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van Overbeek, Rens; Ishaak, Farley; Geurts, Ellen; Remøy, Hilde

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The added value of environmental certification in the Dutch office market

Rens van Overbeek
Delft University of Technology, Delft, Netherlands
Farley Ishaak
Delft University of Technology, Delft, Netherlands and Statistics Netherlands, Den Haag, Netherlands, and
Ellen Geurts and Hilde Remøy
Delft University of Technology, Delft, Netherlands

Abstract

Purpose – This study examines the relationship between environmental building certification Building Research Establishment Environmental Assessment Method (BREEAM-NL) and office rents in the Dutch office market.

Design/methodology/approach – A hedonic price model was used to assess the impact of BREEAM certification on office rents. The study is based on 4,355 rent transactions in the period 2015 to mid-2022, in which 331 transactions took place in certified office buildings and 4,024 transactions in non-certified office buildings.

Findings – The results provide empirical evidence on quantitative economic benefits of BREEAM-certified offices in the Netherlands. After controlling for all important office rent determinants, the results show a rental premium for certified office buildings of 10.3% on average. The green premiums highly differ across submarkets and vary between 5.1 and 12.6% in the five largest Dutch cities. Additionally, the results show significant positive correlation between BREEAM-NL label score and rents, whereby better performing buildings generally command higher rents.

Originality/value – The study contributes to the current literature on green building economics by providing, as one of the first, empirical evidence on the existence of financial benefits for BREEAM-certified office buildings in the Dutch office market.

Keywords BREEAM, The Netherlands, Office market rents, Hedonic price model, Green premium, Rental premium, Empirical analysis

Paper type Research paper

1. Introduction

GRESB, BREEAM, SDG, ESG, CSRD, NFRD, SFDR and *EPC* [1]. This is only a glimpse of the many acronyms that report on sustainability aspects in the financial and real estate sector. The increasing numbers of benchmarks show that professionals, owners, investors and occupiers are increasingly aware of the rapid climate change happening right now. The Intergovernmental Panel on Climate Change presented a scenario in which the earth's temperature will rise by 1.5 °C by 2050 (IPCC, 2021). In order to achieve this scenario, society

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This study is made possible by CBRE B.V. (NL), in particular Frank Verwoerd and Joep van Vliet, who granted access to the extensive and detailed dataset of the Dutch office market.

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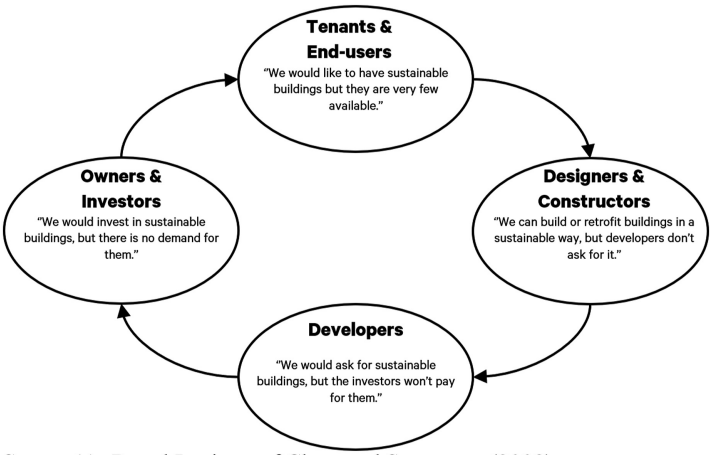
only has a CO2 budget of 330 Gigaton left. Based on the population, this implies that there is CO2 budget of only 946 Megaton left for the Netherlands which now corresponds to 5 times its current annual emissions (DGBC, 2021). The Dutch Green Building Council states that the entire construction and real estate sector accounts for 38% of the total Dutch CO2 emissions (DGBC, 2021) and shows the pivotal role of the built environment in the transition to a sustainable future.

Within the industry, there is a common perception that sustainable buildings generate added value. However, the added value is neither precisely defined nor researched. Although investors and developers are experiencing an increasing urge to invest in sustainability, there is simultaneously the perception that sustainability is very difficult and costly to reach. Real estate developers and investors are conservative in investing in sustainability and environmental measures due to the lack of evidence in their economic feasibility (Eichholtz *et al.*, 2009). The phenomenon explaining the conservative behaviour towards a sustainable built environment, whereby every actor involved passes the responsibility for the first step onto someone else, is referred to as "The Vicious Circle of Blame" (see Figure 1) (Royal Institute of Chartered Surveyors, 2008).

The Royal Institution of Chartered Surveyors (RICS) researched the drivers of this phenomenon during their conference in 2008. One of the main drivers was found to be the inability to properly appraise and value the building's sustainability performance (Royal Institute of Chartered Surveyors, 2008). However, the real estate sector's view on sustainability has significantly changed in the last decade. According to CBRE's global ESG survey (2023), more than 75% of the European real estate investors increased their focus on ESG in 2022. Almost 80% of the respondents argued that green building certification impacts their real estate decisions and almost 50% of the respondents would consider a premium for green-certified buildings (CBRE, 2023).

The European Committee is increasingly forcing investors to be transparent on their actual sustainability performances. The EU Taxonomy, for example, describes the requirements that new constructed, purchased and renovated real estate must meet in order to be classified as "green" or "environmentally sustainable." The new Corporate Sustainability Reporting Directive (CSRD) obliges larger European organisations [2] to report on non-financial (ESG) topics— with results. Both investors and occupiers argued that the



Source(s): Royal Institute of Chartered Surveyors (2008)

Figure 1.
The vicious circle of blame

growing ESG reporting requirements were the main drivers to increase their focus on ESG (CBRE, 2023).

Although the literature on the economic benefits of green buildings rapidly increased in the last decade, the formal integration of sustainability features into property valuations is still missing. The Building Research Establishment Environmental Assessment Method (BREEAM), worldwide the most-used building certification, provides a practical framework for sustainable developments and helps investors to make proper investment decisions. BREEAM certification is one of the many possible mechanisms to report on ESG data and can help investors to deliver up to 70% of the EU Taxonomy required environmental data (DGBC, 2023). Despite the proven broad economical benefits (Wilkinson *et al.*, 2011; Balaban and De Oliveira, 2017), investors first need practical evidence from the market, proving the increased returns and market value. Owners and investors are more likely to commit to a future-proof and environmentally friendly built environment once the investments are financially beneficial (Royal Institute of Chartered Surveyors, 2008).

Green and certified buildings hold many tangible and intangible benefits for building owners such as reliable information on the building's environmental performance (Holtermans and Kok, 2019), reduced operating costs and improved indoor comfort (Zhang *et al.*, 2018), improved health and productivity rates (Harverd Gazarette, 2017) and improved marketing and corporate social responsibility (Qiu *et al.*, 2017). Although the literature presents quite varying conclusions, all indicate that certified buildings hold a significant price premium over non-certified buildings (Chegut *et al.*, 2014; Eichholtz *et al.*, 2009; Eichholtz *et al.*, 2013; Fuerst and McAllister, 2011a, b; Fuerst and McAllister, 2011a, b; Holtermans and Kok, 2019; Porumb *et al.*, 2020; Reichardt, 2014). Furthermore, buildings with higher levels of certification are able to achieve higher rental premia (Fuerst and McAllister, 2011a, b).

The effects of environmental certification in the United States office market have been extensively studied (Eichholtz *et al.*, 2009; Fuerst and McAllister, 2011a, b; Fuerst and McAllister, 2011a, b; Eichholtz *et al.*, 2013; Reichardt, 2014; Holtermans and Kok, 2019). However, less attention has been paid to European markets, including the Dutch office market. Existing Dutch studies tend to focus on the mandatory EPC label (Kok and Jennen, 2012). BREEAM-NL is currently the leading voluntary building certification in Dutch real estate markets. However, the relationship between BREEAM-NL and market rents has not been studied. Additional studies on the effects of environmental certification are needed to address this research gap.

This study examines the effects of BREEAM-NL certification on office rents in the Dutch office market and tests two hypotheses. First, this study tests if BREEAM-NL certified office buildings receive higher rents per square metre than non-certified office buildings. Second, this study tests if these price premiums associated with environmental certification are positively correlated with the BREEAM-NL label score. The empirical analysis reveals the tangible, financial benefits of certified office buildings in the Dutch office market with a rental premium of 10.3% on average. The high level of explanatory power shows practical evidence of the willingness to pay for green buildings in the occupier market.

2. Dutch market for green offices

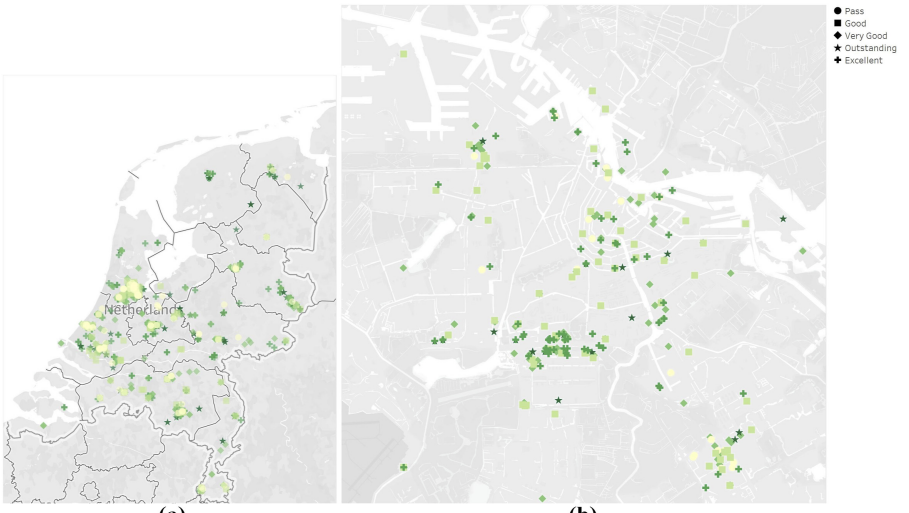
2.1 BREEAM certification in Dutch commercial real estate sector

In the Netherlands as worldwide, BREEAM is the most-used environmental assessment method for large infrastructure and building projects. It values the assets' environmental, social and economic sustainability performance across the entire lifecycle. It distinguishes the performance between new constructed assets, assets in-use

and refurbished assets and values the buildings' environmental performance on nine different categories: management, health, energy, transport, water, materials, waste, land use and ecology and pollution. The final rating ranges from Pass, Good, Very Good, Excellent to Outstanding. The final rating is visualised with a total score percentage and a number of stars on the official BREEAM certification (Building Research Establishment Ltd., n.d.). The Dutch Green Building Council adapted BREEAM to the Dutch regulations and developed BREEAM-NL in 2009. The aim of BREEAM is among others to create market recognition for environmentally friendly buildings and to increase awareness among practitioners on the advantages of environmentally friendly buildings. Over the years, the assessment methods were regularly updated to the new technical standards. As BREEAM-NL is a voluntary label and the criteria are all extra to legal criteria in place, the assessment methods must follow amendments of the national regulations.

2.2 Supply of environmentally certified office space

Although BREEAM-NL is a voluntary certification, its application has grown strongly over the last couple of years. According to annual reports of the Dutch Green Building Council, the number of certified assets amounted to 2,400 in 2022. Whereas 201 unique certifications were issued in 2015, this number grew to 457 in 2020. In 2022, a record number of 1,197 unique certifications were issued. Consequently, the total certified floor space increased from 7,500,000 square metre in 2017 to more than 36,750,000 in 2022, resulting in a Compound Annual Growth Rate (CAGR) of 30.33%. Figure 2 shows the spatial distribution of BREEAM-NL certifications in the Netherlands and Amsterdam based on the data provided by the Dutch Green Building Council. To make sure the analysis included the majority of certified office space in the Netherlands, the analysis includes both stand-alone offices and mixed-use buildings.



Source(s): Author

Figure 2. Geographical distribution of BREEAM-NL certifications in the Netherlands (a) and Amsterdam (b)

2.3 Demand for environmentally certified office space

CBRE data show that 2.6% of the total annual take-up in the Dutch occupier market was BREEAM-NL certified at the moment of transaction in the year 2015. This number gradually increased to 8.9% in 2020. From 2020, this number rapidly increased to 32.3% in 2021 and mid-way 2022 to 35.85% (see Figure 3). The rapid increase runs parallel to the exponential growth of BREEAM-NL certified assets. Zooming in on the BREEAM label scores in 2021, 1.6% was Pass, 7.5% Good, 13.6% Very Good, and respectively 7.3% and 0.5% certified with BREEAM-NL Excellent and Outstanding [3].

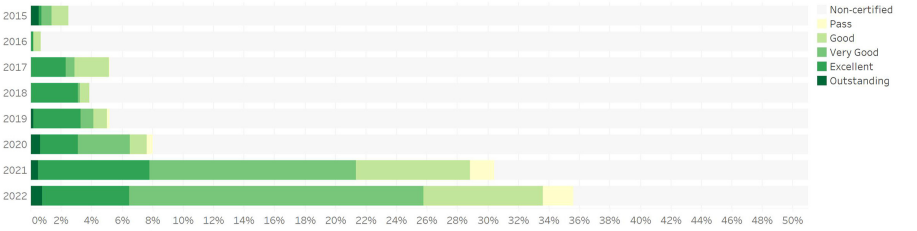


Figure 3.
Percentage of annual take-up by BREEAM certification

Source(s): Author

3. Method and data

3.1 Method

This research adapts the research approach from current literature and uses a hedonic price model to test the effect of environmental certification on office rent prices (Kok and Jennen, 2012; Eichholtz *et al.*, 2009; Eichholtz *et al.*, 2013; Porumb *et al.*, 2020). The hedonic price model is a commonly used technique to analyse the impact of rent determinants in real estate research.

Real estate can be considered as a bundle of building characteristics typical and unique for that particular property. In other words, very few properties are so closely comparable that they are interchangeable as exact substitutes. The heterogeneity of real estate leads to localised and segmented markets, making it difficult to properly value a set of property characteristics. Rosen's general theory on product differentiation (Rosen, 1974) assumed that goods are sold as a bundle of utility-bearing characteristics but that the willingness to pay for those characteristics may change with income. The underlying theory of the hedonic price model is that goods are specified by their unique characteristics and therefore the value of that particular good can be defined as the sum of implicit prices of the underlying characteristics (Herath and Maier, 2010).

Referring back to real estate markets, the price or rent of an unique property is the sum of the implicit value of all rent determinants as depicted in equation (1). The semi-log equation estimates the dependent variable, transaction rent per square metre office space of building K, based on all underlying hedonic property characteristics Z grouped in locational variables L (city, submarket, accessibility), building variables B (size, age, environmental performance and renovation history) and contract variables C (transaction year, lease size, lease length and occupancy rate at moment of transaction). E is a dummy variable with a value of 1 if a building was BREEAM-NL certified at moment of transaction and 0 otherwise. The individual effect of each rent determinant is indicated by the estimated coefficient strengths βi of all underlying rent determinants K. ε_i is the observed statistical error in the model.

$$log\, R(Z_k) = \beta_0 + \sum \beta_l L + \sum \beta_b B + \sum \beta_c C + \beta_e E + \varepsilon_i \quad (1)$$

$R(Z_k)$ = dependent variable, value of all rent determinants Z of the building K

β_0 = intercept, value

β_i = the coefficient strength (value) of independent (control) variable i

L = locational control variables

B = building control variables

C = contract control variables

E = environmental certification

ε_i = observed statistical error

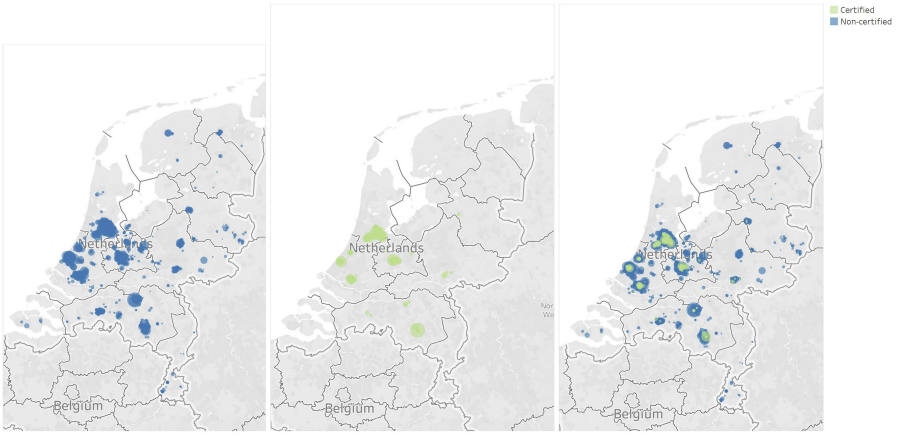
It is possible that BREEAM-NL certified office buildings have other premium building characteristics that explain a rental premium. To isolate the rent effect of BREEAM-NL certification and not overestimate the effect of the certification alone, it is important to take all commonly known real estate rent determinants into account. This study follows previous studies and controls for rent determinants that are proven to have a significant effect on office rent in the current body of literature on green building economics (Chegut *et al.*, 2014; Chegut *et al.*, 2019; Dunse and Jones, 1998; Eichholtz *et al.*, 2009; Eichholtz *et al.*, 2013; Fuerst and McAllister, 2011a, b; Fuerst and McAllister, 2011a, b; Holtermans and Kok, 2019; Kempf, 2016; Kok and Jennen, 2012; Porumb *et al.*, 2020; Robinson and Sanderford, 2015). See detailed explanation of every variable in Appendix.

3.2 Data

To examine the economic effects of environmental certification in the Dutch office market, a combination of three datasets is used. The DGBC provided a list of all BREEAM-NL certified assets and this is matched with two datasets maintained by global real estate advisor CBRE B.V. (NL). First, a rent transaction database that provides information on contract characteristics, such as type of lease, length, size and locational characteristics, such as address, amenities, and submarkets. The second dataset of CBRE B.V. (NL), is a stock dataset comprising information about more than 20,000 office rental units and more than 33,000,000 square metres office space in the Netherlands. This dataset contains information from the National Register of Addresses and Buildings supplemented with information on occupancy levels and proximity to important amenities. The occupancy level is expressed by the absolute vacancy at the end of every quarter. The occupancy level is calculated by dividing the number of vacant square metres by the total square metres of the building. After collecting and cleaning up the data, the dataset consisted of 4,355 rent transactions in the period 2015 to mid-2022. In total 4,024 rent transactions (92.4%) took place in non-certified buildings and 331 rent transactions (7.6%) took place in BREEAM-NL certified buildings. The rent transactions are spread across the country with a clear emphasis on the Randstad. Most rent transactions took place in Amsterdam (N = 1,244), followed by Utrecht (N = 422), The Hague (N = 397), Rotterdam (N = 392) and Eindhoven (N = 249). 1,540 transactions are located outside the big five cities (G5) (see Figure 4).

4. Empirical findings

Figure 5 visualises the relationship between rent price per square metre and transaction year. The horizontal axis represents the transaction date and the vertical axis the rent level per

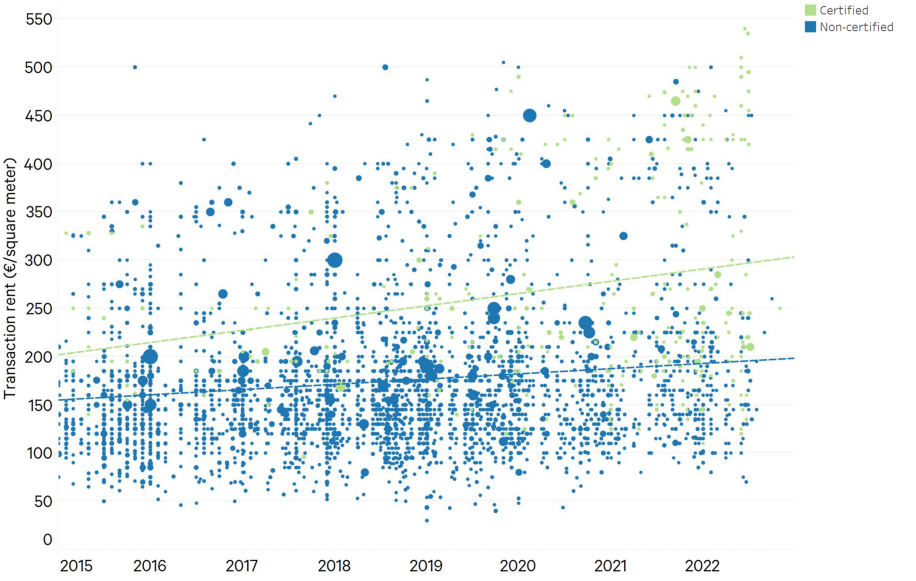


(a) (b) (c)

Source(s): Author

Figure 4.
Geographical spread of rent transactions in the Netherlands (a) non-certified transactions, (b) certified transactions, (c) entire dataset

square metre. BREEAM-NL certified and non-certified offices are presented in respectively green and blue. The size of dots represents the size of rental transactions in square metres lettable floor area. The figure shows on average higher rent levels for BREEAM-NL certified buildings over non-certified buildings. Additionally, it also suggests more rapid growth in rent levels for BREEAM-NL certified buildings. In the last 5 years, rent levels in BREEAM-NL certified buildings have a Compound Annual Growth Rate of 5.80%. In this same period, rent levels in non-certified buildings have a Compound Annual Growth Rate of 3.35%. Further analysis should make clear if this difference is due to BREEAM-NL certification or if BREEAM-NL certified buildings hold other premium characteristics that contribute to a rent premium.



Source(s): Author

Figure 5.
Scatterplot transaction rent by transaction date by BREEAM-NL certification

Table 1 presents the descriptive statistics and highlights the differences including the corresponding *t*-tests for equality of means between transactions in non-certified buildings and BREEAM-NL certified buildings. The table shows the group means for certified and non-certified transactions. Table 1 column (5) presents the results of the *t*-test and assesses if the differences across the group means are significantly different than zero. The significance of the *t*-tests is indicated by asterisks.

The average rent paid for certified buildings is significantly higher than the rent paid in non-certified offices with an average rent per square metre of €271 for certified offices and €173 for non-certified offices. In the dataset, the certified buildings are bigger than non-certified buildings with an average total floor area of 23,018 square metres as compared to 10,640 square metres. The difference in occupancy rate at moment of the transaction indicates that rent transactions in BREEAM-NL certified buildings generally take place in buildings with significantly less vacancy than transactions in non-certified buildings and it could therefore be argued that certified offices are more attractive to occupiers. Also, certified office buildings are significantly newer than non-certified buildings with an average age of 27 years as compared to 46 years. More than 18% of the certified transactions took place in buildings which have been completely refurbished at least once. This is significantly higher than 5.5% of the non-certified transactions. BREEAM-NL certified transactions score higher on energy performance than non-certified buildings [4]. However, both certified and non-certified transactions mostly took place in buildings with energy label A.

BREEAM-NL certified buildings are more often located in central areas than their non-certified counterparts. BREEAM-NL certified buildings have more supermarkets, restaurants and sport facilities in their direct proximity than non-certified buildings. Walk time and distance are the only variables negatively correlated with property's overall attractiveness: higher scores indicate larger distances to the amenities. BREEAM-NL certified buildings are significantly closer to train stations than non-certified buildings with an average walk time of 6.6 minutes compared to 14.4 minutes.

	Total sample N = 4,355	Non-certified transaction N = 4,024	BREEAM-NL certified transaction N = 331	*t*-test
Rent price (€/sqm)	180.98	173.41	271.35	−15.92***
Ln rent price (€/sqm)	5.11	5.08	5.53	−19.91***
Leased floor area (sqm)	1708.99	1711.40	1680.35	0.20
Ln leased floor area (sqm)	6.90	6.90	6.89	0.33
Occupancy rate at moment of transaction (%)	84.22	83.89	88.13	−3.74***
Building size (sqm)	11596.77	10640.18	23017.56	−13.64***
Ln building size (sqm)	8.81	8.73	9.78	−22.50***
Building age	44.35	45.80	27.05	10.128***
Major renovation (%)	6.53	5.52	18.60	−5.99***
Energy label	5.63	5.54	6.68	−15.01***
Number of restaurants	45.04	43.48	63.61	−4.52***
Number of sport facilities	1.56	1.48	2.45	−8.07***
Walk time to train station	13.82	14.43	6.59	13.24***
Average housing price	319.59	317.76	341.31	−5.45***
Number of job opportunities	319.61	311.40	417.31	−8.23***

Note(s): Numbers represent group means. Significance at the 0.10, 0.05 and 0.01 levels are indicated by *, ** and *** respectively
Source(s): Author

Table 1.
Descriptive statistics

The results clearly show that certified office buildings differ from non-certified offices and contain premium building characteristics. BREEAM-NL certified office buildings are larger, have a higher occupancy level, are newer, and more energy-efficient than non-certified office buildings. Additionally, BREEAM-NL certified office buildings are located at better accessible locations with higher levels of amenities. The hedonic price model should clarify if the rent premium paid for BREEAM-NL certified office space is the result of these premium building characteristics or that the rent premium is the result of the BREEAM-NL certification itself.

4.1 Green premium

H1. BREEAM-NL certified office buildings receive higher rents over non-certified office buildings.

Table 2 reports the regression results on green premiums in the Dutch office market, relating the natural logarithm of transaction rent per square metre as dependent variable to the hedonic characteristics as discussed in section 3.1. The final model specification has a high explanatory power and explains up to 78% of the variance within the natural logarithm of transaction rent per square metre. Consistent with the current body of literature on green building economics, the estimated coefficient of environmental certification (BREEAM-NL) is positive and highly significant in all regression models.

Table 2 column (1) presents the relationship between BREEAM-NL certification and rent while controlling for important location proxies, such as city size, amenities and accessibility and building characteristics, such as building size and building age. The model establishes a significant positive coefficient of 0.168. There is a positive relationship between transaction year, coded as dummy, and rent level, which might be explained by the yearly inflation rate. The rent level is positively correlated with the number of restaurants and sport facilities in the proximity, and reveals a premium for buildings in more central areas with higher levels of amenities. The results show a significantly negative coefficient for walk time to train stations, suggesting higher prices for better accessible offices. The average house prices and the number of job opportunities are positively correlated with the rent level, and show higher rents in larger metropolitan areas. The model shows that larger buildings generally command higher rents than smaller buildings. The rent level is positively correlated with the building's occupancy rate at moment of transaction. This might indicate that popular buildings generally hold higher rental levels. Another explanation might be that building owners often offer incentives and lower rent levels to first entrants. Empty buildings are more difficult to market and could result in higher vacancy levels in the long term. Property Grade [5], which takes the applicable building regulations at moment of construction as quality indicator, is significantly and positively correlated with the average rent per square metre. This means that newer buildings generally have higher rent levels than older, comparable buildings.

As the descriptive statistics show, BREEAM-NL certified buildings generally have a higher energy performance and are often accompanied with a renovation. It is important to control for these building factors as this paper analyses the value of the certification itself and not the underlying sustainability performance. Table 2 column (2) controls for these sustainability factors and reveals that renovation history is positively correlated and shows that fully refurbished offices generally hold higher rent levels than non-refurbished comparable buildings. Renovations generally extend the (functional) lifespan and improve the technical and environmental performance of the building. Additionally, energy labels are positively correlated with the rent level, specifically showing that higher energy performance pays off in higher office rents. Table 2 column (2) reveals, after controlling for all abovementioned rent determinants, a positive and significant coefficient for BREEAM-NL certification of 0.158. This regression coefficient shows on average a rent premium of 17.1% [6] for BREEAM-NL certified offices over non-certified comparable buildings and supports hypothesis 1.

	Building control for quality (1)	Building control for sustainability (2)	Geographical control for city (3)	Geographical control for submarket (4)
BREEAM-NL certified	0.168***	0.158***	0.156***	0.095***
Amsterdam			−0.123*	
The Hague			−0.072***	
Rotterdam			−0.059	
Utrecht			−0.018	
Eindhoven			0.030	
2016 dummy	0.014	0.014	0.013	0.008
2017 dummy	0.050***	0.047***	0.048***	0.056***
2018 dummy	0.103***	0.100***	0.100***	0.086***
2019 dummy	0.116***	0.109***	0.110***	0.103***
2020 dummy	0.137***	0.133***	0.133***	0.126***
2021 dummy	0.197***	0.191***	0.191***	0.187***
2022 dummy	0.177***	0.174***	0.174***	0.162***
Number of restaurants	0.020***	0.021***	0.020***	0.007***
Number of sport facilities	0.040***	0.038***	0.039***	0.005**
Walk time to train station	−0.001**	−0.001***	−0.001***	−0.001***
Average housing price	0.002***	0.002***	0.002***	0.002***
Number of job opportunities	0.001***	0.001***	0.001***	0.001***
Submarkets	NO	NO	NO	YES
Occupancy rate of moment of transaction	0.067***	0.072***	0.073***	0.020*
Building size (log)	0.044***	0.038***	0.038***	0.042***
Property grade	0.043***	0.048***	0.047***	0.040***
Energy label		0.003**	0.003	0.003*
Renovation dummy		0.122***	0.114***	0.116***
Constant	3.629***	3.632***	3.620***	3.713***
R-squared	0.644	0.649	0.651	0.784
Adjusted R-squared	0.643	0.648	0.649	0.781
Number of observations	4,211	4,062	4,062	4,062

Note(s): The dependent variable is the natural logarithm of the transaction rent per square metre office space. Significance at the 0.10, 0.05 and 0.01 levels are indicated by *, ** and *** respectively
Source(s): Author

Table 2.
OLS regression on rental premium

Although Table 2 column (2) controls for important location proxies and employment, it does not take the qualitative attractiveness of the business climate into account. The spatial concentration of offices brings many advantages for firms to locate in these areas. There are two types of agglomeration economies, defined as the productivity advantages accompanied with clusters of economic activities, which makes cities distinctive over other peripheral areas (McDonald and McMillen, 2010). Urbanisation economies describe the advantages which originate from the size of the local economy, such as good infrastructure and a wide range of goods, services and amenities. These distinctive factors cause an increase in productivity over peripheral areas. Localisation economies describe the advantages that emerge from the

size of the sector economy in a particular area. Examples of productivity advantages are knowledge spill-overs and labour pooling (McDonald and McMillen, 2010).

The heterogeneity of real estate markets and the distinctive attractiveness of the five largest office markets make it impossible to break down the effect of BREEAM-NL certification to one single rent premium. The average rent levels in Amsterdam (€270 per square metre) compared to the other cities (€165 per square metre) already show the differences across the cities. To control for the urbanisation economies, Table 2 column (3) includes a dummy variable for each G5 city. Table 2 column (4) also controls for localisation economies and geographical differences across cities by including all submarkets of the G5 as dummy variables. Surprisingly, model 3 shows negative coefficients for all G5 dummies while significant rental premiums for offices located within the G5 were expected. However, this confirms the distinctive character of the underlying submarkets. The effect of underlying submarkets is highlighted by the increase in explanatory power from 65.5% to 78.0%. After controlling for the property's submarket, the rental premium for BREEAM-NL certified transactions is on average 10.3% [7] and validates the first hypothesis.

Table 3 tests the differences across cities and splits the sample in the five largest office markets in the Netherlands. Table 3 column (1)–(5) depict the results for the separate model specifications and reveals a significant rental premium for BREEAM-NL certification of 12.6% [8] in the Hague, 5.1% [9] in Rotterdam and 6.5% [10] in Utrecht. Rental premiums in Amsterdam and Eindhoven are not significantly different from zero. The estimated coefficients for transaction year establish the significant rent increases in Amsterdam compared to the rest of the cities.

4.2 Label score differences

H2. Price premiums associated with environmental certification are positively correlated with the label score

Table 4 column (1) tests hypothesis 2 and examines if the green premium paid for BREEAM-NL certified offices is positively correlated with label scores. A simple bivariate correlation analysis reveals that rent level is highly correlated with the BREEAM score (0–100), r (4,243) = 0.313, $p < 001$. To isolate the effect of one single BREEAM-NL label, each BREEAM-

	Amsterdam (1)	The Hague (2)	Rotterdam (3)	Utrecht (4)	Eindhoven (5)
BREEAM-NL certified	0.009	0.119***	0.050*	0.063**	−0.073
	(0.018)	(0.046)	(0.026)	(0.030)	(0.065)
2016 dummy	0.031	0.009	0.032	0.044	0.034
2017 dummy	0.074***	0.048	0.032	0.082***	0.038
2018 dummy	0.132***	0.014	0.037	0.130***	0.034
2019 dummy	0.204***	0.013	0.066**	0.128***	0.113**
2020 dummy	0.217***	0.120***	0.114***	0.165***	0.108**
2021 dummy	0.309***	0.052	0.117***	0.136***	0.241***
2022 dummy	0.310***	0.053	0.087*	0.182***	0.147**
Number of restaurants	0.001***	0.000	0.001***	0.000	0.000
Number of sport facilities	0.017***	0.004	0.001	0.004	−0.020*
Walk time to train station	−0.210***	−0.005***	0.000	−0.002**	−0.003**
Submarkets	YES	YES	YES	YES	YES
Occupancy rate of moment of transaction	0.035	0.022	0.063**	−0.048*	−0.027
Building size (log)	0.041***	0.018*	0.027***	0.035***	0.016

Table 3.
OLS regression on rental premium in G5

(*continued*)

	Amsterdam (1)	The Hague (2)	Rotterdam (3)	Utrecht (4)	Eindhoven (5)
Property Grade by Building Code	0.009	0.036**	0.062***	0.066***	0.087***
Energy label	0.010***	−0.005	0.005	−0.003	0.006
Renovation dummy	0.123***	0.109	0.138***	0.126*	
Constant	4.927***	4.581***	4.509***	4.604***	4.471***
R-squared	0.792	0.584	0.579	0.650	0.495
Adjusted R-squared	0.787	0.556	0.551	0.630	0.445
Number of observations	1,224	383	379	416	232

Note(s): The dependent variable is the natural logarithm of the transaction rent per square metre office space. Significance at the 0.10, 0.05 and 0.01 levels are indicated by *, ** and *** respectively
Source(s): Author

Table 3.

	Non-certified buildings reference group (1)
BREEAM-NL certified	
BREEAM-NL Pass	0.064
BREEAM-NL Good	0.097***
BREEAM-NL Very Good	0.070***
BREEAM-NL Excellent	0.140***
BREEAM-NL Outstanding	0.019
2016 dummy	0.004
2017 dummy	0.051***
2018 dummy	0.085***
2019 dummy	0.101***
2020 dummy	0.128***
2021 dummy	0.191***
2022 dummy	0.168***
Number of restaurants	0.001***
Number of sport facilities	0.000
Walk time to train station	−0.001***
Average housing price	0.002***
Number of job opportunities	0.001***
Submarkets	YES
Occupancy rate of moment of transaction	0.021*
Building size (log)	0.046***
Property Grade	0.032***
Energy label	0.005***
Renovation dummy	0.113***
Constant	3.713***
R-squared	0.784
Adjusted R-squared	0.780
Number of observations	4,062

Note(s): The dependent variable is the natural logarithm of the transaction rent per square metre office space. Significance at the 0.10, 0.05 and 0.01 levels are indicated by *, ** and *** respectively
Source(s): Author

Table 4.
OLS regression on rental premium by label score

NL label (Pass, Good, Very Good, Excellent and Outstanding) is dummied and compared against the non-certified stock.

The results show that buildings certified with a BREEAM-NL Pass label do not command higher rent levels than non-certified buildings. Buildings certified with BREEAM-NL labels

Good, Very Good and Excellent generate a rental premium of respectively 10.2% [11], 7.3% [12] and 15.0% [13]. BREEAM-NL Outstanding -certified buildings do not show a significant rental premium.

The rent levels in Amsterdam are significantly higher than in the rest of the Netherlands. If we would distinguish Amsterdam from the rest of the Netherlands, we can identify a Pearson correlation between BREEAM-NL score and rent of $r\ (2{,}999) = 0.346$, $p < 0.001$ if we exclude Amsterdam, and, $r\ (1{,}244) = 0.370$, $p < 0.001$ in solely Amsterdam.

5. Discussion

The results did not show significant rent premiums for BREEAM-NL certified buildings in Amsterdam and Eindhoven. The insignificance of the results in Eindhoven might be the result of the limited number of observations: 14 certified transactions clustered in 6 certified buildings whereby one building is responsible for 7 certified transactions (50%). The insignificance in Amsterdam is likely a result of a *bias-variance trade-off*. The *bias–variance trade-off* suggests that a model should balance between *underfitting* and *overfitting* the data (Hastie *et al.*, 2017). *Overfitting* is the phenomenon that a model fits the given dataset too closely, limiting the generalisability to other data, resulting in low bias and high variance. *Underfitting* is the phenomenon that a model, fits the given dataset poorly and, therefore, not able to identify underlying patterns, resulting in high bias and low variance (Briscoe and Feldman, 2011). If Table 3 column (1) would be simplified by excluding inner-city submarkets, BREEAM-NL certified buildings would receive a significant rental premium in Amsterdam. However, the inner-city submarkets are of such importance for predicting rent levels, highlighted by the increase in explanatory power in Table 2 from 65.5% to 78.0%, that the effect of environmental certification would be overestimated if this parameter was ignored. A correlation analysis showed that a number of submarkets significantly correlate with BREEAM-NL certification [14], indicating that certified buildings tend to cluster in only a number of submarkets. However, a regression model with the interaction terms between BREEAM-NL certification and Amsterdam submarkets did not show a significant correlation, indicating that the clustering does not significantly affect the results. The relationship with submarkets, therefore, seems to be rather complex.

While the methodology limits the generalisability of the study, the results clearly illustrate the existence of a green premium in the Dutch office market. The lack of transparency and the availability of control variables bring limitations to this study. Although the model shows a high level of explanatory power, it is not possible to include all important rent determinants in the regression analysis. Despite the fact that most important rent determinants are incorporated this remains a limitation of regression modelling in general. Within the timeframe studied, in total more than 6.3 million square metre office space is transacted in the Dutch office market (NVM, 2021). The dataset provides information on approximately 4.8 million square metre leased floor area, resulting in an average saturation of 84% and therefore validates the generalisability to the entire population.

The results did not show a rent premium for BREEAM-NL Pass-certified offices. An explanation might be that *BREEAM-NL Pass* therefore already complies with the current market standard. The insignificance for *BREEAM-NL Outstanding*-certified buildings might be the result of the low number of observations with an *Outstanding* label ($N = 13$) clustered in a few buildings ($N = 5$). Surprisingly, the results show that *Very Good* labelled office buildings generally hold lower rent levels than *Good* labelled office buildings, which again might be explained by the *bias-variance trade-off*. If simplifying Table 4 column (1)–(5) by excluding inner-city submarkets, it would show a positive relationship across all BREEAM-NL labels.

The overall positive relationship between BREEAM-NL score and office rents suggests that tenants value BREEAM-NL certified offices more than the brand alone. A possible side

effect of BREEAM-NL certified offices could be improved indoor climate and higher productivity and satisfaction rates. Some sectors (e.g. business services) could more easily rationalise their need for green buildings due to this increased productivity (Eichholtz *et al.*, 2015). Additionally, tenants might value the energy savings accompanied with high-scoring BREEAM-NL assets. BREEAM-NL In-Use also values the actual energy consumption additional to the building's calculated energy performance (also known as energy label). Energy, electricity and water consumption are examples of BREEAM-NL credits whereby a high score can lead to significant reductions in service costs. Higher rent levels might be justified if it can be compensated by the savings on service costs (Eichholtz *et al.*, 2009). Finally, tenants might value the improved public image accompanied by green buildings (Eichholtz *et al.*, 2015).

6. Conclusion

The growing demand for green buildings emphasises the importance of voluntary environmental certification systems. In the Netherlands, the DGBC program BREEAM-NL, USGBC's program LEED and WELL are the most important voluntary environmental certification systems. This paper documents a significant increase in market adoption of environmentally certified offices. In 2021, more than 30% of the total leased floor area was BREEAM-NL certified.

The aim of this study was to examine the effect of environmental certification on market value within the Dutch office market and to test the existence of quantitative rental premiums for BREEAM-NL certified offices. This study contributes to literature by providing empirical evidence on the willingness-to-pay for environmental certified offices in the Dutch office market. Based on 4,244 rent transactions in the period 2015 to mid-2022, it can be concluded that BREEAM-NL certification positively influences market value in the Dutch office market. After controlling for important location and building characteristics, the average premium for BREEAM-NL certified offices is 10.3%. The effect highly differs across submarkets and this is confirmed by the rental premium varying between 5.1 and 12.6% in the five largest Dutch office markets. Additionally, label scores positively influence the property's market value with a significant positive correlation between BREEAM-NL label score and rents. This shows that better performing buildings generally command higher rents and suggests that tenants do value the tangible and intangible benefits of green buildings as environmentally friendly buildings can significantly reduce energy bills and service costs and improve indoor climate. Referring back to the Vicious Circle of Blame, the results show a growing demand for green offices and that tenants are willing to pay an additional premium for BREEAM-NL certified assets. The results are in line with the current body of literature, showing similar economic benefits of green buildings across real estate markets.

Notes

1. GRESB (Global Real Estate Sustainability Benchmark), BREEAM (Building Research Establishment Environmental Assessment Method), SDG (Sustainable Development Goals), ESG (Environmental Social Governance), CSRD (Corporate Sustainability Reporting Directive), NFRD (Non-Financial Reporting Directive), SFDR (Sustainable Finance Disclosure Regulation), and EPC (Energy Performance Certificates).
2. European organisations meeting two of the following three requirements: more than 250 FTE, €40 million euro net turnover and/or a total balance of at least €20mn euro.
3. The dataset is concentrated on the larger office markets in the Netherlands. In general, the office in these markets have a higher quality than stock in peripheral markets.

4. Variable energy performance is coded as 1 = *G*, 2 = F, 3 = E, 4 = D, 5 = C, 6 = B, 7 = A, 8 = A + - A+++.
5. Variable Property Grade is coded as no Building Code = 1, Building Code 1992 = 2, Building Code 2003 = 3, Building Code 2012 = 4.
6. As the dependent variable is the natural logarithm of rent per square metre, the rent premium can be calculated by the e-return of the regression coëfficient: e^[0.163] = 17.70%.
7. e^[0.098] = 10.3% average rental premium for BREEAM-NL certified offices.
8. e^[0.119] = 12.6% in The Hague.
9. e^[0.050] = 5.1% in Rotterdam.
10. e^[0.063] = 6.50% in Utrecht.
11. e^[0.097] = 10.2% for BREEAM-NL Good.
12. e^[0.070] = 7.3% for BREEAM-NL Very Good.
13. e^[0.140] = 15.0% for BREEAM-NL Excellent.
14. Amsterdam Oud-Zuid, Amsterdam West, Amsterdam Zuidas, Amsterdam Zuidoost, Amsterdam Zuidoost Arena

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(The Appendix follows overleaf)

Appendix

Variable	Explanation
BREEAM-NL certified	Binary variable to indicate if the building was certified with BREEAM-NL at moment of lease
Rent Price (€/sqm)	The transaction rent per square metre lettable floor area office space
Ln Rent Price (€/sqm)	The natural logarithm of the transaction rent per square metre lettable floor area office space
Occupancy rate at moment of transaction (%)	The occupancy rate of the building at moment of lease
Ln building size (sqm)	The natural logarithm of the total building size in gross floor area
Building age	The age of the building measured in years from construction year
Renovation dummy	Binary variable to indicate if the building had a major refurbishment after the building is constructed
Energy label	Indicates the energy label of the building, coded as G = 1 and A + - A+++ is 8
Property grade	Indicates the overall quality of the building based on the Building Code. Properties before 1992 are not built according a Building Code, properties between 1992–2002 are built according Building Code 1992, properties between 2003 and 2011 are built according Building Code 2003 and properties after 2012 are built according Building Code 2012
Number of restaurants	The number of restaurants in the direct proximity of the building
Number of sport facilities	The number of sport facilities in the direct proximity of the building
Walk time to train station	The total walk time to the closest NS train station

Source(s): Author

Table A1.
Overview of control variables

Corresponding author
Rens van Overbeek can be contacted at: rens@van-overbeek.eu

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