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Investors' willingness to pay for offices in multifunctional buildings with a Dutch owners' association (VvE).

Master Thesis, MSc Real Estate Studies

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ABSTRACT:

The purpose of this research is to determine how multifunctional office buildings with an owners' association affect the investment value of office real estate in the Dutch Randstad area. It is explained why an owners' association places restriction on investing in office real estate based on Dutch apartment law. This study used unique data from 283 office real estate transactions in the Netherlands from 2011 to 2021. Hedonic modeling techniques are used. According to the findings of this study, investors pay 11.84% less for offices within an owners' association when compared to single owned, monofunctional office buildings. Furthermore, the investor's origin makes no difference in the price that investors are willing to pay for offices with an owners' association.

Key words: Commercial real estate; condominium law; multiple ownership; hedonic pricing method; multifunctional buildings

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1. INTRODUCTION

1.1 Motivation

Because of population growth and increasing urbanisation, there is a growing interest in developments that integrate multiple functions within a single structure. As a result, issues with ownership within the structure may arise. This could cause a decline in investor interest, particularly in office space.

The population of the Netherlands has been increasing for years. According to Statistics Netherlands (2020), the Netherlands will exceed the number of 19 million residents by 2038. In addition to population growth, urbanisation is on the rise, with the number of residents in the Dutch metropolitan area growing by 12% in the last 10 years (Syntrus Achmea Real Estate and Finance, 2019). The housing shortage is severe. Other amenities, such as offices, retail, and leisure, will be required in addition to residential facilities. Building land is scarce in the Dutch metropolitan area. The urban population growth causes significant need for development, but there is only a limited amount of building land available in the urban context to meet this demand. The rising urbanization, along with ongoing population increase and limited space in densely populated areas, has driven urban planners and developers to use existing space more efficiently and creatively. The usage of stacked high-rise buildings is a well-known method of efficiently utilizing space. This is one of the many reasons that we are increasingly seeing a shift from the development of monofunctional to multifunctional buildings in cities where functions used to be segregated. Multifunctional buildings are multilayer buildings where a combination of two or more functions (residential, office, retail, hotel, recreation or other) are integrated. These types of development are widely advocated by urban planners as integrating multiple functions within one specific area are believed to contribute to sustainable development, encouraging physical activity, enhancing accessibility and generating neighbourhood diversity (Shen and Sun, 2020). Another important driver of the trend is the expressed interest of residents in mixed-use as they are more demanding on the way they want to live, work and play (Syntrus Achmea Real Estate and Finance, 2019). As a result, many of the Dutch regions' current public policy visions support multifunctional development initiatives. The Vision for 2050 of Amsterdam, for example, promotes mixed-use developments that combine functions and provide an appropriate environment for living, working, and leisure (Municipality of Amsterdam, 2021).

However, when different functions are mixed within a single structure, complexities in structuring ownership can arise. To this day, most investors prefer to invest in a single asset class rather than multiple asset classes inside a single building (van der Gijp, 2020). Because of the emergence of multifunctional buildings, various functions with different risk profiles are more prevalent inside a single structure. In 2021 – yields on retail are estimated to be 6.5%, whilst offices traded on 5% (ABN AMRO, 2021). In addition, Hotel yields increased towards around 6% in 2021 (CBRE, 2021), whilst residential yield decreased to 3.75% (Fakton, 2020). Examples of multifunctional developments where at least 3 to 4 of the above-mentioned sectors are incorporated are numerous. In the Netherlands,

examples of these sorts of developments include Symphony, Berghaus Plaza and the Montevideo among others. Because a single investor typically is not investing across real estate classes, multifunctional buildings are not in full acquired by just one investor. Hence, situations emerge in which different types of investors with different risk profiles invest in a property. Consequently, various investors own different components of a building. This means that these investors are not just allowed to change the building the way they want in order to maximize their investment value.

An important question is what type of ownership structure should be used for shared facilities within multiple-owned, multifunctional buildings. Ownership can become complicated when different components must negotiate and pay for common areas and amenities, as this can create a conflict of interest between commercial and residential owners over the allocation of operating costs (Titcher and Lari, 2005). The mandatory owners' association (translated in Dutch: Vereniging van Eigenaren) with mandatory reserve fund is a condominium law system that is common in the Netherlands when it comes to structuring the ownership within multiple owned buildings. This system involves a counselling structure that allows each independent owner to vote on how operating costs are distributed. Due to the mandatory consultation structure, owners cannot simply renovate or change their space without the permission of others.

As returns on different property types are driven by different economic factors, the real estate cycles of different real estate assets are not necessarily correlated with one another (Eichholtz et al., 1995). COVID-19 has shown to have a negative impact on retailing (exception of Supermarkets), offices (working from home) and hotels (no guests). Uncertain to how long this situation is taking (4th wave, vaccinations do not fully protect, medicine has backlashed) – one might consider conversion from one asset class to another. With multiple owners within one structure – changing real estate from one asset class to another impose issues in case co-owners do not agree to that change (e.g., due to noise nuisance from construction). Therefore, one might think that values of components within multiple-owned, multifunctional buildings will be discounted for the degree of inflexibility to change in alternative uses. These issues appear to be the most significant barriers for investors to invest in office buildings located in a multiple-owned, multifunctional building with an owners' association. This research will therefore focus on the willingness to pay of investors in offices within multifunctional buildings with an owners' association.

1.2 Literature review

Rabianski et al. (2009) provide a literature review on 'mixed-use' development. In this review the authors define mixed-use development and describe factors including legal, financial, economic, and social issues encouraging and discouraging this type of development. The authors reflect on the limited theoretical and empirical research and call out for additional research on mixed-use development. This includes additional research on structuring the ownership of vertical mixed-use developments as many approaches to structure ownership of mixed-use (multifunctional) developments provide possibilities for investigating optimal structuring and quantifying the associated risk. Therefore, the aim of the research is to contribute to the assessment of optimum owner structures in multifunctional buildings by quantifying relevant pricing impacts on office transaction values.

Prior studies use a hedonic regression modelling to assess the price effects of office building attributes. In real estate research, hedonic regression modelling is the primary approach for researching price determinants. The premise behind hedonic real estate models is that a property can be characterised by certain physical or hedonic characteristics, and that the intrinsic value of each characteristic can be assessed. There are a few studies that research the relationship between transaction prices and location and office building features. Most of these studies assessed the importance of these traits using hedonic regression (Colwell, Munneke and Trefzger, 1998; Nappi-Choulet, Maleyre and Maury, 2007). Other research on office transaction pricing models has focused on a certain property- (Fuerst, McAllister and Ekeowa, 2011) or location attributes (Tu, Shi-Ming and Hua, 2004). Few studies have assessed the possible relationship between multiple ownership structures within multifunctional buildings and the office transaction price. The study conducted by Devany and Scofield (2017) comes closest to assessing multiple ownership structure and office transaction pricing. In their study about the effects of investor type and nationality on office transaction prices in New York City, Devany and Scofield (2017) use condominium interest[1] as a factor to explain office transaction pricing. Their results show a negative and significant association between condominium interest and office transaction prices in New York.

[1] "Condominium interest refers to an ownership structure in which an individual (group, firm) owns a real estate unit(s) in a multi-unit development. In this structure, the owner has separate ownership of the unit(s) and an undivided interest in the common elements of the building." (Devaney and Scofield, 2017, p.17).

1.3 Research problem statement

The purpose of this study is to provide empirical evidence to support the hypothesis that there is an association between the transaction price paid by investors and offices located within a multifunctional building with an owners' association in The Netherlands.

RQ: What is the willingness-to-pay of investors for offices within a multifunctional building with an owners' association compared to offices located within a single-owned, monofunctional building?

This question will be examined by concentrating on the three sub-questions listed below:

1. *In what way are ownership structures within multifunctional buildings related to office transaction prices according to practice and theory?*

To answer this sub-question, it is necessary to explore the objections of investors to decide not to invest in office space within multifunctional buildings with an owners' association. Both Dutch apartment rights and investor considerations will be investigated for this aim in order to highlight the willingness of investors to pay in this form of real estate.

2. *What is the association between offices within multifunctional buildings with an owners' association and the transaction price paid by investors?*

A hedonic regression model will be utilized to estimate the possible effects on the transaction value of offices. The conceptual model (Figure 1) suggests a negative relationship between the independent variable owners' association and the dependent variable office transaction price because shared owner structures within multifunctional buildings may cause investors to be less willing to pay for these types of offices when compared to single-owned, monofunctional office buildings. Data will be obtained from the Spring Real Estate database, which contains information on Dutch office transactions, including those in multifunctional buildings, between 2011 and 2021. Furthermore, this database also includes the necessary building attributes to perform a hedonic regression model. Data will be collected from office transactions within the G5 (Amsterdam, Rotterdam, The Hague, Utrecht and Almere). These cities are densely populated, with all five focusing on densification within a highly dense urban context (Syntrus Achmea Real Estate and Finance, 2020). As a result, during the last decade, a variety of multifunctional buildings have been completed inside the area.

3. *What is the difference between the willingness to pay of foreign- and domestic investors for offices within multifunctional with an owners' association?*

A robustness check will be undertaken to ensure that the findings of this study are more credible. The objections to Dutch apartment law, which will be discussed while addressing the first research question, entail that investing in apartment rights is forbidden by statute or even by law for some foreign investment funds (Velten and Vonk, 2016). This suggests a possible difference between foreign and domestic investors' willingness to pay. This research will therefore differentiate between foreign and domestic investors, as shown in Figure 1. The study of Devaney and Scofield (2017) assesses the effect of investor nationality (domestic vs. foreign) on office transaction pricing. The PropertyNL Service module, which holds information on investment transactions in The Netherlands, will be used to acquire information on the type of investors.

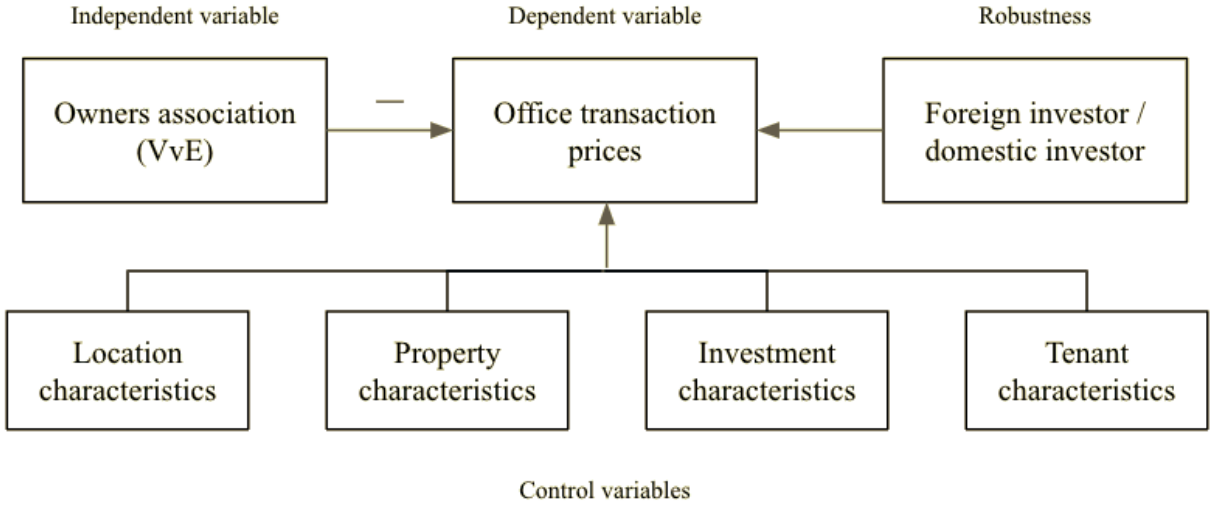

Figure 1. Conceptual model

Furthermore, this study will make every effort to conduct its investigation in the most ethical manner possible. To accomplish this, the 11 points of management research ethics (Bell and Bryman, 2007) will be followed. Appendix A contains a list of these 11 points.

The remainder of this paper is organized as follows. Chapter 2 describes the legal context of subdividing ownership in The Netherlands. Chapter 3 describes the conceptual model by means of a legal framework and a literature study with regard to subquestion 1. Chapter 4 gives insights into the data used for this research. Chapter 5 describes the empirical approach, chapter 6 presents the results regarding sub-questions 2 and 3, and chapter 7 concludes and presents the recommendations for future research.

2. LEGAL FRAMEWORK

2.1 Subdividing ownership in The Netherlands

Due to the destruction caused by World War II, the Netherlands had to reconstruct post-war. The reconstruction necessitated the creation of a legal framework to divide multi-level buildings into separate ownership units. As a result, the Netherlands introduced the concept of "apartment rights" in 1951.

According to Lujanen (2009), in most cases of ‘apartment rights’ or ‘apartment ownership’ the condominium form of ownership is used.

[…] “This ‘condominium model’ means that the owners own their dwelling, but, more accurately, they own the space which is defined by the internal walls of the dwelling, which might not be connected to the ground on which the building stands. Their ownership is listed as property in official records. The communal areas are, however, owned jointly by all owners” (Lujanen, 2009; Ploeger and Groetelaers, 2014, p.272).

Ploeger and Groetelaers (2014) explain that while this definition applies in general to the Dutch apartment rights system, there are some differences. Van der Merwe (1994) describes that there are in general two legal systems for multiple ownership:

I. *Dualistic system:* in this system, the owner is the exclusive owner of the apartment itself and co-owns the building's land and communal areas. (e.g., entrances, hallways, stairways). This is the most widely adopted system.

II. *Unitary system:* In this system the whole building, including the land, is co-owned by all apartment owners and does not provide exclusive ownership to the apartment itself, as many European countries do. Instead, each owner holds an exclusive usage right to the apartment unit in question (Çağdaş et al. 2018).

Dutch apartment law uses the unitary system. The apartment right is defined in article 5:106 of the Dutch civil code. All the apartment owners co-own the entire building, including the land, the apartments and the common areas. In this way, a community is formed. In addition, the apartment owners acquire an apartment right that provides the exclusive right to use one apartment unit of the building (the private part) and the shared use of the common areas (the communal part). The communal areas are often consisting of hallways, stairways, elevators, and so on. However, common areas might

also include a gym or a swimming pool, for example. An apartment right is a real property right that can be mortgaged or transferred in the same way that ownership can (Ploeger and Groetelaers, 2014). Apartment rights can be created under Dutch law for an existing building, a new building, or even a planned construction. The apartment right applies to all types of uses, including commercial, residential, industrial, and other uses, as well as parking spaces. According to Dutch law, the only requirement is that an apartment unit, which can consist of a building or a plot of land, is intended to be used as 'private part'. The division of apartment rights applies to multi-story buildings, a complex consisting of ground-floor units, and even to undeveloped land. Furthermore, Dutch law allows for the division of apartment rights on several cadastral parcels. Ploeger and Groetelaers (2014) define the divided land and/or building into apartment rights the ‘apartment complex’. The examples of the different forms of ‘apartment complexes’ are illustrated in *Figure 2*.

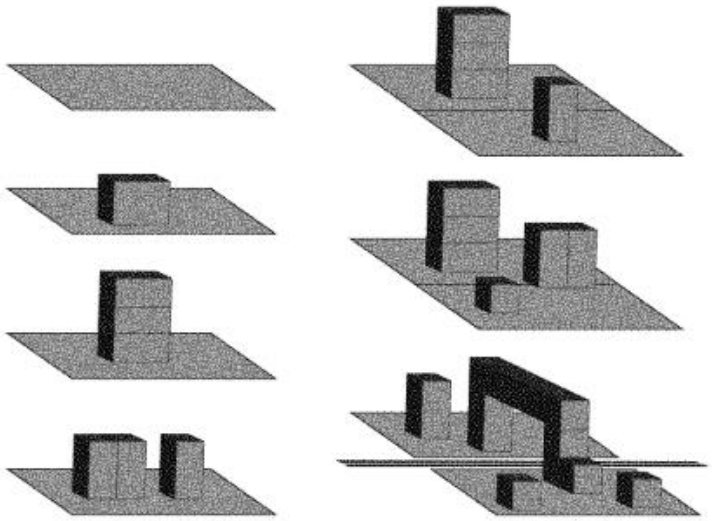

Figure 2. Examples of 'apartment complexes' (Ploeger and Groetelaers, 2014).

When dividing property into apartment rights, a 'deed of division' (in Dutch: Splitsingsakte) must first be drawn up. The (mandatory) division regulations state, among other things, how the complex is divided, the rights and obligations of all apartment owners, the distribution of voting rights, what share each owner must contribute to the costs, and the regulations regarding use, maintenance and management of the communal areas. Additional restrictions for communal and private areas can be included in the (optional) internal regulations (e.g., requiring the front door to be a specific colour) (van Velten, 2015). As soon as the apartment rights are legally acknowledged through the deed of division, an owners’ association (Vereniging van Eigenaren) is formed.

2.2 The ‘Vereniging van Eigenaren’ (VvE)

When a building is divided among separate owners, a Vereniging van Eigenaren, abbreviated VvE, must be formed. Every 'apartment' owner is required to join the VvE. The purpose of a VvE is to look after the common interests of all owners of the apartment complex. As the owner of an apartment, you are obliged to become a member of the VvE. The VvE makes decisions about maintenance, service costs and utilities (gas, water and electricity). The VvE is responsible for and has control over (communal areas of) the building and the land belonging to the building. Management comes down to deciding on maintenance and use of the communal areas. The VvE is required to keep a reserve fund. The apartment owners are required to pay a contribution, also known as service costs, in order to maintain the reserve fund. The idea behind making a reserve fund mandatory is that if you keep a reserve fund, there will be money available for matters as maintenance and renovations. The amount of service costs that each owner pays is based on his share of the total costs of the VvE.

In a VvE, the owners' meeting makes decisions regarding the building. Examples of decisions are expenses for the maintenance and repair of the common areas, expenditure from the reserve fund and adoption or amendment of the internal regulations. Voting is used to make these decisions. The deed of division indicates how many votes each owner is allowed to cast. In some VvEs, each owner has one vote, but the number of votes is often determined by factors such as the size of an apartment. In addition, the deed of division specifies the number of votes required to make the decision (Centraal Beheer, 2020).

In the case of multiple-owned, multifunctional complexes, a subdivision often takes place, which means that one or more apartment rights are in turn also divided into (sub)apartment rights (the subdivision). The (sub) apartment owners will again be part of the (sub) VvE. In this way, the sub-apartment owners have their own consultation structure with their own reserve fund (van Velten and Vonck, 2016). However, the co-ownership of the complex will remain with all the apartment owners.

3. THEORETICAL FRAMEWORK

This thesis investigates the influence of an owners' association within multifunctional complexes on the investors' willingness to pay in office real estate. In order to understand the willingness to pay of investors in office real estate, it is important to know which possible factors influence the value of office real estate. In order to determine the value of office real estate, this thesis looks at the transaction prices. The transaction price is the actual price at which the property was sold. This chapter looks at previous literature on the influences on the transaction value of office real estate. Subsequently, the investors' objections to investing in an office within a multifunctional building with an owners' association will be explained.

3.1 Office transaction value

The pricing of office real estate is influenced by a variety of attributes. The majority of the research has used hedonic regression models to investigate the impact of certain attributes on office pricing and has been based on rental prices. According to Nappi-Choulet (2007), specific research on the attributes influencing office transaction pricing is scarce and primarily focuses on the US or Asian markets. This section will present an overview of existing literature regarding the influence of locational, property, tenant and investment attributes on the office transaction price.

Several studies have found that location attributes influence the office transaction price. Sivitanidou (1995) investigates, among other locational attributes, the impact of accessibility to service employment centres on office transaction prices and discovers that access to service employment centres has a positive influence on office transaction prices. Colwell (1998) also acknowledges the significance of location attributes, demonstrating that increased accessibility has a positive effect on the transaction value of offices. Furthermore, Nappi-Choulet et al. (2007) discover a clear positive relationship between office prices and offices located in central Paris.

In addition to locational attributes, Colwell et al. (1998) find that the physical property attributes lot size, number of floors, building age and parking places have a significant effect on the office transaction price. Previous research has found that sustainable building characteristics, such as the energy label, have significant relationships with transaction value (Fuerst et al., 2011).

The transaction value is also influenced by the characteristics of the tenant(s). The tenants generate the property's income, which influences the price an investor is willing to pay. In their research, Colwell and Munneke (2006) and Fuerst et al. (2011) highlight the importance of tenant characteristics when examining transaction prices. In their studies, they distinguish between offices with multiple tenants and offices with a single tenant. Other tenant characteristics include, for example, the building's occupancy rate. According to Fuerst (2007), the vacancy rate is a tenant characteristic that measures the attractiveness of the property. The lower the vacancy rate, the higher the income of the building and, as a result, the more the investor is willing to pay. Another tenancy attribute is the tenants' lease term.

Fuerst et al. (2011) control for the remaining lease term in their study because the remaining lease term, and thus future rental income, is valuable to the investor. The authors find that the lease term is a significant driver of office values.

When it comes to the transaction value of offices, investment characteristics are also important. The investor type is an example of an investment characteristic. Various studies distinguish between domestic and foreign investors' willingness to pay in office real estate. In their study about the influence of heterogeneous investors on transaction prices, Petrova and Ling (2009) find that 'out-of-state' buyers pay a premium for office properties. This is supported by the findings of Liu, Gallimore and Wiley (2013). This heterogeneity between investors will be further explored in section 3.3. Another example is the transaction year. Studies use the transaction year to control for annual macro-economic change. Downs and Slade (1999), for example, found a significant annual depreciation in the period of 1990-1995, whereas Petrova and Ling (2009) found a significant annual appreciation in the period of 2003-2008.

3.2 Objections to investing in an owners' association

The second chapter explains which property law system is most used to divide ownership in Dutch stacked construction. When investing in an office building in a multifunctional building with a Dutch owners' association, real estate investors are required to abide by the apartment law system. This section outlines the main objections to investing in this type of offices.

There are two regulations that may impose additional restrictions on owners, as described in section 2.1. There are division regulations and (optional) internal regulations. The division regulations may contain far-reaching provisions. Forbidding an apartment owner from renting out his private part is an example of such a broad restriction (Vastgoedjournaal, 2010). There are also internal regulations that can impose even more stringent regulations. As a result, there are two types of regulations that can constrain this flexibility of use for the investor. Building regulations, for example, can make it more difficult for the owner to use standard designs and construction methods to add value to the property at a lower cost (Jensen and Söderman, 2021). This inflexibility to use constitutes a barrier to investing in apartment rights.

Section 2.2 explained the VvE. As stated in this section, the VvE is required whenever apartment rights are subdivided. When it comes to making decisions, the VvE, as previously stated, has a mandatory consultation structure. A large majority of votes is usually needed for a decision to be made. This mandatory voting structure is a significant impediment to investors (Mouthaan, 2012). As a result of this structure, the (office) owner cannot simply proceed with the redevelopment, renovation, or expansion of his space without first obtaining permission from the other owners. According to an interview with a Dutch real estate investor conducted by Hilwerda (2018), investors prefer to acquire

full ownership rather than a share because they do not want to be dependent on other owners. This is exacerbated when different segments with disparate interests are accommodated in the same complex. The restrictions on ownership are the source of these objections. Why is ownership restriction important when it comes to investors' willingness to pay for an office building? A possible explanation is that inflexibility limits the ability to add value through refurbishment, redevelopment, or expansion. Because of the inflexibility, this potential is lower for offices with an owners' association. Dunse and Jones (1998) conducted hedonic research on refurbishment and office prices in Glasgow and discovered that refurbished offices have a higher rental value than non-refurbished offices. Furthermore, Chau et al. (2003) find that refurbishment enhances the value of real estate. In their research, they acknowledged that refurbishment is more difficult for multiple-owned buildings because it is a collective decision. According to them, the governance structure and decision-making process of the owners of a multiple-owned building is an important factor to consider before making investment decisions. Therefore, one might think that transaction values of components within multiple-owned, multifunctional buildings will be discounted for the degree of inflexibility to add value compared to single-owned, monofunctional office buildings.

The mandatory reserve fund is another main barrier to invest in a VvE. As discussed in section 2.2, it is mandatory for a VvE to maintain a reserve fund for maintenance and other purposes. There are various functional components in a multiple-owned, multifunctional building. When different functional components must pay for the common areas and amenities, a conflict of interest could arise over the allocation of operating costs (Titcher and Lari, 2005). Christudason (2008) investigated potential issues in multifunctional complexes in Singapore, which has a condominium model similar to that of the Netherlands. Divergent interests in relation to the contribution for the communal parts of the complex were the source of the issues. The issue was that the contributions were used to pay for common parts that they did not actually use. Commercial owners found it objectionable that their contribution was used to pay for new elevators in the complex's residential part. This problem became even more prominent in more complex multifunctional developments. Investors want to get the most out of the rent of the building and see it as an objection to pay for the costs of others. Investors want to maximize their return and therefore see it as an objection to bear the costs of other owners. In addition, professional investors consider long-term returns. This frequently entails the investor maintaining the properties. Investors are aware of when the complexes require renovation and keep track of maintenance. They contribute their own funds to this. As a result, investors regard the reserve fund as 'unnecessary' (Hilwerda, 2018).

To date, there have been few studies that assess the ownership structure within multifunctional complexes and office transaction prices. Devaney and Scofield (2017) conducted one of the first studies that control for the effect of multiple ownership on office transaction prices. They incorporate the effect of the New York condominium model on office transaction prices into their model. Their results show that prices paid for offices within the condominium form of ownership are 8.61% lower compared to

offices without a condominium form of ownership. New York has a dualistic apartment right system in which you are the sole owner of your own apartment. The Dutch have a unitary system, which has more disadvantages for investors, as discussed in this section. This implies that the Dutch form of multiple ownership within multifunctional complexes has a negative price effect on the transaction price of offices.

3.3 Foreign- vs. domestic investors

The origin of the investor could be a significant source of research heterogeneity. Petrova and Ling (2009) and Liu et al. (2013) both find that non-local investors pay a premium for office properties. These findings suggest that distance increases information asymmetry that puts the non-local investor at a disadvantage. Devaney and Scofield (2017) do not find support for information asymmetry effects. They find that prices were higher when offices were acquired by foreign investors in New York. However, they also find that offices sold at a premium when they were sold by foreign investors. This suggests unmeasured aspects of quality that measures the premium paid by foreign investors.
As discussed in section 3.2, Dutch apartment law does not provide exclusive ownership and sets up certain investment barriers. As a result, in some countries it is prohibited by statute or even by law to invest in this type of real estate (Van Velten and Vonk, 2016). For example, German investors are only allowed to have a certain percentage in their portfolio (Hilwerde, 2018). This indicates a possible difference in the willingness to pay of foreign and domestic investors in offices within a multiple-owned, multifunctional complex.

3.4 Hypothesis

The first hypothesis aims to provide evidence that investors are less willing to pay for offices within a multiple owned, multifunctional complex in The Netherlands. Section 3.2 argues that an owners' association creates barriers to investing in office real estate, leading to a lower willingness to pay.

Hypothesis 1: real estate investors are willing to pay less for offices within a multifunctional building with an owners' association compared to offices within a single-owned, monofunctional office building.

Not acquiring exclusive ownership is a major obstacle for foreign investors to invest in real estate within an owners' association (Van Velten and Vonk, 2016). Foreign investors are thus expected to be less willing to pay for offices within an owner's association.

Hypothesis 2: Foreign investors are willing to pay less for offices within a multifunctional building with an owners' association compared to domestic investors.

4. DATA

This chapter will begin by explaining the sources from which the data were obtained. The operationalization of the variables informs the reader about which variables and why they will be included in the regression analysis. Furthermore, the efforts done to improve the dataset's usability are described, and descriptive statistics are displayed.

4.1 Data sources

Despite an increase in transparency in the commercial real estate market in general, the data required for this research is largely opaque. In many cases, information about transaction prices is kept confidential and is not available to third parties. As a result, acquiring necessary information is a challenging, costly, and sometimes unfeasible process (Downs and Slade, 1999). This explains why empirical research on office transaction pricing in The Netherlands is scarce. Consequently, Spring Real Estate has been constantly processing and archiving transaction data obtained through the Land Registry (het Kadaster) and investment memoranda received since 2012. The Land Registry is a government-managed register that collects information based on ownership transfers. For a charge, a third party can request the documents here. The Land Registry documentation includes information regarding the transaction price, transaction dates, and the name of the legal entity that purchased the land. An investment memorandum is a sales brochure that is offered by the seller to parties interested in a certain investment property. A memorandum contains all the information needed to make an investing decision. Herein, property characteristics such as the size of the object, the number of parking places, vacancy and current tenant(s) information are presented. Spring Real Estate compiles data from both sources into a database. The SREbase contains data on around 14,000 office properties, 7,500 rental transactions, and 3,500 office investment transactions in the Netherlands between 2001 and 2022. Most of the observations were made between 2011 and 2021. Five variables from own research have been manually supplemented or added to the SREbase: the *Walkscore*, *distance to highway ramp*, *distance to train station*, *investors' nationality*, and the *owners' association*. The *Walkscore*[2] of each individual object is obtained by entering the address details in the walkability index provided by Google. The Walkscore is defined in Section 4.2. The *distance to highway ramp* and *distance to train station* of individual objects have both been obtained through Vastgoeddata[3]. Vastgoeddata provides commercial real estate information to Dutch real estate professionals, including Spring Real Estate. The SREbase provides information on the buyer's legal entity to distinguish the investor's origin. By looking up one's country of origin, it is possible to determine whether the relevant investors are domestic or foreign. If the investor is a multinational with a branch in the Netherlands, it is considered a domestic investor.

[2] Data obtained via www.Walkscore.com

[3] Data obtained via www.Vastgoeddata.nl

Several sources were used to determine whether an office building included an Owners' association. First, the investment memoranda were examined to determine whether the building has a VvE. If the information was not available, the property names and/or address details were checked in the Drimble company register[4]. The Drimble Company Register provides a free, up-to-date overview of businesses and institutions. When the address or building name matched the VvE company name, the date of registration at the Chamber of Commerce was considered. The office building is located within a VvE if the VvE was registered prior to the most recent transaction date. If the VvE was registered after the transaction date, a transformation from offices to residences may have occurred. As a result, the presence of a VvE at the address does not always imply the presence of a VvE within an office building at the time of the transaction. Consequently, these transactions have been excluded. If it was unclear whether a VvE was present in the building, the selling document[5] from the Dutch Land Registry was examined. This document specifies whether the building is divided into apartment rights at time of the transaction. An attempt has been made to obtain data in a different manner in order to accelerate the process. Ad Hoc Data[6] made data available containing a land registry identification code of properties in the Netherlands with an Owners' association. The identification code, however, turned out to be different than the code stated in the SREbase. As a result, this data could not be used.

[4] Data obtained via www.drimble.nl/bedrijf/
[5] Subscribers can access the online land register at https://mijn.kadaster.nl/security/login. The fee for retrieving a selling document is € 2.40.
[6] www.adhocdata.nl

4.2 Operationalization of the variables

This section will go over how the model's variables are operationalized, where they are classified, what they measure, what the expected relationship with the transaction price is, and where the data come from.

TABLE 1: VARIABLE OVERVIEW

Variable	Category	Label	Type	Description	Expected Relation	Source
Transaction price	Dependent variable	Ln Transaction price	Continuous	The realized price.	n.a.	SREbase
Owners' association	Independent variable	Owners' association	Categorical	Whether or not an Owners' Association is present at the time of the transaction. Scores 1 for Yes, and 0 for No.	(-)	Own research (See 4.1)
Building age	Property characteristics	Ln age	Continuous	The age of the building.	(-)	SREbase
Size of building	Property characteristics	Ln Total sqm.	Continuous	The size of the property, measured in square meters of lettable floor space.	(+)	SREbase
Parking spaces	Property characteristics	Parking spaces	Continuous	Number of available parking spaces	(+)	SREbase
Energy label	Property characteristics	Energy label	Categorical	The energy label represents a classification of the degree of sustainability of real estate objects. Scores 1 for A, 2 for B, 3 for C and 0 for the remaining labels.	(+)	SREbase
Postal code	Location characteristics	Postal code	Categorical	A dummy for each Postal code, to control for location-specific attributes.	n.a.	SREbase
Walkscore	Location characteristics	Walkscore	Continuous	Score that measures walkability relative to nearby amenities.	(+)	Own research (Walkscore)
Distance highway	Location characteristics	Ln dhighway	Continuous	Distance to nearest highway ramp.	(-)	Own research (Vastgoeddata)
Distance train station	Location characteristics	Ln dtrainstation	Continuous	Distance to the nearest train station.	(-)	Own research (Vastgoeddata)
Transaction year	Investment characteristics	Transaction year	Categorical	A dummy for each transaction year.	n.a.	SREbase
Investment status	Investment characteristics	Status	Categorical	Takes the value 1 if the building is purchased within a portfolio, and 0 if it is purchased as a single ticket.	(+/-)	SREbase
Investors origin	Investment characteristics	Origin	Categorical	Takes the value 1 if it is a foreign investor, and 0 if it is a domestic investor.	(+/-)	Own research (SREbase)
WALL	Tenant characteristics	wall	Continuous	Weighted Average Length of Lease – the average number of remaining contractual lease years, at the time of transaction.	(+)	SREbase
Vacancy rate	Tenant characteristics	Vacancy rate	Continuous	Ratio between the vacant lettable floor area and the total usable area.	(-)	SREbase
Tenancy status	Tenant characteristics	Tenancy	Categorical	If the variable takes the value 1, the object is multi-tenant, the value 2 is vacant, and at 0 the object is single-tenant.	(+)	SREbase

Note: The SREbase data is updated on a monthly basis. The data for this study was exported in February 2022. The findings of this study will not be representative of the period after the export.

Dependent variable

In this study, the dependent variable is the natural logarithm of the *transaction price per square meter*. The transformation of the dependent variable brings the residuals closer to normality, which is

important, as one of the assumptions of linear regression is that the error term is normally distributed (Brooks and Tsolacos, 2010). Appendix B illustrates the transformation.

Main variable of interest

As discussed in section 3, this study will assess if investors are less willing to pay for offices in a multifunctional building with an *owners' association* compared to offices within a single-owned, monofunctional building. To investigate the effect of an owners' association on office price, a dummy variable is generated with the value 1 for offices with an owners' association and the value 0 for offices without an owners' association. This is consistent with the study by Devaney and Scofield (2017), which controls for condominium interest on the transaction price of offices.

Control variables

As according to Section 3.1, transaction price determinants are classified into four categories: property, location, investment, and tenant characteristics. Below, these control variable categories will be discussed.

First, the *property characteristics* are discussed. In terms of the property characteristics, the variable *building age* has been transformed into the natural logarithm of age to bring the residual closer to normality. Furthermore, because the observations in this study are limited, it was decided not to categorise the building's age. Because office buildings deteriorate physically, it is widely assumed that the older the object, the lower the investor's willingness to pay. Users, on the other hand, place a higher value on historical real estate (Colwell, 1998; Fuerst, 2011). As a result, no linear relationship between the year of construction and the transaction is expected. Existing literature does not always find a statistically significant relationship between building age and office value (Shilton et al, 1994). One probable explanation is that owners perform minor renovations on a regular basis during the property's lifecycle. These renovations make the property more marketable and simplify the search for new tenants. The literature shows that the *building size* is one of the most important determinants of office price. This is due to the fact that tenants pay rent for each additional square meter they occupy. According to Colwell et al. (1998), the law of diminishing returns applies to building size. This means that as the lettable floor area increases, the price rises at a decreasing rate. The natural logarithm of the total square meters is used to determine whether the law of diminishing returns applies and to bring the residuals closer to normality. Because transaction price per square meter for offices within a multifunctional, multiple-owned building only apply to the separate office section, it was decided for these observations to consider the lettable floor area of offices as the building size. The number of *parking spaces* is believed to be related to office prices because it improves building accessibility. The number of parking spaces and the size of the office building are also expected to have a strong correlation. A larger office space often means more employees, which necessitates the availability of more parking spaces. It is expected that the transaction price per square meter will increase as the

number of parking spaces increases. The *Energy label* could be an important determinant for office transaction prices. Previous literature has found that energy efficient office buildings trade at a premium compared to non-energy efficient office buildings (Fuerst et al., 2011; Kok and Jennen, 2012). Following the approach of Kok and Jennen (2012), dummy variables will be generated for the energy efficient labels A, B and C and the non-energy efficient labels D, E, F and G.

Second, the *location characteristics* are discussed. The importance of examining location-specific price differences between sub-markets is substantiated by Kok and Jennen (2012). The use of dummy variables for each individual *postal code* allows to control for price differences caused by economic concentrations and the degree of office density. The *Walkscore* variable has been added to link a value to a location's efficiency and quality. The Walkscore[7] is a Google walkability index that assigns a score to a location based on how accessible amenities are on foot. The score ranges from 1-100. Pivo and Fischer (2011) and Kok and Jennen (2012) both found every additional Walkscore to affect office value with a premium. Papers examining core-office samples, on the other hand, find no significant effects for the Walk Score. According to Heus (2014), this is because core locations are typically found in areas with a high degree of amenities and facilities. As discussed in section 3.1, accessibility has a significant effect on office prices. To control for accessibility, the *distance to the nearest highway ramp and train station* are included. This is in line with the approach by Eichholtz et al. (2013). The law of diminishing returns is expected to apply to both distance to highway ramp and train station. As a result, both variables have been transformed into the natural logarithm.

Third, the *investment characteristics* are discussed below. For the variable *transaction year*, including a dummy variable for each individual transaction year will account for changes in the office market as well as annual macroeconomic change (Fuerst et al., 2011). The *investment status* is regarded as an important driver of transaction prices. Office buildings can be purchased as single tickets or as part of a larger asset portfolio. When acquiring in the form of a portfolio, investors frequently expect a discount on the transaction price due to the possibility that a portfolio would include an object that does not initially attract the investor's attention. The portfolio variable has been transformed from a numeric variable to a dummy variable. To control for the *investors origin*, a distinction will be made between foreign- and domestic investors. As discussed in section 3.3, there may be a price difference between foreign- and domestic investors. Therefore, a dummy variable is created with the value 1 if it is a foreign investor and 0 if it is a domestic investor.

Finally, the *tenant characteristics* are discussed. The *Weighted Average Length of Lease (WALL)* variable refers to the weighted average length of the remaining lease term in years. The future rental income and lease term are important factors in determining a buyer's willingness to pay. With a short lease term remaining, an investor risks being confronted with a period of vacancy, the possibility of adjusting the current market rent level to a possibly lower future market rent level, and the possibility

[7]Further explanation of the Walkscore: https://www.walkscore.com/methodology.shtml

of renovation costs (van Gool et al., 2013). The remaining contractual term of the lease is measured in whole years, which was obtained at the time of transaction. The *vacancy rate* is an important factor to consider when determining the value of real estate because tenants are the source of cash flow. According to Fuerst (2007), the vacancy rate can be interpreted as a measure of property attractiveness; that is, the lower the vacancy rate, the more attractive the property. For *tenancy status*[8], Fuerst et al. (2011) emphasize the importance of controlling the number of tenants when examining transaction prices due to structural differences between single-tenant and multi-tenant leased offices. Both leasing types have advantages and disadvantages. Because of the high maintenance costs incurred by the multiple tenants, an investor may be willing to pay less for a multi-tenant office. Single-tenant office buildings, on the other hand, are associated with greater risk, as there is a higher probability of vacancy if the tenant decides not to renew the lease or declares bankruptcy. The rental status has been transformed into a dummy variable. The value 0 represents a single-tenant building, the value 1 represents a vacant building, and the value 2 represents a multi-tenant building.

4.3 Data cleaning

The SREbase, as previously stated, contains approximately 3,500 office transactions in The Netherlands. This section explains how the data were cleaned for this research.

It was first decided to only include transactions that occurred in the Randstad's five largest cities (Amsterdam, Rotterdam, The Hague, Utrecht, and Almere) because multifunctional buildings are mostly found in a densely urban context. The following step was to exclude any observations with missing variables that were relevant to this research. The purpose of the transaction was then examined. In the SREbase, transaction purposes include investments, purchase after lease, own use, and withdrawals[9]. Because this study focuses on the willingness of investors to pay, only the investments are selected. Following that, only those observations are chosen for which it can be determined whether an Owners' association exists. Section 4.1 describes this identification process. Without checking for outliers, there are a total of 310 observations, 233 without and 77 with an owners' association.

The dependent variable transaction price per square meter will be examined to identify outliers in the data. For the transaction price per square meter, the bottom 1% and top 99% of the observations are examined first. Three observations emerge from the bottom 1% with a transaction price per square meter less than €250. These observations are considered as outliers and are thus excluded from the dataset. Three observations in the top 99% have a square meter price of more than €10,000 per square

[8] The correlation matrix in Appendix D shows that the tenancy dummy "Tenancy = vacant" has an extremely high correlation of 0.823 with the vacancy rate. The category "Tenancy = vacant" could be excluded to avoid multicollinearity. However, removing this category would result in the model excluding 35 observations when running the regression. Because the number of observations in the dataset is already limited to 283 observations, removing 35 observations reduces the predictive power of the model significantly. To avoid this, the variable "Tenant status" is decided to be completely excluded from the regression model.

[9] Redevelopment into other use.

meter. In addition, an observation was discovered with a square meter price of more than €9,000. These four were observed to be in Amsterdam's city center, one of the most expensive office locations in the Netherlands. As seen in *Appendix B*, the observations were removed from the dataset because these extraordinary transactions were most likely influenced by investor sentiment. Another way to find outliers in the data is by using the *studentized residuals* method. According to Hocking (1983), this is a reliable method to detect influential observations that could be identified as outliers. The Studentized Residual runs a t-test that allows us to determine the influence of the residue in the model. If the t-statistic exceeds the critical level of 2 at a 5% significance level the observation can be considered as an outlier and will be eliminated. Following the application of this method, 20 observations appear to have a studentized residual greater than 2 and are thus excluded from the dataset. *Appendix B* illustrates this process. The dataset contains 283 observations after removing the outliers.

4.4 Descriptive statistics

Table 2 shows the descriptive statistics for all observations for which complete information is available. In this table, observations are separated based on whether or not an owners' association is present. The dataset contains 218 observations without (monofunctional) and 65 observations with (multifunctional) an owners' association.

In table 2 the dependent variable transaction price per square meter shows that the minimum transaction price per sq m. is €408.84. This office building is located in The Hague. The maximum transaction price per sq m. is €7728.38. This office building is located in Amsterdam's city center. Furthermore, we can see that the average transaction price for single-owned is €2324,94, which is higher than the average transaction price per sq m. for offices within a owners' association, which is €2254.56. The same is true for the average transaction price. This could be an indication that less is paid for offices within a owners' association.

With a total floor area of 43,152 square meters, the office with the largest floor area is in Amsterdam. The smallest office, with 750 square meters of floor area, is located in the city center of Den Haag. Offices without an Owners' association are, on average, much larger than offices with an Owners' association, as shown in Table 2. An explanation for this is that for offices with an owners' association, the lettable office area has been considered as the total floor area of the building. As discussed in section 4.2, this is done because the transaction price only applies to the separately owned office space.

The oldest building, which dates from 1720, is 302 years old. The newest building dates from 2021 and is one year old. Single-owned building offices are 29 years old on average, which is younger than multifunctional offices with an owners' association, which are 36 years old on average. However, as the trend has shifted from monofunctional to multifunctional (re)developments in recent decades, it was expected that multifunctional buildings would have a lower average building age. One possible explanation is that the SREbase does not update the building age following a redevelopment, and that

several multifunctional buildings have been subject to redevelopment in the past. A second explanation is that there was a trend toward more multifunctional developments in urban areas between 1960 and 1980 (Nabil and Abd Eldayem, 2015). There are 20 of the 65 observations with an Owners' association that were built during this time period.

For parking spaces, we can see that the minimum is 0 and the maximum is 975. We also see that offices within multifunctional buildings with an owners' association have fewer parking spaces than single-owned offices on average. A possible explanation is that multifunctional buildings are more common in dense central locations where obtaining a larger number of parking spaces is more complex and costly.

The variable energy label shows that energy label A is the most common in both cases. This is partly due to that A+ and higher are considered energy label A in this study. For offices with and without owners' associations, the ratios between energy efficient labels (A, B, and C) and inefficient labels (other) are relatively close.

The variable distance to the highway ramp indicates that the property closest to a highway ramp is 100 meters away. The property located the farthest away must travel 7,100 meters to the nearest ramp. Single-owned office buildings, on average, are closer to a highway ramp than multifunctional office buildings. This can be supported by the argument that multifunctional buildings are more centrally located and less reliant on cars (Nabil and Abd Eldayem, 2015), and thus located further away from the highway.

The variable distance to the nearest train station indicates that the property closest to a train station is 30 meters away. The property located the farthest away must travel 10,900 meters to the nearest train station. It was expected that multifunctional buildings would be located closer to public transportation as integrating multiple functions within one specific area are believed to contribute to enhancing accessibility (Shen and Sun, 2020). However, monofunctional office buildings, on average, are closer to a train station than multifunctional office buildings. A reason could be that multi-purpose buildings are closer to other modes of public transportation (e.g., metro, bus), but these distances are not incorporated in this research.

The Walkscore shows that multifunctional office buildings, with an average Walkscore of 86, have a much higher Walkscore than monofunctional office buildings, which have an average Walkscore of 75. This supports the idea that multifunctional office buildings are generally located in environments with a higher level of services and amenities than monofunctional office buildings. Because the goal of Integrating functions within dense urban areas is to reduce walking distances and to create accessible and diverse areas where people can 'live', 'work', and 'play'.

The dummy variable created for the transaction year variable indicates how the dataset is distributed over time. The majority of transactions, roughly 79%, were completed in the years 2014, 2015, 2016, 2017, 2018, and 2019. This is notable because it occurs between the period of economic recovery

following the 2008 financial crisis and the emergence of COVID-19. During this period, there were more office transactions in general.

The average wall for offices with an Owners' association is 4.95, making it longer than average wall for offices without an Owners' association, which is 4.6. The shortest wall is 0 years, and the longest wall is 18 years.

In terms of investment status, both types of offices have more single ticket transactions than portfolio transactions. In terms of investor origin, it can be seen that for offices without an owners' association, foreign and domestic investors are evenly split. Foreign investors outnumber domestic investors in offices with an owners' association. One possible explanation is that foreign investors are less informed about apartment rights in the Netherlands and, as a result, are less able to estimate the disadvantages when compared to Dutch investors.

The average vacancy rates for the two types of offices are relatively close, with 24 % for offices without owners' associations and 25.5% for offices with owners' associations.

In both cases, the majority of transactions are for multi-tenant offices, followed by single-tenant offices, and the fewest transactions are for vacant offices.

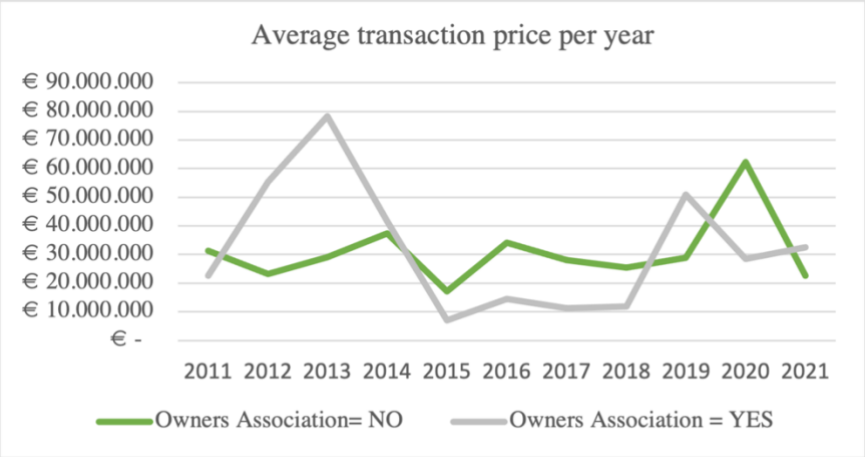

Figure 3. Average transaction price per year

Figure 4. Average transaction price per square meter per year

TABLE 2: DESCRIPTIVE STATISTICS

Owners' Association:	**NO**					**YES**				
	N	Mean	Std. Dev.	Min	Max	N	Mean	Std. Dev.	Min	Max
Transaction price (in k euros)	218	29223	32697	731	200000	65	22360	36586	840	215100
Price per sqm.	218	2324.939	1363.367	317.826	7728.382	65	2254.558	1445.217	408.84	6228.644
Total sqm.	218	11491.842	8624.297	938	43152	65	7544	6694.814	750	34534
Building age	218	29.055	27.170	3	302	65	36.185	25.923	1	122
Parking spaces	218	153.591	143.137	0	975	65	91.815	146.933	0	960
Energy label = A	107	0.491	.	0	1	30	0.462	.	0	1
Energy label = B	39	0.179	.	0	1	13	0.200	.	0	1
Energy label = C	32	0.147	.	0	1	4	0.062	.	0	1
Energy label = Other	40	0.183	.	0	1	18	0.276	.	0	1
Walkscore	218	74.528	18.262	27	100	65	85.831	10.666	41	99
Distance to highway ramp	218	1935.28	1487.867	100	6900	65	2380.031	1749.887	200	7100
Distance to train station	218	1550.821	1329.242	30	6300	65	1792.662	2295.076	200	10900
Transaction year = 2011	7	0.032	.	0	1	4	0.062	.	0	1
Transaction year = 2012	6	0.028	.	0	1	2	0.031	.	0	1
Transaction year = 2013	15	0.069	.	0	1	3	0.046	.	0	1
Transaction year = 2014	23	0.106	.	0	1	3	0.046	.	0	1
Transaction year = 2015	18	0.083	.	0	1	13	0.200	.	0	1
Transaction year = 2016	32	0.147	.	0	1	8	0.123	.	0	1
Transaction year = 2017	38	0.174	.	0	1	15	0.231	.	0	1
Transaction year = 2018	41	0.188	.	0	1	4	0.062	.	0	1
Transaction year = 2019	24	0.110	.	0	1	4	0.062	.	0	1
Transaction year = 2020	4	0.018	.	0	1	3	0.046	.	0	1
Transaction year = 2021	10	0.046	.	0	1	6	0.092	.	0	1
Wall	218	4.606	3.759	0	18	65	4.954	3.756	0	14
Status = Single ticket	133	0.610	.	0	1	36	0.554	.	0	1
Status = Portfolio	85	0.390	.	0	1	29	0.446	.	0	1
Origin = Domestic	109	0.500	.	0	1	23	0.354	.	0	1
Origin = Foreign	109	0.500	.	0	1	42	0.646	.	0	1
Vacancy rate (%)	218	24	33.9	0	1	65	25.5	34.5	0	1
Tenancy = Single tenant	76	0.348	.	0	1	16	0.246	.	0	1
Tenancy = Vacant	27	0.124	.	0	1	9	0.139	.	0	1
Tenancy = Multi-tenant	115	0.528	.	0	1	40	0.615	.	0	1

Figures 3 and 4 depict the average transaction price and transaction price per sq m. of offices with and without an owners' association from 2011 to 2021. The chart of average transaction prices displays more extreme values. Because prices are a quotient of the number of square meters, the graph with the average transaction price per square meter shows that prices are more stable and converge more. The second graph shows that offices with an owners' association have a high value in 2012. This is due to two observations made in 2012 by offices with an owners' association of two completed multifunctional developments in a central location in Amsterdam. After 2012, the price per square meter of offices with an owners' association declines until 2018. Prices for both types of offices rise in 2018. This could indicate that demand for office space increased during this year. In 2019-2020, office prices per square meter fall once more. This is explained by the worldwide epidemic COVID-19. The demand for offices fell during this time period because most people had to work from home. In general, the prices per square meter for both types of offices are comparable. This is also evident in table 2, where the average price per sqm. of offices with owners' associations is slightly lower than the average price per sqm. of offices without an owners' association.

The sample of this study is compared to 1040 office transactions from the SREbase to assess its representativeness. These are all office investment transactions known to Spring Real Estate from the Randstad's five major cities between 2011 and 2021. Figure 5 depicts the average transaction prices per square meter of the investment transactions extracted from the SREbase and the average transaction prices per square meter of the sample used in this study, as well as their respective trends. Figure 5 depicts a similar trend in the average transaction price per square meter per year for both samples. The average prices of the study sample are significantly lower in the years 2017-2018. One possible explanation for this is that a number of more expensive transactions occurred during this time period, the data for which was incomplete to be used in this study. By comparing the lines, it is possible to conclude that the trends are comparable and that the sample of this study is representative of Dutch office prices in a highly dense urban context.

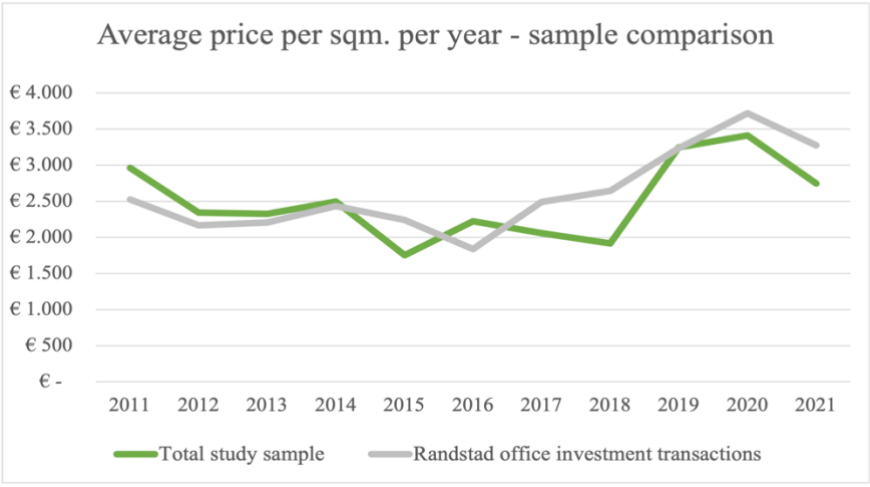

Figure 5. Average prices per sqm. per year of study sample and Randstad office investment transactions

5. METHODOLOGY

5.1 Multiple linear regression model

Based on the hypotheses formulated in section 3.4, this study will determine whether there is a significant relationship between multifunctional buildings with an owners' association and the transaction price per square meter of office real estate. As discussed in sections 3.1 and 4.3, several hedonic control variables that may impact the office transaction price per square meter will be assessed. The hedonic approach is widely accepted as the standard method for assessing the impact of determinants on real estate prices (Brooks and Tsolacos, 2010). A multiple linear regression method will be used to test the hypotheses. This method of analysis will attempt to model the relationship between office real estate transaction price per square meter and the explanatory independent variable.

$$ln\,(Price\ per\ sqm)_{it} = \beta 0 + \beta 1\ Owners\ association_{it} + \beta 2\ Property\ characteristics_{it} + \beta 3\ Location\ characteristics_{it} + \beta 4\ Investment\ characteristics_{it} + \beta 5\ Tenant\ characteristics_{it} + \varepsilon_{it} \quad (1)$$

The model is constructed as follows: the dependent variable in this study is the natural logarithm of the transaction price per square meter of office i at time t. The variable of interest for testing the hypotheses of the second research question is the Owners' association variable. In this study, the interest variable will be the owners' association variable. A significant negative value for β1 indicates investors are less willing to pay for office buildings with an owners' association compared to offices without an owners' association.

When assessing pricing attributes in the commercial real estate market, it is vital to control for object-related characteristics. This can be estimated by including control variable groups, including location characteristics, building characteristics, investment characteristics, and tenant characteristics. These variable groups function as control variables. Using this specific data will correct the problem of unobserved heterogeneity, thereby minimizing endogeneity.
The least squares method (OLS) establishes that the best data distribution is obtained when the sum of "all squared residuals" is minimized (Brooks & Tsolacos, 2010). This method relies on five assumptions. If any of these five assumptions are violated in this study, using a multiple linear regression method will not generate valid results. These assumptions are described in Appendix C.

To test the robustness of the research findings, the data will be segmented based on the investor type. To determine whether there are structural differences between foreign and domestic investors, a regression analysis and a Chow F-test will be performed.

6. RESULTS

6.1 Regression results

The regression results will be discussed in this section. The model will show the effect of an owner association on the dependent variable. The logarithmic transformation of the office transaction price per square meter at the time of the transaction is the dependent variable. The regression results are shown in Table 3.

The regression model consists of the basic model and the four control variable groups described in section 4.2. The control variable groups will be added to the regression model one by one in order to optimise the model's explanatory power.

The basic model depicts the effect of an owners' association on the logarithm of the office transaction price per square meter without the use of control variables. The R-squared of the base model is 0.003 and the adjusted R-squared is -0.001. This means that the variance in the owners' association variable explains 0% of the variance in the transaction price per square meter.

In the second model, the property characteristics variables have been added. With an adjusted R-squared of 0.102, the explanatory power rises to 10.2%.

The location characteristics variables are introduced in the third model. Previous research has demonstrated the significance of location in determining the value of real estate. With an adjusted R-squared of 0.604, the model's explanatory power rises to 60.4%with the addition of this control group. The coefficient of owners' association in this third model is negative, -0.198. The coefficient is significantly different from 0 at the 95% confidence level as the p-value is lower than 0.05. The effect of a multifunctional office building within a owners' association on the transaction price per square meter is -17.96% compared to single-owned, monofunctional office buildings.

The investment characteristics variables are included in the fourth model. With an adjusted R-squared of 0.737, the model's explanatory power increases to 73.7%. The coefficient of owners' association in this fourth model is negative, -0.206. The coefficient is significantly different from 0 at the 95% confidence level as the p-value is lower than 0.05. Multifunctional office buildings with an owners' association trade at a 18.82% discount compared to single-owned, monofunctional office buildings in this model.

In the fifth and final model, the tenant characteristics variables are introduced. This model has the most explanatory power. With an adjusted R-squared of 0.823, adding the tenant characteristics ensures that 82.3% of the variance in the dependent variable is explained by the variance in the examined independent variables. The fifth model will be used to interpret the parameters of the independent variable and control groups.

TABLE 3: REGRESSION RESULTS

VARIABLES	(1) Basic model	(2) + Property characteristics	(3) + Location characteristics	(4) + Investment characteristics	(5) + Tenant characteristics
Owners' association	-0.0813	-0.00703	-0.198**	-0.206**	-0.126*
	(0.0878)	(0.0862)	(0.0923)	(0.0800)	(0.0661)
Ln building age		-0.0909	-0.217***	-0.169***	-0.126***
		(0.0623)	(0.0561)	(0.0464)	(0.0385)
Ln total sqm.		0.0710	0.0462	0.0838*	0.0693*
		(0.0576)	(0.0541)	(0.0465)	(0.0389)
Parking spaces		0.000442	0.000930***	0.000799***	0.000635***
		(0.000328)	(0.000311)	(0.000260)	(0.000214)
Energy label = A		0.214*	0.163*	0.0631	0.0691
		(0.110)	(0.0944)	(0.0787)	(0.0645)
Energy label = B		0.191	0.192*	0.138	0.125*
		(0.119)	(0.105)	(0.0870)	(0.0713)
Energy label = C		-0.0634	0.0438	-0.0559	-0.0663
		(0.128)	(0.102)	(0.0853)	(0.0699)
Walkscore			0.00145	0.000247	0.000103
			(0.00390)	(0.00322)	(0.00265)
Ln dhighway			0.0891	0.0770*	0.0965**
			(0.0555)	(0.0461)	(0.0378)
Ln dtrain			-0.0613	-0.0914*	-0.123***
			(0.0561)	(0.0479)	(0.0396)
Status = portfolio				-0.129**	-0.144***
				(0.0553)	(0.0457)
Origin = Foreign				0.0415	0.0424
				(0.0495)	(0.0406)
Wall					0.0116*
					(0.00608)
Vacancy rate					-0.533***
					(0.0660)
Location fixed effects	NO	NO	YES	YES	YES
Year fixed effects	NO	NO	NO	YES	YES
Constant	7.586***	7.035***	7.802***	8.007***	7.860***
	(0.0414)	(0.536)	(0.844)	(0.724)	(0.594)
Observations	283	283	283	283	283
R-squared	0.003	0.125	0.713	0.821	0.881
Adjusted R-squared	-0.001	0.102	0.604	0.737	0.823

Note: Dependent variable is ln (Price per sqm.). Location fixed effects are the postal codes and the year fixed effects are the transaction years 2011-2021. Standard errors are reported between parentheses.
* $p < 0.10$
** $p < 0.05$
*** $p < 0.01$

By including the tenant characteristics Wall and Vacancy rate, we find that the owners' association variable has less significance and has a smaller negative effect on prices in model 5 than in models 3 and 4. According to the descriptive statistics in *Table 2*, offices with an owners' association have a slightly higher average vacancy rate than offices without an owners' association. Because the vacancy rate is highly significant and also has a negative effect on pricing, this control variable may have reduced the price effect and explanatory power of the owners' association variable due to vacancy being more prevalent in offices with an owners' association.

The findings of model 5 show that the coefficient of owners' association is negative, -0.126. The coefficient is significant at the 90% confidence interval as the p-value is lower than 0.1 ($p = 0.058$). Therefore, multifunctional office buildings with an owners' association trade at an 11.84% discount compared to single-owned, monofunctional office buildings. As a result, we can reject H0 of the first hypothesis at a 10% significance level. Therefore, real estate investors are willing to pay less for offices in a multiple-owned, multifunctional complex with an owners' association than for offices in a single-owned office building without an owners' association. This is attributable to a combination of factors described in section 3.2, including the mandatory payment structure and the inflexibility to renovate due to the consultation structure, as well as the different interests of different building owners. This also demonstrates that the Dutch unitary condominium model results in a greater discount on office transaction prices in the Randstad area (11.84%) than the New York dualistic condominium model (8.51%) (Devaney and Scofield, 2017).

The control group variables' parameters will now be discussed. At a 1% significance level, the age of the building has a negative significant effect on the transaction price per square meter. A 1% increase in building age is associated with a 0.13% decrease in transaction price per square meter. This is consistent with the expectation that as the building ages, investors' willingness to pay will decrease. However, because no building age categories were created due to limited observations, this study was unable to control for the historical value of the buildings.

At a significance level of 10%, the building size in total square meters is positively significant. This means that a 1% increase in building size is associated to a 0.0693% increase in transaction price per square meter. Because building size has a substantial influence on price, the significance level of 10% seems low. The reason for this is that the dependent variable price is already a quotient of the total square meters.

At a significance level of 1%, the variable parking spaces is statistically significant. If the number of parking spaces increases by one, the price per square meter rises by 0.06%. The high scarcity of parking spaces in the Netherlands' compact and metropolitan areas explains this positive and significant result of parking spaces.

Only energy label B out of the three energy efficient energy labels A, B, and C shows a positive significant result with a significance level of 10%. Investors are willing to pay a 13.31% premium for buildings with an energy label B compared to buildings with an inefficient energy label. Furthermore,

it was expected that energy label C would have a significant value because offices in the Netherlands will be required to have at least this energy label by 2023 (Rijksdienst voor Ondernemend Nederland, 2018). This, however, is not the case. The energy labels of the relevant buildings are updated on a regular basis in the SREbase. As a result, the energy label may differ from the actual energy label at the time of transaction in some cases. This could explain why there are no significant relationships between the efficient (A and C) and inefficient energy labels.

The Walkscore is positive but not statistically significant. This is consistent with research that uses core-office samples, such as Heus (2014). Core offices are typically located in areas with a high level of amenities and facilities. This study focuses on offices in the Randstad's five largest cities. Furthermore, descriptive statistics show that the average Walkscores are high. Therefore, it can be assumed that the offices in this sample are mostly close to amenities and facilities, so the effect of the Walkscore on the transaction price per square meter is minimal.

The variable distance to highway ramp reveals a positive and significant result with a significance level of 5%. This means that if the distance to the nearest highway ramp increases by 1%, the transaction price per square meter increases by 0,0965%. This is an unexpected result because it would seem reasonable that there would be more demand for offices that are easily accessible by car for employees. Previous research has showed that investors pay a premium for offices near the CBD or the city center (Nappi-Choulet et al., 2007). Expensive central office locations are frequently further away from the highway ramp, and because this study focuses on offices in densely populated areas, it is common that the most expensive offices are further away from the highway, which can explain the positive effect.

At the 1% significance level, the variable distance to train has a negative and significant effect. If the distance to the nearest train station is increased by 1%, the transaction price per square meter decreases by 0.0123%. This is consistent with the findings of Eichholtz et al (2013), who found that proximity to public transportation results in higher office transaction prices.

The categorical variable status shows that a portfolio has a negative and significant effect at a 1% significance level. Investors pay at a discount of 13.41% when an office is sold as part of a portfolio compared to when the office is sold as a single ticket. This is consistent with the expectation that portfolio discounts will be given because buildings that are not immediately appealing to the investor are frequently added.

The categorical variable investors origin shows that the category of foreign investors is positive but not significant. The positive coefficient could indicate that foreign investors overvalue Dutch offices in comparison to domestic investors, as found in previous research (Petrova and Ling, 2009; Liu et al., 2013). This study, however, yielded no significant results. This could suggest that the data may be heterogeneous between foreign- and domestic investors, which will be investigated further in section 6.2.

At a 10% significance level, the Wall variable is both positive and significant. If the weighted average lease length increases by 1%, the price per square meter increases by 0.12%. This is consistent with expectations, as a longer wall implies a longer period of income for the investor.
The variable vacancy rate is negative and significant at a significance level of 1%. According to the estimated parameter of the vacancy rate variable, the transaction price per square meter could decrease by 41.32% if an office building is sold vacant rather than fully let. Although the influence is expected to be negative, it does have a high value. To provide an unbiased estimate for this control variable, additional variables may need to be controlled for.

6.2 Foreign vs. Domestic investors

It has already been discussed in section 3.3 that there could be a difference in willingness to pay between domestic and foreign investors in multiple-owned, multifunctional office buildings within an owners' association. In Table 3, the origin variable showed no significant outcomes. This contradicts previous research, which found that foreign investors pay a premium compared to domestic investors. (Petrova and Ling, 2009; Liu et al., 2013). One reason for the lack of significance could be that this study includes several offices within an owners' association. Foreign investors may be reluctant to invest in offices within an owners' association (VvE). This is because in some countries investing in Dutch apartment rights is restricted by statute or even law because the Dutch unitary system ensures that the investor does not have exclusive ownership of the purchased part of the building (Velten and Vonk, 2016).
To investigate the difference in willingness to pay for offices within an owners' association, the dataset is divided into foreign and domestic investors. Both groups were subjected to a regression analysis. *Table 4* shows the results of the regression analyses. The dataset is divided into 132 domestic investor observations and 151 foreign investor observations. Domestic observations include 111 offices without an owners' association and 22 offices with an owners' association. Furthermore, there are 109 foreign observations with no owners' association and 42 with an owners' association. It is notable that the Owners' association produces a negative and significant result for foreign investors at a significance level of 5%, but a positive and insignificant result for domestic investors.
Table 4 shows that foreign investors are 19.59% less willing to pay for offices with an owners' association than for offices without an owners' association. The insignificant positive result for domestic investors could indicate that foreign investors are less willing to pay for offices with an owners' association. Domestic investors, on the other hand, have far fewer observations for offices with an owners' association. The limited power could explain the insignificant result. The Chow F-test will be performed at the end of this section to determine whether the *H0* of the *second hypothesis* can be rejected.
There are also some parameters that differ between groups. For example, for building age, foreign investors have a significant and negative result, while domestic investors have a negative but not

significant result. As a result, the age of the building has a greater influence on the investment value for foreign investors than for domestic investors.

TABLE 4: REGRESSION RESULTS: FOREIGN VS. DOMESTIC INVESTORS

VARIABLES	(1) Pooled	(2) Domestic	(3) Foreign
Owners association	-0.118*	0.139	-0.218**
	(0.0657)	(0.128)	(0.108)
Ln building age	-0.125***	-0.00211	-0.164**
	(0.0385)	(0.0728)	(0.0705)
Ln total sqm.	0.0757**	0.0637	0.0872
	(0.0384)	(0.0633)	(0.0677)
Parking spaces	0.000645***	0.00102*	0.000495
	(0.000214)	(0.000588)	(0.000315)
Energy label = A	0.0703	-0.0691	0.0759
	(0.0645)	(0.102)	(0.109)
Energy label = B	0.122*	-0.135	0.203
	(0.0712)	(0.129)	(0.125)
Energy label = C	-0.0649	-0.182*	-0.0423
	(0.0699)	(0.108)	(0.124)
Walkscore	-8.49e-05	0.00382	-0.00241
	(0.00264)	(0.00325)	(0.00635)
Ln dhighway	0.0962**	0.0576	0.176**
	(0.0378)	(0.0606)	(0.0747)
Ln dtrain	-0.125***	-0.180***	-0.0346
	(0.0396)	(0.0642)	(0.0753)
Status = portfolio	-0.139***	-0.149**	-0.178**
	(0.0455)	(0.0725)	(0.0811)
Origin = Foreign (Omitted)			
Wall	0.0116*	0.0161*	0.0101
	(0.00608)	(0.00916)	(0.0114)
Vacancy rate	-0.533***	-0.602***	-0.549***
	(0.0660)	(0.0941)	(0.125)
Location fixed effects	YES	YES	YES
Year fixed effects	YES	YES	YES
Constant	7.858***	7.491***	6.809***
	(0.594)	(0.997)	(1.066)
Observations	283	132	151
R-squared	0.880	0.954	0.898
Adjusted R-squared	0.823	0.881	0.793
K	97	97	97
RSS	12.759	2.085	6.279

Note: Dependent variable is ln (Price per sqm.). Location fixed effects are the postal codes and the year fixed effects are the transaction years 2011-2021. Standard errors are reported between parentheses. K is the number of regressors and RSS is the residual sum of squares.
* $p < 0.10$
** $p < 0.05$
*** $p < 0.01$

In terms of variable parking spaces, it can be seen that domestic investors have a positive and significant result at a significance level of 10%. However, for foreign investors, this variable is insignificant. This could imply that when making investment decisions, domestic investors place a higher value on parking spaces than foreign investors.

In terms of energy labels, this regression analysis shows an unexpected result. Energy label C is negative and significant for domestic investors at a significance level of 10%. This means that domestic investors are willing to pay 16.64% less for offices with energy label C than for offices with inefficient energy labels. This is contrary to expectations that investors will be more willing to pay for energy label C due to its obligation for office buildings in 2023. One possible explanation is that the observations of domestic investors include several monumental buildings that are valued higher due to their historical and aesthetic value. The obligation for energy label C does not exist for Dutch monuments (monumenten.nl), which means that they largely have an energy inefficient label.

For foreign investors, the distance to highway ramp variable has a positive and significant result at a significance level of 5%. There is no significant outcome for domestic investors. The greater the distance between the property and the highway, the higher the price that foreign investors are willing to pay. One explanation is that foreign investors are more willing to pay a premium for centrally located offices that are further away from the highway.

With a significance level of 1%, distance to train station shows a significant and negative relationship for domestic investors. There is no significant result for foreign investors. Domestic investors are willing to pay 0.18% less per square meter as the distance to a train station increases by 1%. Therefore, in this sample, domestic investors rate train station accessibility higher than foreign investors.

Section 6.1 explained that a discount is applied to office real estate purchased as part of an investment portfolio. Table 4 shows that the portfolio category has a significant negative relationship for both types of investors, with a significance level of 5%. However, there is a small difference in the magnitude of this variable's influence. When domestic investors buy an office as part of a portfolio, they will receive a discount of 13.84% compared to purchasing an office as a single ticket. If foreign investors purchase an office as part of an investment portfolio, they will receive a 16.31% discount.

At a significance level of 10%, the domestic investors have a positive significant result for the wall variable. For foreign investors, however, there is no result. Domestic investors are willing to pay 1.62% more for an office if the Wall rises by 1.

At a 1% significance level, the vacancy rate variable is negative for both types of investors and has a significant impact on transaction price per square meter. Domestic investors will be 45.23% less willing to pay if an office is vacant. For vacant offices, foreign investors pay 42.25% less. The vacancy rate variable, as mentioned in section 6.1, has a very high value. In order to provide an unbiased estimate for this control variable, more variables may need to be controlled for.

Two groups were subjected to regression analyses. The Chow test can be used to determine the robustness of the parameters of offices purchased from domestic or foreign investors to determine if the parameters are equal and stable (Chow, 1960). The Chow test statistic will show whether the different investor groups differ significantly from one another. For this test, the null hypothesis is that the datasets of the different groups are identical and show no structural differences.

The Chow F-test produces a test statistic of 0.482 (see Appendix E). The discovered test statistic is less than the critical value (0.482 < 1.412). As a result, the null hypothesis for the Chow F-test cannot be rejected. It can be implied that there are no market segments, and that the origin of the investor makes no difference in the influence on the transaction price per square meter of office real estate.

Based on these results, the *H*0 of hypothesis two will not be rejected. In other words, the investor's origin makes no difference to the willingness of investors to pay in multiple-owned, multifunctional offices with an owners' association.

The test statistic is less than the critical value because the number of observations (283) is relatively low compared to the number of parameters (97). If the number of observations had been greater, perhaps a difference could have been identified. This study, however, was unable to increase the number of observations.

7. CONCLUSION AND DISCUSSION

7.1 Answering the research questions

The extent to which an owners' association influences the investment value of office real estate in the Dutch Randstad area was investigated. To our knowledge, this is the first study investigating the possible relationship between an owners' association and the transaction prices of offices in the Netherlands. For this study, unique data from 283 office real estate transactions in the Netherlands from 2011 to 2021 were collected. Hedonic modeling techniques were used to develop an answer to the main research question: *"What is the willingness-to-pay of investors for offices within a multifunctional building with an owners' association compared to offices located within a single-owned, monofunctional building?"* On a 10% significance level, the findings indicate a negative association between offices within a owners' association and the office transaction prices. multiple owned multifunctional office buildings with an owners' association trade at an 11.84% discount compared to single owned office buildings. This confirms the main hypothesis *"Real estate investors are less willing to pay for offices within a multifunctional complex with an owners' association compared to offices within a single-owned, monofunctional office building."*

Furthermore, a regression analysis was performed in this study to determine whether the origin of the investor influences the willingness to pay for offices within an owners' association. The findings indicate a negative relationship between foreign investors and transaction prices for offices within an owners' association compared to single-owned, monofunctional office buildings. The regression analysis, however, suggests that there are no market segments within this variable and that the investor's origin has no influence on the transaction price of offices.

7.2 Recommendations and limitations

This study contributes to the limited literature on multifunctional development as this study quantified a legal factor of structuring ownership that could discourage investing in multifunctional developments. Furthermore, this study serves as the foundation for future research to identify a country's condominium model, as well as quantify and compare the effect of different condominium models on the price of commercial real estate. This allows it to be determined which legal model is most (dis)advantageous to investors.

The results of this study have implications for future multifunctional developments in The Netherlands. Mixed-use developments are viewed as a potential future-proof real estate investment due to their ability to functionally adapt to changing market conditions, create synergy between functionalities, and be located in desirable locations (Gijp, 2020). According to this research, when multifunctional buildings have multiple owners, it can lead to a lower willingness of investors to pay because conflicts can arise when making a long-term investment decision. To preserve the value of multifunctional buildings, it may be preferable that future developments be designed in such a way that one owner retains control

over the entire structure. This way, there is no need to form an owners' association, giving the investor more flexibility to adapt to changing conditions and add value over time.
The study's findings have implications for investors, particularly those who specialize in office real estate or own or are considering investing in multifunctional buildings. For them, the pricing effect of an owners' association can alter their interpretation of the building's investment value and aid in investment decisions.

This research has several limitations. first, the credibility of this research is based on the fact that research into the relationship between an owners' association and the transaction price of offices is rare. As a consequence, comparing the results to existing literature is difficult. Using the hedonic analysis method for such a relationship requires a large amount of data. Because office transaction data are frequently kept confidential in the Netherlands and information about VvE's is difficult to obtain, comparable research has been unable to use this type of analysis. This research was able to use this type of analysis by utilizing the SREbase and intensively collecting available data from VvE's. To our knowledge, this is the first study to conduct a hedonic analysis method with the owners' association as the primary variable.
Second, because this study was unable to obtain the data, it was unable to control for the number of owners within a building. Due to the owners' association's consultation structure, an increase in owners within a building may reduce flexibility to add value for the investor, potentially lowering the price even further. Future research could look at the interaction between the number of owners in a VvE and the price of offices.
Third, the quality of the VvE was not controlled for in this study. Each VvE has its own set of rules that the owners must adhere. Furthermore, the manner in which the building's ownership is (sub)divided could be important. As the rules and (sub)division become more restrictive, the valuation may fall. These data would have to be obtained and assessed for each individual building, which would be too time-consuming and intensive for the time frame of this research. Future research could evaluate the VvE's quality and investigate their impact on prices.
Fourth, the number of observations is limited. The dataset contains 283 office transactions, of which only 65 are with an owners' association. This is disadvantageous to the representativeness of this study. This study was unable to expand the dataset in order to ensure representativeness.
Finally, this study was unable to include a control variable that controls for an object's tenant status. To avoid multicollinearity, this variable was not included in the analysis.

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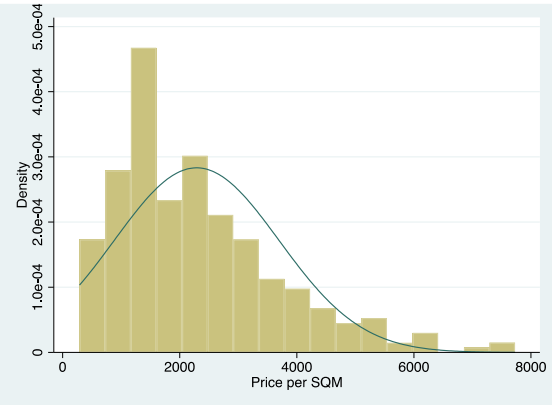
APPENDICES

APPENDIX A: The ethics of management research

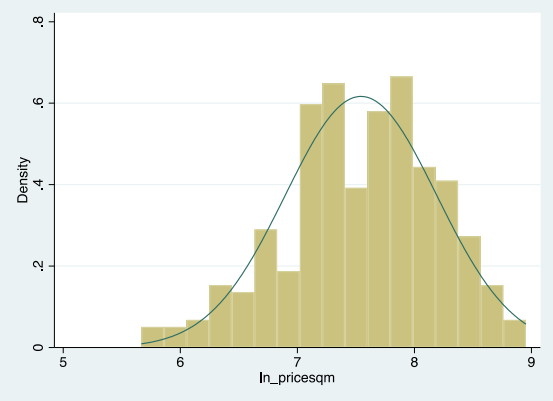
1. Harm to participants – the potential of harming research participants, the researcher, or others as a result of the study process, and the necessity to guarantee physical and psychological well-being of research participants, the researcher, or others.
2. Dignity – the need to treat study participants, researchers, and others with dignity and to prevent causing them distress or concern
3. Informed consent – the importance of obtaining fully informed consent from study participants
4. Privacy – the need to preserve research subjects' privacy or avoid privacy invasions
5. Confidentiality – the obligation for research data related to persons, groups, or organizations to be kept confidential.
6. Anonymity – the preservation of an individual's or an organization's anonymity
7. Deception – the possibility of deception in the study process, whether through falsehoods or misleading behaviour
8. Affiliation – the necessity of disclosing any professional or personal relationships that may have impacted the study, such as conflicts of interest and sponsorship, as well as details regarding where the research was funded.
9. Honesty and transparency – the need of being transparent and honest when conveying research material to all relevant parties, as well as the importance of trust
10. Reciprocity – the premise that the study should benefit both the researcher and the participants, or that there should be some type of collaboration or active engagement.
11. Misrepresentation – the importance of avoiding research findings that are misrepresented, misunderstood, or falsely reported.

Bell, E. and Bryman, A. (2007). The ethics of management research: an exploratory content analysis. *British journal of management*, *18*(1),.63-77.

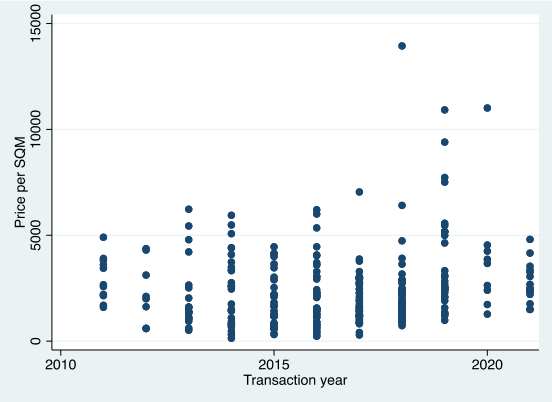
APPENDIX B: Transformation and removal of outliers

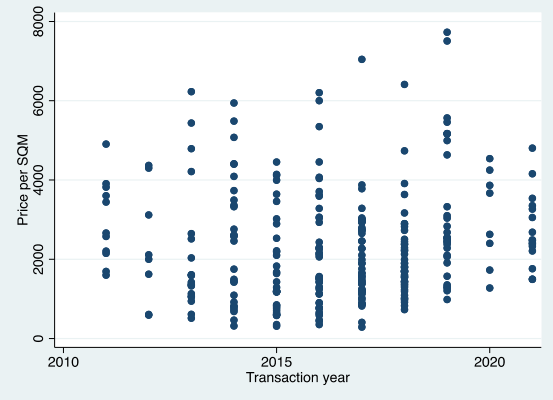


Histogram: Transcation price per sq m.

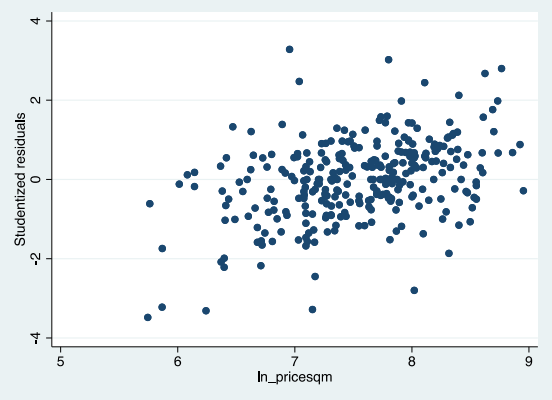


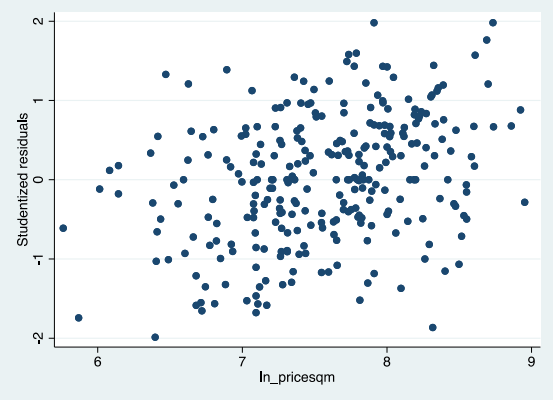
Histogram: ln transaction price per sq m.





Scatterplot of the price per sq m. and the transaction year. Left: before removing outliers, right: after removing outliers.





Scatterplot of the Studentized residuals and the logarithm of the transaction price per sq m. Left: before removing outliers, right: after removing outliers.

APPENDIX C: OLS assumptions

A linear regression model must meet five assumptions to ensure that the coefficients found represent the best possible estimate (Brooks and Tsolacos, 2010). The use of a multiple regression analysis will be unreliable if any of these assumptions are violated.

The errors have zero mean. $E(u_t) = 0$

The first assumption is that the error terms' mean value is equal to zero. This assumption will never be violated if a constant is included in the regression equation, as is the case in this study.

Homoscedasticity var $(u_t) = \sigma^2 < \infty$

This second assumption is built on the assumption that the variance of two or more samples is the same and finite. They are called heteroskedastic if the error term does not have a constant variance. To test this assumption a Breusch-Pagan het test is performed. The Chi2(1) = 0.056 and P-value > 0.05 (P = 0.813). Therefore, there is no heteroskedasticity problem.

Multicollinearity $\text{cov}(u_i, u_j) = 0$

The third assumption is that the covariance between the error term is zero. This means that the error term between two or more independent variables should not be strongly correlated. If the errors are correlated, they are said to be "autocorrelated" or "serially correlated." This could lead to an efficiency bias. Autocorrelation should be avoided to avoid this bias in the results. Multicollinearity will be tested using the Variance Inflation Factor (VIF). Appendix E presents the results of this test. Because all variables in the VIF-analysis are well below 10, no variables are removed from the regression.

Linearity

The fourth assumption is that the relationship between the dependent variable and the independent variables is linear. The relationship between the chosen y and x variables should be expressed schematically in the form of a linear line. The independent variable owners' association is a dummy variable. Dummy variables meet the linearity assumption by definition, because they generate two data points, and two points define a straight line (Hardy, 1993).

Residuals are normally distributed

The fifth assumption is the normality of the residuals. This assumption contributes to the reliability of the hypothesis testing. According to the Shapiro-Wilk W normality test the z-value is 0.426 and the P-value is higher than the critical value of 0.01 (P = 0.239). Therefore, the residuals are normally distributed.

APPENDIX D: Correlation matrix

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)
(1) Price per sqm.	1.000																						
(2) OA = YES	-0.018	1.000																					
(3) OA = NO	0.018	-1.000	1.000																				
(4) age	-0.012	0.114	-0.114	1.000																			
(5) Total sqm.	0.280	-0.198	0.198	-0.204	1.000																		
(6) Parking spaces	0.193	-0.177	0.177	-0.235	0.742	1.000																	
(7) Energy = A	0.235	-0.006	0.006	-0.322	0.314	0.251	1.000																
(8) Energy = B	0.030	0.003	-0.003	-0.050	-0.010	-0.025	-0.451	1.000															
(9) Energy = C	-0.131	-0.102	0.102	-0.010	-0.086	-0.023	-0.376	-0.177	1.000														
(10) Energy = other	-0.210	0.088	-0.088	0.453	-0.307	-0.267	-0.500	-0.235	-0.196	1.000													
(11) Walkscore	0.217	0.274	-0.274	0.269	0.143	-0.109	-0.028	0.061	-0.070	0.036	1.000												
(12) Distance Highway	0.082	0.109	-0.109	0.207	0.129	0.076	0.064	-0.002	-0.091	-0.001	0.375	1.000											
(13) Distance Train	-0.176	0.071	-0.071	-0.010	-0.176	-0.042	-0.040	0.079	0.016	-0.038	-0.361	0.107	1.000										
(14) Transaction year	0.068	-0.036	0.036	-0.039	-0.009	0.027	0.078	-0.036	0.003	-0.064	-0.062	-0.082	0.120	1.000									
(15) wall	0.409	0.045	-0.045	-0.142	0.260	0.205	0.215	0.014	-0.132	-0.170	0.108	0.085	-0.002	-0.057	1.000								
(16) single ticket	0.258	-0.070	0.070	0.040	0.144	0.048	0.164	-0.081	-0.054	-0.082	0.155	0.164	-0.064	0.076	0.041	1.000							
(17) portfolio	-0.258	0.070	-0.070	-0.040	-0.144	-0.048	-0.164	0.081	0.054	0.082	-0.155	-0.164	0.064	-0.076	-0.041	-1.000	1.000						
(18) domestic	-0.175	-0.121	0.121	0.108	-0.200	-0.149	-0.059	-0.017	0.025	0.068	0.018	0.042	0.080	-0.079	-0.126	0.144	-0.144	1.000					
(19) foreign	0.175	0.121	-0.121	-0.108	0.200	0.149	0.059	0.017	-0.025	-0.068	-0.018	-0.042	-0.080	0.079	0.126	-0.144	0.144	-1.000	1.000				
(20) Vacancy rate	-0.339	0.008	-0.008	0.052	-0.058	-0.080	-0.042	-0.093	0.015	0.127	-0.041	-0.050	-0.097	-0.027	-0.480	0.084	-0.084	0.079	-0.079	1.000			
(21) Tenant = Single-	0.156	-0.109	0.109	-0.035	-0.016	-0.022	0.030	0.005	-0.082	0.026	-0.012	0.113	-0.052	-0.170	0.338	0.114	-0.114	0.029	-0.029	-0.373	1.000		
(22) Tenant = vacant	-0.226	0.001	-0.001	0.090	-0.120	-0.085	-0.077	-0.037	0.012	0.120	-0.070	-0.045	-0.073	-0.050	-0.478	0.142	-0.142	0.068	-0.068	0.823	-0.264	1.000	
(23) Tenant = Multi-	0.006	0.102	-0.102	-0.028	0.096	0.078	0.024	0.020	0.069	-0.105	0.059	-0.076	0.099	0.194	0.004	-0.203	0.203	-0.073	0.073	-0.203	-0.761	-0.425	1.000

APPENDIX E: Statistical tests

Chow F-test

The total dataset is divided into two groups in section 6.2: foreign investors and domestic investors. The Chow F-test can be used to determine whether the parameters of foreign and domestic investors are equal and stable. When the test statistic exceeds the critical value of the F distribution, the null hypothesis is rejected. The following formula is used to compute the test statistic:

$$\frac{RSS - (RSS1 + RSS2)}{RSS1 + RSS2} * \frac{T - 2K}{K} \rightarrow \frac{12.76 - (2.085 + 6.28)}{2.085 + 6.28} * \frac{283 - (2 * 97)}{97} = 0.482$$

RSS = residual sum of squares, total sample
RSS1 = residual sum of squares, sub-sample 1 (domestic investors)
RSS2 = residual sum of squares, sub-sample 2 (foreign investors)
T = number of observations
K = number of regressors (including constant)
DF = degrees of freedom

The test statistic calculated is 0.482. The critical value in the F-distribution table at a significance level of 5% was found to be 1,412 with DF1 of 97 and DF2 of 89. The null hypothesis is not rejected because the test statistic found is less than the critical value (0.482 < 1.412).

VIF-Test

Variable	VIF	1/VIF
Owners Association	3.24	0.308968
ln_age	2.67	0.374813
ln_totalsqm	4.68	0.213461
ParkingSpace	4.07	0.245557
energylabel		
A	4.39	0.227542
B	3.18	0.314702
C	2.30	0.435546
Walkscore	8.95	0.111753
ln_dhighway	4.56	0.219138
ln_dtrain	6.19	0.161541
Transaction year		
2012	2.17	0.460782
2013	3.58	0.279506
2014	4.29	0.232887
2015	4.89	0.204318
2016	6.07	0.164674
2017	6.86	0.145741
2018	5.83	0.171398
2019	4.20	0.238260
2020	2.17	0.461330
2021	3.21	0.311582
Status	2.12	0.471867
Origin	1.73	0.577786
wall	2.20	0.454492
vac	2.11	0.473010
Mean VIF	**2.99**	

APPENDIX F: Stata syntax

```
clear all
cd "/Users/GPenders/Desktop/Real Estate Studies/Master Thesis/MT_Output"

*** Import of the data ***
import excel "/Users/GPenders/Documents/SREbase - Master Thesis.xlsx", sheet("Dataset") firstrow

*** Destring data ***
destring TransactionPriceKK, replace force
destring Constructionyear , replace force
destring PriceperSQM , replace force
destring Month , replace force
destring Transactionyear , replace force
destring LFA_office , replace force
destring LFA_industrialBAG , replace force
destring lfa_retailBAG , replace force
destring lfa_hotelBAG , replace force
destring lfa_otherBAG , replace force
destring totalsqm , replace force
destring ParkingSpaces , replace force
destring Walkscore , replace force
destring vacsqm , replace force
destring vac , replace force
destring wall , replace force
destring RVsqm , replace force
destring tenants , replace force
destring DistanceTrain , replace force
destring DistanceHighway , replace force
destring Postalarea , replace force

sort number
*** Formating of year variable ***
format Constructionyear %ty
format Month %ty
format Transactionyear %ty

*** Generating dummy variable for Owners' association Yes/No ***
gen OwnersAssociation_dummy = 0
replace OwnersAssociation_dummy = 1 if OwnersAssociation == "Yes"
label define OwnersAssociation_dummy 0 "No" 1 "Yes"
label value OwnersAssociation_dummy

*** Looking for outliers in the data ***

scatter PriceperSQM Transactionyear
sort PriceperSQM
_pctile PriceperSQM , p(1 99)

list if PriceperSQM <r(r1) | PriceperSQM > r(r2)
drop if PriceperSQM <r(r1) | PriceperSQM > r(r2)
list if PriceperSQM > 9000
drop if PriceperSQM > 9000
scatter PriceperSQM Transactionyear
```

```
*** tranforming PriceperSQM to logarithm ***
hist PriceperSQM, normal
gen ln_pricesqm = log(PriceperSQM)
hist ln_pricesqm, normal


*** tranforming TransactionPriceKK to logarithm***
gen ln_transactionprice = log(TransactionPriceKK)

****** Building characteristics variables ******

*** Generating age log variable ***
hist age, normal
gen ln_age = log(age)
hist ln_age, normal

*** creating categorical variables for constructionyear for optional use ***
gen Constructionyear0_1945=1 if inrange(Constructionyear,1,1945)
replace Constructionyear0_1945=0 if Constructionyear0_1945==.

gen Constructionyear1946_1970=1 if inrange(Constructionyear,1946,1970)
replace Constructionyear1946_1970=0 if Constructionyear1946_1970==.

gen Constructionyear1971_1990=1 if inrange(Constructionyear,1971,1990)
replace Constructionyear1971_1990=0 if Constructionyear1971_1990==.

gen Constructionyear1991_2005=1 if inrange(Constructionyear,1991,2005)
replace Constructionyear1991_2005=0 if Constructionyear1991_2005==.

gen Constructionyear2006_2022=1 if inrange(Constructionyear,2006,2022)
replace Constructionyear2006_2022=0 if Constructionyear2006_2022==.

*** transforming totalsqm to logarithm to make it more normally distributed ***
hist totalsqm, normal
gen ln_totalsqm=log(totalsqm)
hist ln_totalsqm, normal

*** Generating dummy variable for Energylabel ***
gen energylabel_dummy = 0
replace energylabel_dummy = 1 if EnergyLabel =="A"
replace energylabel_dummy = 2 if EnergyLabel =="B"
replace energylabel_dummy = 3 if EnergyLabel =="C"
label define energylabel_dummy 0 "Other" 1 "A" 2 "B" 3 "C"
label value energylabel_dummy energylabel_dummy

****** Locational characteristics variables ******

*** Looking if distancehighway is normally distributed and transform ***
hist DistanceHighway, normal
gen ln_dhighway = log(DistanceHighway)
hist ln_dhighway, normal

*** Looking if distancetrain is normally distributed and transform ***
hist DistanceTrain, normal
gen ln_dtrain = log(DistanceTrain)
```

```
hist ln_dtrain, normal

****** Investment characteristics variables ******

*** Generating dummy variable for transaction type single/portfolio ***
gen status = 0
replace status = 1 if Transactiontype == "Portfolio"
label define status 0 "Single ticket" 1 "Portfolio"
label value status status

*** Transform buyers nationality into a dummy for foreign and domestic investors ***
gen origin = 0
replace origin = 1 if Buyersnationality== "Foreign"
label define origin 0 "Domestic" 1 "Foreign"
label value origin origin

****** Rental characteristics variables ******

*** Looking if rental value per sqm is normally distributed and transform ***
hist RVsqm, normal
gen ln_RVsqm = log(RVsqm)
hist ln_RVsqm, normal

*** Making dummy variable for tenants into vacant/single/multi - for regression ***
gen tenancy = 0 if tenants == 1
replace tenancy = 1 if tenants == 0
replace tenancy = 2 if tenants > 1
label define tenancy 0 "Single Tenant" 1 "Vacant" 2 "Multi Tenant"
label value tenancy tenancy

*** regression for studentized residuals ***
regress ln_pricesqm OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain i.Transactionyear wall i.status i.origin vac

****** searching and removing outliers with Studentized residuals ******
predict rstu if e(sample), rstudent
scatter rstu ln_pricesqm
list if abs(rstu) > 2
drop if abs(rstu) > 2
scatter rstu ln_pricesqm

****** Descriptive statistics ******

*** Descriptives using asdoc for two groups***
bysort OwnersAssociation_dummy: asdoc tabstat TransactionPriceKK PriceperSQM age totalsqm ParkingSpaces energylabel_dummy Walkscore DistanceHighway DistanceTrain Transactionyear wall status origin vac tenancy, replace stat(N mean sd min max)

*** descriptives for dummy variables ***
tab OwnersAssociation_dummy if OwnersAssociation_dummy == 0
tab energylabel_dummy if OwnersAssociation_dummy == 0
tab Transactionyear if OwnersAssociation_dummy == 0
tab status if OwnersAssociation_dummy == 0
tab origin if OwnersAssociation_dummy == 0
```

```
tab tenancy if OwnersAssociation_dummy == 0

tab OwnersAssociation_dummy if OwnersAssociation_dummy == 1
tab energylabel_dummy if OwnersAssociation_dummy == 1
tab Transactionyear if OwnersAssociation_dummy == 1
tab status if OwnersAssociation_dummy == 1
tab origin if OwnersAssociation_dummy == 1
tab tenancy if OwnersAssociation_dummy == 1

****** Correlation matrix ******

*** generating dummies individually for correlation matrix ***
gen oa_yes = 1 if OwnersAssociation == "Yes"
replace oa_yes = 0 if oa_yes ==.

gen oa_no = 1 if OwnersAssociation == "No"
replace oa_no = 0 if oa_no ==.

gen vacancy_0 = 1 if vac == 0
replace vacancy_0 = 0 if vacancy_0 ==.

gen vacancy_35 = 1 if inrange(vac, 0.000001,0.35)
replace vacancy_35 = 0 if vacancy_35 ==.

gen vacancy_35plus = 1 if inrange(vac, 0.35000001, 1)
replace vacancy_35plus = 0 if vacancy_35plus==.

gen single_tenant = 1 if tenants == 1
replace single_tenant = 0 if single_tenant ==.

gen vacant_tenant = 1 if tenants == 0
replace vacant_tenant = 0 if vacant_tenant ==.

gen multi_tenant = 1 if tenants > 1
replace multi_tenant = 0 if multi_tenant ==.

gen domestic = 1 if Buyersnationality == "Domestic"
replace domestic = 0 if domestic ==.

gen foreign = 1 if Buyersnationality == "Foreign"
replace foreign = 0 if foreign ==.

gen single_ticket = 1 if Transactiontype == "Single"
replace single_ticket = 0 if single_ticket ==.

gen portfolio = 1 if Transactiontype == "Portfolio"
replace portfolio = 0 if portfolio ==.

gen label_a = 1 if energylabel_dummy == 1
replace label_a  = 0 if label_a ==.

gen label_b = 1 if energylabel_dummy == 2
replace label_b  = 0 if label_b ==.

gen label_c = 1 if energylabel_dummy == 3
```

```
replace label_c  = 0 if label_c ==.

gen label_other = 1 if energylabel_dummy == 0
replace label_other         = 0 if label_other ==.

*** creating correlation matrix ***
asdoc corr PriceperSQM oa_yes oa_no age totalsqm ParkingSpaces label_a label_b label_c label_other Walkscore DistanceHighway DistanceTrain Transactionyear wall single_ticket portfolio domestic foreign vac single_tenant vacant_tenant multi_tenant

****** RESULTS ******

*** Results with transaction price as dependent variable ***

regress ln_transactionprice OwnersAssociation_dummy
outreg2 using results0.doc, adjr2 append ctitle (Basic model)

regress ln_transactionprice OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy
outreg2 using results0.doc, adjr2 append ctitle (+Property characteristics)

regress ln_transactionprice OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain
outreg2 using results0.doc, adjr2 drop(i.Postalarea) append ctitle (+Location characteristics)

regress ln_transactionprice OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain i.Transactionyear i.status i.origin
outreg2 using results0.doc, adjr2 drop(i.Postalarea i.Transactionyear) append ctitle (+Investment characteristics)

regress ln_transactionprice OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain i.Transactionyear i.status i.origin wall vac
outreg2 using results0.doc, adjr2 drop(i.Postalarea i.Transactionyear) append ctitle (+Tenant characteristics)

*** Results with price per m2 as dependent variable ***

regress ln_pricesqm OwnersAssociation_dummy
outreg2 using results.doc, adjr2 append ctitle (Basic model)

regress ln_pricesqm OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy
outreg2 using results.doc, adjr2 append ctitle (+Property characteristics)

regress ln_pricesqm OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain
outreg2 using results.doc, adjr2 drop(i.Postalarea) append ctitle (+Location characteristics)

regress ln_pricesqm OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain i.Transactionyear wall i.status i.origin
outreg2 using results.doc, adjr2 drop(i.Postalarea i.Transactionyear) append ctitle (+Investment characteristics)
```

```
regress ln_pricesqm OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain i.Transactionyear i.status i.origin wall vac
outreg2 using results.doc, adjr2 drop(i.Postalarea i.Transactionyear) append ctitle (+Tenant characteristics)

*** checking for assumptions ***
regress ln_transactionprice OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain i.Transactionyear i.status i.origin wall vac
regcheck

regress ln_pricesqm OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain i.Transactionyear i.status i.origin wall vac
regcheck

regress ln_pricesqm OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain i.Transactionyear i.status i.origin wall vac
asdoc estat vif

****** Chow - Foreign vs Domestic investors ******

regress ln_pricesqm OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain i.Transactionyear i.status wall vac
outreg2 using chow2.doc, adjr2 drop(i.Postalarea i.Transactionyear) append ctitle (Pooled)

regress ln_pricesqm OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain i.Transactionyear i.status wall vac if origin == 0
outreg2 using chow2.doc, adjr2 drop(i.Postalarea i.Transactionyear) append ctitle (Domestic)

regress ln_pricesqm OwnersAssociation_dummy ln_age ln_totalsqm ParkingSpaces i.energylabel_dummy i.Postalarea Walkscore ln_dhighway ln_dtrain i.Transactionyear i.status wall vac if origin == 1
outreg2 using chow2.doc, adjr2 drop(i.Postalarea i.Transactionyear) append ctitle (Foreign)

tab OwnersAssociation_dummy if origin == 0
tab OwnersAssociation_dummy if origin == 1
```