricing difference between single-tenant and multi-tenant office properties have not been studied.

Hedonic regression modelling is the standard methodology for examining price determinants in real estate research. Hedonic real estate models are based on the assumption that a property can be described by specific physical or hedonic characteristics and that the contributory value of each characteristic can be estimated. The relationship between transaction prices and the characteristic of the location and the characteristics of the property are studied regularly. Most of these research studies performed a hedonic regression mainly to classify the relative importance of these characteristics (Colwel et al., 1998; Nappi-Choulet et al, 2007). Other research on office transaction prices models have studied a specific location characteristic (Tu et al., 2004) or a specific property characteristic (Fuerst et al., 2011). Only a few hedonic office market studies have incorporated the relationship of an office being single- or multi-tenant and the office transaction price (Colwell and Munneke, 2006; Fuerst, McAllister and Ekeowa, 2011). However, these studies lack of evidence that there is a relationship between an office being single- or multi-tenant and the office transaction price.

Do investors have a willingness to pay for a single-tenant or a multi-tenant property? If so, how is this pricing difference incorporated in an transaction price by investors? Is there a relationship between the tenants and the transaction price?

1.1 Research objective

This research aims to provide empirical evidence to support or refute the assumption that there is a relationship between an office property being single- or multi-tenanted and the transaction price paid by investors. Most hedonic office market studies have been based on rental values. However, specific research into determinants of office transaction prices remains rare and primarily concern the US or Asian market (Nappi-Choulet, 2007). The rareness of hedonic office market studies on transaction prices are primarily explained by the difficulty of colleting the necessary data. The heterogeneity of offices makes it difficult to compare one another and by the illiquidity of offices, transactions are less numerous. Yet, Colwell et. al (1998) provides empirical evidence that transaction based commercial real estate indices can be constructed. This research paper is an addition to the existing literature (Colwel et al., 1998; Tu et al., 2004; Nappi-Choulet et al., 2007; Fuerst et al., 2011) of hedonic office market studies on direct measures of pricing.

1.2 Research question and hypothesis

This study answers the following research question; “Is there a pricing difference between an office property being single-tenant or multi-tenant?”.

1.3 Structure of the paper

In this paper we will firstly elaborate on the differences of single-tenant offices and multi-tenant offices and review on earlier literature. In the third chapter we will describe how the Dutch office market developed in the 21th century. In the fourth chapter we will operationalize determinants of office transaction prices. In the fifth chapter, we will discuss the methodology. In the sixth chapter we will construct our regression analysis. In the seventh and final chapter we will conclude on our results and set up the recommendations of the study.

2 Theoretical Framework

The theoretical framework consists out of three parts. First, we will define single-tenant and multi-tenant office buildings and elaborate on their differences. In the second part we will review earlier literature that incorporated the effects that single-tenant and multi-tenant offices have on rental prices and transaction prices (both in terms of the total price and the price per square meter). In the third part we will review literature on office transaction prices to investigate what determinants have an effect on office sales prices.

2.1 Single-tenant vs. Multi-tenant

Within real estate jargon a single-tenant office building is considered to be an office building that is fully occupied by one tenant. Ziermans (2016) stated that a single-tenant property is leased or at least 90% to one tenant.

If a tenant in a single-tenant office decides that - at time of renewal - it is in less need for office space and therefore only renews for a portion of the space in the property, chances are that the owner of that property is likely to transform the property into a multi-tenant property. After all, there arises a change that another company will let the vacant office space and thus two tenants occupy the property. However, if a tenant fully occupies one office property and decides that it is in less need for office space but only gives back a relatively small portion of the office space, it could be very hard to lease out that part of the property to another tenant, due to the dominance of the tenant. Therefore, within the scope of this research paper, we consider a multi-tenant office property as “an office property with more than one tenant or an office property with one tenant and more than 10 percent vacancy”. If an office property has one tenant and less than 10 percent vacancy, we will define it as a single-tenant office property[1].

A notable difference between single-tenant and multi-tenant office properties is the differences in leasing structures. Leasing structures vary nationally and can be broadly classified as passive or active. These differences in leasing practices might be expected to impact performances, specifically through differences in revenues and expenses. Investing in one or in another can be seen as a passive or active investment. While a passive investment can be seen as a buy-and-hold strategy, involving buying an asset with the intention of owning it for many years, an active investor is seeking short-term profit by actively optimize the property.

[1] This research focuses on two broad classifications, namely single-tenant vs. multi-tenant offices. We recognize that this binary approach does not cover the full real estate market and that there could be many differences within both single-tenant and multi-tenant offices.

The absolute extreme of a passive real estate investment is an asset leased to a single tenant with a long-term fully triple-net lease. A triple net lease is a lease agreement that designates the tenant as being solely responsible for all the costs relating to the asset being leased that normally would be paid by the property owner, including real estate taxes, insurance, maintenance, repairs, utilities and other items. For example, under English property law, most commercial leases are known as being triple net. Leases for grade A offices in London are typically agreed for longer periods, rents are fixed for longer periods and repairing and insuring costs are, uniquely for Europe, passed onto tenants (Baum and Turner, 2004). In the case of a single-tenant property with a bondable-net lease and investment grade tenant, the fixed-income asset is ratable based on the tenant credit rating and lease default provisions (Graff, 1999). As the tenant is responsible for all costs relating to the asset in a fully triple-net lease, rental income from the lease resembles the fixed payments one would associate with payments of a bond. The value of such an asset fluctuates with the same factors as that of a bond; duration (in this case of the lease agreement), inflation (in this case of the rental price) and creditworthiness (in this case of the tenant). The investor's primary risk associated with this lease structure is typically the tenant's financial strength and its ability to make rental payments (Lammert, 1996). In addition, the tenants right to cancel a lease and other typical real estate risks such as illiquidity and depreciation of the asset play a role (Lammert, 1996).

At the other extreme, leasing an office property to multiple small- and medium-scale tenants for short lease terms with different expiration dates is considered to be an active investment. This is especially the case when vacancy occurs. With active leasing structures comes a gross lease, in which a commercial landlord seeks a markup on the rent that is found to increase with the cost of property-level operating expenses (Wiley et al. 2014). The value of an asset with active leasing structures is a function of supply and demand for space, in that market, at that specific moment in time. Active leasing structures brings in other type of risks than passive leasing structures. It is argued by Griffiths (2006) that the primary risk associated with the cash-flow quality of multi-tenant properties – and thus property values – has more to do with re-letting potential, rather than financial strength of particular tenants.

Both passive leasing structures with net leases and active leasing structures with gross leases are widely used across international office markets. However, it is important to note that full triple-net lease, as discussed, remains rare in most European office markets, including the Dutch office markets (Baum and Turner, 2004). In the Netherlands, the lessor retains responsibility for damage resulting from visible or hidden defects in the property and is designated the perform major maintenance, but these general provisions do not form part of compulsory law and could be set aside in individual contracts (Kernkamp, 2016). Dutch office leases for smaller- and medium sized tenants are typically agreed for a five-year period with

an annual indexation of the rental income and a tenant's option to renew for a further five years (Lofstedt and Baum, 1993), but parties are free to agree upon any term of a lease agreement. Dutch office leases with large tenants or single tenants are generally longer. For example, law firms AkzoNobel and Stibbe each signed a lease agreement for a fifteen-year period with the developer of their build-to-suit new headquarters on the Amsterdam South-Axis (Union Investment, 2015). The headquarters of construction firm Heerema Marine Contractors in Leiden was even acquired with a lease agreement for a twenty-year period (Property Week, 2016). Unlike multi-tenant office properties, single-tenant office properties do not have the benefit of diversification in the form of a tenant mix. A single-tenant office property is either a 100% occupied and generates a steady stream of cashflow or is a 100% vacant and does not generate any income at all at that specific moment.

While owners of both single-tenant and multi-tenant office properties in the Netherlands generally retain the responsibility of major maintenance, leases for multi-tenant office properties are more likely to reserve operating expense obligations to investors than leases for single-tenant office properties (Baum and Turner, 2004). On top of the management- and maintenance cost, an owner of a multi-tenant office property must deal with are the costs of any vacancy, which will lead to irrecoverable service costs. This is in contrast, obviously, with a long-leased single-tenant office property, where an owner is expected to have little or no costs regarding property management and minor maintenance may be recovered through service charges.

2.2 An overview of earlier literature on single-tenant vs. multi-tenant

Patel (2000) investigated the investment performance of single-tenant offices relative to multi-tenant offices for the Central London office market. He found that the multi-tenant offices had outperformed the single-tenant offices over the 18-year period of analysis. The reason for the out-performance was due to consistently stronger rental growth experienced by multi-tenant offices properties which did not appear to have been factored into the pricing of such assets. This finding is explained by the effect that the multi-tenant sample enjoyed higher reinvestment of income and lower retention rates, resulting in higher rental growth.

Baum and Turner (2004) found a relation between an office property being single- or multi-tenant and reinvestments made by the owner of the property. Baum and Turner (2004) examined several European office markets across which lease structures and retention rates vary. They found evidence that the retention rate - as a percentage of the capital value - of multi-tenant offices in London are approximately four times higher than single-tenant offices in London. In addition, Baum and Turner (2004) found single-tenant offices in London have a higher rate of rental value decline by age than multi-tenant properties in London, respectively

2.45 percent and 1.10 percent. The fact that single-tenant offices experienced a higher rate of rental depreciation than multi-tenant offices as a result of a lower retention rate corresponds with the findings of Patel (2000) that there is a difference in rental change for single-tenant offices and multi-tenant offices.

Moll (2012) incorporated a multi-tenant variable in his research into the determinants during distinct periods of a market cycle and found a significant and positive effect of a multi-tenant office property on the rent level. Moll (2012) found that the estimated rental level in a multi-tenant office property is about 6.5 percent higher than in a single-tenant office property, both in terms of contract rent and effective rent. Moll (2012) gives two explanations for his findings. Firstly, Moll (2012) explains that tenants prefer a multi-tenant property because they can benefit from having other tenants in the property, like a better exchange of information or the creation of good relation with the different tenants. Secondly, Moll (2012) found an explanation for his finding in the fact that large-scale offices in general are multi-tenant and rent levels of large-scale office properties are generally higher. The assumption Moll makes regarding the size of an office property and the office property being multi-tenant corresponds with the findings of Hartzell et al. (1987). They found that the proportion of single- to multi-tenant properties decreases as property size increases. The two largest size categories in the size tests of Hartzell et al. (1987) concerned for 97 percent properties leased to more than one tenant. Existing literature support that the size of office properties has a positive effect on rent levels (Glascock et al., 1990; Glascock et al., 1993, Colwell et al., 1998). Glascock et al. (1990) found that the level of amenities significantly influences rent in a positive direction. Full service properties rent for about 8 percent more than properties with no services and partial service properties rent for about 4 percent more than no service property.

Fuerst, McAllister and Ekeowa (2011) also incorporated a variable for single-tenant properties in a working paper that focuses on the effect of energy performance ratings on the capital values, rental values and equivalent yields of UK commercial property assets. They found that market rents in single-tenant properties are 0.9 percent lower than market rents of multi-tenant properties, but only on a significance level of 10 percent. However, they found no significant effect for an asset being leased to a single tenant for individual commercial real estate segments.

Liu et al. (2013) found that relatively younger and larger single-tenant office properties are significantly more likely to be acquired by nonlocal buyers than by local investors. In addition, Liu et al. (2013) suggests that nonlocal investors are disadvantaged on the market. They provide evidence that nonlocal investors significantly overpay on acquisition by an estimated 13.8 percent relative to similar assets purchased by local investors. Conversely, Liu et al.

(2013) found nonlocal sellers are significantly more likely to divest properties that are single-tenant. According to Liu et al. (2013), these properties are relatively older and larger than the average property sold by local investors. Evidence from Liu et al. (2013) shows that local investors outperform nonlocal investors significantly at disposing assets. Upon exit, nonlocal investors sell their offices at a discount of 7 percent relative to similar assets. These disadvantages relative to local investors expand with the geographic distance separating investor and assets.

Colwell and Munneke (2006) also incorporated a variable for single-tenant office properties in their model that explores the impact of buyer and seller characteristics on the transaction prices of office properties. They found that office properties classified as mid- and high-rise[2] office space are found to have significantly higher prices than single tenant properties.

Fuerst, McAllister and Ekeowa (2011) found no significant effect on both market values per square meter as well as equivalent yields of an asset being leased to a single tenant.

Mooney et al. (1998) argue that cash-flow quality and property value are much more dependent on tenant- and lease quality in a single-tenant property than they are in a multi-tenant property. Using 26 transactions involving single-tenant, net-leased properties - leased to major national retailers with publicly traded stock – Mooney et al. (1998) found that 90 percent of the variability in the overall capitalization rates was explained by a variability of lease and tenant quality. Most notable, Mooney et al. (1998) found that the higher the tenant's beta value, the higher the capitalization rate. In other words, if the tenant has a relatively volatile revenue, an investor is likely to pay lower property price for the property. Conversely, an investor is willing to pay a higher price for a single-tenant property leased to a less risky tenant.

Fehribach et al. (1993) incorporated a dummy variable between multi-tenant and single-tenant properties in their research into the value of industrial properties. Their results showed that industrial properties being a single-tenant property have a significant and positive effect on industrial property values. Fehribach et al. (1993) explains that single-tenant industrial properties are in most cases owner occupied. According to Wheaton and Torto (1992), almost three-fourth of the total industrial space is occupied a single user, and half by owner-occupiers. According to Fehribach et al. (1993) it is commonly perceived in the appraisal field that an owner-occupier grantor is more likely to pay a higher price because of his motivations. Consequently, the reasons surrounding the purchase differ from a multi-tenant industrial property, which is almost always an income producing property.

[2] We must note that Colwell and Munneke (2006) do not identify mid- and high-rise properties as multi-tenant properties. In addition, they do not further define single-tenant properties. Within the definition as described in section 3.1, a single-tenant property could also be a mid- or a high-rise property

2.3 An overview of earlier literature on office prices

In section 2.2 we have conducted a literature review on empirical research papers that have addressed the differences on single-tenant and multi-tenant office properties and have investigated the effects of both on rental prices and property prices. In this section, we will focus on the literature that have investigated the effect on the property, locational-, and transactional characteristics on office property prices. Most hedonic office market studies have been based on rental values. According to Nappi-Choulet (2007), specific research into determinants of office transaction prices remains rare and primarily concern the US or the Asian market. In this section, we will provide an overview on earlier literature on office transaction prices to investigate what the influence is of specific property characteristics and locational characteristics on the sales price of the property.

Sivitanidou (1995) applies a consistent methodology on the sales prices per square foot of 308 properties sold between 1987 and 1992 within Polycentric Los Angeles for identifying large, main or secondary centers of service employment and employs alternative empirical tests of the extent to which office firms value access to these centers. These tests involve the analysis of office property values per unit land across sites differing in center access.

Colwell et al. (1998) conducted a hedonic analysis of Chicago area office properties that sold from 1986 through 1993. The analysis period of this study is comparable to the Dutch office market in the last ten years as the study of Colwell et al. (1998) was conducted in a period with both declining nominal interest rates and increasing vacancy rates. According to Colwell et al. (1998), prior research has generally been conducted on the basis of appraisal values, rather than on office transaction prices. According to the authors, there is a problem with approaching appraisal values, due to the potential bias in return and risk measures.

Downs and Slade (1999) also use a dataset of transaction prices, covering the Phoenix market over the period 1987 – 1996; the objective is principally to compare the properties of indexes based on expert valuations and observed transactions.

Petrova and Ling (2009) examines the impact of heterogeneous investors with asymmetric bargaining positions on transaction prices in private commercial real estate markets, using a dataset that contains nearly 100,000 real estate transactions during 1997 – 2009. The transactions are distributed over ten major metropolitan markets and over 100 submarkets.

Fuerst and McAllister (2011) conducted a study to investigate the price effects of environmental certification on commercial real estate assets due to lower holding costs for investors, additional occupier premiums and lower risk premiums. The dataset of Fuerst and McAllister

(2011) comprises 6,157 transaction prices per square foot in U.S. commercial real estate considered over a period of 10 years from 1999 through 2008.

Liu et al (2013) use a U.S. sample of commercial real estate transaction data including a national sample of office transaction prices per foot meter occuring in more than 100 U.S. markets to identify capital value underperformance for nonlocal investors on both sides of the transaction; when they purchase and when they sale.

Locational Characteristics

Table 2.1 shows the different regression results across literature on the effect of spatial characteristics on office sales prices.

Employment

Colwell et al. (1998) found – as anticipated - that a location in an office employment center within the city limits of Chicago increases the value of an office property. This result indicates that an office property buyer pays a premium for a location near other office-based commercial activity. Colwell et al (1998) examined the effect of a location in an office employment center outside the city limits of Chicago, but they did not found a significant effect for it. In line with the finding of Colwell et al. (1998), Sivitanidou (1995) found that office sales prices are significantly higher in areas with a local concentration of employment in Banking, Finance, Legal and Business Services.

Distance to airport

Another locational finding by Colwell et al. (1998) is that the values of office properties decrease as the distance to O'Hare Airport increases, as expected. Colwell et al. (1998) found that office property within a diameter of 4 miles from the airport sell with a significant premium. Sivitanidou (1995) did not found a significant effect of the properties distance to the closest major airport on office sales prices.

Accessibility

In addition, Colwell et al. (1998) found that an increase in accessibility, as measured by the percentage of land in a quarter section devoted to interstate highways and tollways, has a positive effect on office values. However, Colwell et al. (1998) found that the presence of rail transportation has a negative effect on the value. A possible explanation is that properties in a neighborhood close to rail lines has older or less attractive surroundings or that railway vicinities in some way systematically constitute less desirable office locations. Sivitanidou (1995) incorporated accessibility in its hedonic regression as the properties distance to the closest highway but contrary to Colwell et al. (1998), he found no effect on office sales prices.

Distance to recreation

Colwell et al (1998) found that as the percentage of land devoted to recreational parks increases, the value of office properties is found to increase. Colwell et al. (1998) also incorporated variables for the percentage of quarter-section devoted to golf courses and conservation parks in his regression, but he did not find a significant effect for the variables. Sivitanidou (1995) found that the sales price of offices decreases as the distance to the beach increases.

Distance to CBD

Sivitanidou (1995) found a significant negative effect on office sales prices when its distance to the main central business district increases. In addition, Sivitanidou (1995) also found a significant negative coefficient for the distance to several large secondary centers within Los Angelos on the sales price of offices. Furthermore, Sivitanidou (1995) incorporated a dummy variable for Bevery Hills representing a location prestige, but did not find a significant effect. Others (Colwell et al. 1998; Downs & Slade, 1999) suggest that the distance to the CBD has no statistically significant effect on the value of office properties. However, Colwell et al. (1998) suggests that the insignificance of the distance to CBD parameter may also be explained by the existence of the separate variable measuring a parcel's northward location within the county. The positive coefficient on the distance north variable indicates that office property values are higher at locations farther north within the Chicago's Cook County. Petrova and Ling (2009) and Fuerst and McAllister (2011) also used the latitude and longitude as a control variable of the properties to examine any large-scale effects of the spatial distribution of properties on the sales price of office properties. They found that the latitude and longitude are highly significant on offices sales prices. In addition, Petrova and Ling (2009) found that the estimated coefficients on the submarket cluster dummy variables are statistically significant and model fits are improved substantially by the inclusion of these submarkets fixed effects.

Demographics

Sivitanidou (1995) also found a significant positive effect for income per capita – measured at the census tract level – on the sales price of offices. In addition, Sivitanidou (1995) found a significant negative effect of FBI total crimes per 10,000 residents on office sales prices – measured at the city level. Furthermore, Sivitanidou (1995) found a significant positive effect of retail employment per resident population on office sales prices – measured at census tract level. Sivitanidou (1995) also investigated if the concentration of motion picture employees – measured at census tract level – had a significant effect on office sales prices, but they did not found a effect.

Table 2.1 Summary of regression results of the effect of spatial characteristics on the sales price of office properties.

	Sivitanidou (1995)	Colwell et al. (1998)	Downs & Slade (1999)	Petrova & Ling (2009)	Fuerst et al. (2011)	Liu et al. (2013)	Liu et al. (2013)
	Los Angeles	Chicago	Phoenix	U.S.	U.S.	U.S.	U.S.
Employment Centers within limit	0.008***	1.35***					
Employment Center outside limit		0.91***					
Distance to airport	0.191	0.37**					
Distance to CBD	-0.212***	-0.01	0.004				
Accesibility	0.004	0.02***					
Adjacent to railway		-0.04***					
Distance to beach	-0.069***						
Land devoted to Recreational parks		0.01***					
Land devoted to golf courses		0.10					
Land devoted to conversation parks		0.01					
Income per capita	0.123**						
Retail Employment	0.180***						
Crimes rates	0.172***						
Longitude		0.01***		-0.041**	-0.01***		
Latitude				-0.214***	-0.13**		
Adjusted r^2	59%	84%	85%	86%	42%	56.49%	53.84%
Number of Observations	308	427	935	100,000	6,157	4,766	6,670
Controlled for submarkets	Yes		Yes	Yes	Yes	Yes	Yes

* = significant on 10% level
** = significant on 5% level
*** = significant on 1% level

Property Characteristics

Table 2.2 shows the different regression results across literature on the effect of property characteristics on office sales prices.

Size of property
Colwell et al. (1998) found that the office price increases at a decreasing rate as the footprint of the property increases. This is supported by Downs and Slade (1999) and Petrova and Ling (2009). However, the results of Fuerst and McAllister (2011) and Liu et al. (2013) – both for the buyer and the seller - indicates that office prices decrease as the footprint of the property increases. Sivitanidou (1995) incorporated a variable related to the average floor area, but did not find a significant effect on the sales price.

Number of stories
Colwell et al. (1998) also found an unexpected positive and concave relationship between offices values and the number of stories in a property. This is widely supported (Downs and Slade, 1999; Fuerst & McAllister, 2011). Petrova and Ling (2009) found a negative significant effect on the number of stories in an office property.

Age of property
Colwell et al. (1998) found that the age of the property has a statistically negative impact on the transaction price, as would be expected, but this effect dimishes as the property becomes progressively older. This might be the result of renovation work that older properties typically undergo, as suggested by Colwell et al. (1992). This price mechanism is supported by Petrova and Ling (2009) and Downs and Slade (1999). Sivitanidou (1995) and Liu et al. (2013) also found a negative and significant coefficient for the age of the property. Fuerst and McAllister (2011) found a different pattern in the effect of the age of the property on the sales price. They found that properties constructed in the first 2 years tend to sell at a discount rate compared to older properties. Then they found that the sales price of the property starts to increase per year. Sales prices of properties older than ten years decline in value (Fuerst and McAllister, 2011).

Energy label
Fuerst and McAllister (2011) found that there are clear differences between eco-certified and noncertified properties. Fuerst and McAllister (2011) found a sales premium of just below 30 percent for eco-certified properties.

Quality
Liu et al. (2013) found that class A and class B properties are consistently estimated to transact at a significant premium to class C properties. Petrova and Ling (2009) investigated the relationship between the condition of the office property and the sales price and found that

both office properties in an excellent and in a good condition had a significant positive effect relative to office properties in an average condition. Petrova and Ling (2009) also investigated if there was a significant relationship between the sales price and the fact that a property had been renovated within the last 4 years, but did not found this effect. Liu et al (2013) found that single-tenant offices transact at a significant premium relative to multi-tenanted offices, as discussed in section 2.2.3.

Sivitanidou (1995) incorporated a variable related to the external walls of the property and found that external glass properties have a significant positive effect on office sales prices as they would expect. Sivitanidou (1995) did not found a significant effect of external wooden walls and for metal frames Sivitanidou (1995) only found a significant effect at a 10% level. Sivitanidou (1995) also found a significant positive effect on the number of elevators in an office property. In addition, Sivitanidou (1995) incorporated a dummy for the availability of subterranean parking and found a positive significant effect for subterranean parking.

Lot size

It is found by Petrova and Ling (2009) that the lot size does not have any effect on the sales price of the property. However, Liu et al. (2013) found a negative relation between lot size and the sales price of offices on a 5% level. Others (Colwell et al. 1998; Downs and Slade, 1992; Fuerst and McAllister, 2011) found a significant positive relation.

Table 2.2 Summary of regression results of the effect of property characteristics on the sales price of office properties.

	Sivitanidou (1995)	Colwell et al. (1998)	Downs & Slade (1999)	Petrova & Ling (2009	Fuerst et al. (2011)	Liu et al. (2013)	Liu et al. (2013)
	Los Angeles	Chicago	Phoenix	U.S.	U.S.	U.S.	U.S.
Lot size		0.27***	0.194***	0.000	0.09***	-0.046**	-0.039**
Lot size (Q)				0.000			
size of the property	0.022	0.46***	0.747***	0.005***	-0.23***	-0.110***	-0.077***
Size of the property (Q)				0.000***			
Number of stories		0.84***	0.336***	-0.008***	0.16***		
Age of property	-0.123***	-0.02***	-0.039***	-0.003***	0.51***	-0.168***	-0.164***
Age of property(Q)		-0.1E-3**	0.001***	0.000***			
Class A vs Class C					0.45***	0.426***	0.468***
Class B vs Class C					0.06***	0.110***	0.095***
Excellent vs average condition				0.240**			
Good vs average condition				0.103***			
Fair vs average condition				0.045			
Renovated				0.148			
Multi-tenant						-0.076***	-0.073***
Energy Performance					0.30***		
Metal Frame	-0.391*						
Glass walls	0.503***						
Wooden Walls	-0.181						
Number of Elevators	0.124***						
Parking Facility	0.596***						
Number of Observations	308	427	935	100,000	6,157	4,766	6,670
Controlled for submarkets	Yes		Yes	Yes	Yes	Yes	Yes

* = significant on 10% level
** = significant on 5% level
*** = significant on 1% level

Transactional Characteristics

Table 2.3 shows the different regression results across literature on the effect of transactional characteristics on office sales prices.

Buyers/sellers profile
Downs and Slade (1999) found that a property sells at a relative discount if the property is foreclosed and the financing bank is the seller. Petrova and Ling (2009) found a highly negative significant coefficient for distressed sales. According to findings by Petrova and Ling (2009), REITs pay a premium when purchasing office properties. In addition, Petrova and Ling (2009) found that out-of-state buyers pay premium for office properties. With other words this means that foreign buyers are at a competitive disadvantage when competing for office properties with, presumably, better informed local buyers. This is supported by the findings of Liu et al. (2013) as suggested in section 2.2.2.

Brokers
Petrova and Ling (2009) also found that when the broker of both the seller and the buyer is the same firm this would have a positive significant effect on the sales price of offices.

Transaction year
Downs and Slade (1998) used year dummies for transaction years, with 1987 as omitted variable. They found that the dummy variables showed a consistently year-on-year negative effect, of which the coefficients between 1990-1195 were signficantly different from zero at a 1% level, indicating a strong nominal depreciation of the study period. Petrova and Ling (2009) also used year dummies for the transaction years, with 1997 as the omitted variable. They found that the dummy variables did not show a significant effect until 2000, after which they mostly found a significant negative effect at a 5% significance level until the year 2003. Petrova and Ling (2009) found that the dummy variables showed a consistently positive effect between 2003 and 2008 at a significance level of 1%. 2009 reveals substantial nominal price appreciation over the 13-year study period relative to 1997. This explainable by the start of the global financial crisis in 2008.

Table 2.3 Summary of regression results of the effect of transactional characteristics on the sales price of office properties.

	Sivitanidou (1995)	Colwell et al. (1998)	Downs & Slade (1999)	Petrova & Ling (2009	Fuerst et al. (2011)	Liu et al. (2013)	Liu et al. (2013)
	Los Angeles	Chicago	Phoenix	U.S.	U.S.	U.S.	U.S.
Distressed				-0.192***			
Same broker acts for buyer and seller				0.052***			
Bank is seller			-0.297***				
Buyer is REIT				0.224***			
Non-Local				0.224***		0.138***	-0.070***
Number of Observations	308	427	935	100,000	6,157	4,766	6,670
Transaction year dummy variable			Yes	Yes			
Financing type dummy variables			Yes				

* = significant on 10% level
** = significant on 5% level
*** = significant on 1% level

2.4 Hyptheses

Based on the theoretical framework, we will draw up the hypotheses that will be tested in this research. Each hypotheses consists out of a null hypothesis (H0) and one alternative hypotheses (H1).

Hypotheses 1;

- H0; The difference of being an single-tenant or multi-tenant office property does not influence the transaction price per square meter paid by investors.
- H1; The difference of being an single-tenant or multi-tenant office property does influence the transaction price per square meter paid by investors.

Since a single-tenant property owner is not able to diversify cash flow risk among multiple tenants, the tenant creditworthiness becomes increasingly important in valuing a single-tenant property. Contrary, risk associated with the cash-flow for multi-tenant properties has much

more to do with re-letting potential. The differences between single and multi-tenant properties indicate that there could be a significant pricing difference.

Hypotheses 2;

- H0; Transaction prices per square meter of single-tenant office properties do not depreciate more between sales than transaction prices of multi-tenant properties.
- H1; Transaction prices per square meter of single-tenant office properties depreciate more between sales than transaction prices of multi-tenant properties.

Multi-tenant properties are expected to experience a relatively higher rental growth or a relatively lower rental depreciation between sales. This could have a positively affect the sales price of a multi-tenant property at its second sale. Secondly, it is suggested that single-tenant properties are more likely to be acquired by nonlocal investors, whom underperform local investors both at acquisition and disposition. Therefore, single-tenant properties experience a premium at acquisition and a discount at disposition relative to similar assets.

Hypotheses 3;

- H0; International buyers do not have a lesser disadvantage when acquiring single-tenant offices relative to multi-tenant properties.
- H1: International buyers do have a lesser disadvantage when acquiring single-tenant offices relative to multi-tenant properties.

A disadvantage at acquisitions of non-local investors is mainly relatable to a lack of knowledge on local market dynamics. Liu et al. (2013) suggests that the disadvantage expands with geographical distance between investors and assets. However, single-tenant office properties are fully leased and the leases are generally written for relatively longer periods. Little to no leasing activities are involved for a relatively longer period and therefore it is suggested that, when investing in single-tenant properties, an investor has to understand less about the local market relative to investing in multi-tenant properties. Instead, it is suggested that the tenant and its creditworthiness plays a more important role in valuing single-tenant properties (Lammert, 1996; Mooney et al, 1998). Considering the size of tenants that are leasing a single building and the availability of credit ratings on companies, an analysis on the tenants' business could be performed on a same level by both domestic as international investors. Therefore, we would suggest that domestic investors do not necessarily have an advantage on the single-tenant property investment market.

3 Dutch Office Market in the 21th Century

In this section, we will describe how the Dutch office market has developed in the 21th century on the basis of the conceptual framework for the real estate asset and space market (DiPasquale and Wheaton, 1992).

3.1 Macroeconomic developments

The Framework of DiPasquale and Wheaton (1992) illustrates how real estate is impacted by the macroeconomy. Economy is the exogenous variable that drives demand for office space. Due to a positive correlation between the demand for office space and the economy - in terms gross domestic product - office developments are often thought to respond to the oscillations of the economy. These oscillations could broadly be divided into boosts, busts, recessions and recoveries.

The Netherlands experienced a relatively long period of economic growth in the last decade of the 20th century. In the period 1995 - 2000, the Dutch economy – in terms of gross domestic product – grew by an average of 3.8 percent annually, as seen in figure 3.1. The boost in economy led to an increase in employment. In the period 1996 – 2001, unemployment rates in the Netherlands fell from 8.1 percent to 3.5 percent, as seen in figure 3.2. A year later, the Dutch economy busted by showing a downturn in economic growth, mostly as the result of the crisis that is known as the 'internet bubble'. A mild recession followed in 2002 that lasted no longer than two quarters. In 2003 the Dutch economy started to recover. In the period between 2003 - 2008, the Dutch economy in terms of GDP grew by an average of 2.4 percent, which can be seen as an economic boost. However, unemployment rose sharply in the first years of this boost. The unemployment rate in the Netherlands peaked in 2005 at 6.5 percent, after which it declined to 3.8 percent in 2008.

The Dutch economy busted again in 2008 as the result of the credit crisis that started in the United States halfway 2007. The bust was followed by one of the largest recessions that the Netherlands ever experienced and started in the second quarter of 2008. The recession as the result of the credit crisis lasted for two years. After a minor period of a positive GDP growth in 2010 and 2011, another recession started in 2011 as the result of the European debt crisis. As a result of this period of almost continuous recession, the Dutch unemployment rate grew from 3.8 percent in 2008 to 8.3 percent in 2014. In recent years, a recovery of the Dutch economy is visible. The Dutch GDP grew in 2014 by 1.4 percent and in 2015 by more than 2 percent. The Dutch employment is decreasing since 2014 and recorded a rate of 6.9 percent in 2015.

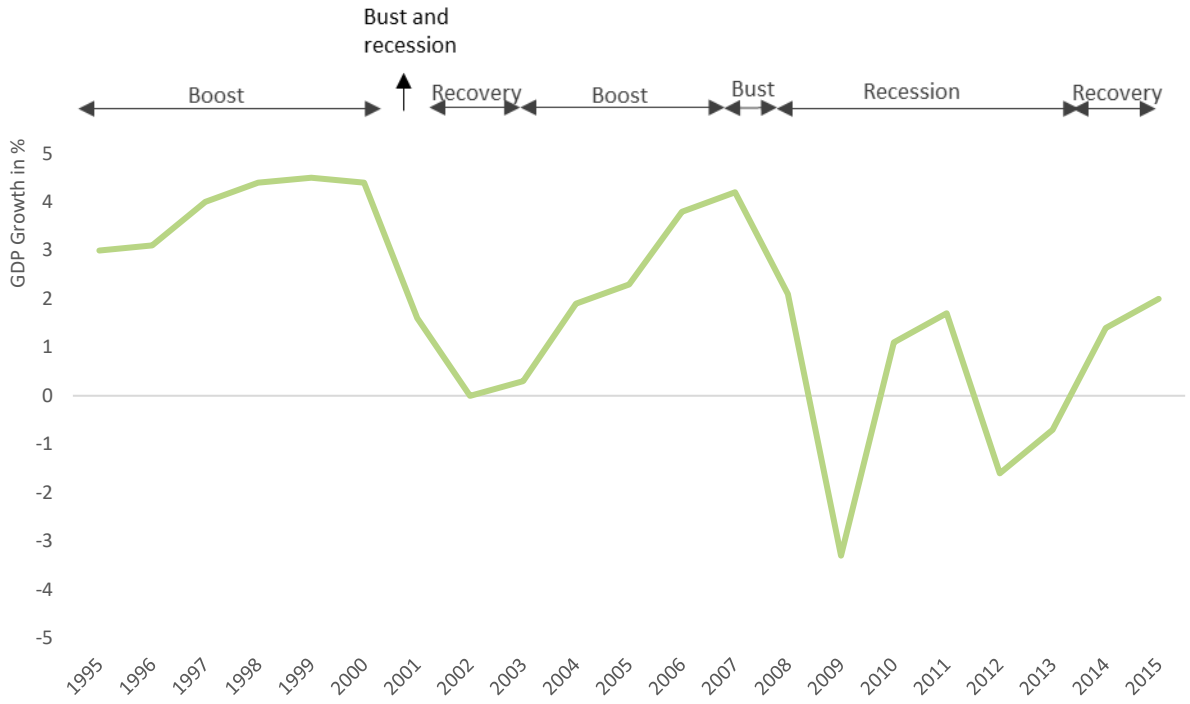

Figure 3.1 Annual Percentage of GDP Growth in the Netherlands. Source; Worldbank[3].

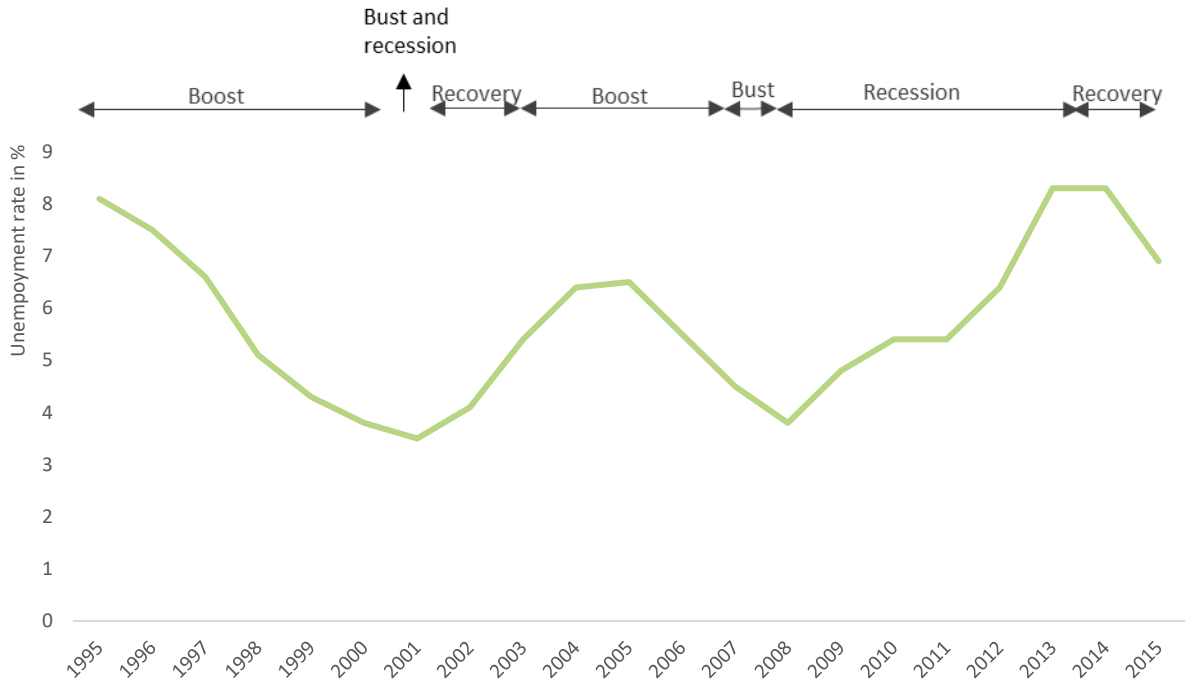

Figure 3.2 Unemployment rates in the Netherlands in the period 1995 - 2015. Source; CBS Statline[4].

[3] Data retrieved on 11-11-2016 via data.worldbank.org/country/netherlands. *Annual percentage GDP growth in the Netherlands.*

[4] Data retrieved on 29-03-2017 via statline.cbs.nl. *Beroepsbevolking; kerncijfers provincie 1987 – 2014* and *Arbeidsdeelname en werkloosheid per maand.*

3.2 Office Market Developments

As discussed in section 3.1, the year-on-year economic growth that the Netherlands experienced in the period 1995 – 2001 resulted in an increase in employment. Following the conceptual framework of DiPasquale and Wheaton (1992), an increase in production and employment eventually leads into an increasing demand for space. In combination with an inelastic 'fixed and given' supply on a short term, the national average vacancy rate in the Netherlands decreased from 7.0 percent 1995 to its lowest point of 4.0 percent 2001, as seen in figure 3.3. In addition, office rents in the Netherlands significantly increased during the economic boost in 1995 – 2001, as seen in figure 3.4.

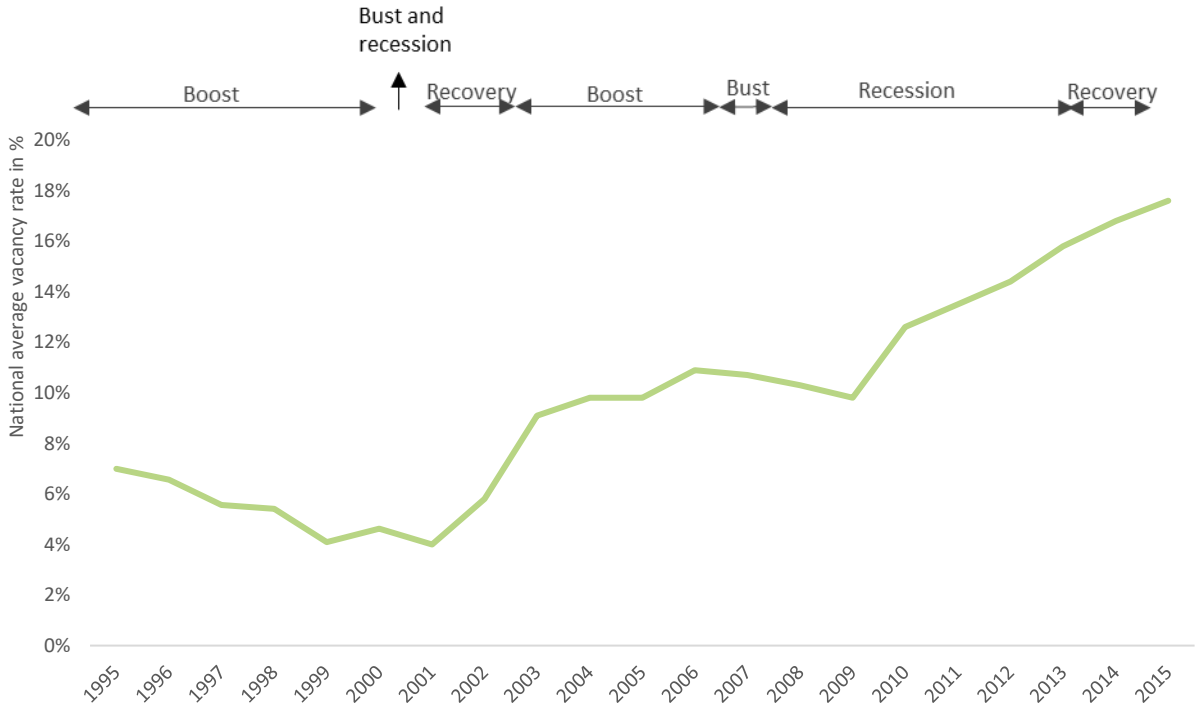

Figure 3.3 The national average vacancy rate per year in the period 1995-2015. Source: CLO[5].

According to the conceptual framework of DiPasquale and Wheaton (1992), higher rents generate a higher asset prices. Higher asset prices, in turn, generate a higher level of construction. This cycle is also known as the hog-cycle in which developers and investors tend to over respond on rising rents and tight market conditions in the property market. This cycle is best explained by (1) the difficulty for investors and developers to anticipate on an increase in demand of office space as the result of economic prosperity and (2) the time lag in construction of real estate. Eventually the anticipation of developers and investors will lead to an oversupply.

[5] Data retrieved on 21-11-2016 via clo.nl/indicatoren/nl2152-leegstand-kantoren. Leegstand van Kantoren, 1991 – 2016.

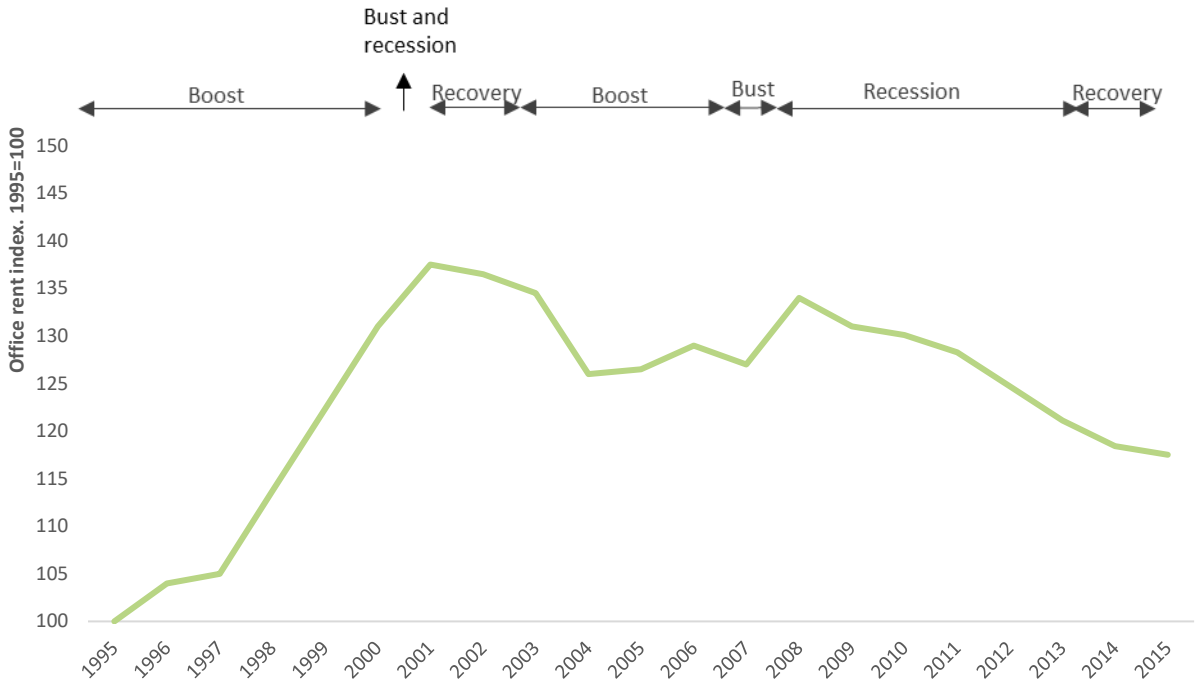

Figure 3.4 Office rent index in the Netherlands in the period 1995 - 2015. Source: DTZ (in Zuidema & van Elp, 2010) and DTZ Nederland compleet[6].

During the economic boost during the period 1995 – 2001, the office stock in the Netherlands grew by more than 25 percent. Especially at the turn of the century, new office developments were massively initiated as a response to rising rents and the shortage of office space, as seen in figure 3.5. The amount of completed office space in the Dutch market peaked in 1999 and 2000 in which the stock changed positively with respectively 2,120,700 square meters and 1,976,600 million square meters. As result of an over anticipated demand for office space by developers and a decreasing demand for offices due to the bust and recession in 2002, the vacancy rate for offices in the Netherlands increased from 4.0 percent in 2001 to 9.8 percent in 2004, as seen in figure 3.4. In addition, rents decreased on average by approximately 8 percent between 2001 and 2004. Following the conceptual framework of DiPasquale and Wheaton (1992), a construction boom eventually leads to a new equilibrium. The national average vacancy rate in the Netherlands was relatively stable in the period 2004 – 2009 and moved between 9.8 percent and 10.8 percent. Furthermore, office rents in the Netherlands remained relatively stable in the period between 2004 – 2009.

Developers and investors responded to the economic boost between 2004 – 2008. Although the construction of new office space was significantly less than the construction boom at the turn of the century, the amount of completed offices almost tripled between 2004 and 2007; in

[6] Data retrieved on 22-11-2016 via publicly available market reports from DTZ via dtz.nl/media. *DTZ Nederland Complet (2012 – 2015).*

2004 relatively 380,000 square meters of office space was added to the stock and in 2008 910,000 square meters of office space was added to the stock.

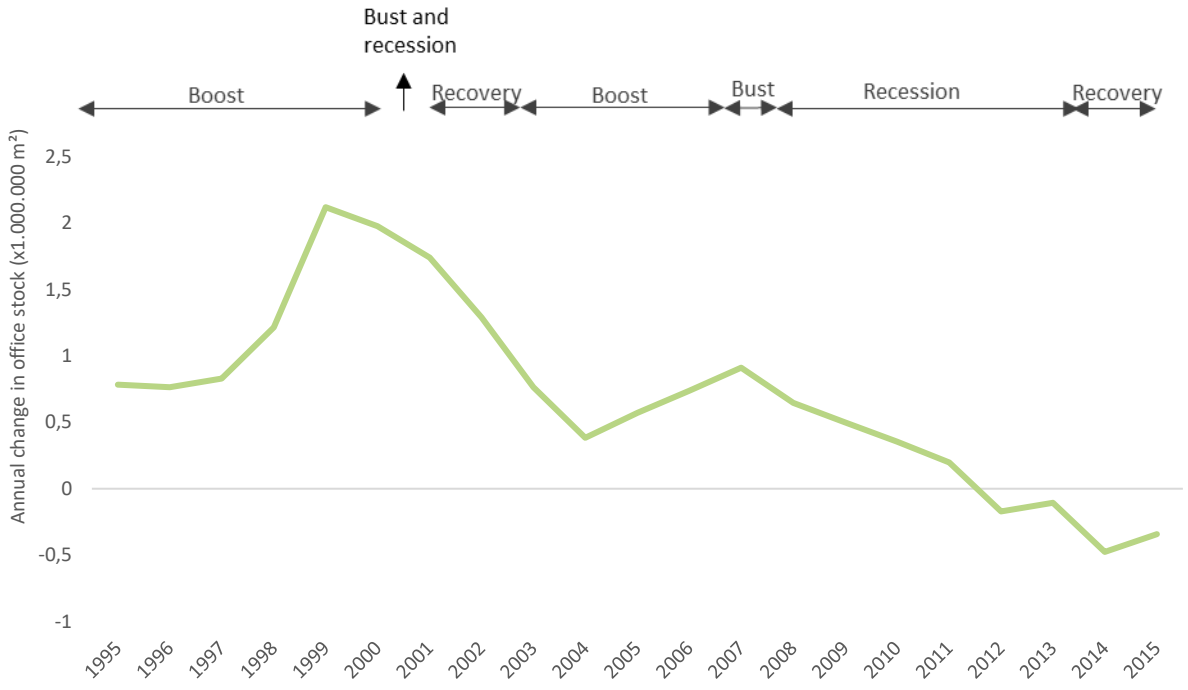

Figure 3.5 The change in the Dutch office stock per year following the formula. Source; CLO[7].

After the long period of almost continuous recession that started in 2008, the vacancy rate for offices in the Netherlands increased rapidly. Following the model of DiPascuale and Wheaton (1992), a strong recession leads to a decrease in demand for office space. The supply of offices has increased since 2009 and reached its peak in 2015, with over 17.6 percent vacancy. Office rents have decreased by 15 percent between 2008 and 2015. Office developments heavily decreased and from upon 2012 the change in office stock has been negative, suggesting that more offices have been transformed or demolished than new offices have been built.

To the authors knowledge, there is little to no convincing evidence for a relationship between the economics of the real estate asset markets and the preference of investors to acquire either single-tenant offices, multi-tenant offices or both. Data from Real Capital Analyzers (2016) helps us to understand how capitalization rates of both single-tenant as multi-tenant offices in European markets tend to move with the macroeconomy, as shown in figure 3.7. In the conceptual framework of DiPascuale and Wheaton (1992), the capitalization rate is taken as an exogenous variable, based on interest rates and returns in broader capital markets. It is the ratio of rent to price (I=R/P) and represents the yield that investors demand in order to hold real estate assets. A comparatively higher cap rate for a property would indicate a greater risk

[7] Data retrieved on 21-11-2016 via clo.nl/indicatoren/nl2152-leegstand-kantoren. Leegstand van Kantoren, 1991 – 2016.

associated with investments and a comparatively lower cap rate for a property might indicate less risk.

The capitalization rates between single-tenant and multi-tenant offices in European markets have been very similar in the period between 2001 - 2008, as seen in figure 3.7. After the economy busted and the long-term recession of 2008-2009 hit the market, multi-tenant offices have yield significantly lower than single-tenant properties with the exception of 2012. Since 2015, a trend is visible in which cap rates for multi-tenant offices further decline and single-tenant offices further increase. The differences in cap rates between single-tenant and multi-tenant offices after 2008 underlines a significant risk regarding investments in single-tenant office properties.

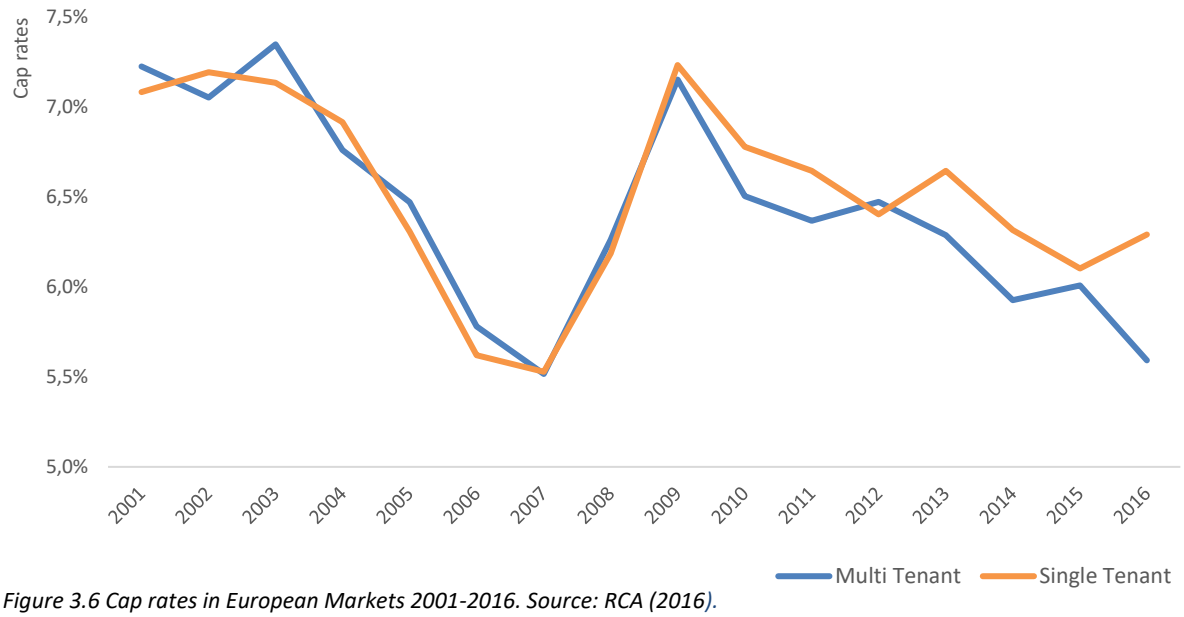

Figure 3.6 Cap rates in European Markets 2001-2016. Source: RCA (2016).

3.3 Randstad Metropolitan Area

The Randstad Metropolitan Area is a high-density region in the Netherlands and the economical center of the Country. Having a population of approximately 7,100,000 inhabitants, it is one of the largest metropolitan regions in Europe. It is considered to be one of the most densely populated economic areas in Northwest Europe. The Randstad Metropolitan Area includes the Port of Rotterdam and the Amsterdam Airport Schiphol, respectively one of the largest Seaport and one of the largest Airports in Europe. The office market in Randstad can roughly be divided in four areas, primarily consisting of the four largest Dutch cities and their neighboring municipalities

Amsterdam Area

The office market in the Amsterdam Area is considered to be the largest and best performing office market in the Netherlands. It houses a great number of national and international companies. The office market in the greater Amsterdam region broadly includes Amsterdam – the capital of the Netherlands – and the neighboring municipalities of Almere, Amstelveen, Diemen and Haarlemmermeer and Hilversum. The total area comprises of 9,342,000 of office space, representing 1/5th of the total Dutch office stock.

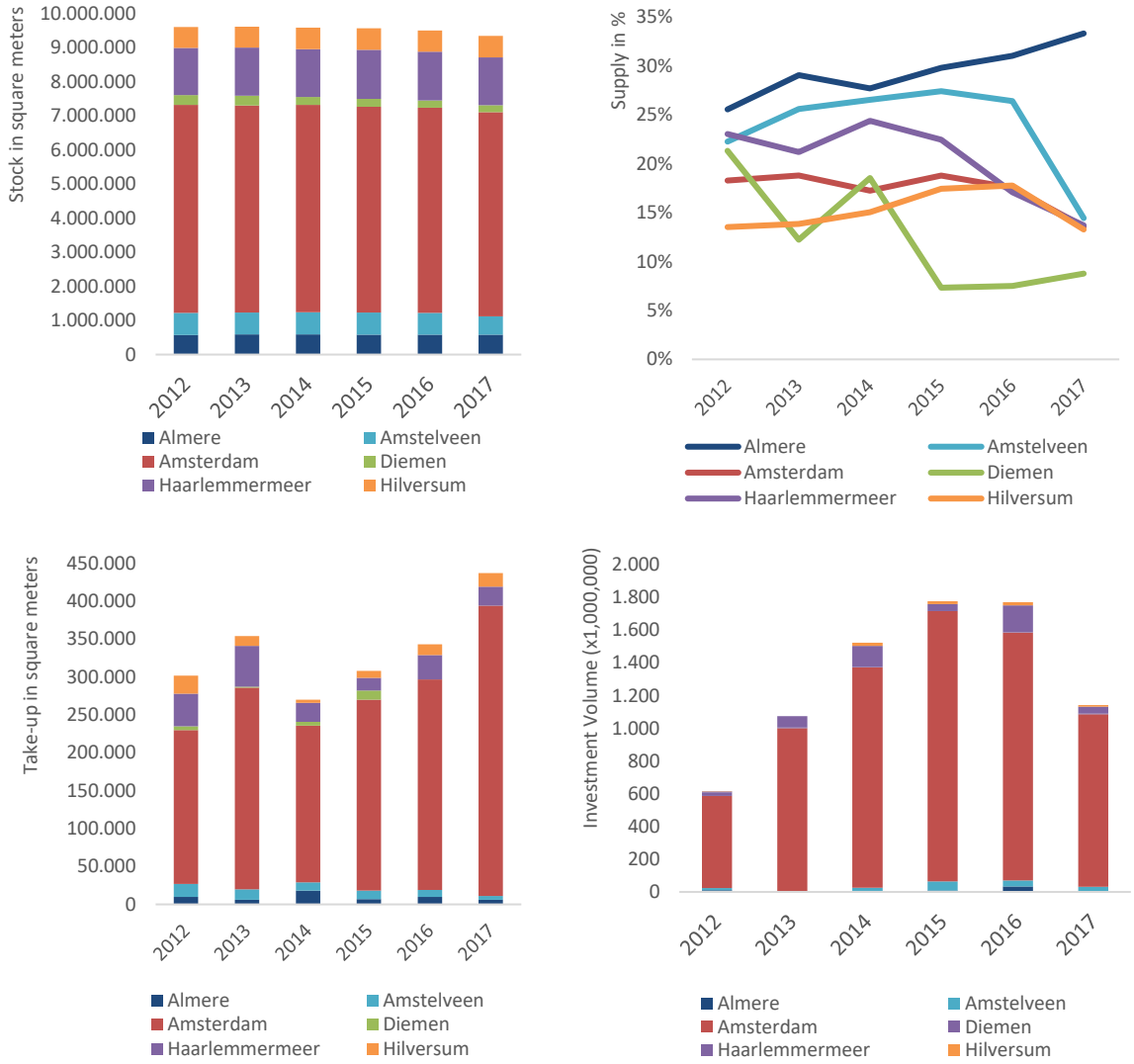

Figure 3.8 office market developments in cities of the Amsterdam area. Clockwise from top left; (1) stock in square meters, (2) supply in %, (3) take-up in square meters and (4) investment volumes in EUR (1,000,000). Source; Nederland Compleet[8] and Springbase

[8] Data retrieved from publically available market reports from DTZ via dtz.nl/media. *Nederland Compleet (2012 – 2016) and view.publitas.com/cushmanwakefield (2017)*

Rotterdam Area

The office market in the Rotterdam Area involves much around the harbor activities in Rotterdam. The office market in the Rotterdam Area broadly includes Rotterdam – the second largest city of the Netherlands – and the neighboring municipalities of Capelle aan den IJssel, Dordrecht, Gouda and Schiedam. The total area comprises of 5,148,000 of office space.

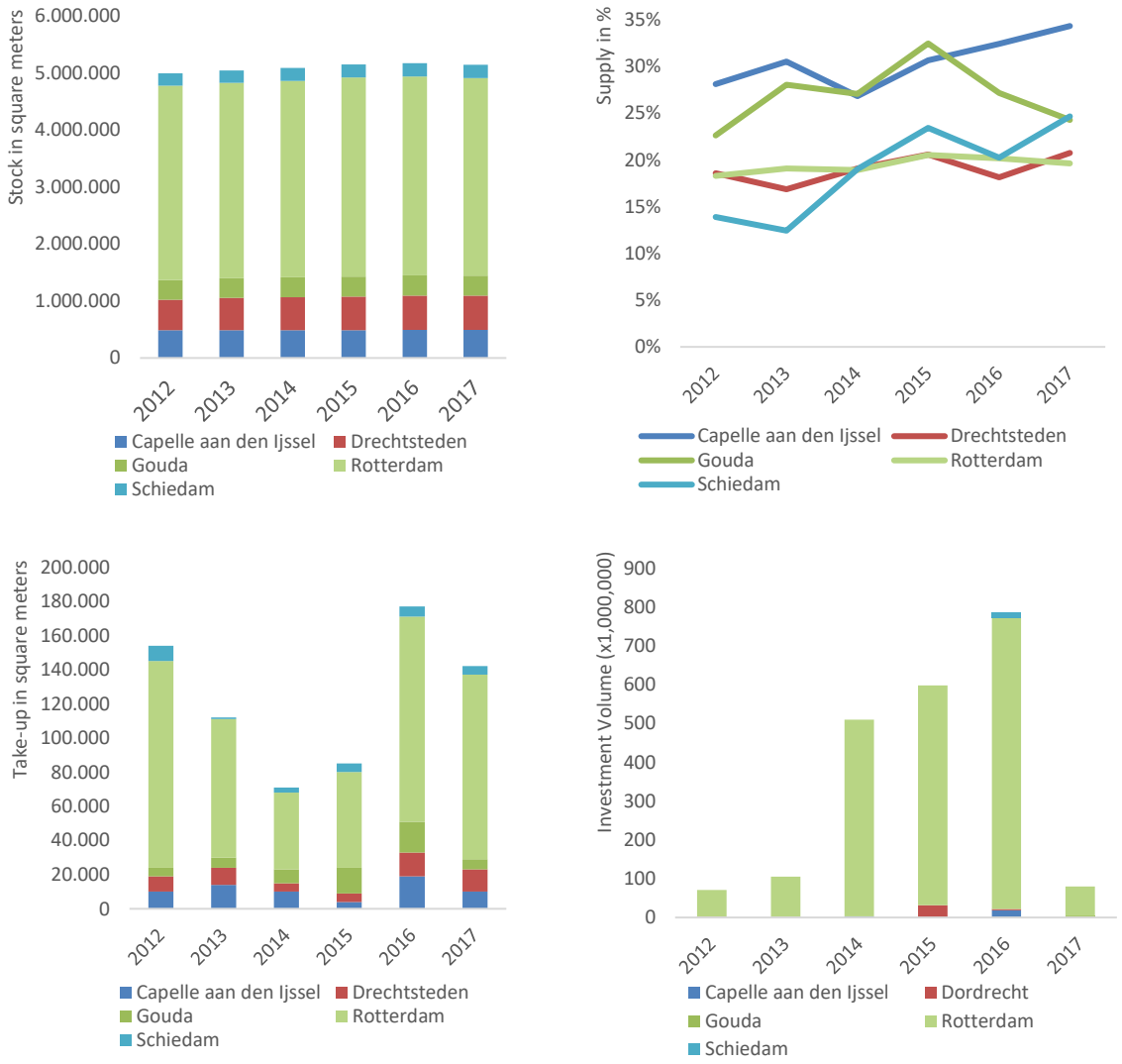

Figure 3.9 office market developments in cities of the Rotterdam area. Clockwise from top left; (1) stock in square meters, (2) supply in %, (3) take-up in square meters and (4) investment volumes in EUR (x1,000,000). Source; Nederland Compleet[9] and Springbase.

[9] Data retrieved from publically available market reports from DTZ via dtz.nl/media. *Nederland Compleet (2012 – 2016) and view.publitas.com/cushmanwakefield (2017)*

The Hague Area

The office market in the The Hague Area involves much around the institutional character of The Hague. While Amsterdam is constitutionally the capital of the Netherlands, The Hague is the seat of the Dutch Government, Parliament, the Supreme Court and the Council of the State. The office market in The Hague Area broadly includes The Hague – the third largest city of the Netherlands – and the neighboring municipalities of Delft, Leiden, Leidschendam-Voorburg, Rijswijk and Zoetermeer. The total area comprises of 6,732,000 of office space.

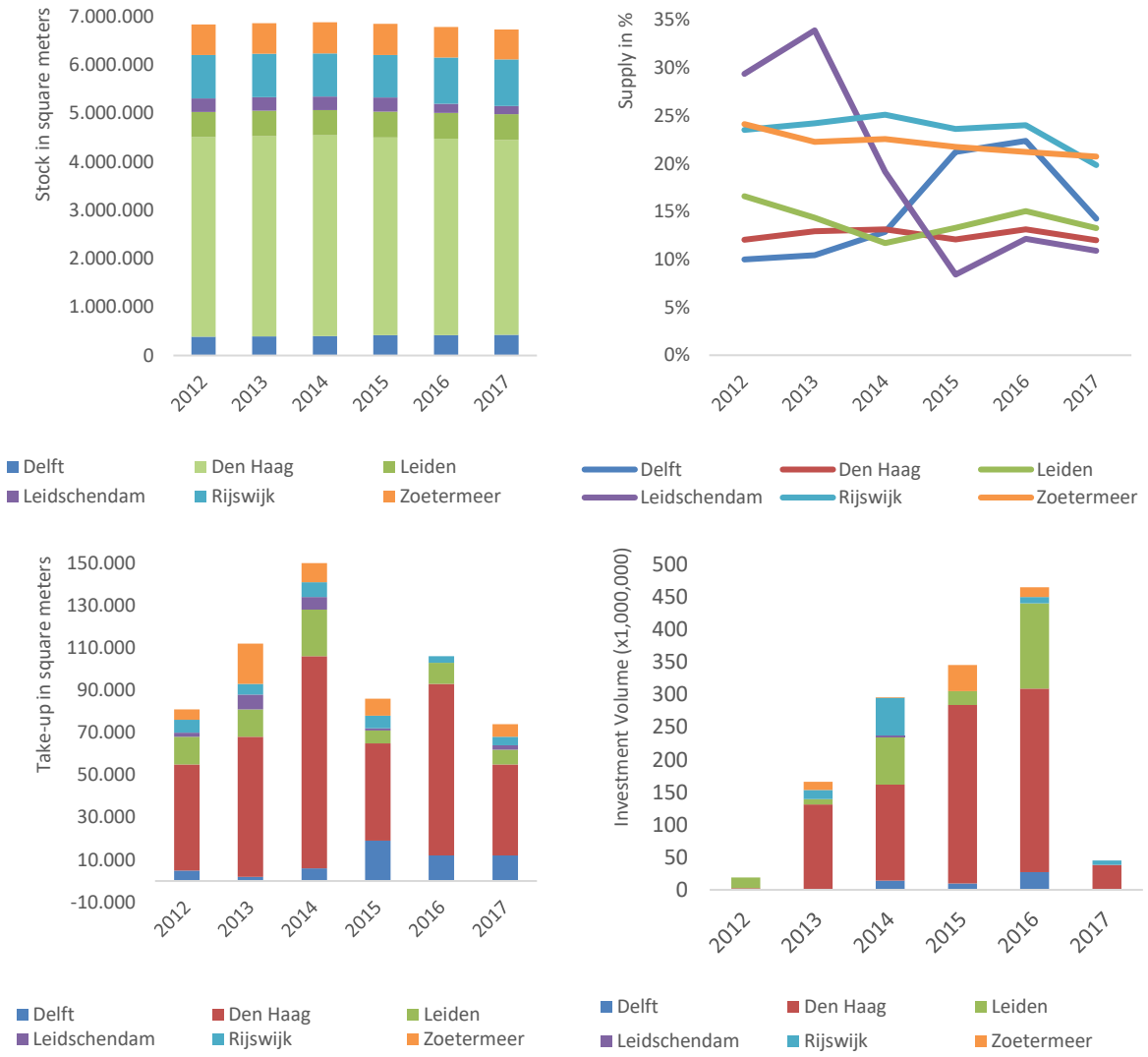

Figure 3.10 office market developments in cities of the The Hague area. Clockwise from top left; (1) stock in square meters, (2) supply in %, (3) take-up in square meters and (4) investment volumes in EUR (1,000,000). Source; Nederland Compleet[10] and Springbase

[10] Data retrieved from publically available market reports from DTZ via dtz.nl/media. *Nederland Compleet (2012 – 2016) and view.publitas.com/cushmanwakefield (2017)*

Utrecht Area

The office market in the Utrecht Area is the smallest within the Randstad office market. The Utrecht region is considered to be one of the most competitive region in the European Union and scores particularly well in terms of its infrastructure and innovation. Utrecht is located in the middle of the Netherlands and the central station is the largest station in the Netherlands. The office market of the Utrecht Area broadly includes Utrecht – the fourth city of the Netherlands – and the neighboring municipalities of Houten, Nieuwegein and Amersfoort. In 2017, the total area comprises 4,218,000 square meters of office space.

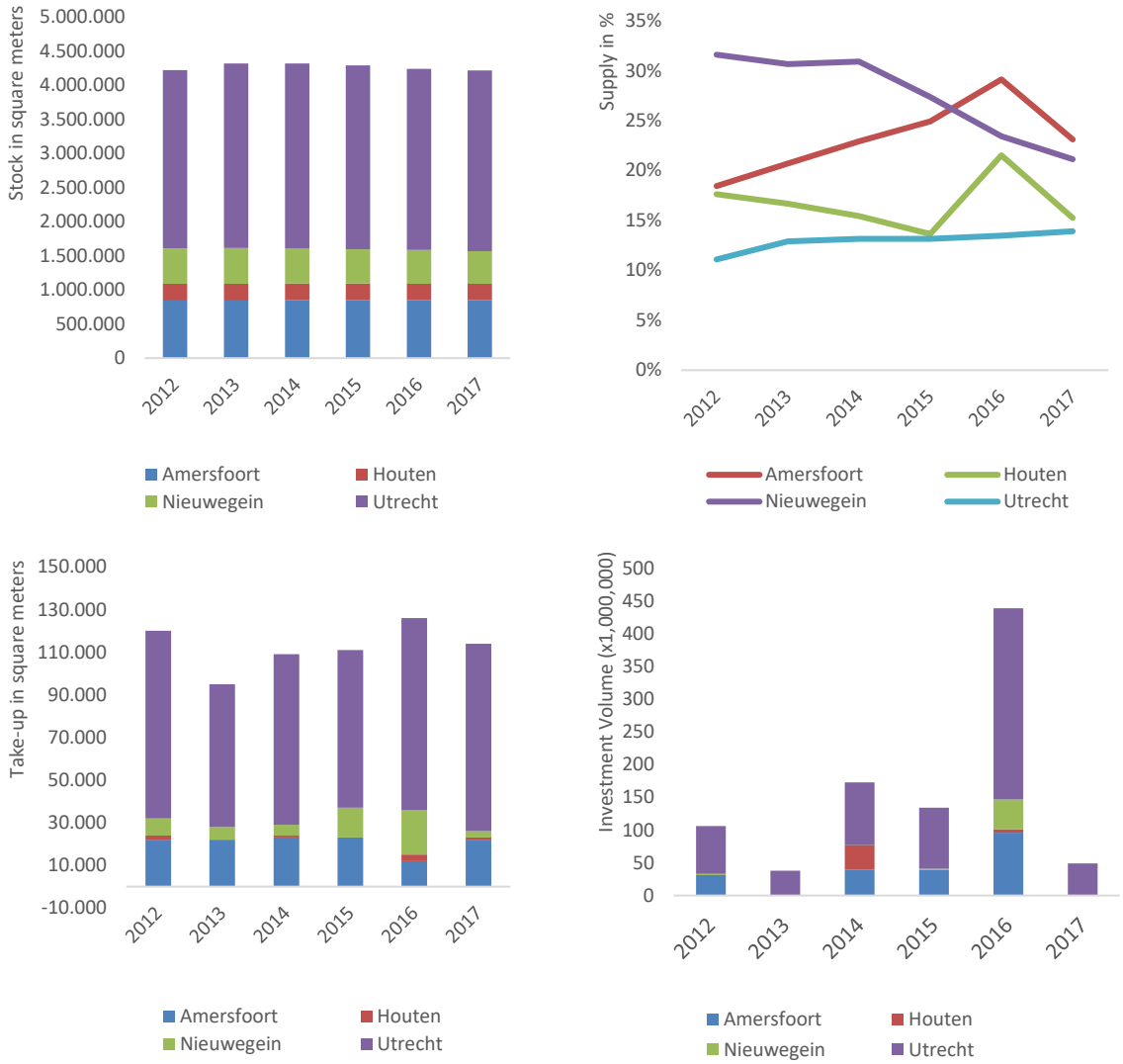

Figure 3.11 office market developments in cities of the Utrecht area. Clockwise from top left; (1) stock in square meters, (2) supply in %, (3) take-up in square meters and (4) investment volumes in EUR (1,000,000). Source; Nederland Compleet[11] and Springbase

[11] Data retrieved from publically available market reports from DTZ via dtz.nl/media. *Nederland Compleet (2012 – 2016) and view.publitas.com/cushmanwakefield (2017)*

4. Data

In this section we will operationalize determinants of office transaction prices (both in terms of the transaction price per square meter and the total transaction price) that we have investigated in section 2. This includes the main subject of this thesis, namely the effect of an office building being single-tenant or multi-tenant. In this section we will describe these variables of the available dataset and their statistics.

4.1 Variable overview

The model has been applied to a dataset of investment transactions of office properties that took place in the Randstad office market. The data set consists of 428 investment transactions that took place during the period 2012 – 2017. In table 4.1 we have listed all variables available in the dataset and their expected relation relative to the transaction price per square meter. In this section we describe the variables that are used in this study and elaborate on their sources.

Table 4.1 Variables, descriptions and data sources

Variable	Measure	Description	Expectations relation	Data Sources
Transaction price square meter	Number variable	The price for which the office property was transacted in square meters		Springbase (Kadaster)
Status	Dummy variable	If property is acquired within a set of other properties (portfolio) = 1, if properties is acquired on a single ticket basis = 0	(+) for portfolio acquisitions. (-) for single acquisitions.	Springbase
Purpose	Dummy variable	If the property is acquired for transformation purpose = 1, if property is acquired as investment = 0.	(+/-)	Springbase
Number of tenants	Number variable	Number of tenants in the property at time of transaction	(+)	Springbase
WALT	Number variable	Weighted average lease term of the existing contracts at time of transaction	(+)	Springbase
Gross passing rent	Number variable	Total contracted gross rent in the property.	(+)	Springbase
Transaction year indicator	Dummy variable	Year property is transacted (6 included)	(+)	Springbase
Buyers nationality	Dummy variable	If the property is acquired by a non-national investor = 1, if property is acquired by a Dutch investor – 0.	(+) relative to Dutch investors	Own research
First sale	Dummy variable	If the property is acquired for the first time = 1, if the property is not acquired for the first time = 0	(-) relative to first sales	Vastgoeddata
Totalsqm	Number variable	Total size of the property in square meters.	(+)	Springbase

Year built	Number variable	Year in which the property has been built	Non-linear	Springbase
Parking Spaces	Number variable	Total parking spaces of the property	(+)	Springbase
Vacancysqm	Number variable	Total vacancy in the property in square meters at time of transaction.	(-)	Springbase
Energy Label	Categorical Variable	Energielabel of the property	(+)	Springbase
Walkscore	Number variable	Measures the service level of the immediate surrounding of the property.	(+)	Own research
Distance ramp	Number variable	Distance to closest located highway ramp	(-)	Own research
Distance highway	Number variable	Distance to closest located train station	(-)	Own research
Vacancy city	Number variable	Percentage of office vacancy per city per year	(-)	Own research
Takeup city	Number variable	Percentage of office take-up per city per year	(+)	Own research
Subarea indicator	Dummy variable			Springbase

4.2 Data Sources

Most of the data are collected from Springbase, the database of nationally operating real estate service provider Spring Real Estate. Springbase is an extensive database containing information on over 14,000 office properties, 1,450 office investment transactions and over 3,300 rental transactions. For our research, we will only use the office investment transactions. The intransparancy of the office market makes it difficult to collect reliable data. It is particularly difficult to build up large databases on office transaction prices, as the relevant information is often confidential (Downs and Slade, 1999). Information on the tenancy of a building (rent, lease terms, incentives) is solely in hands of the owner and possibly in hands of any asset manager or leasing agent, whom are ought not to disclose this information with third parties. The consequences are that data on offices is usually limited to property characteristics.

The transactional data of Springbase is largely derived from the Kadaster and multiple Investment Memorandum that Spring Real Estate has received during the years being a top real estate broker in the Netherlands (PropertyNL, 2017). Springbase contains full information on a large number of office transactions that have occurred in the last five years. An Investment memorandum in the real estate investment market is a selling document that a company presents to potential investors to explain objectives, risks an investment terms. Investment memorandums are provided by the vendor and/or its selling agent towards potential buyers and/or investment brokers.

In general, an Investment Memorandum provide potential investors with the key information regarding an investment opportunity. It includes all property characteristics such as the size of the property in square meters, the number of parking spaces, the age of the property and its energy label. In addition, Investment Memorandums includes a rent roll which provides Springbase with the weighted average lease terms, gross inplace rent, the number of tenants and the vacancy in the property at time of transaction.

To complete a full reference of any real estate transaction, the records in Springbase are supplemented with information from the Kadaster. In the Dutch real estate market, transaction prices of real estate – net of purchasing and transfer costs (k.k.) - exact transaction dates and the legal entities that formally have acquired the concerning property are available at cost at the Kadaster, regardless what sector of real estate. Kadaster is a government held public register of registered properties and its established rights.

Kadaster derives the information from transfer declarations that have to be submitted to the Kadaster. All transaction prices, transaction dates in Springbase are derived from the Kadaster directly, or indirectly through the real estate media.

There are a number of specific variable that Springbase derives from information that is originating from the Investment Memorandum as well as the information that is originating from the Kadaster, namely;

1. Gross initial yields; is derived by dividing the given inplace rent (Investment Memorandum) and the transaction price paid by an investor (Kadaster)
2. Transaction price per square meter; is derived by dividing the given transaction price paid by an investor (Kadaster) by the size of the property in square meters.

Spring Real Estate has signed non-disclosure agreement for most of this information. This study will not reveal any specific information for any observation, but will purely conduct a regression over the observations and conclude the results.

4.3 Additional data collection

Google Walkscore

Springbase does not contain data regarding the quality of the location where the observation occurs. Thus we have included a variable that measures the reachability of any address using a patented system, namely the Walkscore. The Walkscore[12] is powered by Google and

[12] Data retrieved from www.walkscore.com.

analyzes hunderds of walk routes from the concerning property to nearby amenities[13]. The Google Walkscore gives us the opportunity the control for the quality of subareas.

Buyers nationality
Springbase does contain information on the buyer, but it does not contain data regarding the nationality of a buyer. Via own research, the buyer has been identified through the legal entity that acquired the asset. The nationality of the buyer is derived from the location of the parent company that holds the legal entity that acquired the asset. We have identified 15 different nationalities among the buyers of the dataset.

First sales
In our literature review we have concludes that properties can depreciate between sales (Liu et al, 2013; Patel, 2000; Baum and Turner, 2004). Springbase does not contain data regarding how many times a property has switched ownership. Vastgoeddata[14], a database for Dutch real estate, contains this data per property. Thus we have included a variable that indicated if a property is sold for the first time or not.

Distance ramp & highway.
In section 2.3 we have identified that accessibility by public transit and car are of significant importance to derive to office transaction prices. Therefore, we have included a variable to incorporate the accessibility both in terms of public transit. It concerns a measure of the properties' distance to the closest train station and the closest highway ramp measured in meters and has been retrieved via measure distance tools in arcgis.

Cities vacancy rate and the net annual take-up rate
In section 3.3, we have investigated the different market dynamics of the cities that are part of the Randstad Metropolitan area. Based on the data that has been provided by the annual market reports of Nederland Compleet[15], We will include the vacancy rate and the net annual take-up rate of the specific city in the specific transaction. The vacancy rate represents the amount of vacant office space in the city as a percentage of the office stock in the city. The net annual rental take-up represents the amount of vacant office space that has been taken in use , as a percentage of the vacant office space in the city. This is excluding rental renewals and sale-and-leaseback transactions.

4.4 Adjusted variables

[13] Points are awarded based on the distance of the property to amenities in the following categories; Dining & Drinking, Groceries, Shopping, Errands, Parks, Schools, Culture & Entertainment.
[14] Data retrieved from www.vastgoeddata.nl
[15] Data retrieved from publically available market reports from DTZ via dtz.nl/media. *Nederland Compleet (2012 – 2016) and view.publitas.com/cushmanwakefield (2017)*

We have chosen to transform the numeric variable year built into a dummy variable because we do not expect a linear relation between the transaction price per square meter and the age of a property. This is expected because in general properties with a historical appearance are considered to be more popular than properties that are 20 to 30 years old. We have created dummy variables for properties that are built before 1900, properties that are built between 1900 – 1949 and for every single decade after 1949.

We will also transform the numeric variable number of tenants into a dummy variable. We will create a dummy variable named tenant type that categorized the observations into multi-tenant, single-tenant and vacant properties, based on the discussed definition in section 2.

- Multi-tenant properties are properties with two or more tenants, or properties with one tenant and more than 10 percent vacancy.
- Single-tenant properties are properties with one tenant and/or not more than 10 percent of vacancy.
- Vacant properties are properties with 100 percent vacancy or a weighted average lease term (walt) that is shorter than one year.

4.5 Deleted Variables

Energy labels
Since 1 January 2008, a valid energy label is required for each transaction (rental, sale or delivery) that involves a utility property. Only since 1 may 2016, investors in utility properties will be fined if they will not registered the energy label of their properties at time of a transaction. Many of the observations do not have a registered energy label and therefore we have deleted the variable from the dataset.

Gross passing rent
We have chosen to not include the variable gross passing rent per square meter for a number of reasons. The rent that each individual tenant signed for is strongly related to the start date of the lease agreement and the lease terms. Without a trustworthy view on market rent of a specific property at time of a transaction, we cannot conclude if the property is considered to be under-rented or overrented.

4.6 Observation overview

The dataset comprises of 428 observations that were recorded in the Randstad office market in the period between 2012 and 2017. Figure 4.1 shows a geographical overview of the observations from the dataset. The observations are distributed over 21 municipalities within

the Randstad Metropolitan Area. Table 4.2 gives us an overview of the distribution of the observations among the areas in the Randstad metropolitan area and years.

Table 4.2 Distribution of observations among areas and years.

	2012	2013	2015	2016	2017
Amsterdam area	20	25	74	63	20
Rotterdam area	3	13	14	11	1
the Hague area	2	12	13	21	6
Utrecht area	6	5	7	15	2

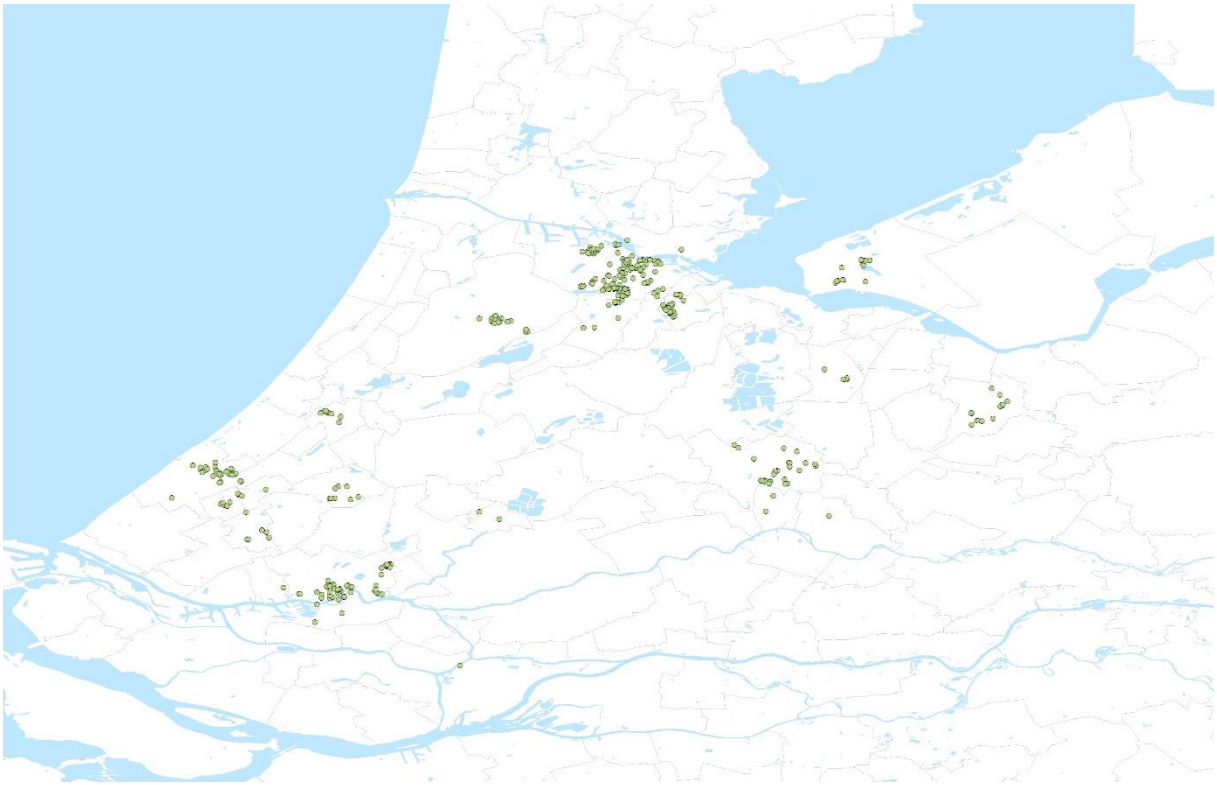

Figure 4.1 Geographical overview of the observations.

4.7 Outliers

Outliers can have a very negative effect on the regression equation that is used to predict the value of the dependent variable based on the independent variable. Therefore we will check if the dataset contains any outliers.

One way to detect outliers is testing the z-score on individual observations. The z-score indicated how many standard deviations an element is from the mean and is calculated as $z = (X - \mu)/\sigma$, in which X is the value of the element, μ is the population mean and σ is the standard deviation. With a normal distribution, about 99% have a z-score between -3 and 3. When calculated the Z-scores, all value below -3 or above 3 (more than 3 times larger than the stand deviation of the mean) are considered to be outliers.

Within all observations, three observations have been identified to have a standard deviation that is three times greater than the mean. Further analysis indicates that all deviant observations are located in the City Centre of Amsterdam, one of the most expensive subareas in the Netherlands. Figure 4.2 shows a graphical representation of the distribution of the dependent variable price per square meter. In this figure, we see a high density of transaction prices between approximately EUR 500 per sqm and EUR 2,000 per sqm. On the far right of the figure we see some level of density around transaction prices of EUR 8,000 per sqm, which can be considered outliers. We have identified one additional observations that has a standard deviation that is three times greater than the mean when taking into account the specific transaction year.

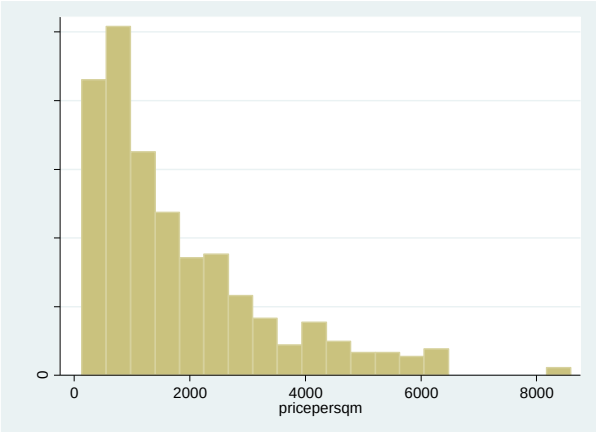

Figure 4.2 price per square meter

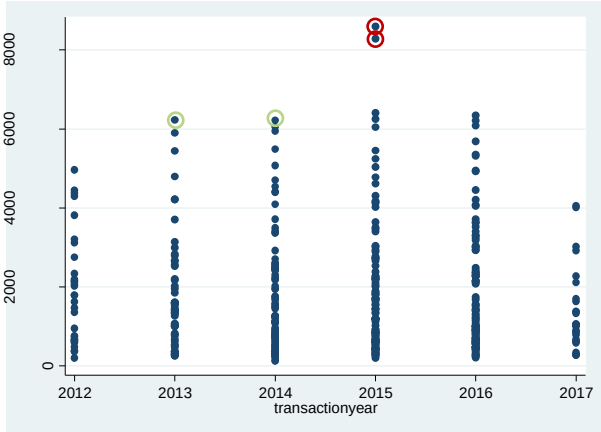

Figure 4.3 Price per square meter per transaction year

Figure 4.3 shows us the scatter plot of the transaction prices per square meter in a specific transaction year. The highest transaction price per square meter in the dataset is that of the office property The Bank. The observation will be deleted from the dataset due to the z-score of 3.85. Another outlier will be deleted from the dataset, based on their z score of 3.68. We have decided to accept the other two outliers, because their z-score of 3.04 and 3.02 is marginal.

In figure 4.4, we have calculated the z-scores of observations per area in order to prevent that outliers within the different areas. We have calculated the z scores per observation and have identified three observations that have a standard deviation that is three times larger than the mean when taking into account the specific transaction year. Further analysis indicates that the other outlier that we have identified cannot be allowed in the dataset, due to the specific aspects of the transaction.

The other outlier, as seen in figure 4.4, concerns a property in Almere. Further analysis indicates that it concerns a fully-leased single-tenant property with a long walt. Prices of EUR 2,288 per sqm in Almere are considered outliers, but taking into account the single-tenant long leased nature of the property, it might nog be as much of an outlier as it looks. Therefore, we have calculated the z-scores on observations per tenant type, the dummy that we have discussed in section 4.4. The property in Almere is acceptable when calculating the z-scores on observations per tenant type. However, we have found four addition observations that have a standard deviation that is three times greater than the mean when taking into account the tenant type. We have dropped those observations from the dataset.

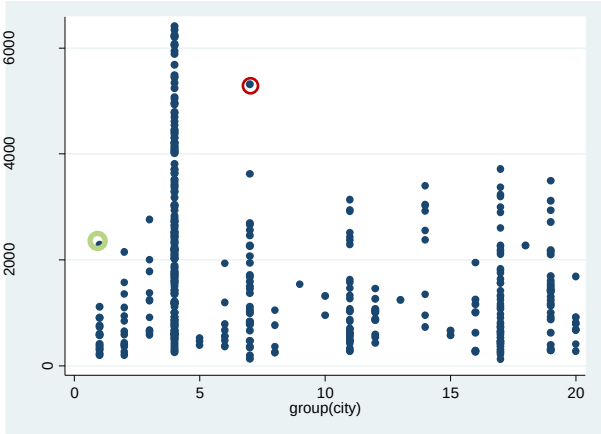

Figure 4.4 Price per square meter per municipality (21 municipalities included)

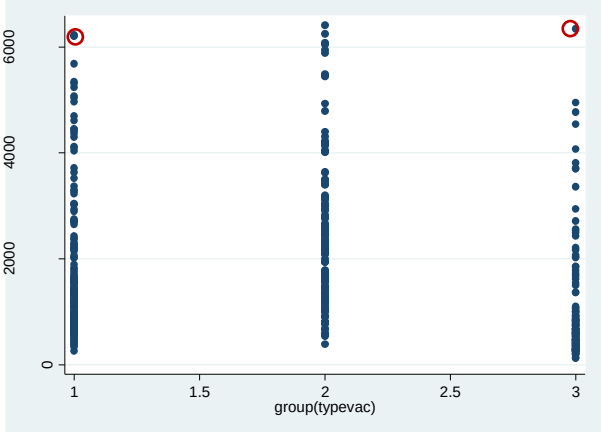

Figure 4.5 Price per square meter per tenanttype

In figure 4.6, we have calculated the z-scores of the variable number of tenants to prevent office properties with a high number of tenants to influence our result. Two observations have been identified in which the number of tenants are considered to be outliers. Please note that the outliers on number of tenants are only considered to be outliers when using the variable instead of the dummy variable tenant type.

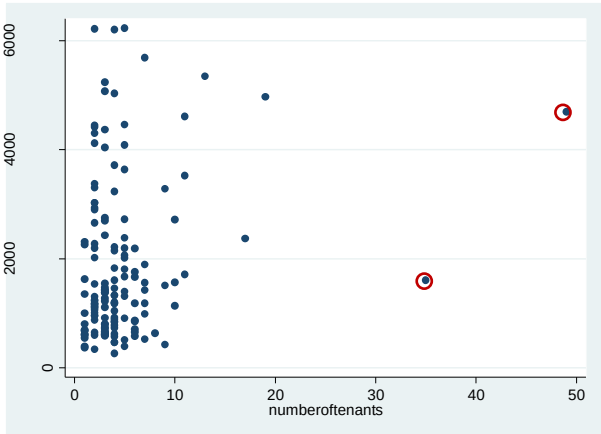

Figure 4.6 Number of tenants.

After dropping the outliers the dataset contains 420 observations. Please note that we have only dropped observations with a standard deviation that were three times greater than the mean. We have not found any observations with a standard deviation that were three times smaller than the mean.

4.8 Descriptive statistics

Table 4.3 gives an overview of the descriptive statistics of all investigated variables. In the table we see that the average transaction price of the dataset is EUR 1,717 per square meters after dropping the outliers that we have discussed in section 4.5. The lowest transaction price in the dataset concerns EUR 128.30 per square meter and was recorded in Rotterdam in 2014. The highest transaction price in the dataset is EUR 6,410.25 per square meter and was recorded in the City Centre of Amsterdam.

The average size of an office property in the dataset is 9,183 square meters. The smallest property in the dataset concerns a property in City Centre of Amsterdam and comprises 351 square meters. The largest property in the dataset concerns a property on the South-Axis in Amsterdam and comprises 51,890 square meters.

The average number of parking spaces of an office property in the dataset is 118. There are a 69 properties in the dataset that do not have any parking spaces. These properties mostly concerns properties in the City Centre of Amsterdam. The property with the most parking spaces concerns an office property in Utrecht that comprises 21,125 square meters of office space. The property has 975 parking spaces

The average walt of an office property in the dataset at time of transaction is 3.93. The office property with the highest walt recorded is located in Leiden. It concerns a single-tenant property that was acquired with a walt of 20 years. At time of the acquisition, the property was just completed.

The average walkscore of an office property in the dataset is 76.38. The lowest walkscore of 3 – indicating a very low level of services in the area - was recorded in Delft. It concerned a single-tenant property with a long lease that could be defined as a highway location. One property within the dataset has a walkscore of 100 – indicating a perfect level of services in the area. The concerning property was located in the City Centre of Amsterdam.

The average distance from an observation to the closest ramp of the highway is 1,657 meters. The property that was located the closest to the highway ramp is located 122 meters from a ramp of the A10 highway ring road of Amsterdam. The property in the dataset that is located the furthest from the highway is located in The Hague, 5,213 meter from the A4 highway. The average distance from an observation to the closest train station is 1,197 meter. The property

that is located the closest to a train station concerns an office property that is located 38 meters from train station Prins Alexander in Rotterdam. The property that is located the furthest from a train station concerns a single-tenant office property that is located in Amstelveen, approximately 6,257 meter from train station Amsterdam Zuid.

The average percentage of supply in the city over the period of 2012 - 2017 in which an observation was recorded was 18.5 percent. Of all cities in the database, the lowest percentage of supply was recorded in Diemen in 2017, when only 8.8 percent of the office stock was vacant. The highest percentage of vacancy was recorded in Almere in 2016. In that year, more than 33.3 percent of the office stock in Almere was vacant.

The average annual take-up per city – as a percentage of the supply – over the period of 2012 –2017 was 16.1 percent. Two municipalities had no take up of supply, concerning Diemen in 2017 and Zoetermeer in 2016. The highest take-up as a percentage of the supply was recorded in Amsterdam in the first half of 2017 when more than 47.1 percent of the supply was taken up.

The average numbers of tenant in an office property in the dataset at time of transaction is 2. Within the dataset of 420 observations, 147 observations are multi-tenant properties, representing a share of 35 percent. The dataset comprises 132 observations are single-tenant properties, representing a share of 31.4 percent. The dataset comprises of 141 vacant properties – properties with 0 tenants or properties with a walt shorter than 1, representing a share of 33.6 percent of the total dataset. The property with the most tenants is located in the South-Axis and has 49 tenants.

The means of the building year dummies give us the share of observations of the dummy in the total dataset. Almost the half of the properties in the dataset was built in the period 1990 – 1999 (23.3%) and 2000 – 2009 (28.6%). Properties that were built between 1950 - 1959 are the smallest group within the dataset (1.9%).

The means of the dummies of the transaction years give us the share of observations of a transaction year in the total dataset. The number of observations in year 2015 and 2016 represent in total half of the observations in the dataset. Transaction year 2017 has the lowest observations of all included year dummies, but the observations only account for the first half of 2017.

Approximately 37.6 percent of all observations were transacted within a portfolio. Approximately 62.4 percent of all observations were transacted as a single-ticket. More than 11 percent of the observations in the dataset was sold for the first time. More than 89 percent of the observations were not sold for the first time. In addition, more than 88.8 percent of the

observations in the dataset were acquired for the purpose of office investments. Almost 11.2 percent of the observations in the dataset were acquired for the purpose of transformation.

We have added and adjusted the nationality of the buyer as a dummy variable, as discussed in section 4.4. More than 52 percent of the buyers in the dataset were Dutch. Almost 48 percent are international.

Table 4.3 Descriptive statistics

	Obs	Mean	Std. Dev	Minimum	Maximum
Price per square meters	420	1717.015	1413.299	128.304	6410.256
Total square meters	420	9183.658	9383.711	351	51890
Vacancy in square meters	420	2928.986	6204.595	0	51217
Parking spaces	416	118.492	138.919	0	975
WALT	420	3.932028	4.200026	0	20
Walkscore	420	76.07857	19.22474	3	100
Distance to closest ramp	420	1657.622	1094.314	121.772	5212.717
Distance to closest station	420	1196.601	998.7315	38.02085	6257.008
Percentage vacancy city	420	0.1854657	0.0428772	0.0878049	0.3333333
Percentage take-up city	420	0.161322	0.0827304	0	0.4710947
Number of tenants	420	1.995238	3.720546	0	49
Year built = < 1900	16	0.0381			
Year built = 1900 – 1949	30	0.0714			
Year built = 1950 – 1959	8	0.0190			
Year built = 1960 – 1969	25	0.0595			
Year built = 1970 – 1979	27	0.0643			
Year built = 1980 – 1989	57	0.1357			
Year built = 1990 – 1999	98	0.2333			
Year built = 2000 – 2009	120	0.2857			
Year built = > 2010	39	0.0929			
Tenant type = Multi-tenant	147	0.3500			
Tenant type=Single-tenant	132	0.3143			
Tenant type = Vacant	141	0.3357			
Transactionyear = 2012	31	0.0738			
Transactionyear = 2013	55	0.1310			
Transactionyear = 2014	94	0.2238			
Transactionyear = 2015	105	0.2500			

Transaction year = 2016	106	0.2524
Transaction year = 2017	29	0.0690
Status = Portfolio	158	0.3762
Status = Single	262	0.6238
Sale = First	47	0.1119
Sale = Not first	373	0.8881
Purpose = Investment	373	0.8881
Single = Transformation	47	0.1119
Buyer = Nationality	220	0.5238
Buyer = Non-nationality	200	0.4762

Table 4.4 is an overview of the descriptive statistics of the numeric variables for multi-tenant, single-tenant and vacant properties.

Single-tenant properties have the highest mean price per square meters. Single-tenant properties transact on average at EUR 2,456. The lowest price per square meter for single-tenant properties concerns a property that was located in Amsterdam Sloterdijk and was acquired in 2012 with a walt of 8.3 years. The highest price per square meter for single-tenant properties concerns a property located in the City Centre of Amsterdam and was acquired in 2015 with a walt of 4.3 years.

Multi-tenant properties transact on average at EUR 1,863. The lowest price per square meter for a multi-tenant observation concerns a property in Rijswijk. The property was acquired for EUR 263 per square meter in 2013. At time of the transaction, the property had 4 tenants, a walt of 1.8 years and vacancy of 43 percent. The highest price per square meter for a multi-tenant observation concerns a property on the South-Axis of Amsterdam. The property was acquired for EUR 6,228 per square meter in 2015. At time of transaction, the property had 5 tenants, a walt of 11.5 years and a 4 percent vacancy.

Vacant properties have the lowest mean price per square meter. Vacant properties transact on average for EUR 871 per square meter. The lowest price per square meter for a vacant observation concerns a property in Rotterdam. The property was acquired for EUR 128 per square meter in 2014 for the purpose of transformation. The highest price per square meter for a vacant observation concerns a property on the South-Axis in Amsterdam. The property was acquired for EUR 4,068 in 2016.

Table 4.4 Descriptive statistics of numeric variables for multi-tenant, single-tenant and vacant properties.

	Obs	Mean	Std. Dev	Minimum	Maximum

Price per sqm	Multi-tenant	147	1863.059	1437.011	263.5362	6228.644
	Single-tenant	132	2458.002	1425.996	385.8261	6410.256
	Vacant	141	871.0656	812.9637	128.3035	4068.950
Size of property	Multi-tenant	147	9777.537	9771.363	618	51890
	Single-tenant	132	10283.20	9338.184	351	45659
	Vacant	141	7535.15	8838.47	540	51217
Walt	Multi-tenant	147	4.571511	2.986953	1.0	14.4
	Single-tenant	132	7.366611	4.229156	1.0	20
	Vacant	141	0.0499786	0.1575347	0	0.9
Walkscore	Multi-tenant	147	76.27891	18.25459	19	100
	Single-tenant	132	73.45455	21.79935	3	99
	Vacant	141	78.32624	17.3878	24	99
Distance to ramp	Multi-tenant	147	1587.541	1153.074	121.772	5215.717
	Single-tenant	132	1714.904	1129.652	140.5375	4180.428
	Vacant	141	1677.060	997.3685	236.0063	4508.866
Distance to station	Multi-tenant	147	1262.446	1115.855	38.02085	6021.975
	Single-tenant	132	1246.596	1127.65	65.05361	6257.008
	Vacant	141	1081.15	690.357	58.14693	3378.478

Single-tenant properties are on average the largest properties. Single-tenant properties on average have a size of 10,283 square meters. Multi-tenant properties on average have a size of 9,777 square meters. Vacant properties are relatively smaller and have an average size of 7,535 square meters.

Single-tenant properties transact on average with the longest weighted average lease length (WALT). The average walt of a single-tenant property at time of the transaction is 7.36 years. Multi-tenant properties transact on average with a walt of 4.57 years. Needless to say is that the average walt of vacant properties at time of transaction is close to zero.

Surprisingly, vacant properties have the highest average walkscore of 78.3, indicating that vacant properties are located in environments that have a high level of services. Single-tenant properties have on average the lowest Walkscore or 73.5. In addition, single-tenant properties have the widest range, ranging from 3 to 99. Multi-tenant properties have on average a Walkscore of 76.3.

On average, multi-tenant properties are located the closest to a highway ramp, with a mean distance of 1,587 meter. Single-tenant properties are located the farthest from a highway ramp,

with a mean distance of 1,714 meter. Vacant properties are on average located at 1,677 distance of a highway ramp.

There is not much difference between multi-tenant and single-tenant properties when it comes to the average distance to the closest train station, respectively 1,262 meters and 1,246 meters. Surprisingly, vacant properties are located the closest to a train station. On average, vacant properties are located 1,081 from the closest train station.

Table 4.5 is an overview of the descriptive statistics of the dummy variables for multi-tenant, single-tenant and vacant properties.

Vacant properties are generally old, with more than 90 percent of the observations being built before 2000. The largest group of vacant properties within the dataset at properties that are built in period between 1980 – 1989 (25.5%). Multi-tenant and single-tenant properties are relatively newer.

As we have seen in table 4.5, most observations in the dataset were recorded in 2015 and 2016. This corresponds with our market analysis in section 4. Overall, there is not much of tendency of investors to invest in one type or another in the specific transaction year. We can conclude that single-tenant property investments are overrepresented in 2013 and multi-tenant property investments are underrepresented in the first half of 2017 within the dataset.

Most multi-tenant properties have been acquired within a larger portfolio of properties while most single-tenant and vacant properties have been acquired on a single-ticket basis.

Most properties in the dataset have not been acquired for the first time. For the 147 observations that are multi-tenant properties, 19 observations (12.9%) have been acquired for the first time. For the 132 observations that are single-tenant properties, 22 observations (16.7%) have been acquired for the first time. Only 4.3% of the vacant properties in the dataset concerned properties that were sold for the first time.

Naturally, all single-tenant and multi-tenant properties have been acquired for the purpose of an office investment, but 33 percent of the vacant properties in the dataset have been acquired for the purpose of transformation to other types of real estate, such as dwellings and hotels.

Most of the multi-tenant and of the single-tenant properties are acquired by international investors, respectively 59.9% and 64.4%. Most vacant properties (80.1%) have been acquired by national investors.

Tabel 4.5 Descriptive year built per tenant type

	Multi-tenant	Single-tenant	Vacant

	Obs.	Percent	Obs.	Percent	Obs.	Percent
Year built = < 1900	3	2.04	5	3.79	8	5.67
Year built = 1900 – 1949	6	4.08	7	5.30	2	1.42
Year built = 1950 – 1959	2	1.36	4	3.03	9	6.38
Year built = 1960 – 1969	10	6.80	6	4.55	13	9.22
Year built = 1970 – 1979	7	4.76	7	5.30	28	19.86
Year built = 1980 – 1989	16	10.88	13	9.85	36	25.53
Year built = 1990 – 1999	32	21.77	30	22.73	25	17.73
Year built = 2000 – 2009	55	37.41	40	30.30	3	2.13
Year built = > 2010	16	10.88	20	15.15	8	5.67
Transactionyear = 2012	13	8.84	9	6.82	9	6.38
Transactionyear = 2013	16	10.88	23	17.42	16	11.35
Transactionyear = 2014	32	21.77	29	21.97	33	23.40
Transactionyear = 2015	39	26.53	30	22.73	36	25.53
Transactionyear = 2016	44	29.03	28	21.21	34	24.11
Transactionyear = 2017	3	2.04	13	9.85	13	9.22
Status = Portfolio	147	56.46	45	34.09	30	21.28
Status = Single	64	43.54	87	65.91	111	78.72
Sale = First	19	12.93	22	16.67	6	4.26
Sale = Not first	128	87.07	110	83.33	135	95.74
Purpose = Investment	147	100.00	132	100.00	94	66.67
Single = Transformation	0	0	0	0	47	33.3
Buyer = Nationality	59	40.14	48	36.03	113	80.14
Buyer = Non-nationality	88	59.86	84	63.64	128	19.86

5 Methodology

In this section, we will discuss the methodology. On the basis of the methodology, we will test the hypothesis of this research.

5.1 Multiple Linear Regression Analysis.

This research is an explanatory research which is quantitatively conducted by a regression analysis. Hedonic regression modeling is the standard methodology for examining price determinants in real estate research. Hedonic regressions are widely used in housing market studies to determine price effects. It is less applied on commercial real estate markets. We will use this technique in order to determine the price effects of occupiers on office transaction.

This research tests if there is a significant relationship between an office property being single-tenant, multi-tenant or vacant and the transaction price, while controlling for a number of transactional, spatial and property variables that could have an influence on the transaction price, as we have discussed in section 2.3. A multiple linear regression helps us testing the hypothesis. A multiple linear regression attempts to model the relationship between the explanatory independent variables (the transactional, spatial an property variables outlined in section 5.1) and the dependent variable. The linear regression model is shown as followed;

$$\partial i,t = \alpha + \beta_1 \delta i,t + \sum \beta_3 Pi,t + \sum \beta_4 Si,t + \sum \beta_5 Ti,t + \varepsilon i,t$$

Here the ∂,t is the transaction price per square meter for transaction i at time t. δ denotes the dummy tenant type for transaction at time t which is our variable of interest. P denotes a vector for several explanatory property characteristics for transaction i at time t. S denoted a vector for several explanatory spatial characteristics for transaction i at time t. T denoted a vector for several explanatory transactional characteristics for transaction i at time t. ε denotes the error term, which embodies other influences of transaction i. at time t.

There are five assumptions that underpin the classical linear regression model (Brooks and Tsolacos, 2010). These assumptions were required to show that the estimation technique had a number of desirable properties and also that hypothesis tests regarding the coefficient estimates could be conducted validly. If any of these five assumptions are not met, you cannot analyze your data using multiple regression because you will not get a valid result. The five assumptions are tested in appendix 1.

5.2 Log transformations

The regression analysis will be executed in Stata. To optimize the regression results, we have to evaluate whether each variable can be used best in the analysis in its original form, as a

natural logarithm or as a dummy variable. Log transformations can be used to make highly skewed distributions less skewed. The dependent variable – the transaction price per square meter – has undergone a log transformation. The transaction price per square meter shows a skewed distribution, as seen in figure 6.1. After the log transformation, the transaction price per square meter is relatively normally distributed, as seen in figure 6.2. In addition, the variables distance to train station and distance to ramp have undergone a log transformation.

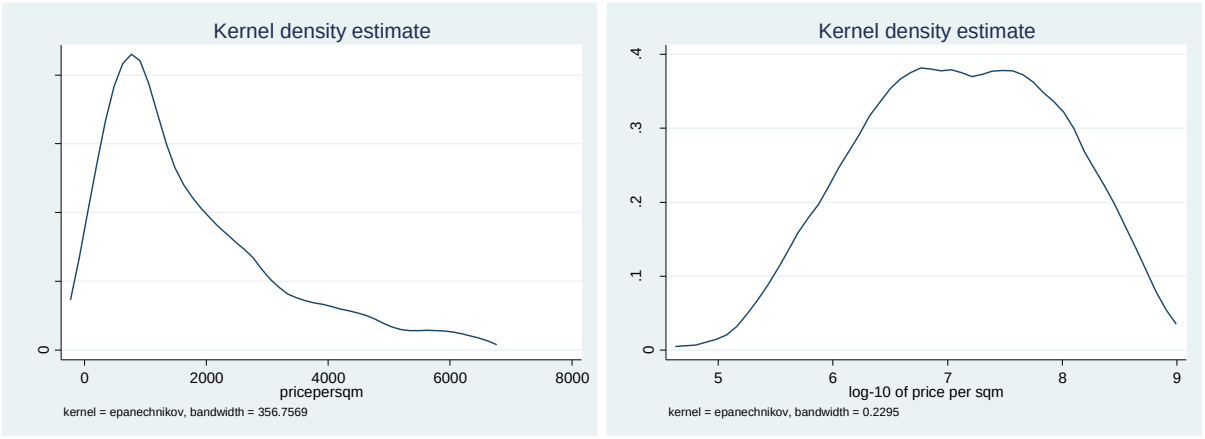

Figure 6.1 and 6.2 Distribution of transaction price per square meter before and after log transformation.

6 Estimation results

In this section we will construct our regression analysis. The models are used to determine the effect of an office property being single- or multitenant at time of transaction. The dependent variable is the logarithm of the transaction price per square meter at time of a transaction.

6.1 Regression results

Table 6.1 shows the regression results on the dummy variable tenant type. In the basic model (1) we will only regress the logarithm of the transaction price per square meter with the tenant type. Then we will set up three additional models in which we will at the property characteristics (2), transactional characteristics (3), and the locational characteristics (4).

The basic regression model shows the effect of the dummy variable tenant type on the logarithm of the transaction price per square meter. The basic model shows us on a 1% significance level that, relative to multi-tenant properties, single-tenant properties transact at a 45.5% premium. Vacant properties transact at a 55.1% discount relative to multi-tenant properties. Table 6.1 shows us that the basic model has achieved an adjusted r-squared of 0,3254. This tells us that 32.5% of the variance in the dependent log-variable transaction price per square meter is explained by its difference of being a multi-tenant, a single-tenant or a vacant property. The remaining 67.5% is not explained by the independent dummy variable tenant type.

The basic model had 420 observation. The basic regression model does not tell us much about the relationship between the transaction price and the tenant type because we have not included any other variables that could have an effect on the transaction price, as we have discussed in section 2.3.In model 2 we have added the property characteristics, in model 3 we have added the transactional characteristics and in model 4 we have added to locational characteristics. The explanatory power of model 2 increases to 52%, telling us that almost 1/2 of the variance in the dependent log-variable transaction price per square meter is explained by the independent dummy-variable tenant type and property characteristics. Model 2 has 416 observations. The loss in observations compared to the basic model is the result of 4 observations that have missing parking places. The explanatory power of model 4 increase to 57.8%. The explanatory power of model 4 improves to 63.83%, telling us that our model explains more than 2/3 of the variance in the dependent log-variable transaction price per square meter. Throughout model 2 and 3, the positive correlation between a single-tenant office property and the transaction price per square meter remains present at a 1% significance level. In model 2, single-tenant office properties transact at a 31.5% premium relative to multi-tenant office properties. In model 3, single-tenant office properties transact at a 16.4% office

premium. In model 4, the positive correlation between a single-tenant office property and the transaction price per square meter is present at a 5% significance level. In model 4, single-tenant office properties are expected to transact at a 17.9% premium relative to multi-tenant office properties.

Table 6.1 Regression results.

	(1)	(2)	(3)	(4)
	Basic model	+property characteristics	+transactional characteristics	+locational characteristics
Tenant type= Multi-tenant (Omitted)				
Tenant type = Single-tenant	0.375*** (0.0836)	0.274*** (0.0723)	0.152** (0.0766)	0.165** (0.0695)
Tenant type = vacant	-0.802*** (0.0828)	-0.564*** (0.0820)	-0.341*** (0.0937)	-0.316*** (0.0849)
Square meters		2.78e-05*** (4.95e-06)	2.26e-05*** (5.03e-06)	1.13e-05** (4.82e-06)
Vacant square meters		-3.29e-05*** (6.71e-06)	-2.65e-05*** (6.83e-06)	-2.62e-05*** (6.15e-06)
Parking places		-0.000574* (0.000315)	-0.000563 (0.000310)	-4.49e0.5 (0.000286)
Year built = before 1900		0.0677 (0.183)	0.0280 (0.177)	0.0450 (0.156)
Year Built = 1900 - 1949 (omitted)				
Year Built = 1950 - 1959		-0.582** (0.237)	-0.659*** (0.229)	-0.358* (0.210)
Year built = 1960 - 1969		-0.554*** (0.165)	-0.655*** (0.164)	-0.587*** (0.149)
Year built = 1970 – 1979		-0.958*** (0.162)	-0.944*** (0.158)	-0.712*** (0.146)
Year built = 1980 – 1989		-0.848*** (0.137)	-0.826*** (0.133)	-0.551*** (0.126)
Year built = 1990 – 1999		-0.870*** (0.127)	-0.893*** (0.128)	-0.533*** (0.125)
Year built = 2000 - 2009		-0.681*** (0.127)	-0.744*** (0.127)	-0.325** (0.126)
Year built = 2010 and after		-0.0515 (0.155)	-0.539** (0.177)	-0.171 (0.166)
Walt			0.0407*** (0.0108)	0.0330*** (0.0979)
Status = Portfolio (omitted)				
Status = Single			0.0893 (0.0705)	0.0487 (0.0643)
Sale = First				

(omitted)				
Sale = not first			-0.305** (0.119)	-0.270** (0.108)
Purpose = investment (omitted)				
Purpose = Transformation			-0.134 (0.113)	-0.0102 (0.0103)
Buyer = National (omitted)				
Buyer = Non-nationality			0.250*** (0.692)	0.219*** (0.0634)
Transaction year = 2012 (omitted)				
Transaction year = 2013			0.00771 (0.135)	0.0256 (0.124)
Transaction year = 2014			-0.0243 (0.123)	0.0165 (0.112)
Transaction year = 2015			0.0537 (0.125)	0.0698 (0.113)
Transaction year = 2016			0.0969 (0.123)	0.0941 (0.113)
Transaction year = 2017			0.0835 (0.156)	0.00301 (0.145)
Walkscore				0.00885*** (0.00184)
Log distance to ramp				-0.00118 (0.0378)
Log distance to station				0.0526 (0.0327)
Vacancy in city				-2.129*** (0.800)
Take-up percentage city				1.844*** (0.423)
Subarea dummy				-0.00335*** (0.00128)
Constant	7.263*** (0.0560)	7.746*** (0.122)	7.723*** (0.0937)	6.692*** (0.472)
Observations	416	416	416	416
Adjusted R-squared	0.3242	0.5197	0.0578	0.6383

* = significant on 10% level
** = significant on 5% level
*** = significant on 1% level

Therefore we can reject the H0 of hypotheses 1 and accept that “the difference of being an single-tenant or multi-tenant office property does influence the transaction price per square meter paid by investors”.

A main reason for this result could be explained by the fact that a single-tenant investment strategy is considered to be investor friendly because there are limited responsibilities to the owner. Another explanation could be found in the results of Liu et al. (2013) in the U.S. market. Liu et al. (2013) found that relatively younger and larger single-tenant office properties are significantly more likely to be acquired by nonlocal buyers than by local investors. In addition, Liu et al. (2013) suggests that nonlocal investors are disadvantaged on the market. They provide evidence that nonlocal investors significantly overpay on acquisition by an estimated 13.8 percent relative to similar assets purchased by local investors. This could be an indication that single-tenant investors are usually nonlocal investors and have little knowledge on the local market. However, when comparing the buyer nationalities of single-tenant vs multi-tenant office properties in the descriptive statistics, there is no clear indication that single-tenant properties are more likely to be picked up by local (national) investors relative to non-local (international) investors.

Throughout all models, the negative correlation between vacant properties and the transaction price per square meter remains present at a 1% level. In model 2, vacant office properties are expected to transact at a 43.1% discount, relative to multi-tenant properties. In model 3, vacant office properties are expected to transact at a 28.8% discount, relative to multi-tenant properties. In model 4, vacant office properties are expected to transact at a 27.1% discount, relative to multi-tenant properties. The negative relation between vacant properties and the transaction price per square meter was expected.

6.2 Multi-tenant vs. single-tenant

The results on the dummy variable tenant type in model 1 to 4 indicates that there is a significant willingness to pay for tenants in office properties. After all, vacant properties transact at a significant discount relative to office properties that have tenants (multi-tenant and single-tenant) while controlling other variables. The results on the dummy variable tenant type indicates that there is a significant willingness to pay for office properties that have only one tenant than office properties with multiple tenants.

In model 5, the regression is repeated with an interaction term on each control variable. Adding interaction terms to a regression model can greatly expand understanding of the relationship among the variables in the model and allows the stated hypotheses in 2.4 to be tested. The

model is based on 145[16] multi-tenant observations and 132 single-tenant observations. Model 5 has a relatively high explanatory power with an adjusted r-squared of almost 60.2%.

In model 5, we have found that the square meters in an office property positively correlates with the transaction price per square meter, The effect is statistically significant at a 5% level. We have found that for each additional square meter of lettable office space, we expect the transaction price per square meter of an office property to increase with 0.0000132%. However, the interaction term between the square meters and tenant type shows a negative relation at a 10% significance level. This suggests that in case the property is single-tenant, it is expected that the transaction price per square meter will decrease with 0.000013% - 0.0000170% = 0.0000038% for each additional square meter of lettable office space..

Most of the dummies on the year the office property has been built, show a statistically significant effect on the transaction price per square meter. Model 5 shows us that all office properties that have been built between 1960 and 2009 are significant and correlates negatively with the transaction price per square meter. Of all categories, office properties that were built between 1960 and 1969 transacted with the highest discount of 59,7%. The regression results on the year dummies are as expected. Office properties that were built before the second world war transact at a higher price than properties that were built after the second world war, due to the fact that most of the older office properties have a historical appearance and are considered to be more attractive than properties that are younger. Another reason could be that, due to monumental status, owners are not allowed to demolish the property, while properties that are built in certain periods after the world war are of a lesser quality and generally are demolished more easily to build new properties. All interaction terms between each year built category and tenant type are not significant.

As expected, we have found that the weighted average lease term of an office property at time of transaction has a statistically significant effect at a 1% level. The weighted average lease term correlates positively with the transaction price per square meter. For each weighted average lease term in years, we expect the transaction price per square meter to increase with 5.7%. The reason why the weighted average lease length positively effects the transaction price is because the longer the lease, the longer an office property is guaranteed of an income (with the exception of tenants going bankrupt). However, the interaction term between the weighted average lease term and tenant type shows a negative relation at a 1% significance level. This suggests that in case the property is single-tenant, it is expected that the transaction price per square meter will increase with 5.7% - 3.6% = 2.1% for each weighted average lease term in years. The difference in the coefficients between multi-tenant and single-tenant

[16] Two observations have been identified as outliers based on the z-scores of the variable number of tenants.

properties could be explained by the fact that single-tenant properties have lease terms written for relatively longer periods than multi-tenant properties. In general, cash flows that are to be received in ten years are worth less that cash flows that are to be received in the upcoming years and therefore investors are on average less likely to pay for properties with a long lease terms relative to properties with a short terms.

As expected, we found a negative relation between the transaction price per square meter and the property not being sold first the first time. The effect is statistically significance level of 5%. In model 5 we found that office properties that were not sold for the first time transact at a discount of 29.4%. The interaction term between the sales dummy and tenant type is not significant. Therefore we can accept the H0 of hypotheses 2 and conclude that “transaction prices per square meter of single-tenant office properties do not depreciate more between sales than transaction prices of multi-tenant properties”.

In model 5 we have found that office properties that are acquired by international investors transact at a 22.6% premium relative to office properties that are acquired by domestic investors. As previously discussed, international investors can have a disadvantage at acquisitions which are mainly relatable to the local market dynamics. Liu et al. (2013) suggests that the disadvantage expands with geographical distance between investors and assets. Liu et al. (2013) found a similar effect in the U.S. market, namely that properties that were acquired by local investors transacted at a premium of 13.4% relative to properties that were acquired by non-local investors. The interaction term between the nationality of the buyer and tenant type is not significant. Therefore we can accept the H0 of hypotheses 3 and conclude that “International buyers do not have a lesser disadvantage when acquiring single-tenant offices relative to multi-tenant properties.”

As expected, we have found that the walkscore which indicates a high level of amenities in the surrounded area of the office property has statistically significant effect at a 1% level. The walkscore positively correlates with the transaction price per square meter. In model 5, we have found that for each walkscore in points, we expect the transaction price to increase with 0.77%. The interaction term between the walkscore and tenant type are not significant.

We found a negative significant effect between the log-transformation of the distance an office property is located from the nearest train station and the transaction price per square meter at a significance level of 5%. As expected the log-transformation of the distance to the nearest train station correlates negatively with the transaction price. We found that for each percentage increase in the distance of an office property to the nearest train station, the transaction price per square meter decreases with 0.12%. However, the interaction term between the log-transformation of the distance to the nearest train station and tenant type shows a negative

relation at a 1% significance level. This suggests that in case the property is single-tenant, it is expected that, with each percentage increase in the distance to the nearest train station, the transaction price per square meter will increased with -0.12% + 0.2% = 0.08%. While we would also expect that there would have been a negative effect between the distance of single-tenant office property to the nearest train station and the transaction price per square meter, an explanation for our results might be that locations within railway vicinities are considered to be less attractive or in some way constitute less desirable office locations, as suggested in section 2.3.1

We have also found a significant effect between the net annual take-up rate in the city and the transaction year the property was acquired at a 1% significance level. As expected, the net annual take-up rate positively correlates with the transaction price per square meter. We have found that for each additional percentage point of vacancy in a city in the specific transaction year, the transaction price per square meter is expected to increase with 2.5%. The interaction term between the net annual take-up rate and tenant type is not significant.

Table 6.2 regression results from multi-tenant and single-tenant.

	(5)
	Single- vs. multi-tenant
Square meters	1.32e-05** (6.61e-06)
Square meters * tenant type	-1.70e-05*
Vacant square meters	-5.98e-05*** (1.39e-05)
Parking places	0.0000314 (0.000428)
Parking places * tenant type	2.47e-05 (0.000612)
Year built = before 1900	-0.200 (0.318)
Year built = before 1900 * tenant type	0.305 (0.940)
Year Built = 1900 - 1949 (omitted)	
Year Built = 1900 - 1949 * tenant type	-0.102 (0.916)
Year Built = 1950 – 1959	-0.131 (0.376)
Year Built = 1950 – 1959 * tenant type	-0.335 (0.964)
Year built = 1960 – 1969	-0.909*** (0.244)
Year built = 1960 – 1969 * tenant type	0.817 (0.904)
Year built = 1970 – 1979	-0.545** (0.254)
Year built = 1970 – 1979 * tenant type	-0.107 (0.921)
Year built = 1980 – 1989	-0.638*** (0.231)
Year built = 1980 – 1989 * tenant type	0.167 (0.856)
Year built = 1990 – 1999	-0.646*** (0.222)
Year built = 1990 – 1999 * tenant type	0.245 (0.848)
Year built = 2000 – 2009	-0.376* (0.214)
Year built = 2000 – 2009 * tenant type	0.146 (0.852)
Year built = 2010 and after	-0.256 (0.268)

Year built = 2010 and after * tenant type	0.192 (0.855)
Walt	0.0555*** (0.0163)
Walt * tenant type	-0.0369* (0.0193)
Status = Portfolio (omitted)	
Status = Single	-0.0312 (0.0916)
Status * tenant type	0.109 (0.131)
Sale = First (omitted)	
Sale = not first	-0.258** (0.174)
Sale * tenant type	0.0499 (0.223)
Buyer = National (omitted)	
Buyer = Non-nationality	0.204** (0.0922)
Buyer * tenant type	-0.0146 (0.132)
Transaction year = 2012 (omitted)	
Transaction year = 2013	-0.0259 (0.135)
Transaction year = 2014	-0.103 (0.121)
Transaction year = 2015	-0.0958 (0.123)
Transaction year = 2016	-0.0464 (0.122)
Transaction year = 2017	-0.0868 (0.163)
Walkscore	0.00765*** (0.00279)
Walkscore * tenant type	-0.000283 (0.00380)
Log distance to ramp	0.0645 (0.0514)
Log distance to ramp * tenant type	-0.130 (0.0796)
Log distance to station	-0.123** (0.0483)
Log distance to station * tenant type	0.201*** (0.0733)

Vacancy in city	0.615 (1.254)
Vacancy in city * tenant type	-0.340 ((1.636)
Take-up percentage city	2.469*** (0.699)
Take-up percentage city & tenant type	-0.753 (0.822)
Subarea dummy	-0.00446*** (0.00162)
Constant	6.996*** (0.680)
Observations	277
Adjusted R-squared	0.6020

* = significant on 10% level
** = significant on 5% level
*** = significant on 1% level

7 Conclusion and recommendations

7.1 Conclusions

This study answers the following research question; “Is there a pricing difference between an office property being single-tenant or multi-tenant?”. Characteristic for this study is that it has made use of Investment Memoranda as their main data source, a selling document that a company presents to potential investors to explain the investment objectives and terms. Therefore, this study tackles the problem of the transparency of the office market and the difficulty to collect reliable data. In addition, a number of variables that have been collected from the Investment Memoranda and applied in the study are relatively rare in other hedonic regressions. This concerns the main variable of interest; the number of tenants and the dummy variable that has been derived from this variable. Another variable that is rare in the opinion of the author relative to other studies, is the weighted average lease term.

In order to answer the research question, a hedonic regression has been applied. Results presented in this study provide evidence that there is a significant willingness from investors to pay for office properties that have one tenant (single-tenant) rather than office properties that have multiple tenants. We found evidence that single-tenant office properties transact with an estimated premium of 17.9% relative to multi-tenant office properties. The premium paid for single-tenant properties relative to multi-tenant properties could be explained by the fact that a single-tenant investment strategy is considered to be an ‘investor friendly’ investment due to the limited management that is needed. In contrast, owners of multi-tenant office buildings have higher costs on management and maintenance that comes on top of financial loses on any vacancy and non-recoverable service costs.

We have also found evidence that multi-tenant office properties transact at an estimated premium of 27.1% relative to vacant properties. This results support the fact that having any tenants in an office building in general is valuable.

The findings of this study are only related to the office market in the Randstad area in the Netherlands. Overall, we consider the results of this study to give a good impression on the pricing differences between single-tenant and multi-tenant offices.

7.2 Recommendations

The results of this study can be of value for a wide range of professionals in the real estate market. Firstly, a recommendation of the implications of the results of this study can be given to researchers. Secondly, this study could be interesting for real estate office investors – especially those whom specifically approach a single-tenant investment strategy. For them the pricing effect of single-tenant and multi-tenant office investors could be interpreted as another point of view on their underwriting at upcoming investment propositions. At last, the results of this study could be of interest for real estate investment brokers. If these parties have better insight in the pricing effects of single-tenant and multi-tenant office properties, then they could probably offer better suitable services.

This study has several limitations. Firstly, the reliability of the results is subject to the fact that studies that have investigated the pricing difference between single-tenant and multi-tenant properties remain rare. To our knowledge, this is the first research that targets the effect of an office building being single-tenant or multi-tenant as their main variable of interest. The previous studies that acknowledged differences between multi-tenant and single-tenant properties and have investigated their differences mainly by investigating their differences in rental prices. Therefore the results cannot be compared with existing literature.

Secondly, the tenant creditworthiness has not been incorporated in our study. The tenant creditworthiness plays a more important role in valuing single-tenant properties rather than multi-tenant properties, because single-tenant properties are not able to diversify risk across multiple tenants. For multi-tenant properties, risk associated with the cash-flow quality are diversified among multiple tenants. If one tenant is not capable of paying its rent, the owner of a property will still receive income from other tenants in the property. Therefore, the creditworthiness of individual tenants plays a less important role in valuing a multi-tenant property. It would be interesting to include a variable that denotes the creditworthiness of a tenant when applying a hedonic regression for single-tenant properties.

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Appendix 1: multiple linear regression assumptions

There are five assumptions that underpin the classical linear regression model (Brooks and Tsolacos, 2010). These assumptions were required to show that the estimation technique had a number of desirable properties and also that hypothesis tests regarding the coefficient estimates could be conducted validly. If any of these five assumptions are not met, you cannot analyze your data using multiple regression because you will not get a valid result. In this section we will test the dataset on these five assumptions.

Average value of errors = 0
The first assumption required is that the average value of the errors is zero. If a constant term is included in the regression equation, this assumption will never be violated (Brooks and Tsolacos, 2010). We have incorporated a constant term in our regression, as discussed in section 6.1.

Homoscedasticity
One of the main assumptions for the ordinary least squares regression is the homogeneity of variance of the residuals. If the model is well-fitted, there should be no pattern to the redials plotted against the fitted values. If the variance of the residuals is non-constant, then the residual variance is said to be heteroscedastic. After we have run our regression analysis, we will use the stata commands estat imtest and estate hettest. The tests, respectively known as the White's test and the Breusch-Pagan test, test the null hypothesis that that the variance of the residuals is homogenous.

Multicollinearity
If there are two variables that are near perfect linear combinations of one another, the estimates for a regression model cannot be uniquely computed. Therefore, in order to use a linear regression, a strong relation between two or more independent variables needs to be avoided. The primary concern is that as the degree of multicollinearity increases, the regression model estimates of the coefficients become unstable and the standard errors for the coefficients can get inflated. After we have run our regression analysis, we will use stata command VIF to check for multicollinearity.

Normal distribution of residuals
After we have run our regression analysis, we will use the stata command predict to create residuals and then use stata command swilk to test for normality. The test is known as the Shapiro-Wilk test for normality and tests the null hypothesis that the distribution of the residuals is normal.

Non-Linearity

In order to use a linear regression, a model that is linear is required. This means that the relationship between x and y must be capable of being expressed diagrammatically using a straight line. If this assumption is violated, the linear regression will try to fit a straight line to data that does not follow a straight line. After we have run our regression, we will plot the standardized residuals against each of the predictor variables in the regression model. We will do so by using stata command acprplot.

Appendix 2: Cameron & Trivedi's decomposition of IM-test

Model 4; Cameron & Trivedi's decomposition of IM-test

Source	Ch2	DF	P
Heteroscedasticity	380.50	378	0.4542
Skewness	33.25	29	0.2678
Kurtosis	4.62	1	0.0315
Total	418.37	449	0.3507

Appendix 3: Breusch-Pagan/Cook-Weisberg test for heteroskedasticity

Model 4; Breach-Pagan / Cook-Weisberg test for heteroscedasticity

Ho: Constant variance

Variables: fitted values of lgpricepersqm

Chi2(1)	=	1.29
Prob > chi2	=	0.2554

Appendix 4: VIF

	Model 4	
	VIF	1/VIF
Tenant type= Multi-tenant (Omitted)		
Tenant type = Single-tenant	1.67	0.598189
Tenant type = vacant	2.54	0.393477
Total square meters	3.25	0.307360
Vacant square meters	2.23	0.448308
Parking places	2.52	0.397083
Year built = before 1900	1.53	0.655113
Year Built = 1900 - 1949 (omitted)		
Year Built = 1950 - 1959	1.33	0.753834
Year built = 1960 - 1969	1.86	0.538726
Year built = 1970 – 1979	2.06	0.485437
Year built = 1980 – 1989	3.01	0.332118
Year built = 1990 – 1999	4.45	0.224879
Year built = 2000 - 2009	5.21	0.191820
Year built = 2010 and after	3.73	0.267919
Walt	2.69	0.371447
Status = Portfolio (omitted)		
Status = Single	1.55	0.643886
Sale = First (omitted)		
Sale = not first	1.89	0.528513
Purpose = investment (omitted)		
Purpose = Transformation	1.60	0.624897
Buyer = National (omitted)		
Buyer = Non-nationality	2.70	0.370491
Transaction year = 2012 (omitted)		
Transaction year = 2013	2.73	0.366589
Transaction year = 2014	3.50	0.285741
Transaction year = 2015	3.80	0.263427

Transaction year = 2016	3.87	0.258598
Transaction year = 2017	2.19	0.457375
Number of tenants		
Walkscore	2.00	0.500801
Log distance to ramp	1.43	0.700324
Log distance to station	1.39	0.717242
Vacancy in city	1.88	0.530773
Take-up percentage city	1.96	0.509799
Subarea dummy	1.60	0.625117
Mean VIF	3.01	

Appendix 5: Shapiro-Wilk W test for normal data

Model 4; Shapiro-Wilk W test for normal data

Variable	Obs.	W	V	Z	Prob>z
Normality	416	0.99580	1.198	0.430	0.33370