Quantitative approach

"The effect of sustainability on Dutch office asset value"

"Sustainable Real Estate Investors Pathway"

university of groningen

faculty of spatial sciences

Author:	R.B. (Roeland Bernhard) Strotmann
	(s2599295)
Address:	Kampervest 43b
	2011 EZ Haarlem
Telephone:	+31 (0)6 21 45 98 35
E-mail:	roeland@strotmann.nl
Supervisor:	Dr. X. (Xiaolong) Liu – University of Groningen
	xiaolong.liu@rug.nl
2nd Supervisor:	Dr. M. (Michiel) Daams – University of Groningen
	m.n.daams@rug.nl
Master:	MSc Real Estate Studies
Faculty:	Faculty of Spatial Sciences
Department:	Department of Economic Geography

"Men argue. Nature acts."
— *Voltaire*

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Above all I hope that you enjoy reading my master thesis and that this added academic knowledge will support valuers, banks and property owners in the process of sustainabilization of commercial properties. If there are any questions about this thesis feel free to contact me.

Roeland Strotmann
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Abstract

Previous studies on the effect of sustainability, i.e. energy efficiency on the value of office buildings, mainly focused on markets other than the European market. This paper shows the highly significant effect of the level of sustainability on the transaction price of office buildings in the Dutch market, based on 406 office transactions from the years 2013 to 2018. It demonstrates that there is a significant effect of energy efficiency on realized transaction prices. Using data provided by Cushman & Wakefield, the statistical analysis indicates that investors rationally or irrationally take sustainability into account when investing in offices during the period of 2013 till 2018. It indicates a decrease in transaction price of 35% when the energy index of an office building increases with one unit.

Hence, the research based on 406 office transactions indicates that the effect of energy efficiency has a significant effect on realized transaction prices.

Keywords: Sustainability, Office buildings, Energy efficiency, Office transactions, Dutch office market

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1. Introduction

The real estate sector has a significant impact on the overall environment. For example, the largest individual user of fossil fuels is the building and real estate sector in conformity with Elfving (2009). Buildings are responsible for almost 40% of the world's primary energy use, in accordance with calculations of UNEP (2007). Calculations indicate that buildings cause 30% of the world's CO_2 emissions. Thirty percent of the operating expenses of typical US office buildings come from its energy costs (Eichholtz et al., 2010). There is a growing concern that worldwide greenhouse gas emission might double in the next two decades. This increase in greenhouse gas emissions would be a consequence of the expansion of construction in emerging economies, along with limited devotion or attention on energy efficiency of buildings during the process (Ciora et al., 2016). The European Union (EU) has made bold obligations in the 2010 'Energy Performance of Buildings Directive' that must be ensured by its Member States. After 31 December 2018, the following obligation will be enforced: new buildings that will be occupied and owned by public authorities must be nearly zero-energy buildings (European Parliament, Art. 9, 2010; Desideri et al., 2013). With regard to the obligations as stated above, the Dutch government has announced the statutory obligation that office buildings need to be renovated up to a minimum Energy-Index (EI or Energy Performance Certificate[1]) of 1.3, no later than 1 January 2023. This EI corresponds with an energy label C. As from 2023 property owners are not allowed to lease or use their offices if the EI is lower than 1.3. Most probably by 2030 Dutch office buildings are required to have energy label A. The main goal of this Dutch obligation is to incite energy use reduction in this specific sector. The 21st Conference of the Parties of the United Nations (COP21) in Paris (2015) and its outcomes enforced the importance of further academic research on the effects and requirements of more sustainable office buildings. Because sustainable real estate has become an even more pressing item on the agenda of governments worldwide, news media and (institutional) investors.

Existing studies that examine the impact of the level of sustainability on the value of buildings are mostly based on the market in the United States (U.S.) (Ciora et al., 2016). These "sustainability studies" are solely focused on the effects of sustainability on rents and based on American data (Op't Veld et al., p.5, 2013). When taking this into consideration, Ciora et al. (2016) states that there are still numerous hypotheses which can be implied on the European real estate market. European countries have a wide variety of differences when considering the location of green buildings, whether in or outside the Central Business District (CBD) (Ciora et al., 2016). There are papers that have examined the effect of sustainability of Dutch office buildings on rent levels (Baas, 2013; Broek, 2010; Cox, 2017; Heineke, 2009; Kok & Jennen, 2012;). Prior research like Eizchholtz et al. (2013) focusing on office values, Brounen & Kok (2011) focusing on the housing market, Op't Veld et al. (2013) focusing on the retail market and Kok & Jennen (2012) focusing on office rents, have examined specific

[1] See appendix 1 for brief definitions of the energy-index (EI) and energy performance certificate (EPC).

elements of the effects of sustainability on real estate. Earlier research that focused on the effects, costs and or revenues of sustainable real estate has investigated mainly the US office- and housing markets because of the amount and quality of available data in the US of these real estate sectors (Vlasveld et al., 2013). Although academic research that looks into the effect of sustainability on asset values of European office buildings remains to be scarce. Thus, it remains difficult for investors and property owners to determine how much there should be invested in sustainability, since range of costs, green premiums on asset values and brown discounts in the relation of the degree of sustainability remain unclear.

This paper examines the effects of energy efficiency on asset values. Complementary to previous academic research and the social importance of the subject, this study aims to provide clarification on the effect of sustainability of Dutch office properties on realized asset values, based on approx. 400 office building transactions.

This paper will focus on one main research question. The central research question in this paper is as follows:

1) ‘To what extent does energy efficiency affect the realized transaction prices within the groups of “brown” and “green” office buildings over the time-period from 2013 to 2018?’

It examines whether investors already take a brown discount or green premium into account when making real estate investment deals over the years 2013 up to and including 2017.

The remainder of this paper is structured as follows. In section 2 the relevant literature is discussed. Section 3 describes the methodology and the empirical model which is used in the quantitative approach. The results of the quantitative approach are reported in section 4. The conclusions are provided in section 5, followed by a discussion.

2. Literature Review

This section conducts a summary of key literature that has been previously studied to understand variation in yields and real estate asset values due to the level of sustainability. It will point out and describes the relevant parameters and the theoretical framework in relation to investment theory in relation to sustainability. A priori, additional background information about sustainability is shared.

2.1 Operationalization and challenges when making buildings sustainable

Currently, there is a lack of European academic studies that focus on the effect of the level of sustainability and energy efficiency on the asset values of office buildings. Kok & Jennen (2012) mentioned that the influence of sustainability in relation to financial benefits of commercial real estate remain unclear. Potential profits of commercial properties with reference to their degree of sustainability are usually a topic of speculation, rather than that it is a topic of an empirical study (Kok & Jennen, 2012).

There is an ongoing discussion on the costs and benefits of 'greening' real estate. Green building improvements in the commercial property sector still didn't take off yet on a large scale. Remarkable according to Kok & Jennen (2012) at the time, considering the major influences of the real estate sector on CO2 emissions, the increasing evidence of the importance of sustainable real estate in relation to global warming and the large potential to decrease environmental issues (Enkvist et al., 2007; Kok & Jennen, 2012). Sustainability of buildings through small improvements already can have large effects on greenhouse gas emissions and would result in an economy that is more energy efficient (Eichholtz et al., 2010). On top of that, when buildings are more energy efficient, they could deliver higher returns on investment and they might result in a higher productivity or increased health for employees (Ciora et al., 2016). Investment returns of non-sustainable buildings could be affected negatively due to the high correlation with price increases of energy and commodities (UNEP, 2007).

Investing in buildings that are labeled by certified independent rating agencies may provide a hedge against higher energy prices and an increased robustness against shifting preferences of tenants and investors with respect to environmental issues (Eichholtz et al., 2013). Evidence of Eichholtz et al. (2013) suggests that investors in real estate properties already value the lower risk premium that comes with certified commercial office buildings. An explanation can be found in the fact that green certified real estate can be more robust in times of increasing energy prices. Investors can see investments in sustainable real estate as an insurance against a future increase in energy prices. Green buildings might provide risk-mitigation for owners and other parties like banks and private equity. When considering future alterations and stricter public rule-making regarding sustainability requirements, it could also improve the exit yield rate in relation to that of non-future-proof properties. Aggressive policies of certifying and rating buildings can result in a large payoff in terms of energy use and simultaneously the course of global warming (Miller & Garber, 2013, Eichholtz et al., 2010).

Not only the investors may benefit, office occupants can also reduce expenses. Tenants can benefit through lower utility bills, higher employee satisfaction. The economic benefits for investors lie in higher rents and lower risk premiums. Thirty percent of the operating expenses of typical US office buildings come from energy costs. These expenses are the most manageable costs in the provision of office space (Eichholtz et al., 2013).

However, Cox (2017) states that operationalization for individual properties remains troublesome. Because of the unique attributes of each property and their sustainability features, it is challenging to be able to match the level of sustainability per office building (Warren et al., 2009). In a publication of the Royal Institution of Chartered Surveyors (hereinafter referred to as RICS) Green Value is roughly described as the net additional value that is obtained by a green building in the market when compared to a non-green peer group. RICS (2005) states that the green value is an integral part of the overall market value and that these components can only be separated theoretical wise. Therefore, there is still an important barrier present for further investments in 'greening' existing office property portfolios, due of the lack of systematic evidence on its returns on investments (Kok & Jennen, 2012).

Ciora et al. (2016) state that the green premium could be retrievable in the benefit of the owner(s) in increased resale value, improved occupancy and operating rates, higher net operating income and lower capitalization rates. Energy Star labelled properties entail ten to eleven percent higher occupancy rates in relation to comparable office properties. For LEED properties (Leadership in Energy and Environmental Design), this comes down to approximately sixteen to eighteen percent higher occupancy rates. As already stated in Warren et al. (2009) there are multiple studies that demonstrate that the additional cost of sustainability is minimal (Consultancy, 2004, Mathiessen & Morris, 2004 and Suttel, 2006). When following these outcomes, it should be financially interesting to invest in sustainable, i.e. to improve operating expenses. Fuerst & Mc Allister (2011) and Cajias et al. (2013) also show improvements of cash flow through higher occupancy rates and lower costs of capital for green assets. Fuerst (2015) discusses the fact that risk-return profiles should improve when real estate companies participate in sustainability benchmarking programs, like GRESB (Global Real Estate Sustainability Benchmark). Kahn (2009) deliberates that small increases or investments in the energy efficiency of buildings can lead to large effects on their current use of energy and life cycle energy consumption, but in fact will also improve investments performances. Finally, Pascuas et al. (2017) mentions that EPC or EI´s should influence transaction prices as a result of improved energy-efficiency, reduction in energy consumption and improved internal comfort. However, there is also criticism on the unreliability of EI´s because of the difficulties regarding their readability and understandability. Interpretation remains a challenge (Pascuas et al., 2017).

In addition, Muldavin (2010) points out that other factors that may influence transaction prices, like mass transit orientation, nearby daily and non-daily amenities, community connectivity, but also land-use and urban and regional planning do have an impact in developing and/or maintaining sustainable regions and communities, and thereby buildings with sustainable fundamentals, through the characteristics and topographic features of their locality. Traditionally, research tailored on sustainable building research or certification structures in general focuses on the specifics and technological facilities of a property, rather than incorporate these above-mentioned issues. Specifications like, the accessibility by car or public transport and the walkability in relation to nearby amenities and their influence on realized transactions prices will be examined in this paper.

As Muldavin (2010) partly mentioned, real estate valuers and investors already are fully capable to weigh and include these complexities into the valuation. However, these issues are not always seen as constitutive elements for the level of sustainability of an (office) building. In the field of office valuations, certain ‘sustainability’ characteristics of office accommodations, are already included in the valuation process, but are not directly linked to sustainability. These features do have an impact on property value, like the extent of daylight illumination can mark the quality of office space. It can also contribute to the worker productivity, might influence the level of the rents and can help decrease operating expenses (Muldavin, 2010). Chao et al. (1999)´s results of the article named “Energy Efficiency & Property Valuation” back the theory that the green premium of commercial real estate is disclosed in reduced net operating income (Popescu et al, 2009).

2.2 Costs and benefits of sustainable buildings

Eichcholtz et al. (2010) have analyzed 10,000 commercial buildings that are located within the US and are LEED or Energy Star certified. These properties were classified into 900 clusters mainly based on their location. Many hedonic characteristics of rental and sold green office buildings and control office buildings are taken in consideration in this article, like size, age, its quality, ratio of story’s, variable costs for tenants or full-gross rental contracts, presence of on-site amenities and proximity to public transport (Eichholtz et al., 2013). The outcome of this study shows an increase of 16 percent in transaction price due to the level of sustainability. In addition a, decrease in energy consumption was directly correlated with a higher building value. In the case that there is a 10 percent decrease in relation to the energy consumption this would have a 1 percent rent increase or value premium for a property that is labelled.

The study of Fuerst (2015) featured multiple results of various sustainability papers that present the effect of sustainability on all types of property or operational parameters. In contrast to non-rated buildings, the transaction premium for a green building is 15.8% up to 16.8% higher. These results are based on 199 transactions of green office buildings between 2004 and 2007, which were compared to transaction of 1,614 non-rated properties located near these green office buildings. The distance was no more than circa 400 meters (Eichholtz et al., 2010; Ciora et al, 2016). Complementary studies of Fuerst & Mc Allister (2009) and Miller et al. (2008) confirm value premiums. Fuerst & Mc Allister (2009) display a sale price premium of 31% and 35% respectively for Energy Star and LEED certified properties. Miller et al. (2008) present a 5.3% percent and 9.9% percent value premium in relation to Energy Star and LEED certified buildings (Ciora et al., 2016).

The extreme volatility in the property markets during the period of 2007-2009 did not affect “green” real estate as much as “brown” real estate has endured during these downwards markets according to Eichholtz et al. (2013). It suggests that office buildings with a higher level of sustainability are more resilient and robust during market cycles. It turns out that the economic premiums for green office buildings are the result of their level of sustainability (Eichholtz et al., 2012). In Eichholtz et al. (2013) the economics of green building have been analyzed. The authors have analyzed the economic significance of increasing popularity and with it the increase of supply of green buildings regarding the private market for commercial office space. Previous findings of Eichholtz et al. (2012) include the following. In their paper, office buildings are examined that were certified by independent rating agencies. Large increases in the amount of green buildings did not significantly affect the relative yields of green buildings. Likewise, the extreme volatility in the property markets did not affect them. They found out that the economic premiums in rental and property values are substantial. But more importantly they relate these economic premiums for green buildings to the level of sustainability. Their study gives theoretical underpinning that thermal efficiency and sustainability have significant effect on the premiums in rents and property values. Between the green buildings the increased energy efficiency is taken into account into the rents and property values. Models of Eichholtz et al. (2013) examine the transaction prices of green and brown buildings close to each other. What turns out is that property values of identical green buildings sell with premiums of almost thirteen percent (Eichholtz et al., 2013).

The paper of Kok & Jennen (2012) offers systematic insight in effects of sustainability, energy efficiency and accessibility and what is does with realized rents in the EU office market. In their paper the Dutch real estate market is used as a case study. Kok & Jennen (2012) evaluate the financial implications of two elements of sustainability in the market of commercial real estate. These elements are energy efficiency and accessibility. They have conducted research based on 1,100 leasing transactions of office buildings in the Netherlands during the period of 2005 up to and including 2010. The level of sustainability has been measured by the EI in terms of energy labels A to G. An outcome of their analysis showed that energy inefficient office buildings (labeled D to G) obtain rental levels that are 6.5 percent lower in relation comparable office buildings that are energy efficient (labeled A to C). A noteworthy outcome of their study is that office buildings located in multi-functional areas (access to public transport and facilities) account for rental premiums over mono-functional office districts. Energy efficiency and location diversification are important when stricter environmental regulation and changing tenant preferences will come into play. Interesting will be whether this paper will show premiums in yields or asset values in relation to the group of green (labeled A, B or C) office buildings and the group of brown (labeled D or worse) office buildings in the research population controlling for location categories. Fuerst & Mc Allister (2011), Eichholtz et al. (2012) present rental premiums.

In the study of Cox (2017) the effect of sustainability on the rent of Dutch office buildings has been examined further based on 333 leasing transactions during the years 2014, 2015 and 2016. Other Dutch studies like Heineke (2009) shows that only at the prime office locations in the Randstad conurbation the EI had a significant effect on rental levels. This rent premium was three-point-seven percent. Baas (2013) & Broek (2010) demonstrated that sustainable offices had a ten-point-seven to twelve percent rent gain in relation to non-sustainable offices. The results of Cox (2017) has shown that the rental difference between green and brown office buildings sums up to sixteen percent. Office buildings with an energy label A have an additional rental level of about nineteen percent in relation to brown office buildings. Green office building with an energy label B or C have an added rental level of approximately thirteen percent. For office premises with an energy label A in comparison to premises with an energy label B or C, this rental difference is considered to be about six percent. Recent research from ING Real Estate Finance (REF) and the University of Maastricht display that energy efficiency does have a positive effect on the valued market value and rents of Dutch energy efficient office properties over the period of 2011-2014, but were not significantly higher than inefficient properties. Howbeit, in 2015 and 2016 the energy efficient office buildings did have a significantly higher valued market value and rents. In 2015 and 2016 the market value of Dutch energy efficient office properties were nine-point-one percent and eight-point-six percent higher. The rental values were eleven-point-eight percent and nine-point-nine percent higher (ING REF & University of Maastricht, 2017). The results of the statistical analysis's have shown that the EI affects the level of the rent of offices. This paper will display the effect of energy efficiency based on 400 office transactions in the Netherlands.

3. Methodology

To analyze the effect of energy efficiency on asset value in anticipation of the Dutch 2023 regulations, an OLS regression has been used. To determine whether there are significant differences between energy efficient and inefficient office groups, the office properties will be divided into two groups. Group 1: the energy efficient office group contains all office properties with an EI[2] of 1.30 or lower.

Group 2: the energy inefficient group include the properties with an EI of 1.31 or higher. The EI gives a rating to the energy efficiency of a building. This type of rating is valid for 10 years. The highest rating is 'A++', which stands for most efficient. Where the least rating that can be given is 'G'. See figure 3.1 for the label classes that correspond with these EI.

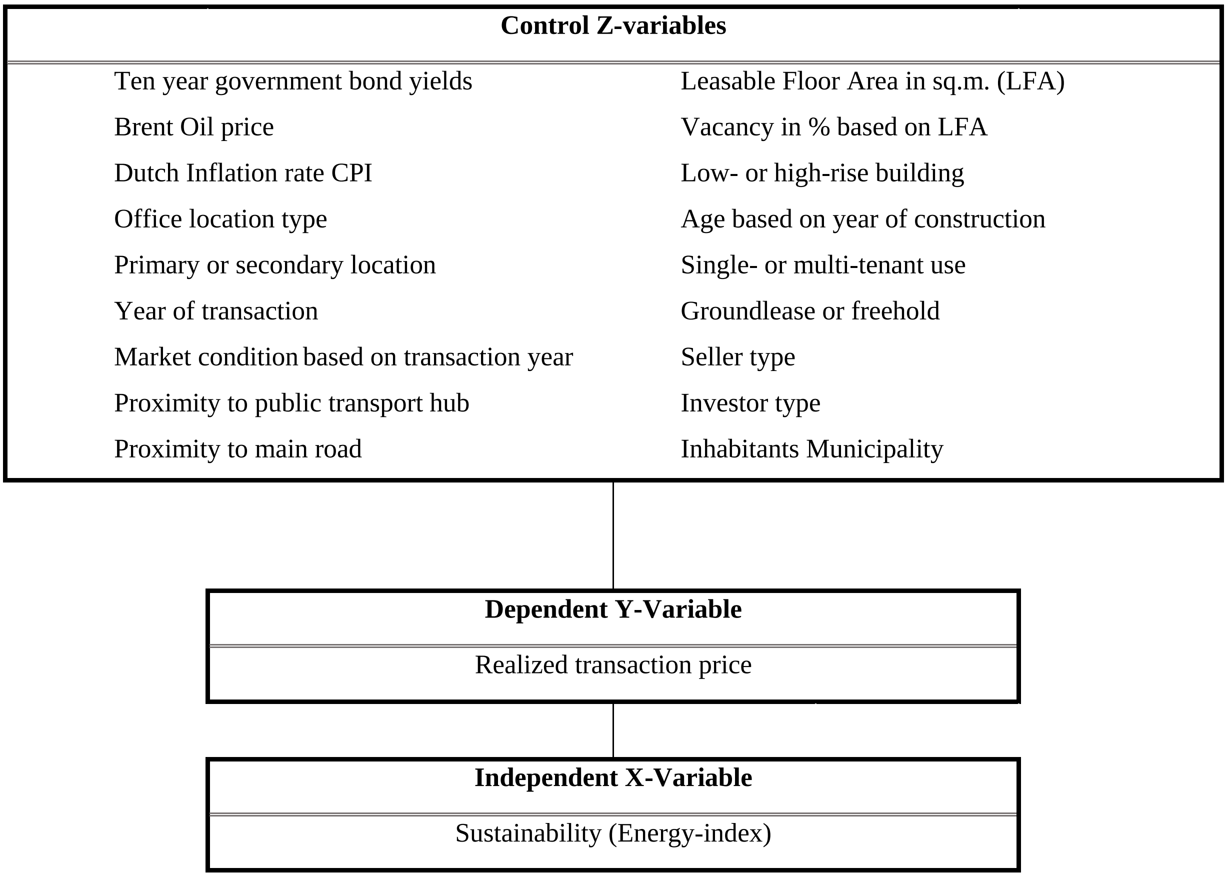
Figure 3.1: Label classes based on energy-index (EI)

A++	≤ 0,50
A+	0.51 – 0.70
A	0.71 – 1.05
B	1.06 – 1.15
C	1.16 – 1.30
D	1.31 – 1.45
E	1.46 – 1.60
F	1.61 – 1.75
G	> 1.75

(Rijksoverheid, 2015; Op ´t Veld et al., 2014)

The dependent variable is the realized transaction value of office buildings (Y). The independent variable is energy efficiency in terms of the ratio of EI (X). The conceptual model in figure 3.2 on the next page provides an overview of the variables that have an expected relationship with transaction prices in general, partly based on various relevant academic theory (Chegut et al. (2014); Kok & Jennen, 2012; Eichholtz et al., 2013; Ziermans et al., 2016; Brooks & Tsolacos, 2014). The paper of Eichholtz et al. (2010) showed a detailed set of control variables and propensity score weights in their analysis. However, their paper was restricted by the immature green buildings practice at that time. During the review period of the used research population with transactions from 2013 up to 2017, sustainability has become an even more pressing agenda item.

[2] Note: Definitions on how EI is constructed are described in appendix 1 as well as relevant abbreviations.



Based on cp. Chegut et al. (2014), Kok & Jennen (2012), Eichholtz et al. (2013) and Brooks & Tsolacos (2014).

Figure 3.2: Conceptual model

3.1 Empirical model

The empirical model that is used in this study to denote the effect of sustainability on asset value, is a multiple Ordinary Least Squares (OLS) regression analysis. This regression method is also used by Vlasveld et al. (2013) and partly in line with Chegut et al. (2014), Eichholtz et al. (2010) and Brounen & Kok (2011). In line with the model specification of Op't Veld et al. (2013), the effect of energy efficiency, specified by the energy-index (EI), on asset value is analysed using a semi-log equation. The following general formula is used in the regressions analysis:

$$\mathrm{LogP_{it}} = \alpha + \beta_i X_i + \beta_1(\mathrm{EI_{t0}}) + \beta_2(\mathrm{LocationType_{t0}}) + \beta_3(\mathrm{Marketcondition_{t0}}) + \delta g_i + \varepsilon_i \quad (1)$$

The dependent variable is the logarithm of the realized transaction price per net square meter (P) of property *i* at transaction year *t*. The logarithmic transformation solved the heteroscedasticity issue in the original model without the log component, but also facilitates a more functional interpretation of the presented coefficients.

The regressions coefficients β_1 up to β_3 represent the influence of the independent and control variables on the dependent variable. The effect of energy efficiency on realized transaction prices as independent variable is measured through β_1. It will also demonstrate whether there are significant differences among the energy efficient and inefficient office property groups. In model 1, four dummy variables will indicate whether location in bigger or smaller cities and central or decentral location types will endorse the classic location theories. This variable, through β_2, will be important to control for the expected significant influence of the location type on transaction prices. During the years 2013 to 2018 the overall market conditions for office properties were very capricious in 2013 up to and including 2015, with downward pressure on asset values. During the years 2016 and 2017, the overall market conditions improved, especially in 2017 compared to the years prior to 2016. In 2017 the total investment volume reached a record level. The market condition is measured through dummy variable β_3, where the years 2013-2015 and 2016-2017 are marked separately.

X_i is the set of hedonic characteristics of building i, like building age, storeys, leasable floor area (LFA), vacancy rate, suitability for single-tenant or multi-tenant use and proximity of a public transport hub and main roads. Other features are investor- seller type and macroeconomic parameters, i.e. monthly Brent oil prices, monthly Dutch CPI inflation rates and monthly ten-year interest rates on government bonds of the Netherlands, Germany, the US and China. Some of these variables are dummy variables. Literature of Eichholtz et al. (2013), Kok & Jennen (2012) and Fuerst & McAllister (2008) use dummy variables to weigh them into the balance to control for certain sustainability parameters or location characteristics. A bond portfolio will be incorporated to evaluate the impact of changes in macroeconomics parameters and to control for the effect of declining or rising interest rates on the realized transaction prices.

α is the constant. g_i is a dummy variable with a value of one if a property is encumbered by a ground lease and ε_i is an error term. Parameters that need to be estimated in this model are α, β_i and δ. The effect of the variable of interest, X, will be controlled via z-variables. Similar studies that examined energy efficiency in relation to realized rent or asset transactions (Eichholtz et al., 2013; Kok & Jennen, 2012;), expect that age of the building is heavily correlated with the energy-index. An interaction term is added to solve for this distortion in the empirical model (1).

$$\mathrm{LogP_{it}} = \alpha + \beta_i X_i + \beta_1(\mathrm{EI_{t0}AGE_{t0}}) + \beta_2(\mathrm{LocationType_{t0}}) + \beta_3(\mathrm{Marketcondition_{t0}}) + \delta g_i + \varepsilon_i \quad (2)$$

This interaction term between age and energy efficiency is not involved in models of i.e. Eichholtz et al. (2013) or Kok & Jennen (2012). However, Fuerst et al. (2013) endorse that variable interactions between these two variables would be useful. One can expect that more recently built office buildings will be certified with higher energy efficiency labels in relation to older counterparts, or that they can be upgraded more easily. To be able to include the potential of more recently built office buildings this interaction term will be used in this paper, while following the statements of Brambor et al. (2006).

4. Data

For this paper Cushman & Wakefield (C&W) has provided data from their transaction database, which includes of 1,074 sale transactions of office buildings in the Netherlands during the years 2013 to 2018, resulting in a total capital flow of 16.8 EUR bln. The original database contains 74% of the total office investment volume during this time period. Variables that were collected in this dataset includes variables like, e.g. net purchase price, price per sq.m., size in sq.m., vacancy rate, tenants, parking spaces and market rent, theoretical rental income, number of tenants, weighted average lease term, lease term of the main tenant, freehold/leasehold, year of construction, yields, rental income, market rent, location category, specific purchaser and seller. This dataset was merged with the EP-online database which provides the recorded EI for a part of the mentioned C&W transaction database. The EP-online database is the official and public database from the Dutch Central Government, in which the registered energy labels can be searched online. For each office building the transaction EP-online was manually checked for the matching energylabel(s). This merge resulted in a dataset of 406 observations of office building transactions during the period of 2013 up to and including 2017, resulting in a total capital flow of 5.6 EUR bln, which represents 25% of the total office investment volume during the time period of interest. Only for a portion of the office buildings of the original database this merger with the EP-online database resulted in matching energylabels. Other energylabels were signed off more recent than the transaction date, were incomplete or were unknown. However, these merged datasets did not include all basic building characteristics like age or storeys or other variables of interest like proximity to amenities, public train stations or motorways. The age of property i was calculated based on the year of construction. The proximity to the closest public train stations and the closest motorway were computed via ArcGIS using the latitude and the longitude. Walk Score defines the walkability of amenities on a scale from 1 up to 100, see figure 4.1 for the Walk Score descriptions. The data was provided by Redfin Real Estate (2018). Amenities that include daily necessities generate a higher number of points. Pivo & Fisher (2011) demonstrated that the walkability of office locations is value enhancing for office properties in the US, however they also noted some limitations of Walk Score. It weighs all types of destinations equally; the same value is given to full service and limited service supermarkets and it doesn't take account of physical barriers or connectivity. Via multiple variables location features are analysed for possible impact on the transaction prices.

Figure 4.1: Walk Score description

90 – 100	Walker´s Paradise, daily errands do not require a car;
70 – 89	Very Walkable: most errands can be accomplished on foot;
50 – 69	Somewhat Walkable: some errands can be accomplished on foot;
25 – 49	Car-Dependent: most errands require a car;
0 – 25	Car-Dependent: almost all errands require a car.

(Walk Score, 2018)

The public CBS database provided the number of inhabitants per municipality in the transaction year and the Dutch inflation rate on the basis of the consumer price index. It also provided the allocation for the NUTS-regions ('Nomenclature des Unités Territoriales'), which allocation is based on European Eurostat guidelines. The global financial portal of Fusion Media Ltd. (2018) provided the monthly BRENT oil prices, Dutch-, German-, USA- and CHINA ten-year bond yields. The number of storeys was manually recorded via the Globespotter interface of Cyclomedia, which can show street view photos, aerial photos and 3D-oblique phots per observation dating to 2013.

4.1 Descriptive statistics

Table 4.1 provides an overview of the descriptive statistics for the dataset of 406 office transactions with the combined green and brown office groups. It is distinctive that on average the property age in years is quite low, i.e. 35 years. Noteworthy is that the standard deviation is higher than the reported mean.

Table 4.1: Descriptive statistics of the sample of green and brown office buildings groups combined

Variables	Mean	Std. Dev.	Min	Max
Price per sq.m. (€)	1,366.46	1,325.76	63.88	9,846.49
EPC	1.35	.4613	.54	4.09
Age (years)	35.16	38.91	1	361
Leasable floor area (sq.m.)	8,145.75	8,635.78	435	60,000
Vacancy (percent)	.4146	.4319	0	1
Storeys	6.52	4.52	2	33
Multi-tenant suitability	.7759	.4175	0	1 (1 = yes)
Groundlease	1.78	.4142	1	2 (2 = yes)
Google Walkscore	75.80	18.88	9	1,00
Distance to motorway (m)	1,629.73	1,362.42	78	8,76
Distance to train station (m)	1,313.08	1200.23	29	7,86
Inhabitants of municipality	377,290	308,429	15,156	844,947
Located in the four major cities	.4458	.4977	0	1 (1 = yes)
Located in city with metro facilities	.3473	.4767	0	1 (1 = yes)
Bigger cities – central location	.2537	.4357	0	1 (1 = yes)
Smaller cities – central location	.1773	.3824	0	1 (1 = yes)
Bigger cities – decentral location	.2956	.4569	0	1 (1 = yes)
Smaller cities – decentral location	.2709	.4450	0	1 (1 = yes)
Private investor	.5517	.4979	0	1 (1 = yes)
Foreign investor	.3473	.4767	0	1 (1 = yes)
Institutional investor	.0394	.1948	0	1 (1 = yes)
Developer investor	.0640	.2451	0	1 (1 = yes)
Year of Transaction	2015.34	1.30	2013	2017
Market condition (2 = 2016 & 2017)	1.49	.5005	1	2
Private seller	.5443	.4987	0	1 (1 = yes)
Foreign seller	.2759	.4475	0	1 (1 = yes)
Institutional seller	.1626	.3694	0	1 (1 = yes)
Developer seller	.0172	.1303	0	1 (1 = yes)
Higher than six storeys	.3350	.4726	0	1 (1 = yes)
Ten storeys or more	.1724	.3782	0	1 (1 = yes)
Fifteen storeys or more	.0714	.2579	0	1 (1 = yes)
Twenty storeys or more	.0246	.1552	0	1 (1 = yes)
Northern NUTS region	.0345	.1827	0	1 (1 = yes)
Eastern NUTS region	.1133	.3174	0	1 (1 = yes)
Western NUTS region	.7291	.4450	0	1 (1 = yes)
Southern NUTS regions	.1232	.3290	0	1 (1 = yes)
Monthly BRENT oil price ($)	64.23	23.42	35	114
Monthly Dutch ten-year bond yield	.7865	.5931	-.006	2.289
Monthly German ten-year bond yield	.6092	.5208	-.127	1.941
Monthly USA ten-year bond yield	2.22	.3317	1.45	3.026
Monthly CHINA ten-year bond yield	3.49	.4782	2.74	4.63
Dutch Inflation CPI	1.00	.6615	-.2	3.1
N = 406				

The mean and median price per sq.m. for all transactions are 1,366 EUR and 921 EUR respectively, this is lower than Eichholtz et al. (2013) which reported a mean of the transaction price of approximately 2,633 EUR per sq. m and significantly lower than Chegut et al. (2014), which shows an average transaction price of 7.485 EUR per sq. m. As shown in appendix 2, the distribution of price per sq.m. is skewed to the left (figure A2.1). While running tests to find possible heteroscedasticity it appeared that price per sq. m. had to be adjusted using a log-function. This is also in line with Kok & Jennen (2012) and Eichholtz et al. (2010) in which a semi-log equation was used for either office selling prices or rents. Figure A2.2 in the appendix, shows the adjusted distribution for transaction price per sq. m. using a log-function. It would be favourable to calculate the residual value per sq. m. of the realized office transactions, using a negative correction based on the present value of expected future cash flows. This way it would be possible to control more precisely for (partly) leased office properties in relation to properties that were unencumbered by tenancy. Unfortunately, there were too many missing values in the original database. The energy indexes of the EPC´s are slightly skewed to the left (figure A2.3) as expected. There are not many buildings that are A++, A+ or G certified. In the total sample there are no office properties with an energy index lower than 0.54 (see figure 3.1 for the current label classes). Tables A2.1 and A2.2 in appendix 2 show the proportion of each label class in relation to the total sample. The green office group includes 55% of the 406 office transactions, and the brown office group consists of 45%. The leasable floor area for the total sample has a mean and median of 8,146 sq. m. and 5,150 sq. m., which is significantly larger than the size of the office buildings in the sample of certified office properties of Eichholtz et al. (2013). In their sample the propensity-score weighted observations show a weighted average of 3,032 sq. m., which could explain the relatively high transaction prices versus the sample of this paper. The size of the office buildings of Chegut et al. (2014) are quite bigger: 17,172 sq. m. Over the years 2013 to 2018 there has been a contradictive interest rate path of 10-yr government bonds in relation to the Dutch prime yields. Especially when comparing those of European countries like the Netherlands and Germany with those of countries like the US and China. When reviewing figure A2.7 in appendix 2 a yield compression can be observed between the prime yields and Dutch 10-yr government bonds. Literature on declining interest rates and opportunity cost of capital suggests that investors will allocate their capital towards real estate when interest rates and yields on bonds are low (Geltner et al., 2001). Interesting will be whether declining or rising interest rates will point towards a significant influence in relation to the realized transaction prices. In table 4.1 it is displayed what the new legal ownership distribution is, 55% is purchased by private investors, which were dominate in buying green office property, foreign investors make-up for a 35% portion of the sum of the transactions. Institutional investors and developers have made 10% of the investments deals. However institutional investors are also partially grouped under foreign investors.

The average walkscore in the dataset is 76. The lowest Walkscore is 9 and is registered along the Molengraaffsingel in Delft. The two highest scores of 100 are registered at the Reguliersdwarsstraat and the Vijzelstraat, which are located in the heart of the city of Amsterdam. Figure A2.4, shows that Walkscore is slightly skewed to the right, which could partially be explained by the densely populated character of the Netherlands. In table 4.2 the descriptive statistics for the dataset of the 406 office transactions is provided, separating the more energy efficient, green office group (N = 225) and the less energy efficient brown office buildings (N = 181).

Table 4.2: Descriptive statistics of the green (A – C) and brown (D – G) office groups

Variables	Mean (A – C)	Std. Dev.	Mean (D – G)	Std. Dev.
Price per sq.m. (€)	1541.06	1241.93	1149.4	1396.34
EPC	1.06	.1594	1.72	.4471
Age (years)	25.72	29.44	46.90	45.59
Leasable floor area (sq.m.)	9886.57	9408.1	5981.75	7010.82
Vacancy (percent)	.3075	.3989	.5474	.4354
Storeys	7.36	5.22	5.47	3.16
Multi-tenant suitability (1 = yes)	.8089	.3941	.7348	.4427
Groundlease (2 = yes)	1.76	.4307	1.81	.3917
Google Walkscore	74.05	19.22	77.96	18.26
Distance to motorway (m)	1566.24	1382.35	1708.65	1336.84
Distance to train station (m)	1290.64	1198.19	1340.98	1205.5
Inhabitants of municipality	397262.6	317366.3	352462.8	295936.5
Located in the four major cities*	.4711	.5003	.4144	.494
Located in city with metro facilities*	.3778	.4859	.3094	.464
Bigger cities – central location*	.28	.45	.221	.4161
Smaller cities – central location*	.1511	.359	.21	.4085
Bigger cities – decentral location*	.3022	.4603	.2873	.4538
Smaller cities – decentral location*	.2667	.4432	.2762	.4484
Private investor (1 = yes)	.4622	.4997	.6630	.4740
Foreign investor (1 = yes)	.4578	.4993	.21	.4084
Institutional investor (1 = yes)	.0356	.1856	.0442	.2061
Developer investor (1 = yes)	.0489	.2161	.0829	.2765
Year of Transaction	2015.41	1.31	2015.25	1.30
Market condition (2 = 2016 & 2017)	1.51	.501	1.46	.5001
Private seller (1 = yes)	.5022	.5011	.5967	.4919
Foreign seller (1 = yes)	.3289	.4709	.21	.4084
Institutional seller (1 = yes)	.1467	.3546	.1823	.3872
Developer seller (1 = yes)	.0222	.1477	.0111	.1048
Higher than six storeys (1 = yes)	.4089	.4927	.2431	.4301
Ten storeys or more (1 = yes)	.2311	.4225	.0995	.3001
Fifteen storeys or more (1 = yes)	.1067	.3094	.0276	.1644
Twenty storeys or more (1 = yes)	.04	.1964	.0055	.0743
Northern NUTS region (1 = yes)	.0311	.1740	.0387	.1934
Eastern NUTS region (1 = yes)	.0933	.2916	.1381	.346
Western NUTS region (1 = yes)	.7511	.4333	.7017	.4588
Southern NUTS regions (1 = yes)	.1244	.3308	.1216	.3277
Monthly BRENT oil price ($)	64.32	22.74	64.12	24.3
Monthly Dutch ten-year bond yield	.7736	.5707	.8027	.6212
Monthly German ten-year bond yield	.6009	.5055	.6195	.5405
Monthly USA ten-year bond yield	2.25	.3169	2.19	.3472
Monthly CHINA ten-year bond yield	3.51	.4736	3.47	.4841
Dutch Inflation CPI	1.02	.6254	.9851	.7052
*(1 = yes)	N = 225		N = 181	

It displays the structure of the two groups and it shows the dependent and independent variables, comparing the characteristics of the green and brown office group. On average the dependent variable, the realized transaction price per sq. m, is 25% lower in the brown office group than in the more energy efficient office group. These averages are 1,149 EUR versus 1,541 EUR in the more energy efficient group. However, to draw conclusions based on the aforementioned averages would be somewhat short-sighted, because in this observation important differences held out of the equation (also see table A2.3 for the summary on transaction prices and other averages per energylabel class). For instance, proximity to the nearest train station or motorway is shorter for the green office group. Also, the average vacancy rate is lower and the average number of storeys is slightly higher. Especially in the more energy efficient group 40% of the properties are higher than six storeys, in contrast of 24% in the other office group. It also stands out that the vacancy rate is significantly higher in the brown group. This could mean that the reletting potential is somewhat inferior for these offices. Another reason could be that these buildings are located at a less popular location and that for this reason property owners would be less inclined to invest in energy efficiency. In relation to the brown peer group there are relatively more foreign investors and sellers in the green office group. Noteworthy is the average property age in years of the brown office group, which is 82% higher than that of the green group. This can be explained by the fact that over the years energy efficiency requirements have become more demanding and building materials have enhanced with regard to their energy efficiency (Op't Veld & Vlasveld, 2013). Which can lead to more energy efficient buildings when they are more recently built. Contradictive is that the green office buildings are significantly larger in size than their brown peer group. One would expect a negative influence of the property´s size as to the realized transaction price per sq. m.

Other features like the distribution among the NUTS regions and whether the office buildings are located in the four major cities are somewhat comparable between the office groups. On average 47% of the green office transactions were registered in one of the four largest cities, which are Amsterdam, Rotterdam, Utrecht and Den Hague respectively. Additionally, the transactions of the brown office group were registered for 41% in these cities. There has been one alternation in the allocation of the provinces of the Netherlands among the four NUTS regions. In the Southern NUTS region, the province of Zeeland is included and removed from the Western NUTS region. This is because of the geographical location and the uniform distribution of the 12 provinces of the Netherlands among the four NUTS regions.

4.2 Results

In this section the regression results are presented. First of all, the correlation matrix for the building characteristics are set out regarding energy efficiency (EPC) and the realized transaction price per sq. m. Energy efficiency and sales price are negatively correlated, as anticipated. The higher the energy index, the lower sales prices are expected to be. The matrix also points out the expected correlation between energy efficiency as to the age of the office buildings. It makes sense that the vacancy rate and whether a property is held in freehold also are negatively correlated with the realized transaction price. Through the correlation matrix there is no indication of multicollinearity among the included variables. Table 4.3 shows the correlation matrix containing the most important variables.

Table 4.3: Correlation Matrix of building characteristics, energy efficiency and the dependent variable: ln price per sq. m.

Variables	LnPrice	EPC	Age	LFA	Vacancy	Storeys	Multitenant	Groundlease
LnPrice per sq. m. (€)	1.0000							
ationalEPC	-0.2207*	1.0000						
Age (years)	0.1185*	0.3799*	1.0000					
LFA (sq. m.)	0.1941*	-0.1951*	-0.1771*	1.0000				
Vacancy (percent)	-0.4711*	0.3005*	0.2009*	-0.1874*	1.0000			
Storeys	0.2396*	-0.1717*	-0.1672*	0.6027*	-0.1482*	1.0000		
Multi-tenant suitability	-0.0062	-0.1223*	-0.2501*	0.2841*	-0.1675*	0.2871*	1.0000	
Groundlease	-0.2198*	0.1312*	0.1497*	-0.1763*	0.1294*	-0.2227*	-0.0421	1.0000

* $p < 0.05$

The semi-log regression results are presented in Table 4.4. All three models report a highly significant[3] effect of energy efficiency on the realized transaction price per sq. m. When interpreting the coefficients, the first semi-log model shows that when EPC would increase with one unit, ceteris paribus, the transaction price per sq. m. would decrease with 26% (see column 1). The coefficients of the second and third model, both mark a decrease of 35%, under the same assumption that all other independent variables are held constant (see columns 2 and 3).

The R-squared indicates an increasing explanatory power from the first to the third model. In the first two models the same or equivalent variables are incorporated. Howbeit in the second model an interaction term between Age and the EPC is added, on the one hand because of the rational correlation between them and one the other to suppress variation and solve for heteroscedasticity. In the first model, Age is highly significant.

[3] *** highly-, ** very-, * significant. See p values in table 4.4.

Table 4.4: The effect of energy efficiency (dependent variable: logarithm of transaction price per sq. m.)

Variables	(1) logPricePerM²	(2) logPricePerM²	(3) logPricePerM²
EPC	-0.302***	-0.433***	-0.427***
	(0.071)	(0.092)	(0.091)
Age (years)	0.004***	0.000	-0.000
	(0.001)	(0.002)	(0.002)
c.EPC#c.Age (interaction term)		0.002**	0.002**
		(0.001)	(0.001)
Leasable floor area (sq.m.)	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Vacancy (percent)	-0.632***	-0.618***	-0.631***
	(0.077)	(0.077)	(0.077)
Storeys	0.005	0.004	-0.008
	(0.009)	(0.009)	(0.024)
Multi-tenant suitability (1 = yes)	-0.242***	-0.237***	-0.216***
	(0.077)	(0.077)	(0.078)
Groundlease (1 = yes)	0.162*	0.166*	0.105
	(0.091)	(0.091)	(0.090)
Google Walkscore	0.007***	0.007***	0.008***
	(0.002)	(0.002)	(0.002)
Distance to motorway (m)	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)
Distance to train station (m)	0.000**	0.000**	0.000***
	(0.000)	(0.000)	(0.000)
Inhabitants of municipality	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Located in the four major cities	-0.236	-0.207	-0.377**
(1 = yes)	(0.155)	(0.154)	(0.169)
Located in city with metro facilities	-0.264*	-0.270*	-0.301*
(1 = yes)	(0.156)	(0.155)	(0.155)
Bigger cities – central location	0.522***	0.489***	0.562***
(1 = yes)	(0.118)	(0.118)	(0.126)
Smaller cities – central location	0.157	0.160*	0.187**
(1 = yes)	(0.096)	(0.095)	(0.094)
Bigger cities – decentral location	0.237**	0.213*	0.258**
(1 = yes)	(0.116)	(0.116)	(0.125)
Private investor (1 = yes)	-0.118	-0.126	-0.065
	(0.126)	(0.125)	(0.125)
Foreign investor (1 = yes)	0.200	0.185	0.201
	(0.135)	(0.134)	(0.136)
Institutional investor (1 = yes)	0.322*	0.317*	0.297
	(0.191)	(0.190)	(0.188)
Year of Transaction	0.044	0.042	-0.229***
	(0.046)	(0.046)	(0.085)
Market condition	0.092	0.089	0.355**
(1 = 2017 & 2016)	(0.119)	(0.119)	(0.153)
Foreign seller (1 = yes)			-0.012
			(0.073)

Institutional seller (1 = yes)			-0.078
			(0.086)
Developer seller (1 = yes)			0.255
			(0.231)
Storeys:			
Higher than six storeys (1 = yes)			0.050
			(0.114)
Ten storeys or more (1 = yes)			0.137
			(0.142)
Fifteen storeys or more (1 = yes)			0.024
			(0.208)
Twenty storeys or more (1 = yes)			-0.117
			(0.271)
Eastern NUTS region (1 = yes)			0.086
			(0.183)
Western NUTS region (1 = yes)			0.177
* excluding province of Zeeland			(0.166)
Southern NUTS regions (1 = yes)			-0.021
* including province of Zeeland			(0.180)
Macroeconomic parameters:			
Monthly BRENT oil price ($)			-0.015***
			(0.004)
Monthly Dutch ten-year bond yield			0.163
			(0.477)
Monthly German ten-year bond yield			-0.563
			(0.595)
Monthly USA ten-year bond yield			0.191
			(0.163)
Monthly CHINA ten-year bond yield			0.551***
			(0.151)
Dutch Inflation consumer price index (CPI)			0.237***
			(0.072)
Constant	-83.777	-78.088	466.375***
	(92.578)	(92.139)	(170.832)
Observations	406	406	406
R-squared	0.584	0.589	0.627

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

The third model adds buyer and investor type, extends and specifies certain building characteristics like the number of storeys, as well as it specifies location features where NUTS regions are added to the equation. Chegut et al. (2014) already mentioned that theoretically there should be no anticipated price difference when looking into buyer and investor types, but it may well be of importance because of different (dis)investment criteria or the mandates that they should follow. Only the first and second model show a significant impact when institutional investors make acquisitions. This could be explained by the fact that the third model incorporates macroeconomic variables with explanatory power. Considering the impact of change in the macroeconomic parameters the following is sorted out based on the presented outcomes. Change in Chinese 10-yr government bond prices and BRENT oil prices are highly significant to the realized sales prices. When investing in energy efficient office properties is part of the investment strategy in order to hedge for increasing oil prices, one would be surprised that increasing oil prices yields a decrease in the transaction price, however only slightly (1.4%, ceteris paribus). Increasing Chinese long-term interest rates are found to be significant and yield a positive effect on transaction prices. In accordance with research conducted by C&W, Asian investors have seized a bigger part of the total investment volume in the Dutch property investment market (4% and 6% in 2016 and 2017 versus 0%, 2% and 1% in 2013, 2014 and 2015). The yield compression of the Dutch 10-yr government bonds in relation to the prime yields doesn't appear to have any repercussions on the sample, as shown via the variable monthly Dutch ten-year bond yield.

It was expected that certain building characteristics, like age, property size, number of storeys, amenities would have a positive and significant effect on the dependent variable, which is in line with the expectations of Chegut et al. (2014). This does apply for the age in years of $property_i$. Albeit the age effect is altered in the equation because of its significant correlation with EPC. As indicated earlier, in the second and third model the interaction term with EPC is added. Furthermore, the level of nearby amenities, benchmarked via the Walkability Score, shows a highly significant impact. In similar studies number of storeys were of highly significant influence (Eichholtz et al., 2013) or very- to significant influence (Chegut et al., 2014) and property size were highly- to very significant (Eichholtz et al., 2013; Chegut et al., 2014). These building characteristics aren't significant in either of the three models remarkably.

In the paper of Kok & Jennen (2012) the "Amsterdam" effect is introduced to extract whether the importance of energy efficiency is more present at hotspots with international allure. The regression results show that the "Amsterdam/Rotterdam" effect is present in all three models, in which it shows to be significant, via the "located in city with metro facilities" variable. These are the only two cities in Netherlands that have metro facilities. Surprisingly, the "Amsterdam/Rotterdam/Den Hague/Utrecht" effect is not present in the first two models. Yet, very significant in the third model. The importance of location is also shown through the four location categories, in which the "bigger cities – central location" category is highly significant in all three models. Additionally, the population size of the city where the property is located is of influence, as demonstrated through the highly- and very- to significant influence of the number of inhabitants of the municipality and the "bigger cities – central location" category on the transaction price. This does not apply for a more higher scale when witnessing the influence of the NUTS regions.

Column 1 and 2 of Table 4.5 report the two models in which the green and the brown office group are disaggregated from the total sample. These two regression models help explain the difference in transaction prices among the two energy efficiency groups, in which one represents the more energy efficient office properties and the other the less energy efficient office properties. These two models are the extended versions of the third model in Table 4.4.

Table 4.5: Two models in which the green (energy-labels A-C) and the brown office group (D-G) are disaggregated

Variables	(1) logPricePerM² A – C Green office group	(2) logPricePerM² D – G Brown office group
EPC	-1.209***	0.026
	(0.375)	(0.179)
Age (years)	-0.005	0.003
	(0.017)	(0.003)
c.EPC#c.Age (interaction term)	0.008	0.000
	(0.015)	(0.002)
Leasable floor area (sq.m.)	-0.000	-0.000
	(0.000)	(0.000)
Vacancy (percent)	-0.776***	-0.532***
	(0.100)	(0.120)
Storeys	0.014	-0.055
	(0.028)	(0.044)
Multi-tenant suitability (1 = yes)	-0.214**	-0.093
	(0.104)	(0.124)
Groundlease (1 = yes)	0.086	-0.025
	(0.111)	(0.155)
Google Walkscore	0.003	0.015***
	(0.002)	(0.004)
Distance to motorway (m)	-0.000	-0.000
	(0.000)	(0.000)
Distance to train station (m)	0.000**	0.000***
	(0.000)	(0.000)
Inhabitants of municipality	0.000**	0.000***
	(0.000)	(0.000)
Located in the four major cities	0.016	-0.877***
(1 = yes)	(0.203)	(0.300)
Located in city with metro facilities	-0.201	-0.387
(1 = yes)	(0.189)	(0.261)
Bigger cities – central location	0.394***	0.691***
(1 = yes)	(0.148)	(0.215)
Smaller cities – central location	0.333***	0.038
(1 = yes)	(0.121)	(0.150)
Bigger cities – decentral location	0.044	0.362*
(1 = yes)	(0.161)	(0.202)
Private investor (1 = yes)	0.006	-0.082
	(0.174)	(0.182)
Foreign investor (1 = yes)	0.250	0.176
	(0.183)	(0.210)
Institutional investor (1 = yes)	0.482*	0.351
	(0.252)	(0.289)
Year of Transaction	-0.156	-0.205
	(0.099)	(0.158)
Market condition	0.195	0.359
(1 = 2017 & 2016)	(0.196)	(0.253)

Foreign seller (1 = yes)	-0.059	0.022
	(0.087)	(0.136)
Institutional seller (1 = yes)	-0.205*	-0.095
	(0.106)	(0.148)
Developer seller (1 = yes)	-0.180	0.960*
	(0.250)	(0.522)
Storeys: Higher than six storeys (1 = yes)	0.161	0.020
	(0.127)	(0.223)
Ten storeys or more (1 = yes)	-0.142	0.670***
	(0.165)	(0.257)
Fifteen storeys or more (1 = yes)	0.010	0.238
	(0.224)	(0.462)
Twenty storeys or more (1 = yes)	-0.268	-0.368
	(0.278)	(0.762)
Eastern NUTS region (1 = yes)	0.232	0.188
	(0.235)	(0.298)
Western NUTS region (1 = yes)	0.311	0.093
* excluding province of Zeeland	(0.209)	(0.289)
Southern NUTS regions (1 = yes)	0.195	-0.155
* including province of Zeeland	(0.226)	(0.305)
Macroeconomic parameters: Monthly BRENT oil price ($)	-0.009*	-0.023***
	(0.005)	(0.007)
Monthly Dutch ten-year bond yield	0.225	0.918
	(0.493)	(1.067)
Monthly German ten-year bond yield	-0.712	-1.255
	(0.616)	(1.358)
Monthly USA ten-year bond yield	0.248	0.167
	(0.198)	(0.281)
Monthly CHINA ten-year bond yield	0.394**	0.709**
	(0.174)	(0.283)
Dutch Inflation consumer price index (CPI)	0.196**	0.364***
	(0.090)	(0.131)
Constant	320.650	415.541
	(199.659)	(317.335)
Observations	225	181
R-squared	0.687	0.665

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

The semi-log regression model in column 1 find strong support for the significant (p<0.01) effect of the level of energy efficiency in the “green” energy efficient office group on realized transaction prices. The corresponding coefficient demonstrates a decrease of 70% in transaction price when EPC would increase with one unit. As Sayce et al. (2010) stated, the most direct evidence of a link between sustainability and value should be identified when a change in either rents or value is obtained. The statistical analysis shows the highly significant effect of the level of sustainability on the transaction price of office buildings in the Dutch market. It indicates that investors rationally or irrationally take sustainability into account when making investments deals over the years 2013 to 2018. As column 2 reports, the level of sustainability in the brown office group is not found significant as it not significant on one of the three significance levels. Lastly, also see appendix 3, table A3.1, were the regression results per energylabel class of the green office group are presented. As shown in column 1, the level of sustainability is very significant for office buildings with an energylabel A. The office buildings with an energylabel B do not show any indication of a significant effect regarding the impact of the level of energy efficiency on transaction prices. The office buildings that are rated with an energylabel C are reported to be significant as reported in column 3 as to the level of energy efficiency. This could be explained by the fact that the governmental threshold requirement is set at an EI of 1.3, which corresponds with an energylabel C. A similar outcome is reported in Kok & Jennen (2012). It also demonstrates that properties with an energylabel B are not valued on regard of their level of sustainability.

In contrast to more dated literature there are an extensive number of office properties that are labelled with an energylabel A, which represents 28% of the total sample (also see table A2.1). The results can indicate that investors value energy labeled A more than other green office buildings. Which makes sense because over the years the sustainability criteria and ambitions are becoming more relevant for property owners and investors which are influenced by their stakeholders to engage in the sustainabilization process of their portfolios.

5. Conclusion & discussion

This paper examined the impact of the level of sustainability among realized brown energy inefficient and green energy efficient office transaction groups. The main research component, which covers for the effect on realized transaction prices, looks into whether there is an apparent effect of energy efficiency in the whole research population when combining the brown and green office groups. All of the three models reveal a highly significant effect of the level of energy efficiency in relation to the realized transaction prices.

An OLS semi-log regression analysis was used to address the effect of energy efficiency on asset values. This model was applied to a dataset, provided by C&W, which contained more than 1,050 office transactions. The dataset was merged with the EP-online database, which provided the recorded EI for a portion of the database. It resulted in a dataset of 406 office transactions during the years 2013 up to and including 2017. This paper finds a negative relationship between a high EI and realized transaction prices during this time-period. Thus, the conclusion of this paper is that a more energy efficient office property does have a positive effect on the realized transaction prices of Dutch energy efficient office buildings. The findings are in line with Eichholtz et al. (2014).

When interpreting the coefficients of the three models based on the total office transaction group, the first semi-log model shows that when the energy index would increase with one unit (i.e. from A to G, from 1 to 2), ceteris paribus, the transaction price would decrease with 26%. The coefficients of the more complete second and third model, both mark a decrease of 35%, under the same assumption that all other independent variables are held constant.

This paper also shows the results of the models on the “green” energy efficient and the “brown” energy inefficient office groups. The level of energy efficiency in the brown office group is not found to be significant. The regression models find strong support for the significant ($p<0.01$) effect of the level of energy efficiency in the “green” energy efficient office group on realized transaction prices. The corresponding coefficient demonstrates a decrease of 70% in transaction price when the energy index would increase with one unit, ceteris paribus. In the green office group, only the groups of office buildings with an energylabel A and C have a significant effect of energy efficiency on transaction prices. This could be explained by the fact that the governmental threshold requirement is set at an EI of 1.3, which corresponds with an energylabel C. A similar outcome is reported in Kok & Jennen (2012).

The results of the OLS regression analysis also indicate that there are significant differences between energy efficient and inefficient office groups, which is in contradiction to ING REF & University of Maastricht (2017).

Their study found that energy efficiency had a positive effect on the value, but were not significantly higher than inefficient properties. Albeit, their research was based on market value and not on realized transaction prices.

In the past few years the office market registered considerable sharper yields at prime locations, i.e. at the Southern Axis and in the heart of the city of Amsterdam. In the paper of Kok & Jennen (2012) the “Amsterdam” effect is introduced to extract whether the importance of energy efficiency is more present at hotspots with international allure. This study addressed the issue of the location effect, which shows that there is a “Amsterdam-/Rotterdam” effect present in all three models. This location effect does only apply in the third and most complete model when focusing on the “Amsterdam/Rotterdam/Den Hague/Utrecht” location effect. Noteworthy is that the energy inefficient buildings are located at less popular locations, have a higher vacancy rate and that for this reason property owners could be less inclined to invest in energy efficiency.

The overall results do indicate that the real estate market does rationally or irrationally take the Dutch national sustainability obligations into account, relating to realized transaction prices within the groups of energy efficient and energy inefficient office properties from 2013 to 2018.

The following discussion is merely speculative and suggestive and is not based upon the used empirical model or any of the presented theories. There is an ongoing discussion about if more sustainable properties lead to better investment returns in the real estate sector and if energy efficient office buildings outperform energy inefficient office buildings when it comes down to higher market rents or re-valuation after improving the level of sustainability of the property. Over the last couple of years, the Dutch real estate market has benefited from economic growth, decreasing interest rates and the overall investment market has improved significantly with a turnaround in market sentiment in relation to the office investment market. The question can be asked if investors will allocate their capital towards “green” real estate or that they will renovate their “brown” properties before legalization will be enforced. For further research it would be interesting to monitor the following years after 2018.

Kempton & Layne (1994) already gave insight in the fact that inefficient data allocation on energy consumption limits energy savings behavior of consumers. Transparency in information about energy consumption could have positive effects on the encouragement of energy conservation amidst private consumers. After an office property is made more energy efficient, property owners should make transparent what the energy consumption of their tenants/occupiers is. This could stimulate tenants to move into these more energy efficient office properties.

Through improvements of the energy efficiency, financial benefits can be extracted from lower energy costs. Additionally, this energy efficiency could also be capitalized at the time of sale. Which could result in a higher transaction price. However, the renovation and construction costs might increase substantially during the current economic upturn and favorable investment circumstances. Better insight in effective labeling and the needed renovation costs to reach an EI of 1.3 or higher, might lead to more investments to enhance energy inefficient buildings. Which should lead to decreasing energy consumption and carbon emissions of office properties.

Limitations & recommendations

There are however some limitations to this study.

It would be favorable to calculate the residual value per sq. m. of the realized office transactions, using a negative correction based on the present value of expected future cash flows. This way it would be possible to control for (partly) leased office properties in relation to properties that were unencumbered by tenancy. Unfortunately, there were to many missing values in the original database. In this paper variable was included to control for the vacancy ratio, howbeit the outcomes could be made be more powerful. For that reason, it would be interesting for further research to incorporate the weighted average lease expiry or the weighted average lease lengths (WALL) into the equation in relation to the realized transactions.

It would have been an enhancement to be more fully able to control for spatial and quality characteristics of the office buildings. The somewhat unrefined spatial control variables that were used in this paper could not thoroughly control to account for unobserved quality and spatial characteristics. An effort has been made to control for i.e. city type, center or more remote location type and COROP location effects have been examined. An additional more enriched model that includes of more fine-grained spatial fixed effects could fix this issue. Furthermore, such an extension could ameliorate or decrease any potential omitted variable bias. These components would improve the statistical models that were used in this research, as suggested by Muldavin (2010). Another appealing modification of the main research component of this paper would be the inclusion of a control group of nearby office buildings. In this manner the green premium could be estimated.

Even though the academic research of Eichholtz et al. (2010) have a detailed set of control variables and propensity score weights in their analysis, their paper is restricted by the availability of data and immature green buildings practices. This paper used labelled office properties in a more matured green building practice environment, however the analysis could be improved using a longer time series and with repeated observations of the buildings that were already certified in the used sample period.

Availability and quality of transaction data of commercial real estate can often limit the potential of academic research. This could be partly explained by the heterogeneous characteristics of real estate markets and that they trade in illiquid, highly segmented local markets (Clayton et al., 2009) but also because of the inaccessible and confidential data of real estate funds and that property owners do not exchange confidential information with third parties.

References

Anghel, I., & Onofrei, M. (2009). Sustainibility Aspects Of Property Valuations. Theoretical and Applied Economics, 5(05 (534)(supplement)), 7-13.

Annunziata, E., Frey, M. & F. Rizzi (2013). Towards nearly zero-energy buildings: The state-of-art of national regulations in Europe. Energy, 57, 125-133.

Baas, L. (2013). The incorperation of sustainabillity into the real estate investment portfolio. Delft: Delft University of Technology

Beumer, J. (Writer), Kosters, R (Research) & Kieft, M. (Director). (2015, November 29). Fossil free [Television series episode]. In M. Meerman & D. Romeijn (Executive producers), Backlight. Hilversum: VPRO.

Brambor, T., Clark, W. R., & Golder, M. (2005). Understanding interaction models: Improving empirical analyses. Political analysis, 14(1), 63-82.

Broek, J. van. (2010). Groen licht voor duurzame kantoren? Amsterdam: Amsterdam School of Real Estate.

Brooks, C. & Tsolacos, S. (2014). Real Estate Modelling and Forecasting. Cambridge: Cambridge University Press.

Brounen, D., & Kok, N. (2011). On the economics of energy labels in the housing market. Journal of Environmental Economics and Management, 62(2), 166-179.

Brueggeman, W., & Fisher, J. (2010). Real Estate Finance & Investments (Real Estate Finance and Investments). Boston: McGraw-Hill.

Chapin III, F. S., Pickett, S. T. A., Power, M. E., Collins, S. L., Baron, J. S., Inouye, D. W., & Turner, M. G. (2015). Earth stewardship: an initiative by the Ecological Society of America to foster engagement to sustain planet Earth. In Earth Stewardship (pp. 173-194). Springer International Publishing.

Chao, M., & Goldstein, D. (1997). Energy efficiency and property valuation by appraisers and financial markets: the need for commissioning and credible performance documentation.

Chegut, A., Eichholtz, P., & Kok, N. (2014). Supply, demand and the value of green buildings. Urban Studies, 51(1), 22-43.

Clayton, J., Ling, D.C., & Naranjo, A. (2009). Commercial real estate valuation: fundamentals versus investor sentiment. The Journal of Real Estate Finance and Economics, 38(1), 5-37.3

Cox, K. (2017). Het effect van duurzaamheid op de huurprijs en de vertaling naar de waarderingen van kantoren in Nederland. Utrecht: University of Utrecht.

Desideri, U., Arcioni, L., Leonardi, D., Cesaretti, L., Perugini, P., Agabitini, E., & Evangelisti, N. (2013). Design of a multipurpose "zero energy consumption" building according to European Directive 2010/31/EU: Architectural and technical plants solutions. Energy, 58, 157-167.

DiPasquale, D., & Wheaton, W. C. (1992). The markets for real estate assets and space: A conceptual framework. Real Estate Economics, 20(2), 181-198.
Elfving J. (2009). Green Building vain Green City. In: Junnila, S. (Ed.), Rakentamisenenergiatulevaisuus. Sitra, Helsinki, pp. 27–33, Sitran raportteja 84.

Enkvist, P.A., Naucler, T. & Rosander, J. (2007). A Cost Curve for Green House Reduction. The McKinsey Quarterly, 1, 35-45.

European Parliament (2010). The Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings, Official Journal of the European Union, 53, 2010. Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:153:0013:0035:EN:PDF

Eichholtz, P., Kok, N., & Quigley, J. M. (2013). The economics of green building. Review of Economics and Statistics, 95(1), 50-63.

EIB (2016). Mandatory energylabel for offices. Amsterdam: Economisch Instituut voor de Bouw

Ellis, E.C. & N. Ramankutty (2008). Putting people on the map: anthropogenic biomes of the world. Front Ecol Environ 6(8):439–447

Foley, J.A., DeFries, R. & G.P. Asner (2005). Global consequences of land use. Science 309:570–574

Fuerst, F. (2015). The Financial Rewards of Sustainability: A Global Performance Study of Real Estate Investment Trusts. Available at SSRN 2619434.

Fuerst, F. (2015). The Financial Rewards of Sustainability: A Global Performance Study of Real Estate Investment Trusts. Available at SSRN 2619434.

Fuerst, F., & McAllister, P. (2008). Green noise or green value? Measuring the price effects of environmental certification in commercial buildings.

Fuerst, F., Van de Wetering, J., & Wyatt, P. (2013). Is intrinsic energy efficiency reflected in the pricing of office leases?. Building Research & Information, 41(4), 373-383.

Geltner, D. M., Miller, N. G., Clayton, J., & Eichholtz, P. (2001). Commercial real estate analysis and investments (Vol. 1, p. 642). Cincinnati, OH: South-western.

Hammond, C. M. (2013). The Evolving Role for Transactional Attorneys Responding to Client Needs in Adapting to Climate Change, 47 J. Marshall L. Rev. 543 (2013). The John Marshall Law Review, 47(2), 4.

Hammond, C. M. (2014). Climate Change: Implications for Commercial Real Estate Clients (and Their Attorneys): Legal Update. The ACREL Papers, Fall.

Heineke, W.M.H. (2009). Energiezuinige kantoren, loont het om te investeren? Groningen: University of Groningen.

ING REF & University of Maastricht (2017). "Groenwaarde" wetenschappelijk bewezen in Nederlandse kantorenmarkt. Amsterdam: ING Bank N.V.

INREV. (2010). Sustainability Report. Amsterdam: INREV.

Kahn, M.E. (2009). Urban Growth and Climate Change. Annual Review of Resource Economics, 1, pp. 333-49.

Kempton, W. & L. Layne (2009). The Consumer's Energy Analysis Environment. Energy Policy 22, p. 857-866.

Kok, N., & Jennen, M. (2012). The impact of energy labels and accessibility on office rents. Energy Policy, 46, 489-497.

Kok, N., Miller, N., & Morris, P. (2012). The economics of green retrofits. Journal of Sustainable Real Estate, 4(1), 4-22.

Marusiak, J. (2012) "Properly pricing green buildings". Viewed on 27-12-2017 via http://www.eco-business.com/news/properly-pricing-green-buildings. Singapore: Eco-Business.

MEA (2005). Ecosystems and human well-being: current status and trends. Vol 1. Cambridge University Press, Cambridge, UK

Miller, J. & B. Garber (2013). Green building and property value: a primer for buildings owners and developers. Washington: Institute for Market Transformation and Appraisal Institute

Muldavin, S. R. (2010). Value beyond cost savings: How to underwrite sustainable properties. Green Building FC.

NEEA (2011). A Search for Deep Energy Savings. Portland: NBI new buildings institute.

Nozeman, E. F., Fokkema, J., Laglas, K., & van Dullemen, K. (2008). Handboek projectontwikkeling: een veelzijdig vak in een dynamische omgeving. Neprom.

Op't Veld, H., & Vlasveld, M. (2013). The Effect of Sustainability on Retail Investment Performance: International Evidence. In American Real Estate Society Meetings in Hawaii, April.

Pascuas, R. P., Paoletti, G., & Lollini, R. (2017). Impact and reliability of EPCs in the real estate market. Energy Procedia, 140, 102-114.

Pivo, G., & Fisher, J. D. (2011). The walkability premium in commercial real estate investments. Real Estate Economics, 39(2), 185-219.

Popescu, D., Mladin, E. C., Boazu, R., & Bienert, S. (2009). Methodology for real estate appraisal of green value. Environmental Engineering and Management Journal, 8(3), 601-606.

RMI (2012). Building the Case for Deep Energy Retrofits. Colorado: Rocky Mountain Institute

Rockström, J., Steffen, W. & K. Noone (2009). A safe operating space for humanity. Nature 461:472–475

Royal Institution of Chartered Surveyors. (2005). “Green Values – Green buildings, growing assets”. London: RICS.

Sayce, S., Sundberg, A., & Clements, B. (2010). Is sustainability reflected in commercial property prices: an analysis of the evidence base.

Steffen, W.L., Sanderson, A. & P.D. Tyson (2004). Global change and the Earth system: a planet under pressure. New York: Springer

UNEP, 2007. Buildings and climate change - Status, Challenges and Opportunities. United Nations Environment Program. 78 p.

U.S. Global Change Research Program (2009). Global Climate Change Impacts In The United States 9 (2009). Viewed at 1-3-2017 via http://downloads.globalchange.gov/usimpacts/pdfs/climateimpacts-report.

Vlasveld, M., Marquard, A., & Op‘t Veld, H. (2013). Het effect van duurzaamheid op de beleggingsprestaties van winkels.

Walk Score (2018). Walk Score Methodology. Retrieved on May 12, 2018 from https://www.walkscore.com/methodology.shtml. Phoenix: Redfin.

Warren-Myers, G. (2011). Sustainability–The Crucial Challenge for the Valuation Profession. Pacific Rim Property Research Journal, 17(4), 491-510.

Ziermans, B., Dröes, M., & Koppels, P. (2016). De determinanten van incentives op de Amsterdamse kantorenmarkt. Real Estate Research Quarterly, 15.

Appendices

Appendix 1: Energylabels, Energy-indexes and Energy Performance Certificates

Appendix 2: Histograms, scatterplots, frequency tables and other figures

Appendix 3: Regression results per energylabel class in the green office group

Appendix 1: Energylabels, Energy-indexes and Energy Performance Certificates

Starting from January 2008 property owners of commercial real estate are obligated to submit a energylabel to the buyer or tenant when selling or leasing out their property. The label presents the energy-efficiency of the object by rating it from A (very energy-efficient) up to G (very energy-inefficient). The exact rating is given by an energy-index, from which the letter can be inferred. A different terminology for an energy-index rating is an Energy Performance Certificate (EPC). The EPC or an energy-index which corresponds for a energylabel are documents which are recognized by a European Union Member State.

Appendix 2: Histograms, scatterplots, frequency tables and other figures

Appendix 2A: Histograms

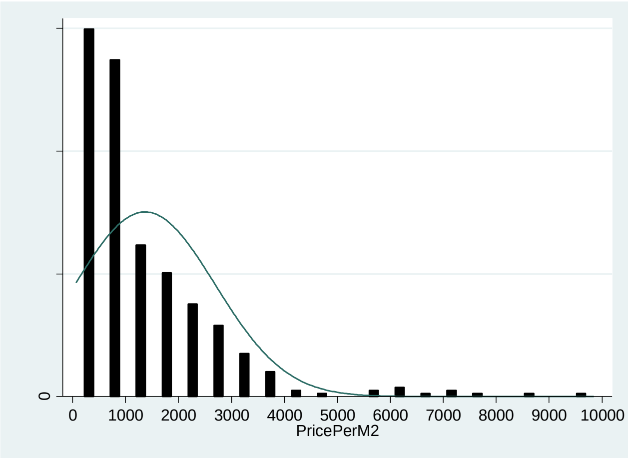


Figure A2.1: Transaction price per sq. m.

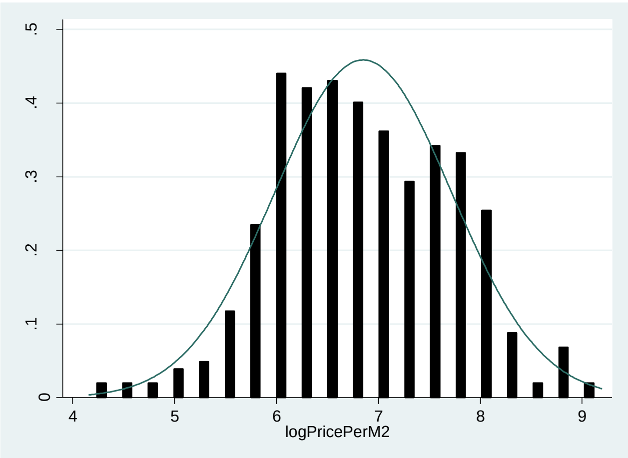


Figure A2.2: LnTransaction price per sq. m.

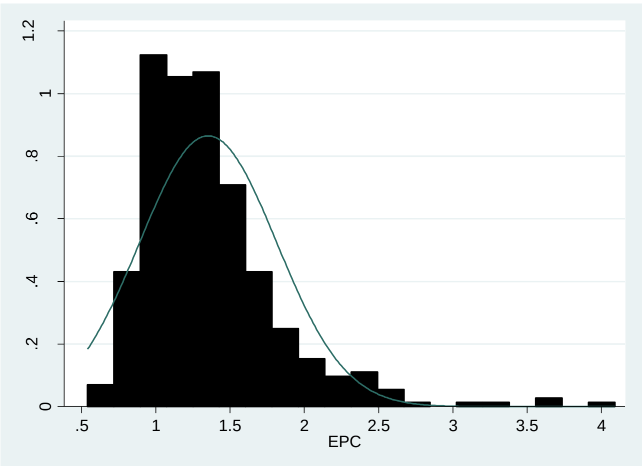


Figure A2.3: EPC

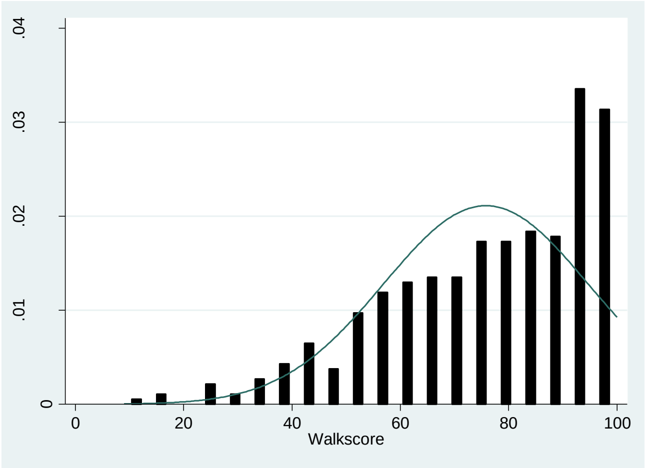


Figure A2.4: Google Walkscore

Appendix 2B: Scatterplots

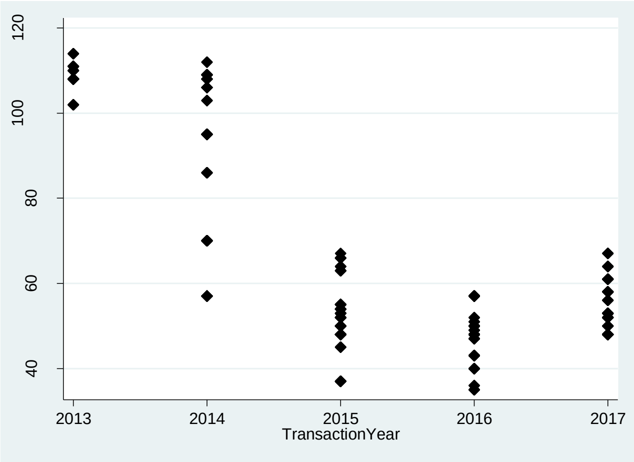


Figure A2.5: BRENT oil price per month in relation to the transaction year

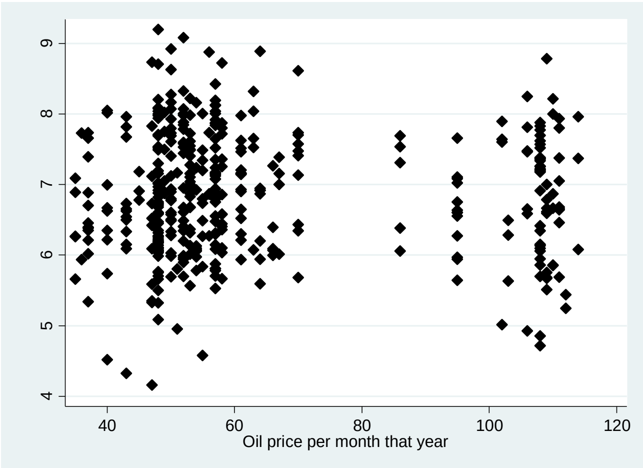


Figure A2.6: Ln price per sq. m. in relation to BRENT oil price per month of that year

Appendix 2C: Frequency and summary tables

Table A2.1: Frequency table of energy labels in the sample of research component #1

Energylabel	Frequency	%	Cum.
A	114	28.08	28.08
B	47	11.58	39.66
C	64	15.76	55.42
D	55	13.55	68.97
E	41	10.10	79.06
F	30	7.39	86.45
G	55	13.55	100.00
Total	406	100.00	

Table A2.2: Frequency table of the green (ABC) and brown (DEFG) office group of research component #1

Energylabel	Frequency	%	Cum.
Green group	225	55.42	55.42
Brown group	181	44.58	100.00
Total	406	100.00	

Table A2.3: Summary table of transaction prices and other averages in the sample of component #1 per energylabel class

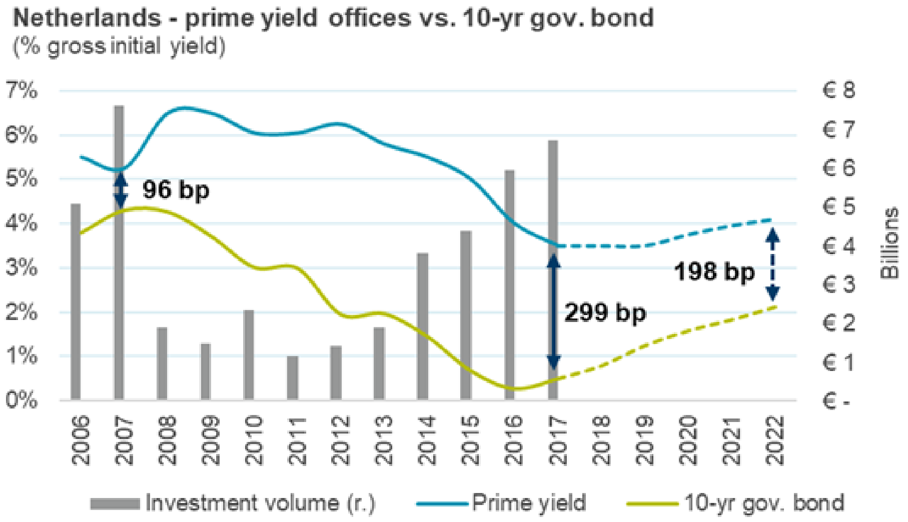
Energylabel	Obs	Mean (€)	Std. Dev.	Min	Max	Vacancy (%)	Age in years	Located in the 4 major cities
A	114	1,911	1,423	112	7,251	25%	21	61%
B	47	1,445	984	251	4,556	33%	36	36%
C	64	952	735	206	3,501	39%	28	31%
D	55	1,103	1,405	92	8,781	47%	36	29%
E	41	1,041	958	138	3,617	52%	41	61%
F	30	1,336	1,878	97	9,847	54%	45	30%
G	55	1,175	1,385	64	7,489	65%	64	46%

Table A2.4: Frequency table of energy labels in the sample of research component #2 (case study)

Energylabel	Frequency	%	Cum.
D	30	33.33	33.33
E	26	28.89	62.22
F	16	17.78	80.00
G	18	20.00	100.00
Total	90	100.00	

Appendix 2D: Other figures

Figure A2.7: Prime yield offices vs. 10-yr gov. bonds (% gross initial yield).



Research of C&W (2018)

Appendix 3: Regression results per energylabel class in the green office group

Table A3.1: Regression results in the green office group per energylabel

Variables	(1) logPricePerM2 A	(2) logPricePerM2 B	(3) logPricePerM2 C
EPC	-2.065***	5.437	7.061*
	(0.737)	(7.624)	(3.681)
Age	-0.049	0.056	0.388**
	(0.036)	(0.132)	(0.176)
c.EPC#c.Age	0.063*	-0.053	-0.320**
	(0.037)	(0.120)	(0.147)
LeasableFloorArea	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)
Vacancy	-1.019***	-0.646	-0.568**
	(0.162)	(0.443)	(0.226)
Storeys	-0.000	-0.081	0.070
	(0.045)	(0.128)	(0.061)
MultiTenant1	-0.023	-1.425**	-0.175
	(0.177)	(0.603)	(0.215)
Groundlease	0.028	0.909	-0.174
	(0.166)	(0.696)	(0.294)
Walkscore	-0.005	-0.003	0.012**
	(0.004)	(0.013)	(0.006)
ProximityMainRoad	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)
ProximityTrain	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
InhabitantsMunicipality	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Big4cities	-0.185	0.280	-0.577
	(0.309)	(0.641)	(0.793)
Metro	-0.248	-0.052	0.321
	(0.298)	(0.544)	(0.567)
LocationCat1	0.773***	0.247	-0.388
	(0.260)	(0.559)	(0.312)
LocationCat2	0.478**	0.336	-0.096
	(0.220)	(0.524)	(0.236)
LocationCat3	0.494*	-0.875	-0.448
	(0.271)	(0.587)	(0.394)
Investor1	0.042	0.749	0.244
	(0.281)	(1.131)	(0.380)
Investor2	0.204	1.732	0.607
	(0.286)	(1.278)	(0.431)
Investor3	0.389	1.417	1.120
	(0.367)	(1.349)	(0.738)
TransactionYear	-0.205	-0.167	0.102
	(0.147)	(0.456)	(0.323)
Cycle	0.114	0.161	-0.133
	(0.345)	(0.860)	(0.462)
Seller2	-0.080	0.046	-0.136
	(0.126)	(0.277)	(0.217)
Seller3	-0.307**	0.140	-0.446
	(0.152)	(0.545)	(0.312)

Seller4	-0.461	-0.560	0.999
	(0.461)	(0.666)	(0.814)
StoreysPlus6	0.294	-0.256	0.165
	(0.196)	(0.382)	(0.364)
Storeys10ormore	-0.110	0.249	0.006
	(0.259)	(0.618)	(0.538)
Storeys15ormore	0.154	0.314	-1.293*
	(0.307)	(1.206)	(0.659)
Storeys20ormore	-0.335		-0.113
	(0.376)		(0.688)
NUTSregions2	-0.316	1.145**	0.161
	(0.503)	(0.487)	(0.604)
NUTSregions3	0.079	0.255	0.411
	(0.421)	(0.483)	(0.592)
NUTSregions4	-0.316	0.978	0.606
	(0.477)	(0.629)	(0.578)
BrentOIL	-0.008	-0.011	0.009
	(0.007)	(0.015)	(0.015)
YieldDutch10yr	-0.269	-4.151	1.778
	(0.571)	(2.662)	(1.704)
YieldGerman10yr	-0.667	3.874	-2.724
	(0.723)	(3.496)	(2.096)
YieldUSA10yr	0.086	0.726	0.808*
	(0.313)	(1.161)	(0.460)
YieldCHINA10yr	0.537**	0.414	0.354
	(0.266)	(0.635)	(0.525)
DutchInflationCPI	0.371**	0.222	-0.193
	(0.153)	(0.552)	(0.231)
Constant	419.694	333.475	-212.891
	(296.494)	(916.211)	(651.575)
Observations	114	47	64
R-squared	0.755	0.919	0.852

Note: Storeys20ormore omitted because of collinearity in model 2
Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1