EFFECT OF GREEN BUILDING CERTIFICATION ON HOUSING PRICES IN THE NETHERLANDS

by

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5837731

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Preface

This master's thesis represents the culmination of my studies in the Construction management and Engineering master's program at TU Delft. The inspiration for this research stems from my interest in sustainable development and the economic mechanisms driving the real estate sector. Throughout my academic journey, I developed a keen interest in how financial incentives and market behaviour influence sustainable construction practices. This thesis provided an opportunity to bridge sustainability and economics through a rigorous quantitative analysis, allowing me to refine my data analysis skills and deepen my understanding of real estate valuation methods.

I would like to express my sincere gratitude to my supervisors, Dr. D.F.J. Schraven and Dr. E. (Enno) Schröder, for their invaluable guidance, thoughtful feedback, and continuous support throughout this process. I am also thankful to Ir. E.H.M. (Ellen) Geurts for her contributions and encouragement. Lastly, I extend my appreciation to my family and friends for their unwavering support during this journey.

I hope this thesis contributes meaningful insights to both academia and practice. Enjoy reading, and feel free to reach out if you have any questions.

Sincerely,

Divyank Raj
The Hague
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Abstract

The increasing emphasis on sustainability in the built environment has led to the adoption of voluntary green building certifications such as BREEAM-NL. While the financial benefits of environmental certifications are well-documented in commercial real estate markets, research on their impact in residential markets remains limited, particularly in the Netherlands. This thesis investigates the effect of BREEAM-NL certification on residential transaction prices in the Dutch housing market using a hedonic price model.

A comprehensive dataset of residential property transactions is analysed, controlling for property characteristics (e.g., area, number of rooms, and year of construction), locational attributes, and neighbourhood factors (e.g., crime rates and proximity to amenities). The analysis reveals that BREEAM-NL-certified properties command a statistically significant price premium ranging between 7.2% and 15.7%. These findings align with international studies on the added value of green certifications but indicate a slightly larger premium in the Dutch residential sector.

The results highlight the economic feasibility of green certifications, offering valuable insights for developers, investors, and policymakers. For developers, the premium demonstrates that sustainability investments can yield tangible financial benefits. Policymakers can use this evidence to design targeted strategies and incentives to encourage broader adoption of green building standards.

This research fills a critical gap in the literature by providing empirical evidence on the impact of BREEAM-NL certification in the residential housing market. The findings support the role of green building certifications in driving economic value while contributing to broader sustainability goals.

Keywords: green premium, BREEAM-NL, residential real estate, hedonic price model, sustainable building, price premium, Dutch housing market

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1
Introduction

In alignment with global efforts to combat climate change, such as the Paris Agreement and the European Green Deal, the Dutch government has committed to ambitious sustainability targets through its National Climate Agreement (NCA). Central to these efforts is the transformation of the built environment, which plays a pivotal role in achieving national carbon reduction goals. Specifically, the NCA outlines a vision for 2050 to retrofit 7 million dwellings and 1 million buildings to be well-insulated and no longer reliant on natural gas, instead utilizing renewable heating sources and generating clean electricity. This vision emphasizes strong social cooperation with residents and building owners to ensure a successful transition (Ministry of Economic Affairs and Climate Policy, 2019).

To progress toward this long-term vision, the NCA sets intermediate targets for 2030, aiming to make 1.5 million existing residential and non-residential buildings more sustainable. The built environment sector is expected to reduce carbon dioxide emissions by 3.4 megatons (Mt) in residential and an additional 1 Mt in non-residential buildings by 2030. Achieving these goals requires an approach that demands collaborative efforts from both local authorities and building owners, determining the best solutions for each district, facilitating a tailored and community-focused transition (Ministry of Economic Affairs and Climate Policy, 2019).

While the current mandates like the Energy Performance Certificates (EPCs) emphasize energy efficiency, they fall short of addressing the broader sustainability challenges envisioned by NCA. The EPC framework primarily targets the reduction of energy consumption and improvement of building insulation, aiming for increased energy efficiency in the built environment. However, the NCA highlights additional sustainability challenges beyond energy efficiency. These include reducing dependency on fossil fuels like natural gas, increasing the use of renewable heating and energy sources, promoting resource efficiency, waste reduction and achieving significant carbon reductions within specified timelines. Moreover, the NCA calls for a district-oriented approach that involves social collaboration and a focus on community-level solutions, which current policies do not fully incorporate

1.1 Background of the Study

The built environment plays a significant role in global environmental challenges. In the Netherlands, approximately 28% of total energy consumption is attributed to buildings as shown in figure 1. These figures underscore the urgent need for greener, more energy-efficient dwelling as part of the solution to mitigate environmental degradation and achieve national climate goals. Currently, to meet the need for a more sustainable built environment, the Dutch government has implemented a requirement for a minimum EPC rating for all buildings that are put up for sale, rent, or when construction is completed.

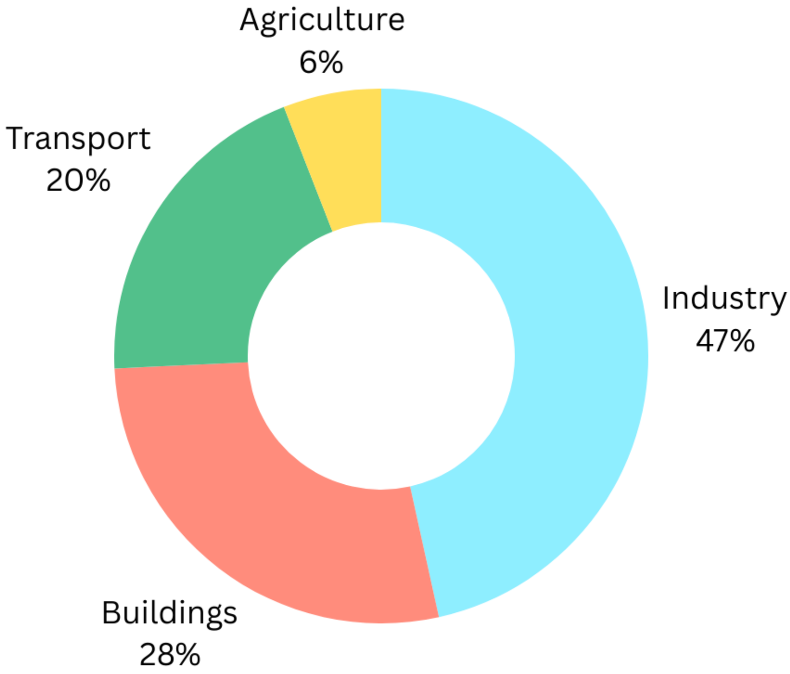

Figure 1 Energy demand among sectors(Netherlands) Source: EBN (2022)

The EPC, commonly known as the Energy Label in the Netherlands, was introduced in 2008 as part of the European Union's Energy Performance of Buildings Directive (EPBD). The EPC provides an energy efficiency rating for buildings, with the aim of reducing energy consumption and greenhouse gas emissions. Updated in 2015 and again in 2021, EPC assigns a building a rating based on the energy efficiency of its thermal envelope and installations, with ratings ranging from A (most efficient) to G (least efficient). In addition to the rating, the EPC may include recommendations on potential energy efficiency improvements and, in some cases, provide estimates of the corresponding cost savings (Murphy, 2014).

However, while EPCs play an important role in improving energy efficiency, they focus narrowly on energy performance, overlooking other sustainability factors. For instance, EPCs do not address how buildings consume and manage water resources, such as implementing water-saving technologies or recycling greywater. Similarly, they ignore waste management practices, such as minimizing construction waste and promoting circular construction, which are vital for reducing environmental impact. Furthermore, EPCs fall short in encouraging the adoption of renewable energy systems, like solar panels or geothermal heating, which are crucial for reducing reliance on fossil fuels. As a result, EPCs are limited in their ability to support the Dutch government's ambitious goals. Apart from EPC's narrow scope, its calculations are based on theoretical models that estimate energy usage rather than measuring actual energy performance which depends on various other factors such as occupant behaviour, this can lead to inaccuracies (Cozza et al., 2020). This makes it insufficient for meeting these wider sustainability targets set by the National Climate Agreement (NCA), such as reducing carbon emissions, transitioning to renewable energy sources, and achieving holistic building sustainability.

One such approach is green building certifications such as Building Research Establishment Environmental Assessment Method- Netherlands (BREEAM-NL) that evaluates buildings based on nine sustainability categories, including energy, water, materials, and health and well-being. Unlike EPCs, BREEAM-NL offers a holistic assessment of a building's overall environmental performance, making it a more effective tool for achieving the government's sustainability goals (DGBC, 2023).

Major investors like Vesteda and ASR have already started moving in this direction by certifying large portions of their portfolios under BREEAM-NL (ASR, 2022; Vesteda, 2023). Despite these positive steps, the housing market has been slow to adopt such certifications. Barriers to the adoption exist, including lack of information, cost, incentives, and regulations (Darko & Chan, 2017). Addressing these barriers is essential to promote the widespread adoption of green building certification systems, which serve as valuable instruments for achieving said goals. By facilitating the adoption of these certification systems, the building industry can be guided toward sustainable construction practices, ultimately supporting the national goal of a more sustainable built environment in the Netherlands.

1.2 Problem Statement

Incorporating green building certifications into housing development addresses several key challenges: reducing energy consumption, lowering greenhouse gas emissions, and ensuring the health and well-being of occupants (DGBC, 2023). Certification systems like BREEAM-NL serve not only as quality markers for sustainability but also as a way to meet the regulatory and policy requirements outlined in national initiatives such as the Dutch National Climate Agreement. By adhering to these certification standards, developers can help the Netherlands achieve its ambitious goals of reducing carbon emissions and improving the overall energy performance of the built environment.

Despite the clear environmental and financial benefits of certified green buildings, their widespread adoption faces two key market failures: **positive externalities** and **information asymmetries.**

Positive externalities occur when the actions of one party result in benefits for others that are not fully accounted for in the decision-making process (Pindyck & Rubinfeld, 2017). In the context of green buildings, the societal benefits—such as reduced greenhouse gas emissions, improved air quality, and public health enhancements—extend far beyond the immediate financial returns seen by developers and investors. Just as a homeowner who beautifies their property inadvertently benefits their neighbors without direct compensation, developers who invest in sustainable construction practices generate widespread environmental benefits that are not reflected in their financial incentives. These sustainability measures often entail higher initial costs, ranging from 0.4% to 21% more than traditional construction (Dwaikat & Ali, 2016), but lack mechanisms to capture the broader societal benefits, such as cleaner air or reduced environmental degradation. As a result, this market failure leads to underinvestment in green building initiatives from a societal perspective, as developers primarily focus on maximizing private returns rather than accounting for the collective gains (Dalton & Fuerst, 2018).

One potential way to incentivize developers to consider the societal benefits of green building practices is to demonstrate a clear market preference for green-certified properties. If empirical evidence shows that buyers are willing to pay a premium for properties with sustainable certifications, developers could potentially offset the higher initial costs associated with green construction through increased sale prices or rental income. This aligns with the hypothesis that green certifications enhance property demand, indicating that these buildings are valued more by buyers and investors due to their sustainability attributes. Evidence of such willingness to pay (WTP) could encourage developers to internalize the societal benefits associated with green buildings, as they would see a direct financial return on their investment (Dalton & Fuerst, 2018). Additionally, government incentives, such as tax breaks or subsidies for certified sustainable developments, could further support developers in offsetting initial costs, making it financially viable to pursue projects with positive externalities (Hoffman & Henn, 2008).

Information asymmetry plays a significant role in the underinvestment in green buildings, as it occurs when one party in a transaction has more or better information than the other (Pindyck & Rubinfeld, 2017). In the case of green buildings, sellers often have detailed knowledge about sustainability features, such as high-performance insulation or advanced HVAC systems, which can significantly reduce energy bills for buyers over time. However, buyers may lack this information, creating information asymmetry. While certifications like BREEAM-NL help bridge this gap by highlighting features and long-term benefits, such as energy savings, higher resale values, and superior environmental performance, many market participants remain hesitant to invest due to the perceived high upfront costs. This reluctance stems from a limited understanding of the long-term financial gains that certified green buildings can offer. Consequently, the focus on initial costs overshadows the potential for economic benefits over time, deterring homeowners and investors from embracing these sustainable properties despite evidence of their price (Hwang et al., 2017).

In the Dutch residential market, this problem is exacerbated by a lack of empirical research specific to the effects of green building certifications, like BREEAM-NL, on housing prices. Although numerous studies in the U.S. and U.K. show a price premium for certified commercial and residential properties (Bond & Devine, 2016; Chegut et al., 2014), little is known about how these findings translate to the Dutch housing market. Without data on the financial benefits of green certifications, developers and investors remain hesitant to invest in sustainable construction practices.

This study seeks to address the market failures in the Dutch housing market by quantifying the price premium associated with BREEAM-NL certification. By providing empirical evidence of the financial benefits of certified green buildings, the research aims to improve market transparency and enable developers, investors, and homebuyers to make informed decisions. This study adopts a quantitative research design, utilizing regression-based statistical methods to analyse the relationship between green building certification and transaction prices. Specifically, the Hedonic Price Model is employed to decompose property prices into their constituent attributes, isolating the impact of BREEAM-NL certification while controlling for other influencing factors. This approach provides evidence of the certification's effect on market behaviour and its role in determining property values.

In conclusion, addressing market failures would not only provide financial benefits to developers and investors but also contribute to the Dutch government's sustainability goals, as outlined in the National Climate Agreement. Improved market transparency can align private investment incentives with collective sustainability objectives, benefiting both the economy and the environment.

1.3 Research Objectives

This study aims to explore the effect of BREEAM-NL certification on the transaction prices of residential buildings in the Dutch real estate market. By examining how certification influences property values, the research seeks to uncover whether certified buildings command a price premium and how certification interacts with other factors that affect transaction prices. The study contributes to a deeper understanding of the economic impacts of sustainable building practices in the Dutch housing sector.

Main Research Question:

"What effect does BREEAM-NL certification have on the transaction prices of residential buildings in the Dutch real estate market?"

Sub-Questions:

1. What does the latest academic literature reveal about the relationship between sustainability certifications and residential building prices?
2. Do BREEAM-NL-certified buildings in the Netherlands sell at a premium compared to similar non-certified ones?

1.4 Significance of the Study

By quantifying the price premiums associated with BREEAM-NL certification for residential properties, this study provides valuable practical and scientific insights into the Dutch real estate market.

From a societal perspective, this research delivers critical insights for developers, investors, and policymakers. The findings demonstrate how BREEAM-NL certification influences transaction prices, offering empirical evidence that addresses concerns regarding the financial feasibility of green certifications. Developers and investors often view sustainability certifications as costly and perceive the risks to outweigh potential benefits (Darko & Chan, 2017). However, this study reveals that certified properties generate significant price premiums, which can offset the initial costs of certification while improving long-term profitability. These results enable developers and investors to make better-informed decisions, align their investment strategies with sustainability goals, and enhance the overall economic value of their projects.

For policymakers, this study provides a foundation for designing targeted strategies to encourage sustainable construction practices. By quantifying the economic value of BREEAM-NL certification, the research demonstrates that certified properties generate significant price premiums. However, the upfront costs of certification and retrofitting can still pose barriers, particularly for smaller developers and individual homeowners who may be hesitant to make the initial investment. Financial incentives, such as tax rebates, subsidies for retrofitting existing buildings, or reduced property transfer taxes, can help overcome these barriers by reducing the initial costs and accelerating the adoption of green building standards. Additionally, such incentives serve to align private investments with public policy objectives, ensuring that market adoption of sustainable practices supports broader national sustainability goals (Kumar et al., 2024). Beyond financial incentives, the findings highlight the importance of public awareness campaigns that promote the financial and environmental benefits of certified green housing. Such measures can help bridge this information gap, fostering greater trust and understanding of green certifications(Borawska, 2017).

From a scientific perspective, this study addresses a significant gap in the existing literature on green building economics. While the price premiums associated with green certifications have been extensively studied in commercial markets (Eichholtz et al., 2010; Fuerst & McAllister, 2011), research on residential markets remains scarce, particularly in Europe. Most existing studies focus on U.S. and Asian markets, such as Energy Star-certified homes in California (Kahn & Kok, 2014) and BEAM Plus-certified residential buildings in Hong Kong (E. C. M. Hui et al., 2017). This research expands the body of knowledge by examining BREEAM-NL, the leading green building certification in the Netherlands, within the residential housing sector. It provides critical empirical evidence specific to the Dutch market, contributing regional insights to the global understanding of sustainable value drivers.

By using a hedonic pricing model, the study examines how BREEAM-NL certification relates to housing prices while controlling for various property and locational characteristics. Although similar methods have been used in other studies, applying this framework to residential buildings with BREEAM-NL certification in the Dutch context addresses a gap in the existing literature. The findings provide a localized understanding of how sustainability measures affect property values, which can inform future research and practical applications in similar markets.

This study’s contribution lies in its ability to provide empirical evidence where it is currently scarce, specifically in the residential housing market in the Netherlands. While it does not aim to make broad generalizations, it adds depth to the discussion of green building economics by expanding the scope of contexts and certifications studied. These findings can serve as a reference for further exploration of the economic implications of green certifications in diverse geographic and market settings.

2

Literature Review

2.1 Introduction

This chapter provides a comprehensive review of existing literature on the factors influencing transaction prices in the Dutch residential real estate market, with a particular emphasis on sustainability and green building certifications such as BREEAM-NL. The chapter begins by exploring how transaction prices reflect market dynamics, including buyer willingness to pay (WTP) for properties with desirable attributes such as location, neighbourhood characteristics, and sustainable built features. A key focus is placed on how green certifications like BREEAM-NL impact WTP by signalling both tangible benefits, such as energy efficiency and lower operational costs, and intangible benefits, such as improved indoor environmental quality and reduced carbon footprints.

The hedonic price model (HPM) is introduced as a methodological framework to quantify the effects of property attributes on market value. This approach underpins many empirical studies, allowing for the isolation and analysis of factors such as location, building characteristics, and sustainability certifications. The chapter highlights global evidence of price and rental premiums associated with green-certified buildings, illustrating the economic advantages of sustainability in real estate.

The review concludes by identifying a gap in localized studies of the Dutch residential market and emphasizing the need for further research into the price premiums associated with BREEAM-NL certification. By synthesizing insights from international and Dutch contexts, the chapter lays the theoretical foundation for the subsequent empirical investigation, aiming to quantify the relationship between green certifications and housing prices in the Netherlands.

2.2 Transaction Prices and Willingness to Pay

Transaction prices represent the actual amounts at which properties are sold or leased. These prices are distinct from appraisals or asking prices, which are based on forecasts or market projections. A key concept related to transaction prices is **WTP,** which represents the maximum amount a buyer is willing to pay for a property. WTP is typically influenced by a combination of the perceived costs and benefits associated with owning or renting a dwelling, relative to a buyer’s specific needs, desires, and financial constraints (Zalejska-Jonsson et al., 2020). This is central to a buyer’s decision-making process when determining the value of a property. According to Boardman et al. (2018), WTP serves as the guiding principle for valuation, taking into account all the potential impacts of a decision or policy.

In the context of real estate, the WTP for a dwelling is shaped by factors such as location, amenities, and the property's sustainability credentials. Sustainable Built Characteristics, such as energy-efficient systems or environmentally friendly designs, may contribute to both costs and benefits, ultimately affecting a buyer’s or tenant's WTP. For instance, while green certifications like BREEAM-NL may involve upfront costs, they are often associated with long-term benefits, such as reduced energy expenses and improved living conditions, making buyers more inclined to pay a premium (Wiencke, 2013; Zalejska-Jonsson et al., 2020; Zhang et al., 2018). This higher WTP for sustainable buildings directly influences transaction prices, as properties with green certifications tend to command higher prices due to their perceived long-term value.

Studies in the Netherlands show that, apart from various factors like location, property characteristics, market demand, and economic conditions, another important factor affecting transaction prices in commercial buildings is green building certification(D. N. Kok & Jennen, 2010; Reinders, 2020; van Overbeek et al., 2024). Certifications like BREEAM-NL not only signal sustainability and energy efficiency but also enhance the perceived long-term value of properties. This trend is supported by research from various global markets, where green-certified buildings command higher prices due to the benefits associated with lower operational costs and improved environmental performance (Ghosh & Petrova, 2023; Leskinen et al., 2020; Porumb et al., 2020; Sánchez-Flores & Marisol, 2017).

Given this evidence, it can be hypothesized that there is a price premium associated with green building certifications like BREEAM-NL in the Dutch residential market as well. Buyers in the residential sector, much like those in the commercial sector, may be willing to pay more for properties that offer sustainability credentials, leading to higher transaction prices for certified homes.

2.3 Hedonic Price Model (HPM)

In their comprehensive exploration of urban economics and real estate theory, McDonald and McMillen (2010) examine the role of hedonic modelling in understanding housing values. They present two fundamental models of housing valuation: Richard Muth's model and the Lancaster-Rosen model, which differ in their treatment of housing as either a single-dimensional or a multi-dimensional product.

The Muth model, conceived by economist Richard Muth (1969), views housing as a "bundle of services" generated by housing capital and land. Muth simplifies housing into a unidimensional service, defining its value based on the total expenditure necessary to purchase a standardized amount of these services. This model emphasizes the income and price elasticity of housing demand, supply elasticity, and patterns of land-use intensity, making it a staple for understanding broad patterns in housing demand and development.

In contrast, the Lancaster-Rosen model, inspired by the work of Lancaster (1966) and Rosen (1974), conceptualizes housing as a multidimensional good composed of various attributes. These attributes, including size, location, and specific features, cater to consumer preferences and collectively determine the price of the property. By treating housing as a composite of characteristics, the Lancaster-Rosen model has enabled more nuanced, attribute-specific analyses of property values and has reshaped real estate appraisal practices. This approach underlies the modern statistical methods used to estimate housing values, collectively termed hedonic price models.

HPM is a widely used technique for estimating the value of specific characteristics that indirectly influence the market price of a commodity. In addition to evaluating these individual characteristics, HPM is also employed to estimate the demand for goods and services. Its applications extend across various fields, including consumer and market research, the calculation of consumer price indices, tax assessments, and the valuation of goods such as cars and computers. However, the methodology has gained significant prominence in real estate economics and appraisal, which is the focus of this discussion.

2.3.1 Structure of the Hedonic Price Model

The hedonic price method (HPM), also referred to as hedonic demand theory or hedonic regression, is a method used to estimate economic values for ecosystem or environmental services that directly affect market prices. The model is based on the premise that the price of a marketed good is related to its characteristics or features. In the context of real estate, the HPM posits that the price of a property is determined by its attributes, such as location, size, age, and other physical and environmental factors. HPM utilizes regression analysis to estimate how various attributes of a property influence its market value. Multiple regression analysis can be performed using various techniques, such as ordinary least squares (OLS) regression or maximum likelihood estimation, which applies the log-likelihood function derived from the hedonic model.

Typically, the dependent variable in this model is the property's price, while independent variables represent characteristics like square footage, lot size, age, and location. McDonald and McMillen (2010) illustrate a basic version of the HPM through the following linear equation:

$$V = \alpha_0 + \alpha_1 F + \alpha_2 L + \alpha_3 x + \varepsilon$$

where:

V represents the property's market value,

F denotes interior square footage,

L is the exterior lot size,

x indicates distance to employment centres, and

ε represents a random error term capturing unobserved factors affecting property price.

Each coefficient in the equation (e.g., α_1, α_2, α_3) quantifies the market value associated with a unit increase in each respective characteristic. For instance, α_1 might indicate the value added by each additional square foot of interior space, while α_3 captures the decrease in value associated with increased distance from employment hubs. This approach enables a breakdown of housing prices into the marginal contributions of each attribute, offering insight into the value that the market assigns to specific features.

2.3.2 Application of HPM in Real Estate

Within the realm of real estate market research, HPM has been utilized extensively for a variety of purposes. These include adjusting for quality differences in real estate price indices, estimating property values in the absence of transaction data, analysing demand for specific features, and exploring broader real estate demand trends. Additionally, HPM has proven to be a valuable tool for testing theoretical assumptions in spatial economics, further cementing its role as a foundational approach in real estate studies (Herath & Maier, 2010).

The HPM has been instrumental in linking theoretical constructs with empirical evidence, enabling researchers to quantify the WTP for specific housing features and better understand market trends. Its flexibility allows for analysing a wide range of property characteristics and external factors that influence housing demand and valuation. Researchers have applied HPM to explore diverse factors influencing real estate, from environmental conditions to demographic trends and urban infrastructure.

The studies highlighted in table 1. showcase the diverse applications of HPM in real estate research. Each study offers valuable insights into how housing markets reflect consumer preferences, societal trends, and policy impacts.

The role of environmental attributes, particularly air quality, has been a central focus in HPM research. Research such as Harrison & Rubinfeld (1978) highlights the effectiveness of hedonic modelling in estimating WTP for marginal improvements in air quality by regressing housing values against pollution levels and other attributes. With the use of a hedonic housing price model and data for the Boston metropolitan area, author noted that marginal air pollution damages increase with pollution levels and household income, and improper use of constant marginal valuations can overstate benefits of non-marginal air quality improvements by up to 30%, emphasizing the need for accurate hedonic specifications. Similarly, Palmquist and Israngkura's (1999) work demonstrated regional variations in WTP for air quality, indicating that socioeconomic characteristics and distinct housing market conditions significantly influence residents' valuation of air quality improvements, with WTP for a 20% improvement in air quality varying across pollutants and methods. These findings illustrate how housing markets encapsulate the value residents place on environmental externalities.

Demographic factors, including racial and socioeconomic characteristics, also play a pivotal role in shaping housing markets. Bajari and Kahn’s (2005) research sheds light on how racial segregation influences housing preferences. Their study found that white suburbanization is primarily driven by a preference for larger single detached homes and high human capital communities, while black urbanization is influenced by proximity to work in city centres and barriers such as lower income, education levels, and marriage rates. The selective migration of wealthier, educated black individuals to the suburbs reduces the exposure of urban minority poor to role models, which has intergenerational consequences such as lower educational attainment and diminished engagement in the legal workforce. This work underscores the nuanced role of sociocultural factors in shaping property values and reveals critical implications for urban policy, highlighting the need to address the externalities of suburbanization and segregation to mitigate long-term social and economic disparities.

McMillen and McDonald’s (2004) analysis highlights the premium placed on proximity to public amenities, showing that properties near the Midway Line transit stations experienced a 15.2% greater negative price gradient per mile after the line's opening, and a 6.89 percentage point higher appreciation rate between 1986 and 1999 compared to homes farther away. This suggests that investments in transit infrastructure can significantly boost nearby property values, providing strong support for integrating public transport development into urban planning and infrastructure strategies.

The studies showcased in Table 1 highlight the versatility of HPM in addressing housing market dynamics. Each study offers valuable insights: **environmental attributes**, such as air quality, significantly influence housing values (Harrison & Rubinfeld, 1978; Palmquist & Israngkura, 1999); **demographic factors**, like racial segregation, shape housing preferences and spatial distribution (Bajari & Kahn, 2005); and **proximity to public infrastructure** impacts property valuation, as seen in increased appreciation near transit investments (McMillen & McDonald, 2004). These findings demonstrate how HPM links theoretical concepts with practical applications, offering actionable insights for urban policy and sustainability. The variables discussed in Table 1 will inform the selection of factors analyzed in the next section on transaction prices.

Table 1: Selected Studies Utilizing the HPM to Analyse Real Estate Markets (Source: Author)

Author(s)	Title	Variables	Brief Note about Results
Harrison and Rubinfeld (1978)	Hedonic Housing Prices and the Demand for Clean Air	No of rooms, age, black population, crime rate, zoning restrictions, non retail businesses, property tax, pupil-teacher ratio, river dummy, distance from employment centres, accessibility to highways, nitrogen oxide, particulate concentration	The study finds that marginal air pollution damages increase with pollution levels and household income, and improper use of constant marginal valuations can overstate benefits of non-marginal air quality improvements by up to 30%, emphasizing the need for accurate hedonic specifications.
Boyle et al. (1999)	Estimating the Demand for Protecting Freshwater Lakes from Eutrophication	Visibility, price of visibility, property price, income	The study highlights the importance of water clarity in environmental demand models, demonstrating that hedonic models can estimate demand for amenities across markets.
Palmquist and Israngkura (1999)	Valuing Air Quality with Hedonic and Discrete Choice Models	Characteristics of the structure, lot, neighbourhood, location, and jurisdiction and air pollutants: total suspended particulates, nitrogen dioxide, ozone, and sulphur dioxide	The study uses hedonic models and RUM to estimate WTP for air quality, finding hedonic models more effective across pollutants.
Chattopadhyay (1999)	Estimating the Demand for Air Quality: New Evidence Based on the Chicago Housing Market	No of rooms, area, age, AC, no of bathrooms, garage, property tax rate, neighbourhood demographics, distance from downtown, distance from expressway, air quality indicators, location, household attributes(total income, children, race)	The study provides reliable WTP estimates for both marginal and non-marginal air quality changes, highlighting that households value PM-10 reduction more than sulphur reduction.
Paterson and Boyle (2002)	Out of Sight, Out of Mind? Using GIS to Incorporate Visibility in Hedonic Property Value Models	House style, year built, family room, fireplace, no of bedrooms, parking, no of bathrooms, basement, acreage of land	Visibility significantly influences property values, with the study showing that omitting visibility variables in hedonic models can misrepresent the impact of environmental conditions, emphasizing that undesirable land uses may have less effect if hidden from view.
McMillen and McDonald (2004)	Reaction of House Prices to a New Rapid Transit Line: Chicago's	Building area, lot size, age, no of bedrooms, more than one story, masonry used in construction, basement, attic, AC, Garage,	Proximity to the Midway Line significantly increased residential property values, with strong price appreciation and steep distance

	Midway Line, 1983–1999	neighbourhood demographics, neighbourhood	gradients, reflecting homeowners' high valuation of transit access.
Ihlanfeldt and Taylor (2004)	Externality Effects of Hazardous Waste Sites	Year built, area, no of improvement, acreage of property, age, external wall material, tax grade, parking, location, land use, distance to central business district, distance to station, distance to highways, distance to airport, income, population density, employment density	The study finds hazardous waste sites significantly reduce property values, with losses in Fulton County, Georgia, reaching $1 billion, suggesting policies like tax-increment financing could mitigate effects, especially in urban areas like Atlanta.
Bajari and Kahn (2005)	Estimating Housing Demand With an Application to Explaining Racial Segregation in Cities	Physical attributes- no of rooms, age, ownership dummy and community attributes percentage of black households, percentage of college educated households, proximity to centre city.	Housing demand differs as whites prefer suburbs for larger homes and high-capital areas, while blacks favour cities due to employment proximity, unrelated to racial preferences.
Cohen and Coughlin (2006)	Airport-Related Noise, Proximity, and Housing Prices in Atlanta	Average peak noisiness, no of aircrafts heard, age, no of garage, type, no of bedroom, no of living room, month of sale	The study finds proximity to Atlanta airport raises housing prices, but noise reduces them, with discounts up to 17.7%. Declining noise levels increased prices by 20%.
Noonan (2007)	Finding an Impact of Preservation Policies: Price Effects of Historic Landmarks on Attached Homes in Chicago, 1990-1999	Area, year built, no of units in building, no of rooms, no of bathrooms, fireplace, garage, parking, distance to central business district, distance to lake, distance to park, neighbourhood attributes(income, value, density, no of non white), district, landmark	Landmark designation impacts property prices, with higher values observed for designated landmarks and nearby properties due to external benefits like neighbourhood prestige, though challenges like endogeneity and unobserved traits complicate causal inferences.

2.3.3 Effect of Green Building Certificate on Prices

The earliest studies on the price and rental effects of green building certifications primarily focused on certifications such as LEED, ENERGY STAR, and BREEAM. These certifications have been extensively examined in various markets, revealing consistent evidence that green-certified buildings command a price or rental premium compared to non-certified ones. Furthermore, buildings with higher levels of certification tend to achieve greater premiums, reflecting their enhanced energy efficiency, sustainability, and broader appeal.

Table 2 summarizes a selection of studies that employed the HPM to quantify the effect of green building certifications on property prices and rents. These studies span different markets and property types, illustrating the wide applicability of HPM in measuring the economic benefits of certification.

Table 2: Current literature on effects of green building certification (Source: Author)

Author(s)	Title	Market	Certification	Findings
Miller et al. (2008)	Does Green Pay Off?	U.S. commercial Market	LEED/ES	Price premium: 9.94% (LEED); 5.76% (ES)

Eichholtz et al. (2010)	Doing Well by Doing Good? Green Office Buildings	U.S. commercial Market	LEED/ES	Average rental premium: 1.9–2.6%
Kok and Jennen (2010)	De waarde van energiezuinigheid en bereikbaarheid	Dutch office market	Energy Label	Lower rated buildings have price discount of 6.5%
Chegut et al. (2011)	The Value of Green Buildings New Evidence from the United Kingdom	U.K. residential market	BREEAM certification	Price premium: 8% Rental premium: 16% - 20%
Fuerst and McAllister (2011)	Green Noise or Green Value?	U.S. commercial Market	LEED/ES	Price premium: 10% (ES); 31% (LEED)
Addae-Dapaah and Chieh (2011)	Green Mark Certification: Does the Market Understand?	Singapore residential market	GM certification	Price premium: 9.61% - 27.74%
Jayantha and Man (2013)	Effect of green labelling on residential property price: a case study in Hong Kong	Hong Kong residential market	HK-BEAM certification and HK-GBC Award	Price premium: 3.4% - 6.4%
Kok and Kahn (2014)	The Value of Green Labels in the California Housing Market	U.S. residential market	LEED/ES/Green Point Ratings Programme	Price premium: 9%
Bond and Devine (2016)	Certification Matters: Is Green Talk Cheap Talk?	U.S. residential market	LEED certification	Rental premium: 8.9%
E. C. M. Hui et al. (2017)	The effect of BEAM Plus certification on property price in Hong Kong	Hong Kong residential market	BEAM Plus certification	Price premium: 4.4% - 6.2%
Walls et al. (2017)	Is energy efficiency capitalized into home prices?	U.S. residential market	ES	Price premium - 2%
Hui and Yu (2021)	Housing market segmentation and the price effect of certified green residential properties	Hong Kong residential market	BEAM Plus, HK BEAM, Energywi$e and Wastewi$e certification	Price premium: 32% - 40% (HK BEAM); 5.5% - 26.9% (BEAM Plus)
Van Overbeek et al. (2024)	The added value of environmental certification in the Dutch office market	Dutch office market	BREEAM-NL certification	Price premium: 5.1% - 12.6%; Rental premium: 10.3%

In the U.S. commercial market, Miller et al. (2008) demonstrated that LEED-certified office buildings experienced a price premium of 9.94%, while ENERGY STAR-certified buildings achieved a 5.76% premium. Eichholtz et al. (2010) further reported average rental premiums between 1.9% and 2.6% for these certifications, reinforcing their value in the office sector. Fuerst and McAllister (2011) expanded on these findings, revealing significant premiums of 10% for ENERGY STAR-certified buildings and up to 31% for LEED-certified buildings, demonstrating a robust market preference for higher-rated green certifications.

The Dutch office market also shows compelling evidence of green premiums. Kok and Jennen (2010) reported a rental discount of 6.5% for non-green (energy label D-G) office buildings compared to green-certified (energy label A-C) buildings, indicating a clear economic advantage for environmentally certified properties. More recently, van Overbeek et al. (2024) highlighted that BREEAM-NL-certified office buildings in the Netherlands achieved price premiums ranging from 5.1% to 12.6% and rental premiums of 10.3%, showcasing the growing market recognition and demand for sustainable office spaces in the country.

While the majority of research focuses on office buildings, studies have also examined the impact of green certifications in residential markets. Chegut et al. (2011) found that BREEAM-certified residential buildings in the U.K. experienced a price premium of 8%, with rental premiums ranging from 16% to 20%. Similarly, Addae-Dapaah and Chieh (2011) identified price premiums between 9.61% and 27.74% for Green Mark-certified residential properties in Singapore. In the U.S., Kok and Kahn (2014) reported a 9% price premium for residential properties certified under LEED, ENERGY STAR, or the Green Point Ratings Programme. These findings emphasize the significant role of green certifications in enhancing the market value of residential buildings globally.

In Hong Kong, Hui and Yu (2021) observed some of the highest premiums, with HK BEAM-certified properties achieving price increases of 32% to 40%, and BEAM Plus-certified properties showing premiums of 5.5% to 26.9%. These results indicate a strong market preference for green-certified residential properties in certain regions.

Although there is substantial evidence supporting the hypothesis that green building certifications lead to higher prices and rents, most studies focus on office buildings or residential markets outside the Netherlands. Research on the impact of green certifications on Dutch residential properties remains limited. Given the increasing importance of sustainability in the real estate sector, understanding how certifications such as BREEAM-NL influence housing prices in the Dutch context represents a valuable area for future investigation. Addressing this gap could provide critical insights into consumer preferences and guide sustainable housing policies in the Netherlands.

By synthesizing the findings from studies presented in Table 2, this section highlights the significant value of green certifications in both residential and office sectors. The use of the HPM in these studies demonstrates its effectiveness in isolating and quantifying the economic benefits of green building certifications. While global trends clearly support the economic advantages of certification, localized studies are essential to fully understand their implications within specific markets, such as the Dutch residential sector.

2.4 Factors Affecting Transaction Price

Transaction prices in the real estate market are influenced by a range of factors, including location, neighborhood characteristics, property attributes, and the presence of sustainability certifications such as BREEAM-NL. These variables reflect buyer preferences, market dynamics, and broader economic conditions that drive housing valuations. Studies discussed in previous sections, particularly those highlighted in Table 1, will be revisited here to explore how specific factors — such as environmental quality, demographic trends, and access to amenities — impact transaction prices. This section categorizes these influences into four key groups: neighborhood and location variables, general building characteristics, sustainable built characteristics, and general market conditions. By examining these factors, the analysis lays the groundwork for understanding the key drivers of property values in the Dutch housing market.

2.4.1 Neighbourhood and Location Variables

The combined influence of **neighbourhood** and **location** variables plays a pivotal role in determining real estate values. Properties situated in desirable areas, particularly urban centres or near essential amenities such as transport hubs, schools, healthcare facilities, and shopping centres, typically command higher transaction prices due to the convenience and accessibility they offer (Ball et al., 1998). For instance, homes located near schools, supermarkets, and public transport systems in cities like Amsterdam or Rotterdam are highly sought after, driving up their value. Similarly, proximity to healthcare services and low-crime areas further enhances property desirability (Kahr & Thomsett, 2005).

In addition to physical proximity, neighbourhood characteristics significantly influence property values. These encompass broader socio-economic, cultural, and environmental qualities such as socio-economic status, cultural attributes, air quality, noise levels, and the overall prestige or reputation of an area. Properties in prestigious, environmentally conscious neighbourhoods tend to have higher values, even if similar properties in less renowned areas offer comparable amenities. Buyers often prioritize these characteristics when making purchasing decisions, aligning with a growing preference for environmentally sustainable and high-quality living environments (Ferlan et al., 2017).

The relationship between location and transaction prices is also shaped by competition for prime sites. Buyers and investors evaluate the unique advantages of specific locations through a process of constrained optimization, where the price reflects the desirability of the site's attributes. This competitive dynamic often results in land rent capturing a significant portion of a site's benefits, ultimately impacting transaction prices (Ball et al., 1998). Together, neighbourhood and location variables serve as critical determinants of property value, reflecting the interplay between physical accessibility, socio-economic factors, and buyer preferences.

2.4.2 General Building Characteristics

The **General building characteristics** of a property, including its age, size, and amenities, are critical determinants of its market value. Studies consistently show that older properties tend to sell for lower prices due to depreciation and potential maintenance needs (Ferlan et al., 2017). The size of a property, typically measured by floor area and the number of rooms, directly impacts its transaction price. Larger properties tend to command higher prices, especially when they include additional amenities like parking, recreational spaces, or scenic views(Benson et al., 1998; Jim & Chen, 2007). For example, properties with ocean or park views, or those located near natural water features, are often valued more highly by buyers seeking both aesthetic and practical benefits.

2.4.3 Sustainable Built Characteristics

Sustainable built characteristics encompass both tangible and intangible attributes that contribute to a property's sustainability and market appeal. As awareness of environmental sustainability grows, green buildings have become a focal point in real estate, particularly due to their potential for reducing energy usage and creating healthier living environments (Eichholtz et al., 2010). Tangible features include physical infrastructure such as solar panels, sustainable construction materials, and energy-efficient fittings. These not only reduce operational costs but directly influences **WTP** among buyers and tenants. Studies show that environmentally conscious consumers are willing to pay a premium for buildings that feature eco-friendly designs and resource efficiency (E. C. M. Hui et al., 2017).

Beyond these physical benefits, green built characteristics provide significant intangible advantages that contribute to a healthier and more sustainable living environment. These include better indoor air quality, reduced carbon footprints, and overall improvements in environmental sustainability. Research shows that green buildings typically offer better thermal and visual comfort, leading to greater productivity, satisfaction, and health benefits for occupants (Hammer, 2017; Zhang et al., 2018). These intangible benefits enhance the perceived long-term value of properties, further influencing **WTP** among buyers and tenants.

However, assessing the sustainability of a building can be challenging for buyers and investors, especially during the construction phase (E. C. M. Hui et al., 2017). Green building certifications, such as BREEAM-NL, address this issue by offering a standardized framework to evaluate both tangible and intangible benefits. These certifications enhance transparency and provide investors with reliable metrics for assessing a building's environmental performance, aligning projects with sustainability goals. By reducing uncertainty and offering clear benchmarks, certifications empower buyers and investors to make informed decisions. Properties with green certifications frequently achieve price premiums, driven by their tangible environmental benefits, operational cost savings, and appeal to environmentally conscious buyers and tenants (Chegut et al., 2014). Moreover, investors in green-certified buildings often enjoy higher returns due to lower risk (Fuerst & McAllister, 2011).

2.4.4 General Market Conditions

General market conditions, including interest rates, inflation, and economic growth, play a pivotal role in shaping the value of residential properties, including those with green building certifications.

1. Interest Rates: Lower interest rates make borrowing more affordable, boosting housing demand and prices. Conversely, higher interest rates can reduce affordability and dampen demand (Mishkin, 2014).
2. Inflation: Inflation increases the cost of construction and maintenance, leading to higher property prices as developers pass costs onto buyers (Case & Shiller, 2003).
3. Economic Growth: Economic expansion increases disposable incomes, fueling demand for sustainable housing options. Buyers become more willing to invest in properties offering long-term savings and environmental benefits (Gyourko et al., 2013).

The table 3. presents the key variables that influence transaction prices in the Dutch housing market, as identified in the literature review. These variables will be included in the regression analysis to assess their impact on property values, particularly in relation to green building certifications such as BREEAM-NL. This approach allows for a comprehensive understanding of the factors that drive housing prices and how sustainability considerations influence market dynamics.

Table 3: Factors affecting Transaction Price. (Source: Author)

Location	General Building Characteristics	Sustainable Built Characteristics	General Market Conditions
• Distance to GP • Distance to Supermarket • Distance to School • Distance to Train Station • Distance to City Centre • Crime Rate	• Size • Age • Type • No of Bedroom • No of Bathroom • Garage • House type	• BREEAM-NL Certification • Energy Performance	• Interest Rate • Inflation • Economic Growth

• Neighbourhood demographics			

2.5 Green Building Certification

Green building certifications play a critical role in promoting sustainability within the built environment by providing measurable frameworks to assess and improve environmental performance. These certifications address areas such as energy efficiency, water conservation, material sourcing, and indoor environmental quality. Through mandatory and voluntary certifications, the real estate sector can reduce environmental impact, enhance the economic value of properties, and meet increasingly stringent regulatory standards.

The origins of green building certifications can be traced back to the 1990s when environmental concerns about the construction industry's contribution to global pollution and energy consumption came to the forefront. The first major certification system, BREEAM , was introduced in 1990 by the Building Research Establishment (BRE) in the United Kingdom. BREEAM set the foundation for a global shift toward sustainable building practices, influencing both industry standards and market demand. Over the years, BREEAM has been adapted to local contexts, including in the Netherlands, where BREEAM-NL has become a key tool in sustainable construction and property management (DGBC, 2023).

BREEAM

BREEAM is one of the most widely recognized voluntary certification systems globally, evaluating the sustainability of buildings across various categories, including energy use, water, materials, and health and well-being. The Dutch version, BREEAM-NL, was introduced in 2009 by the Dutch Green Building Council (DGBC) to align with national environmental policies and market needs. BREEAM-NL certifies a range of building types, including residential, commercial, and industrial properties, using a points-based system that assesses a building's environmental impact.

BREEAM-NL operates under two key certification types: *BREEAM-NL New Construction* and *BREEAM-NL In-Use*.

1. **BREEAM-NL New Construction** focuses on the sustainability of buildings from the design phase through to construction and completion. Its primary aim is to reduce the environmental impact of buildings across their lifecycle in a robust and cost-efficient manner. The certification process evaluates a building's environmental impact across multiple categories, including Energy, Materials, Health and Well-being, Water, and Waste. Importantly, integrating BREEAM-NL criteria early in the design phase is recommended to maximize the score. However, only after project delivery and occupation can a building receive an official BREEAM-NL certificate, as post-delivery performance may differ from the design phase requirements. Assessments conducted within 12 months of delivery are categorized as new construction; beyond that, the building is considered existing. The assessment employs a five-star rating system, ranging from Pass to Outstanding, based on credits earned across various sustainability categories (DGBC, 2023).
2. **BREEAM-NL In-Use** applies to existing buildings and aims to reduce negative environmental impacts during the operational phase of a building's lifecycle. This certification emphasizes improving sustainability performance over time through

efficient resource use, management practices, and building upgrades. BREEAM-NL In-Use assesses operational buildings based on two distinct categories: **Asset**, which focuses on the location, architectural features, and climate-related aspects of the building, and **Management**, which evaluates how property management is organized and maintained. The BREEAM-NL In-Use methodology also follows a three-part structure: Part 1 (Asset Performance), Part 2 (Building Management), and Part 3 (Occupier Management), ensuring a comprehensive review of how existing buildings maintain and improve their sustainability performance (DGBC, 2023).

BREEAM Categories and Weightings

For each category, sustainability objectives are defined and criteria that must be met. When the criteria are demonstrably and traceably met, the Assessor can award points. The sustainability objectives exceed the legal minimum as laid down in the Building Decree or other laws and regulations . BREEAM-NL certification is therefore 'above the legal limit' and is therefore a voluntary choice of the client . The objectives are based on current practical guidelines (best practices). There is freedom of choice for most categories. For example, development and construction teams can choose for themselves which credits they want to earn the points for, in order to build up the intended total score. A minimum standard applies to a number of criteria that you must achieve if you want to achieve a certain total score. These are minimum requirements and mandatory points. Once all credits within a category have been assessed, the assessor can determine a category score , which is weighted according to the percentages shown in Table 4.These weighted scores are then summed to calculate the final score, which determines the building's BREEAM rating, ranging from Pass to Outstanding. (DGBC, 2023)

The categories are as follows:

- Energy: Assesses the building's energy use and carbon emissions. This makes energy-efficient buildings more attractive to tenants and investors alike.
- Health and Well-being: Focuses on occupant comfort, natural lighting, and indoor air quality.
- Materials: Evaluates the environmental impact of construction materials. Sustainable materials contribute to a building's overall quality and marketability. Buildings constructed with environmentally friendly materials are perceived as higher quality, attracting tenants seeking modern and sustainable office spaces.
- Water: Measures water efficiency and conservation strategies. Efficient water usage not only reduces operational costs but also improves market perception of the building's sustainability. Buildings with strong water management practices are increasingly sought after by tenants prioritizing environmental stewardship.
- Waste: Encourages waste reduction during construction and operation. Sustainable waste management practices add value by reducing operational inefficiencies and aligning with broader environmental goals. They also appeal to tenants and buyers focused on reducing their environmental footprint.
- Pollution: Aims to minimize air, water, and noise pollution. Green certifications often lead to higher occupancy rates due to reduced noise and air pollution impacts on tenants.
- Land Use and Ecology: Focuses on the building's impact on local biodiversity and land use.

- Transport: Promotes the use of sustainable transport options. Proximity to public transportation and provisions for alternative modes of transport, such as bike facilities, make buildings more accessible and appealing to tenants, especially in dense urban areas.
- Management: Covers the building's lifecycle management practices. Effective management ensures that operational sustainability standards are met and maintained, leading to higher overall tenant satisfaction.
- Innovation (Bonus): Awards extra credits for innovative sustainability solutions. Innovation fosters unique advantages for certified buildings, creating a marketing edge and attracting tenants who value modern, cutting-edge solutions.

Table 4: Weighting of categories within BREEAM-NL In-Use and BREEAM-NL New Construction. (Source: DGBC, 2023)

Category	BREEAM-NL In-Use (%)	BREEAM-NL New Construction(%)
Energy	23	19
Health and Well-being	17	15
Materials	19	12.5
Water	5	6
Waste	-	7.5
Pollution	4	10
Land Use and Ecology	5	10
Transport	16	8
Management	11	12
Innovation (Bonus)	Up to 10	Up to 10

2.6 Conceptual Model

Building on the comprehensive literature review discussed earlier, this study constructs a conceptual model to explore the impact of Green Certificates on residential property values within the Dutch housing market. As highlighted in the model, the **Green Certificate** is treated as the independent variable, which is hypothesized to influence **Price**, the dependent variable.

However, residential property values are influenced by more than just green certifications. The market value is shaped by implicit factors categorized into the following groups:

General Building Characteristics such as the size, age, and type of building.

Neighbourhood and Location Variables, including proximity to amenities like general practitioners (GPs), schools, supermarkets, and train stations, as well as crime rates.

Green Building Characteristics refer to the specific design and construction elements that contribute to the sustainability of a building. These include features such as: Use of Sustainable Materials, Energy Efficiency and Water Efficiency.

These factors are treated as control variables to ensure that the study isolates the effect of the Green Certificate on property prices. Additionally, **General Market Conditions**, encompassing economic growth, supply, demand, and inflation that fluctuate over time, are considered to act as moderating variables. These variables influence the relationship between green certification and property values.

This conceptual framework provides a systematic approach to investigating how green certifications affect property prices in the Dutch housing market. The model (shown in Figure 3) serves as the foundation for the empirical analysis, ensuring a comprehensive investigation of the complex factors driving property values.

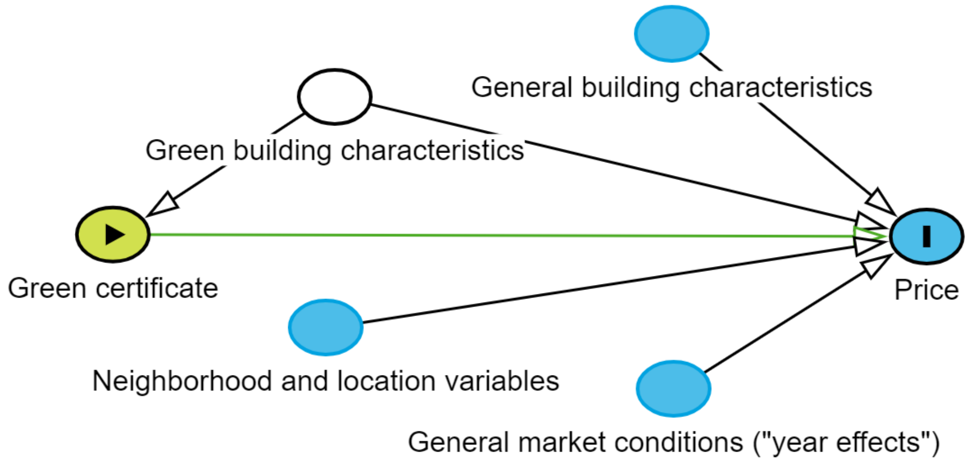

Figure 2: Conceptual Model (Source: Author)

2.7 Hypothesis

The main aim of this research is to examine the relationship between environmental certification and transaction prices. Based on the literature review, the following hypothesis have been formulated for this study:

Hypothesis: BREEAM-certified residential buildings command a price premium compared to non-certified buildings of similar characteristics.

This hypothesis builds on the premise that environmental certification provides added value to properties by enhancing their sustainability credentials, energy efficiency, and market appeal. While certified buildings might already exhibit higher sale prices due to attributes like newer construction or better locations, this study aims to isolate the effect of certification itself. By using a hedonic pricing model, the research seeks to identify whether certification increases prices beyond what can be attributed to other factors, thereby quantifying the price premium associated with BREEAM-NL certification.

3
Research methodology

This chapter will present the methodology chosen to study the effect of green building certification on transaction prices of residential buildings in Netherlands.

3.1 Data Overview

This study utilizes a comprehensive dataset of real estate transactions from five major cities in the Netherlands: Amsterdam, Utrecht, Rotterdam and The Hague. These cities were selected for their high population density, diverse urban landscapes, and relevance to the study of sustainable housing. The data were obtained from a collection of three datasets. Sales transaction data were sourced from the Dutch Cooperative Association of Estate Agents and Appraisers NVM U.A. (*De Nederlandse Coöperatieve Vereniging van Makelaars En Taxateurs in Onroerende Goederen NVM U.A*, 2023). NVM is an established association of real estate agents and appraisers in the Netherlands, dating back to 1898, and covers 75 percent of all houses sold across the Netherlands (NVM, n.d.). The dataset spans the period from 2015 to 2021, providing a rich source of information to examine trends in BREEAM-NL-certified housing and its impact on property prices.

The dataset comprises 172,154 residential property transactions, which includes detailed information on each property's sale price, physical attributes (e.g., size in square meters, number of bedrooms and bathrooms, age), and location (e.g., proximity to schools, supermarkets, and public transport). These variables are essential for implementing the Hedonic Pricing Model (HPM), which will be used to isolate the effects of BREEAM certification on transaction prices, controlling for other factors such as property characteristics and locational amenities.

BREEAM certification data were obtained from the Dutch Green Building Council (DGBC), identifying which properties are certified and at what level (e.g., Pass, Good, Excellent, Outstanding). The dataset includes 186 BREEAM-NL-certified residential buildings across the selected cities, allowing for a comparison between certified and non-certified properties in terms of sale prices and other attributes.

Additionally, neighbourhood characteristics were gathered from the Dutch Central Bureau of Statistics (CBS). This includes data on proximity to key amenities such as general practitioners, schools, supermarkets, and train stations, as well as the number of crimes reported in the neighbourhood. These locational variables are crucial to understanding the role that neighbourhood features play in property valuation and how they interact with BREEAM certification.

Data Processing and Categorization

As part of the data cleaning process, several steps were taken to refine the dataset and make it suitable for analysis:

Type of House: Initially, the dataset contained 34 categories of property types, which included non-residential entries such as houseboats, parking spaces, and other irrelevant entries. These non-residential categories were removed to focus solely on residential buildings. After filtering, the properties were categorized into three main types:

1. Apartments and Flats
2. Terraced and Semi-Detached Houses
3. Detached Houses and Luxury Properties

This re-categorization helped standardize the data, making it easier to compare similar types of residential properties across different locations.

Age of House: The age of each property was grouped into three categories to capture the effect of building age on property prices:

1. 0-20 years (Built after 2000)
2. 20-60 years (Built between 1960-2000)
3. 60 years and above (Built before 1960)

This segmentation allows for a more nuanced analysis of how the age of the property interacts with BREEAM certification and other variables in determining sale prices. Older properties might carry different price premiums compared to newer homes, depending on factors like maintenance, renovation, or historical value.

To ensure the robustness of the analysis, the dataset was cleaned for missing values. Transactions with incomplete information, such as missing sale prices or inconsistent data on property attributes, were excluded from the final analysis. This process resulted in a refined dataset that is both comprehensive and reliable for exploring the research hypotheses, particularly the evolving price premium in the Dutch housing market.

3.2 Variables Used in the Study

The variables used in this study are grouped into four main categories: green building characteristics, general building characteristics, neighbourhood and location variables and general market conditions. These groups capture the key factors that influence residential property prices in the Dutch real estate market.

Green Building Characteristics

- **BREEAM Certification (Dummy Variable):** This binary variable indicates whether the property has a BREEAM certification. BREEAM certification serves as an indicator of a building's environmental performance, with certified properties often perceived as higher quality, potentially commanding a price premium. These features are seen as value-adding, as they reduce operational costs and align with increasing consumer preferences for eco-friendly housing. Research by Eichholtz et al. (2010) and Fuerst and McAllister (2011) confirms that green-certified buildings often command significant price premiums.

General Building Characteristics

- **Area:** This variable represents the total floor area in sq.m. of the property, measured in square meters. Larger properties generally command higher prices due to the increased living space they provide, which is highly valued by buyers.
- **Gross Volume:** This variable represents the volume of the property, measured in cubic meters.
- **Age:** The age of each property was grouped into three categories to capture the effect of building age on property prices. Older properties might be less expensive due to potential maintenance needs or depreciation, though well-preserved older homes or those with historic significance can retain higher values.
- **House Type:** This categorical variable differentiates between types of properties such as detached houses, semi-detached houses, and apartments. Each type has different market demand dynamics, influencing the property's price.
- **Number of Bedrooms:** These variables quantify the number of bedrooms in the house. More bedrooms increase a property's functionality and appeal, particularly to families, thus raising the property's transaction price.

Neighbourhood and Location Variables

- **Distance to GP (General Practitioner):** Proximity to healthcare services in km, particularly GPs, is an important factor, as closer access is convenient for residents, particularly families and the elderly.
- **Distance to Supermarket:** This variable measures the distance from the property to the nearest supermarket in km. Proximity to shopping facilities is a key factor in property valuation due to the convenience it provides.
- **Distance to School:** This variable captures the proximity to the nearest school in km, an important factor for families with children. Properties closer to good schools often attract a price premium.
- **Distance to Train Station:** Proximity to public transportation, especially train stations, is crucial, particularly in urban areas. Properties near train stations are typically more valuable due to the ease of commuting.
- **Crime Rate:** This variable represents number of crimes reported per 1000 residents in the neighbourhood. Low-crime areas further boosts property values.

General Market Conditions

- **Transaction Year (Dummy Variable):** This set of dummy variables controls for the year in which the property transaction occurred, capturing the effects of macroeconomic conditions, inflation, interest rates, and other temporal factors that influence housing prices.
- **City (Dummy Variable):** This categorical variable differentiates which city each property is located in. Each type has different market demand dynamics, influencing the property's price.

Omitted Variable

Although the **Energy Label (EPC)** is a critical determinant of property prices, particularly in markets where energy efficiency is increasingly valued, this study lacks data on this variable.

The Energy Label is likely correlated with both the dependent variable (property price) and independent variables such as property size, age, and sustainability certification (BREEAM). The absence of the Energy Label from the analysis may lead to **omitted variable bias**.

Omitted variable bias occurs when an important variable that influences both the dependent and independent variables is left out of the model. As a result, the effects of other variables may be over- or under-estimated because the omitted variable's influence is inadvertently captured by those variables. In this case, properties with higher energy labels tend to command higher prices and are often newer or more energy-efficient, meaning the omission of the Energy Label could bias the estimated effects of other property characteristics (Wooldridge, 2019).

Despite this limitation, the current analysis provides valuable insights by controlling for other key factors. However, future research should prioritize the inclusion of Energy Label data to enhance the precision and robustness of the findings and to minimize potential omitted variable bias.

3.3 Model Equation

The hedonic pricing model for this study can be specified as follows:

$$\boxed{\begin{aligned} P = \alpha + \beta_1 BREEAM + \beta_2\ AREA + \beta_3\ VOL + \beta_4\ AGE + \beta_5\ BED +\\ \beta_6\ TYPE + \beta_7\ D_{GP} + \beta_8\ D_{MRT} + \beta_9\ D_{SCH} + \beta_{10}\ D_{TRN} +\\ + \beta_{11} CRM + \beta_{12}\ CITY \quad \textstyle\sum_{J=1}^{n} \gamma_J \times YEAR_J + \varepsilon \end{aligned}} \tag{2}$$

Where:

- P is the transaction price(in €100,000).
- BREEAM is a dummy variable indicating BREEAM-NL certification (1 if certified, 0 if not).
- AREA is the size of the house in square meters.
- VOL is the gross volume of the house in cubic metres
- AGE is a categorical variable indicating age of the house.
- BED is the number of bedrooms.
- TYPE is a categorical variable indicating the type of house.
- D_{GP} is the distance to the nearest general practitioner in km.
- D_{MRT} is the distance to the nearest supermarket in km.
- D_{SCH} is the distance to the nearest school in km.
- D_{TRN} is the distance to the nearest train station in km.
- CRM is the crime reported per 1000 residents in that neighbourhood
- CITY is a categorical variable representing the city where the property is located (e.g., Amsterdam, Utrecht, Rotterdam, The Hague).
- $YEAR_j$ are dummy variables representing each transaction year.
- ε is the error term.

This model will allow us to estimate how each factor contributes to the overall property price, providing insights into the value of physical attributes, location, sustainability certifications, and the effects of market conditions over time.

To enhance the model's performance and address potential issues such as skewness and heteroscedasticity, the natural logarithms of the transaction price, crime rate and the size of the property (area and volume) have been applied. This transformation is commonly used in econometric analysis as it helps linearize the relationship between the independent and dependent variables, allowing for a more accurate estimation of coefficients. It also facilitates easier interpretation of results, with the coefficients representing percentage changes, which is particularly useful when working with data that may not have a linear relationship in its raw form(Benoit, 2011).

3.4 Descriptive Analysis

Table 5 presents the descriptive statistics for certified and non-certified properties, highlighting key differences between these two gr oups in terms of transaction prices, physical attributes, and proximity to amenities.

- **Area and Number of Rooms:** Certified properties have a slightly larger average area (128.19 square meters) compared to non-certified properties (118.02 square meters). However, certified properties tend to have fewer rooms on average (3.56 compared to 3.91 for non-certified). This could suggest that certified properties focus more on space efficiency or design quality, with fewer but potentially larger rooms.
- **Transaction Price:** Certified properties exhibit a notably higher average transaction price (€497,354.75) compared to non-certified ones (€403,784.42). This suggests a potential price premium for certified properties, likely due to their enhanced environmental performance, sustainability credentials, and potentially lower operational costs, making them more attractive to buyers.
- **Crime Rate (CRM):** The average crime rate in areas with certified properties (16.54 crimes per 1,000 inhabitants) is virtually the same as in non-certified areas (16.60), indicating no meaningful relationship between certification and crime levels.
- **Proximity to Amenities:** There is no significant difference in access to key services, such as general practitioners, supermarkets, schools, and train stations, between certified and non-certified properties. The distances are nearly identical, showing that certification has no measurable impact on proximity to amenities. It is important to note that this observation reflects a simple correlation rather than a causal effect of certification on proximity to amenities. Certification itself does not mandate or influence the location of properties in relation to amenities, and any observed similarities are likely attributable to other factors, such as zoning or urban planning.

It is important to note that these descriptive findings alone are not enough to draw conclusive insights, as the mean values have not been adjusted for quality-related factors, such as property age, specific building features, or neighbourhood characteristics. These factors will be addressed in the regression analyses, which will provide a more accurate and robust assessment of the impact of certification and other variables on transaction prices and other outcomes.

Table 5: Descriptive Statistics (Source: Author)

	count		mean		standard deviation		min		max	
	Certified	Non Certified	Certified	Non Certified	Certified	Non Certified	Certified	Non Certified	Certified	Non Certified
Area	763	171391	128,19	118,02	59,46	767,48	38	25	540	300172
No of Rooms	763	171391	3,56	3,91	1,20	1,68	1	1	10	99
Transaction Price	763	171391	49,7	40,4	33,9	33,8	10,8	0,0	325,0	1500,0
CRM	763	171391	16,54	16,60	8,18	12,06	8	0	57	419
Distance GP (km)	763	171391	0,58	0,54	0,27	0,31	0,2	0,1	1,8	5,7
Distance Supermarket	763	171391	0,50	0,51	0,26	0,32	0,1	0,1	2	5,9
Distance School	763	171391	0,55	0,49	0,24	0,25	0,2	0,1	1,1	4,6
Distance Train	763	171391	2,31	2,32	1,21	1,12	0,7	0,1	5	6,1

4

Empirical findings

This chapter evaluates the influence of BREEAM-NL certification on transaction prices in the Dutch housing market, highlighting its economic significance while controlling for property, locational, and temporal factors using an incremental hedonic pricing model.

4.1 Overview of the Regression Models

The analysis uses seven progressively complex regression models to examine the relationship between BREEAM-NL certification and transaction prices in the Dutch housing market. The dependent variable in all models is **Transaction price**, representing the transaction price in €100,000s. The models incrementally include additional variables and transformations to isolate the effects of green certification while studying whether the observed price difference is due to certification or other factors. This approach follows the recommendations of Taylor (2003), beginning with a simple model to establish baseline relationships and progressively introducing additional variables and log transformations. Starting with a basic model avoids overfitting and allows the identification of core effects before adding additional variables. While log transformations are applied in later models for nonlinear relationships, consistent with the findings of Boyle et al. (1999) and Kuminoff et al. (2010), who recommend flexible functional forms for hedonic price functions.

- Model 1 is a simple regression model examining the direct relationship between the Certificate variable and the dependent variable, Transaction price. This model provides a basic estimate of the green premium associated with BREEAM-NL certification, without accounting for other factors. It serves as the foundation for progressively more complex models.
- Model 2 introduces general building characteristics, such as area, gross volume, number of rooms, and type dummies (with 'Type 1: Apartments and Flats' as the reference category), as well as year of construction (with 'properties built after 2000' as the reference category). This model accounts for variations in transaction prices caused by physical attributes of the properties.
- Model 3 incorporates transaction year dummy variables to capture temporal effects, such as inflation or changes in the housing market, and city dummies (with 'Amsterdam' as the reference category) to account for differences in demand across cities. The motivation for adding these controls is to study whether the price premium attributed to certification could be partially explained by market dynamics or location-specific effects.
- Model 4 incorporates additional neighbourhood and locational variables, including distance to general practitioners (GP), supermarkets, schools, and train stations, as well as crime rate (CRM). By introducing these variables, the model controls for the influence of accessibility and neighbourhood safety on housing prices, providing a clearer understanding of how green certification impacts transaction prices relative to these factors.

- Model 5 revisits the specifications of Model 2 but applies log transformations to both the dependent variable (Transaction price) and key independent variables, such as area and gross volume. This transformation allows for proportional interpretations of the coefficients, making it possible to estimate percentage changes in transaction prices in response to changes in the independent variables.
- Model 6 extends Model 3 by applying log transformations to the dependent variable and relevant independent variables. This model explores the combined effects of property attributes, market dynamics, and spatial factors, interpreted in terms of elasticities. By doing so, it addresses potential nonlinear relationships while maintaining the broader scope of Model 3.
- Model 7 builds on Model 4 by applying log transformations across all relevant variables. It integrates property characteristics, location, neighborhood, and temporal effects into a single model, allowing for a refined and proportional interpretation of transaction prices. This model provides the most comprehensive view of the determinants of transaction prices and the impact of BREEAM-NL certification.

By progressively introducing additional variables and transformations, the seven models offer a robust framework to analyze the green premium in the Dutch housing market. The incremental complexity helps identify the specific contribution of green certification to transaction prices while accounting for confounding factors such as property attributes, market trends, and locational effects.

4.2 Regression Results

This section summarizes the key findings from the regression analysis presented in Table 6, highlighting the effects of BREEAM-NL certification, property-specific attributes, locational characteristics, and temporal controls on transaction prices. The adjusted R-squared values range from **0.320 in Model 1** to **0.873 in Model 7**, indicating that the inclusion of additional variables and log transformations improves the models' ability to explain variance in transaction prices. Across all specifications, the models demonstrate strong explanatory power, accounting for **32% to 87.3%** of the variance in transaction prices. These high adjusted R-squared values underscore the robustness of the findings and the reliability of the models in capturing the determinants of transaction prices.

4.2.1 BREEAM-NL Certification

The regression results indicate that BREEAM-NL certification consistently adds value to transaction prices, although the magnitude of the premium decreases as additional controls are introduced. Initially, certified properties exhibit a significant price premium of **€91,700 in Model 1**, reflecting the market's strong valuation of sustainability when no other variables are included. When city-specific effects and transaction year variables are accounted for in **Model 3**, the premium reduces to **€36,000**, indicating that part of the certification premium is explained by the properties being located in high-demand cities or sold during specific market conditions. Adding neighbourhood-level variables, such as crime rates and proximity to amenities in **Model 4**, further reduces the premium to **€32,000**, emphasizing the importance of locational factors in shaping property values.

In models with log transformations (Models 5–7), the certification effect is measured in proportional terms, allowing for a more nuanced interpretation of the green premium. In Model 5, which applies log transformations to transaction prices and general building characteristics, the certification premium translates into a 22.2% price premium. This figure decreases in Model 6, which adds market-level variables, to 17.6%. Finally, in Model 7, which includes neighbourhood and locational variables alongside log transformations, the certification premium stabilizes at 9.4%, reflecting the combined effects of green certification after accounting for property, market, and spatial factors.

Using the mean transaction price for certified properties **(€497,354.75)**, the 9.4% premium in the final model corresponds to an absolute increase of approximately **€46,749.35**. Even at the lower bounds of the certification premium in the linear models, the results demonstrate that BREEAM-NL certification adds significant value to residential properties.

The confidence intervals further underline the robustness of the results. For example, in the first model (with a coefficient of **0.917** and SE of **0.111**), the 95% confidence interval for the certification premium ranges from €68,000 to €115,400. In model-7, the interval for the certification effect ranges from 7.6% to 11.2%, demonstrating that certification consistently exerts a substantial and statistically significant positive effect on transaction prices. Across the log-linear models, the narrowing of confidence intervals highlights the increasing precision of the estimates as more controls and log transformations are introduced.

The models also provide insight into the relative contributions of different factors. For instance, the inclusion of neighbourhood and locational variables in Models 6 and 7 accounts for a significant portion of the variation in transaction prices, demonstrating the importance of accessibility, crime rates, and proximity to amenities in explaining property values. The proportional effects estimated in the log-transformed models further emphasize the economic significance of BREEAM-NL certification as a key driver of transaction prices.

These results confirm that green certification, even after accounting for various property and locational attributes, remains a significant determinant of transaction prices. This finding underscores the growing market preference for sustainable housing and reflects the increasing importance of environmental considerations in the Dutch real estate market. The analysis also highlights that both absolute and proportional price effects of certification are economically meaningful, reinforcing the value of green building certification as a key driver of property demand.

4.2.2 Practical Implications of BREEAM-NL Certification

The sales price premium observed in this study, ranging from **€32,000 to €91,700**, can directly offset the costs associated with obtaining certification. When expressed as a percentage of the mean transaction price of certified properties (**€497,354.75**), these premiums represent a **6.4% to 18.4%** increase, highlighting the significant financial value of certification. Developers often perceive the additional costs of achieving sustainability certifications like BREEAM-NL as a barrier to adoption (Darko & Chan, 2017). However, research by Chegut, Eichholtz, and Kok (2019) reveals that while **design costs for environmentally certified buildings** can be approximately **31% higher** compared to conventional buildings, the **overall increase in total construction costs averages only 6.5%**. These marginal costs make certification more accessible than commonly perceived, particularly at lower certification levels.

Despite these additional costs, the observed sales price premiums of 6.4–18.4% for certified properties clearly demonstrate that certification offers substantial net financial benefits and a positive return on investment. In particular, the premium observed in the model with highest r-squared value (9.4%) underscores the growing market preference for sustainability and shows that even after accounting for locational and temporal factors, certified properties command a significant price advantage. This economic benefit reinforces the argument for developers and policymakers to prioritize green building certifications, as the returns outweigh the upfront costs associated with achieving certification.

4.2.3 Interpretation of Other Variables

Building Characteristics:

- **Area and Gross Volume:** Larger properties consistently command higher transaction prices. In all models, area and gross volume are statistically significant at the 1% level. In linear models, gross volume contributes approximately €200-€500 per cubic meter, while area increases transaction prices by approximately €3700-€4700 per square meter. When log transformations are applied a 1% increase in gross volume results in a 0.37%-0.91% increase in transaction prices, and a 1% increase in total area leads to a 0.61% increase in transaction prices.
- **Year of Construction:** Properties built before 1959 exhibit significant price premiums, reflecting historic value. In contrast, homes built between 1960–2000 show negative effects due to potentially outdated designs or locations. These findings may indicate that the housing market values properties for either their historic significance or modern functionality, leaving mid-century properties at a relative disadvantage.
- **Type of building: Terraced and Semi-Detached houses** (Category 2) demonstrate a small positive premium while **Detached Houses and Luxury Properties** (Category 3) show a negative impact on transaction prices as compared to **Apartments and Flats.** In models with log transformations, these effects are observed proportionally, where Category 2 houses exhibit a 16.6% premium, while Category 3 houses no significant impact compared to the reference category. These results suggest that the housing market in the Netherlands favours compact, functional housing types like apartments and terraced houses, which cater to a wide range of buyer preferences and budgets.

Table 6: Transaction price OLS regression results (Source: Author)

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Dependent Variable	Transaction Price (in 100k €)				ln{Transaction Price (in 100k €)}		
Intercept	4.034 (0.008)***	-0.320 (0.055)***	1.990 (0.049)***	1.991 (0.046)***	-3.667 (0.028)***	-2.728 (0.028)***	-2.882 (0.023)***
Certificate	0.917 (0.111)***	0.780 (0.070)***	0.360 (0.063)***	0.320 (0.060)***	0.222 (0.012)***	0.176 (0.010)***	0.094 (0.009)***
General Building Characteristics							
No. of Rooms		-0.315 (0.030)***	-0.230 (0.026)***	-0.219 (0.026)***	-0.021 (0.002)***	-0.022 (0.002)***	-0.020 (0.002)***
Area		0.037 (0.002)***	0.047 (0.002)***	0.047 (0.002)***			
Gross Volume		0.005 (0.001)***	0.002 (0.001)**	0.002 (0.001)***			
ln(Area)					-0.039 (0.011)***	0.462 (0.010)***	0.619 (0.008)***
ln(Gross Volume)					0.906 (0.009)***	0.404 (0.009)***	0.377 (0.007)***
Year of construction (-1959)		0.833 (0.024)***	0.856 (0.022)***	0.708 (0.021)***	0.059 (0.003)***	0.087 (0.003)***	0.066 (0.002)***
Year of construction (1960 - 2000)		-0.162 (0.027)***	-0.155 (0.023)***	-0.183 (0.022)***	-0.154 (0.003)***	-0.155 (0.003)***	-0.146 (0.002)***
Type 2 (semi-detached houses)		-0.033 (0.094)	0.115 (0.085)	0.177 (0.084)**	0.120 (0.006)***	0.158 (0.006)***	0.166 (0.005)***
Type 3 (Detached and luxury Properties)		-0.738 (0.029)***	-0.476 (0.025)***	-0.292 (0.023)***	-0.114 (0.003)***	-0.090 (0.003)***	0.001 (0.002)
General Market Conditions							
City - Hague			-2.585 (0.019)***	-2.607 (0.017)***			-0.636 (0.002)***
City - Rotterdam			-2.499 (0.015)***	-2.482 (0.015)***			-0.652 (0.002)***
City - Utrecht			-1.497 (0.016)***	-1.471 (0.015)***			-0.364 (0.002)***
Transaction Year - 2015			-2.555 (0.037)***	-2.552 (0.037)***		-0.664 (0.004)***	-0.660 (0.003)***
Transaction Year - 2016			-2.174 (0.032)***	-2.165 (0.032)***		-0.581 (0.004)***	-0.553 (0.003)***
Transaction Year - 2017			-1.770 (0.031)***	-1.761 (0.031)***		-0.451 (0.004)***	-0.421 (0.003)***
Transaction Year - 2018			-1.354 (0.024)***	-1.344 (0.024)***		-0.319 (0.004)***	-0.294 (0.003)***
Transaction Year - 2019			-1.141 (0.022)***	-1.131 (0.022)***		-0.244 (0.003)***	-0.230 (0.002)***
Transaction Year - 2020			-0.838 (0.021)***	-0.830 (0.021)***		-0.164 (0.003)***	-0.152 (0.002)***
Neighbourhood and Location Variables							
Crime Rate				0.007 (0.001)***			
ln(Crime Rate)							-0.039 (0.002)***
Distance to GP				-0.346 (0.020)***			-0.086 (0.004)***
Distance to School				0.339 (0.026)***			0.142 (0.004)***
Distance to Supermarket				-0.478 (0.021)***			-0.116 (0.004)***
Distance to Train Station				0.073 (0.004)***			0.020 (0.001)***
R-squared	0.320	0.552	0.715	0.720	0.461	0.572	0.783
Adj. R-squared	0.320	0.552	0.715	0.720	0.461	0.572	0.783

Note: Table 6 presents the results of the Ordinary Least Squares (OLS) regression models, which quantify the relationship between BREEAM-NL certification and residential property transaction prices in the Dutch housing market. The dependent variable in Models 1-4 is Transactieprijs_100k, representing transaction prices in €100,000s. In Model 5-7, the dependent variable is transformed into its natural logarithm (ln(Transactieprijs_100k)) to account for non-linear relationships. The table reports the coefficients for key explanatory variables, along with robust standard errors (in parentheses) and significance levels, indicated by p values (e.g., ∗∗∗p<0.01, ∗∗p<0.05, ∗p<0.1).

Locational Factors:

- **Crime (CRM):** With log-transformation higher crime rates have a negative impact on property values, with a log-transformed elasticity indicating a -3.9% decrease in transaction prices for a 1% increase in crime. But in linear model the positive coefficient for crime rate is another result that contrasts with conventional findings in the literature(Thaler, 1978), which typically suggest a negative relationship between crime and property values. This unexpected result may reflect broader neighbourhood dynamics, where affluent urban areas with higher demand tend to report more crime due to greater law enforcement resources or awareness. Alternatively, crime rate may be capturing factors like urban density or socioeconomic status rather than purely reflecting safety concerns.

- **Distance to GP (Healthcare Services):** The negative coefficients across all models indicate that properties closer to healthcare facilities are more desirable. This aligns with findings in previous studies(Huh & Kwak, 1997), as proximity to healthcare enhances convenience and accessibility, particularly for families and elderly buyers, increasing property value.
- **Distance to Supermarkets:** Similarly, shorter distances to supermarkets are positively associated with transaction prices. Buyers value convenience in accessing daily necessities, and homes closer to shopping facilities command higher prices, a result consistent with existing literature on locational amenities(Rosiers et al., 1996).
- **Distance to Schools:** Contrary to findings in many studies(Clauretie & Neill, 2000; Hayes & Taylor, 1996), greater distances from schools are associated with higher transaction prices.
- **Distance to Train Stations:** Similarly the coefficients for proximity to train stations also contradicts earlier studies. Moderate proximity positively affects transaction prices due to increased connectivity, a result supported by earlier studies (So et al., 1997). However, in this model greater distance from station are associated with higher prices.

General Market Conditions:

- **Year of sale** dummies capture temporal trends in housing prices, reflecting macroeconomic conditions and housing market dynamics over time. In this study, 2021 serves as the base year for comparison, and the coefficients for earlier years are interpreted relative to it. The coefficients for all earlier years (2015–2020) are negative relative to 2021, reflecting a consistent upward trend in housing prices during the study period. For example: Properties sold in 2015 and 2016 have the largest negative coefficients, indicating significantly lower transaction prices compared to 2021. This trend is likely driven by increasing housing demand, limited supply, and economic growth in the Netherlands during this period.
- **City**-specific dummy variables are critical for capturing regional differences in housing prices. They account for variations in urban density, economic conditions, and local amenities that significantly influence transaction prices. These variables are critical in explaining transaction price variation, as evidenced by their impact on the adjusted R-squared values. When city dummies are included the adjusted R-squared increases significantly, highlighting their importance in improving the model's explanatory power. City dummies show significant premiums for properties in Amsterdam in comparison with The Hague, Rotterdam, and Utrecht, reflecting the relative economic conditions, housing supply, or demand dynamics in these cities.

4.2.3 Assumption Testing

This section evaluates whether the final regression model (Model 7, Table 6) satisfies the key assumptions underlying multiple linear regression: linearity, homoskedasticity, normality of residuals, and absence of multicollinearity. The detailed results and visualizations supporting these tests are included in the Appendix.

To examine linearity, a residuals versus fitted values plot was generated. The scatterplot demonstrates that the residuals are evenly scattered around zero, indicating no systematic patterns or deviations. This suggests that the relationship between the dependent variable and the independent variables is approximately linear.

Homoskedasticity was assessed using the same residuals versus fitted values plot. The absence of a clear funnel shape or clustering in the scatterplot confirms that the variance of the residuals is constant across all levels of predicted values, satisfying the assumption of homoskedasticity.

The assumption of normality of residuals was tested through a Q-Q plot of the residuals. The Q-Q plot shows that the residuals generally align with the theoretical quantiles, with slight deviations at the tails. While this indicates a slight departure from perfect normality, the alignment of the majority of points suggests that the assumption of normally distributed residuals is reasonably satisfied.

Multicollinearity was examined using the Variance Inflation Factor (VIF), as summarized in Table A (Appendix). Most variables exhibit VIF values well below the threshold of 5, suggesting minimal multicollinearity among the predictors. While Area and Gross Volume have slightly higher VIF values of 13.90 and 12.52, respectively, this is expected due to their inherent relationship as measures of property size and volume. Crucially, the primary variable of interest, Certificate, has a VIF value of 1.01, indicating no collinearity concerns. This ensures that the estimated premium for green certification remains reliable and unaffected by multicollinearity.

The results of these diagnostic tests support the validity of the regression model for analysing the effect of BREEAM-NL certification on housing prices. While some minor deviations were observed, none are significant enough to undermine the overall robustness of the findings. Detailed plots and the VIF table are presented in the Appendix for further reference.

4.3 City-Specific Analysis

The city-specific analysis of BREEAM-NL certification on transaction prices demonstrates the economic value of sustainability in the Dutch housing market. The findings, summarized in Table 7, reveal that certification consistently adds value across four major cities—Rotterdam, Utrecht, The Hague, and Amsterdam—though the magnitude of the premium varies significantly based on local market dynamics. Certification provides measurable financial benefits in all cities, reinforcing its importance as a key determinant of transaction prices.

Table 7: City-specific regression results showing the impact of BREEAM-NL certification on transaction prices. (Source: Author.)

	Hague	Rotterdam	Utrecht	Amsterdam
Intercept	-4.719 (0.037)***	-4.292 (0.069)***	-2.512 (0.081)***	-2.629 (0.028)***
Certificate	0.043 (0.042)***	0.186 (0.011)***	0.099 (0.015)***	0.053 (0.012)***
General Building Characteristics				
No. of Rooms	-0.033 (0.002)***	-0.032 (0.007)***	-0.009 (0.003)***	-0.004 (0.002)***
ln(Area)	0.656 (0.016)***	0.658 (0.022)***	0.377 (0.018)***	0.670 (0.009)***
ln(Gross Volume)	0.495 (0.013)***	0.505 (0.017)***	0.415 (0.024)***	0.274 (0.009)***
Type 2 (semi-detached houses)	0.175 (0.006)***	0.085 (0.010)***	0.206 (0.020)***	0.073 (0.006)***
Type 3 (Detached and luxury Properties)	0.047 (0.005)***	-0.036 (0.007)***	0.061 (0.008)***	-0.097 (0.004)***
Year of construction (-1959)	0.011 (0.006)*	-0.122 (0.006)***	0.100 (0.004)***	0.227 (0.004)***
Year of construction (1960 - 2000)	-0.032 (0.005)***	-0.146 (0.005)***	-0.146 (0.004)***	-0.134 (0.004)***
General Market Conditions				
Transaction Year - 2015	-0.634 (0.006)***	-0.719 (0.006)***	-0.665 (0.005)***	-0.627 (0.004)***
Transaction Year - 2016	-0.558 (0.005)***	-0.623 (0.006)***	-0.566 (0.005)***	-0.486 (0.004)***
Transaction Year - 2017	-0.435 (0.005)***	-0.480 (0.006)***	-0.458 (0.006)***	-0.348 (0.004)***
Transaction Year - 2018	-0.299 (0.005)***	-0.330 (0.006)***	-0.351 (0.004)***	-0.232 (0.004)***
Transaction Year - 2019	-0.235 (0.005)***	-0.236 (0.006)***	-0.287 (0.004)***	-0.188 (0.004)***
Transaction Year - 2020	-0.159 (0.005)***	-0.154 (0.006)***	-0.172 (0.004)***	-0.134 (0.003)***
Neighbourhood and Location Variables				
ln(Crime Rate)	0.032 (0.003)***	-0.041 (0.006)***	0.055 (0.005)***	-0.097 (0.004)***
Distance to GP	-0.030 (0.006)***	-0.262 (0.010)***	-0.191 (0.008)***	-0.097 (0.006)***
Distance to School	0.077 (0.006)***	-0.004 (0.011)	0.096 (0.008)***	-0.162 (0.005)***
Distance to Supermarket	0.263 (0.008)***	0.357 (0.011)***	0.000 (0.007)	0.082 (0.006)***
Distance to Train Station	0.027 (0.001)***	0.005 (0.002)**	-0.056 (0.002)***	0.080 (0.001)***
R-squared	0.823	0.772	0.795	0.806
Adj. R-squared	0.823	0.772	0.795	0.806

Note: The table presents certification premiums across four major Dutch cities—Rotterdam, Utrecht, The Hague, and Amsterdam—along with the aggregate effect across all cities. Coefficients are expressed in percentage terms for log-transformed models, demonstrating the economic value of certification while controlling for property, locational, and temporal factors.

In Rotterdam, certification commands the highest premium at 18.6%, reflecting strong market appreciation for sustainability. This substantial value may stem from Rotterdam's emphasis on urban renewal projects and growing demand for modern, environmentally conscious housing. Utrecht follows with a 9.9% premium, which aligns with its reputation as a progressive urban center with increasing attention to sustainability initiatives. The results for The Hague show a significant, albeit smaller, premium of 4.3%, indicating that sustainability is gaining traction in this market. While this premium is lower compared to other cities, it demonstrates a growing awareness among buyers of the benefits of green certifications. In Amsterdam, the certification premium is 5.3%, which, although significant, reflects the city's unique housing dynamics where factors such as location and property-specific attributes may outweigh sustainability in determining transaction prices. These variations highlight the need to tailor sustainability strategies to specific urban contexts, where local preferences and economic conditions influence the valuation of certifications.

The bar chart in Figure 3 illustrates the certification premiums across the four cities, with an additional bar representing the combined model. This comparison visually highlights Rotterdam's leading position in terms of green premium, while also showing that certification provides a measurable average benefit of 9.5% across the Dutch housing market. The inclusion of the "All Cities" aggregate emphasizes the broader economic relevance of BREEAM-NL certification, complementing the city-specific results.

These findings build on the conclusions from earlier sections by demonstrating that BREEAM-NL certification is not only significant but contextually adaptable across different housing markets. Rotterdam's high premium underscores its readiness for sustainability-driven housing demand, while The Hague's smaller but significant premium reflects an emerging trend of buyer interest in green certifications. The differences across cities emphasize the role of local market dynamics in shaping the economic value of certification. By integrating property-specific and locational attributes into the models, the certification effect is reliably isolated, strengthening the robustness of these findings.

This city-specific analysis reinforces the broader conclusion that sustainability plays an important role in shaping transaction prices in the Dutch housing market. The significant premiums across all cities demonstrate that green building certifications not only support environmental goals but also offer tangible financial benefits for property owners and developers. These results highlight the need for policymakers and developers to continue investing in sustainable housing practices to align with market preferences and capitalize on the growing demand for certified properties.

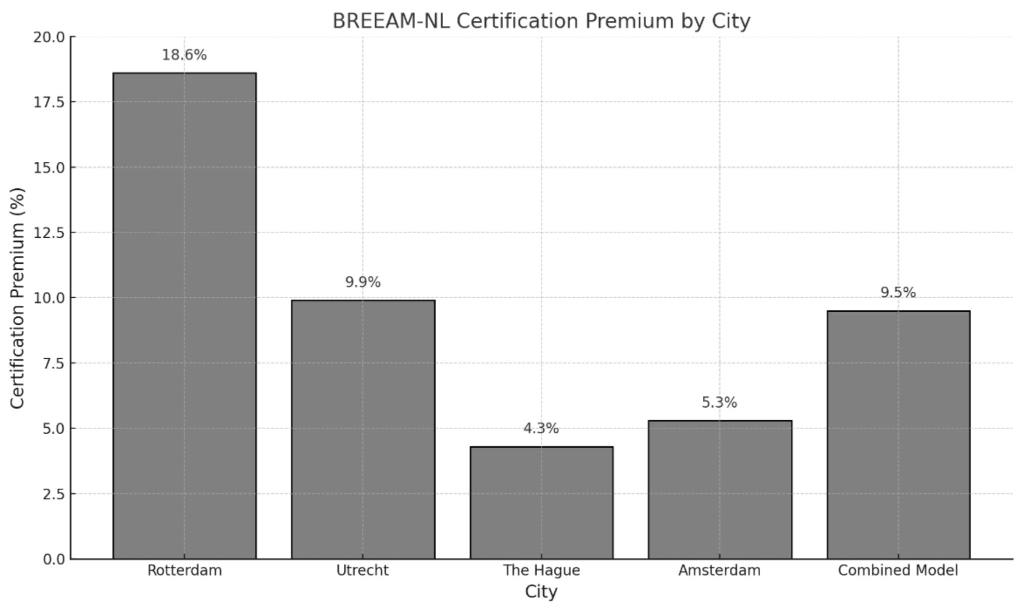

Figure 3: BREEAM-NL certification premium by city. (Source: Author)

5 Conclusion

This chapter synthesizes the findings of this study, addresses the limitations and concludes with a reflection on the research contribution and suggestions for future research.

5.1 Interpretation of Key Findings

The findings of this study demonstrate that BREEAM-NL certification significantly enhances property values, with certified properties commanding premiums of **€32,000 to €91,700**, representing **6.4% to 18.6%** of the mean transaction price for certified properties. These results underscore the market's growing recognition of sustainability and the perceived benefits of certified properties. Buyers value the assurance that certified buildings meet established standards for energy efficiency, environmental performance, and occupant well-being. The city-specific analysis introduced in Section 4.3 further highlights how these premiums vary across urban contexts, with Rotterdam showing the highest premium (18.6%) and The Hague the lowest (4.3%), while Utrecht (9.9%) and Amsterdam (5.3%) fall in between. These differences reflect local housing market dynamics and provide deeper insight into how certification is valued regionally.

Despite these promising results, a key limitation of this study is the potential for omitted variable bias due to the exclusion of specific sustainability characteristics that directly or indirectly influence transaction prices. Tangible and measurable features, such as **solar panels, advanced insulation, and energy-efficient fittings**, are well-documented drivers of property value due to their ability to lower operating costs and improve energy efficiency. However, data limitations prevented these attributes from being explicitly included in the analysis, which may have led to an overestimation of the premium attributed solely to BREEAM-NL certification.

On the other hand, there are sustainability characteristics that are less visible or quantifiable but still play an important role in influencing buyer preferences. Attributes such as **better indoor air quality** or **low carbon emissions**, achieved through the use of sustainable construction materials, and better resource efficiency in energy and water usage, often go unnoticed by buyers because they are not easily observable or measurable in transaction decisions. Certifications like BREEAM-NL bridge this gap by providing a standardized framework to evaluate and communicate these benefits, ensuring they are reflected in transaction prices. This explains why certifications carry a significant price premium—they provide buyers with transparency and align the property with their environmental and sustainability goals.

The results validate the hypothesis that buyers are willing to pay a premium for sustainable housing, highlighting the importance of green building certifications in addressing two critical market failures: **positive externalities** and **information asymmetry**, as outlined in the problem statement.

Positive externalities arise because green buildings generate benefits that extend beyond individual homeowners, contributing to broader societal gains such as reduced carbon emissions, enhanced resource conservation, and improved air quality. The city-specific findings, particularly the strong premiums in Rotterdam and Utrecht, demonstrate that buyers are increasingly internalizing these external benefits. The observed price premiums for BREEAM-NL-certified homes incentivize developers to incorporate green certifications, offsetting the higher initial costs associated with sustainable construction. This shift bridges the gap between societal benefits and private investment decisions, encouraging further adoption of sustainable practices in housing development.

Information asymmetry, a long-standing barrier in the real estate market, has historically hindered the adoption of certifications like BREEAM-NL. Developers and sellers often lack clear data on the financial benefits of certification, perceiving it as an additional cost with uncertain returns. This study provides empirical evidence of significant sales price premiums for certified properties, demonstrating that sustainability credentials enhance property value. By addressing this asymmetry, stakeholders—including developers, investors, and policymakers—can make better-informed decisions, encouraging broader investment in sustainable technologies and certifications.

BREEAM-NL certification not only signals the quality and sustainability of a property but also helps address critical inefficiencies in the real estate market. It aligns private investment with societal goals, ensuring that sustainability is no longer seen as a cost but as an opportunity for financial and environmental gains. The inclusion of city-specific analysis adds further depth to these findings, revealing that local market dynamics influence the strength of the certification premium. These findings underline the value of certifications in driving market transformation toward a more sustainable and equitable built environment.

5.2 Discussion

This study provides empirical evidence that BREEAM-NL certification is associated with significant price premiums in the Dutch residential housing market, ranging from 6.4% to 18.6%. These premiums align with international findings but are notably higher than those observed in other markets, reflecting the Netherlands' increasing societal awareness of sustainability and the maturity of its green certification framework.

Comparison with Previous Studies

The existence of price premiums for green-certified buildings has been widely documented in international markets. For instance: Kok and Kahn (2012) found a 9% price premium for Energy Star, LEED, and GreenPoint Rated homes in the California housing market. Walls et al. (2017) observed 2–4% premiums for Energy Star-certified homes in U.S. cities like Portland and the Research Triangle. In Hong Kong, Hui et al. (2017) reported a premium of 4.4%–6.2% for BEAM Plus-certified residential properties. These findings suggest that sustainability certifications are recognized globally as a value-adding feature in residential real estate.

The premiums observed in this study, ranging from 6.4% to 18.6%, are comparatively larger, which could reflect several factors specific to the Dutch market. First, the Netherlands' advanced regulatory framework and national policies promoting green buildings may have increased public awareness and market demand for sustainability. Second, cultural preferences and consumer priorities in the Netherlands may favor certified homes more strongly, particularly in urban centers like Rotterdam, where the observed premium reaches 18.6%. Finally, the credibility and widespread adoption of BREEAM-NL as a certification system may enhance its influence on transaction prices compared to other certifications like Energy Star or BEAM Plus.

Contribution to the Literature

This study contributes to the growing body of green building economics literature by providing evidence from the underexplored Dutch residential market. Unlike prior studies that predominantly focus on commercial properties or international residential markets, this research provides insight into how BREEAM-NL certification impacts transaction prices in the Netherlands. Previous studies, such as Kok and Jennen (2012), have documented rent and sales premiums for energy-efficient office buildings in the Netherlands, while Chegut, Eichholtz, and Kok (2011) found significant premiums for BREEAM-certified commercial properties in the UK. By shifting the focus to residential properties, this study addresses an important research gap and highlights the financial benefits of certifications in a sector that has been relatively overlooked.

Furthermore, this study extends the analysis by incorporating city-specific dynamics, demonstrating that premiums for BREEAM-NL certification vary significantly across markets. Rotterdam's 18.6% premium stands in stark contrast to The Hague's 4.3% premium, reflecting the critical role of local economic and social factors in shaping sustainability valuation. These findings highlight the importance of localized studies in understanding the nuanced effects of green certifications, as opposed to treating housing markets as homogeneous entities.

Tangible and Intangible Benefits of Certification

The observed price premiums likely capture both tangible and intangible benefits associated with certified properties. Previous research has shown that tangible features like energy savings and reduced operational costs significantly enhance property value. For example, Chegut, Eichholtz, and Kok (2014) noted that certified office buildings in the UK attract higher rents due to their ability to reduce energy costs and provide measurable financial returns to occupants. While explicit energy efficiency data was unavailable in this study, it is reasonable to infer that similar drivers contribute to the premiums observed for BREEAM-NL-certified residential properties.

In addition to tangible benefits, certifications like BREEAM-NL signal quality and sustainability, which appeal to buyers' preferences for intangible benefits. Hui et al. (2017) found that tenants value attributes such as better indoor air quality, enhanced comfort, and environmental responsibility, all of which are associated with green-certified properties. These benefits align with the increasing demand for homes that meet not only practical needs but also align with personal or corporate sustainability goals. The ability of certifications to provide transparency and assurance regarding these features likely explains the significant premiums observed in this study.

Implications for Practice and Research

These findings underscore the importance of green certifications in shaping residential real estate markets and provide actionable insights for developers, investors, and policymakers. Developers can leverage certifications like BREEAM-NL to capture price premiums and align with market demand for sustainable housing. Policymakers may consider using these results to design targeted incentives that promote green certifications in cities like The Hague, where premiums are currently lower. Future research could expand on these findings by exploring additional variables, such as energy efficiency ratings or life-cycle cost analyses, to better understand the specific drivers of green building premiums.

By combining insights from international studies with localized analysis of the Dutch residential market, this study adds a valuable dimension to the literature on green building economics. The results confirm that BREEAM-NL certification offers tangible financial benefits while addressing growing societal demand for sustainability, reinforcing its role as a key driver of market transformation.

5.3 Policy Implications

The findings of this study underscore significant opportunities for policymakers to address barriers to the adoption of green certifications like BREEAM-NL and promote sustainable construction in the Netherlands. While financial premiums of 6.4% to 18.6% provide strong evidence of market demand for certified buildings, significant challenges such as high costs, information asymmetry, and weak enforcement frameworks persist. Addressing these barriers is essential for achieving broader adoption of green certifications and aligning real estate practices with national sustainability goals.

Tackling Financial Barriers

High upfront costs remain one of the most significant deterrents to green building adoption. Chegut et al. (2019) identify increased design fees (up to 150% higher for BREEAM Outstanding projects) and extended construction timelines (11% longer) as key financial risks for developers. To reduce these barriers, policymakers should consider:

- **Tax Incentives:** Policies such as property tax reductions for certified buildings or accelerated depreciation schemes for green investments can encourage adoption. These measures have been shown to effectively reduce financial barriers in countries like Singapore and the UK(Saha et al., 2021). Financial incentives can be particularly impactful in cities like The Hague and Amsterdam, where observed premiums for certified properties are lower (4.3% and 5.3%, respectively). Targeted support in these markets can increase adoption and reduce disparities in green certification benefits across cities.
- **Green Loans:** Providing developers with access to low-interest green financing, similar to initiatives observed in other markets, can lower the capital risk associated with sustainable construction (Santana et al., 2023).

Reducing Information Asymmetry

Information asymmetry continues to hinder green certification adoption by limiting awareness among buyers, developers, and investors. As highlighted by Saha et al. (2021), a lack of stakeholder knowledge on green building benefits discourages demand for certified properties. To address this:

- **Standardized Metrics:** Introducing standardized frameworks for evaluating the economic and environmental benefits of green certifications can enhance market transparency and enable better decision-making by stakeholders(Santana et al., 2023).

- **Mandatory Reporting:** Requiring developers to disclose the sustainability credentials and anticipated cost-benefit outcomes of their projects can increase trust and encourage broader adoption of green certifications(Saha et al., 2021)
- **Public Awareness Campaigns**: Promote the benefits of certifications through targeted campaigns that educate stakeholders about cost savings, health benefits, and environmental impacts.

Strengthening Policy Enforcement

The successful adoption of green certifications also hinges on robust policy frameworks and enforcement mechanisms. As highlighted by Santana et al. (2023), ineffective implementation of environmental laws and regulations can hinder progress. Policymakers should:

- Enforce minimum green building standards for all new construction projects, supported by financial penalties for non-compliance.
- Facilitate public-private collaboration to improve knowledge sharing and promote innovation in green building practices.
- Set clear intermediate goals for certification adoption, aligned with broader EU and Dutch climate objectives.

By addressing these barriers and leveraging the demonstrated economic benefits of certifications like BREEAM-NL, policymakers can create a supportive ecosystem for sustainable construction in the Netherlands. These efforts will not only promote environmental stewardship but also ensure that green buildings become a mainstream standard in the real estate market.

5.4 Limitations and Directions for Future Research

While this study provides robust evidence on the impact of BREEAM-NL certification on transaction prices, several limitations need to be addressed to improve the accuracy and scope of the findings.

Limitations of Locational Data

Due to time constraints, this study utilized neighbourhood-level locational data instead of precise geographical coordinates for properties. As a result, the coefficients for location-related variables, such as proximity to amenities or transport hubs, may lack precision. For example, the effect of accessibility to key services, such as supermarkets or train stations, may be understated or overgeneralized when aggregated at the neighbourhood level.

Additionally, the absence of exact geographical location data indirectly affects the accuracy of other variables, such as crime rate. Crime data is typically geographically specific, and its aggregation at the neighbourhood level may lead to skewed results, as areas within a neighbourhood can exhibit vastly different safety profiles. Including detailed locational data in future studies would improve the reliability of these coefficients.

Future Research Directions

This study opens several avenues for further exploration:

1. **Certification Levels and Price Premiums:** While this research demonstrates that BREEAM-NL-certified properties command significant premiums, it does not

differentiate between certification levels (e.g., Outstanding, Excellent, Very Good). Future research could investigate how varying levels of certification influence premiums, offering more granular insights into the valuation of sustainability credentials.

2. **Evolution of Premiums Over Time:** As awareness of climate change continues to grow, buyers may increasingly prioritize sustainability, leading to evolving premiums for certified properties. Longitudinal studies could examine how these premiums change over time, capturing the impact of shifting market dynamics and public sentiment on the valuation of green certifications.
3. **Integration of Energy Labels and Advanced Features:** Future research should incorporate energy label data and specific green building features, such as renewable energy systems and smart technologies, to better understand their individual and combined effects on transaction prices. This would help disentangle the value of green building certifications from other sustainability-related attributes.

By addressing these limitations and exploring these research directions, future studies can build on the findings of this work to provide a more comprehensive understanding of the value of green building certifications and their role in sustainable real estate markets. These insights will further inform developers, policymakers, and investors in fostering a more environmentally conscious housing market.

5.5 Conclusion

This chapter underscores the importance of BREEAM-NL certification in the Dutch housing market, demonstrating its significant sales price premiums and its potential to address key market inefficiencies. The findings provide clear evidence that sustainability credentials are valued by buyers, presenting opportunities for developers, investors, and policymakers to foster greener real estate practices. While the study has its limitations, including the absence of energy label data and precise geographical locational variables, it lays the groundwork for future research to explore certification levels, the temporal evolution of premiums, and the integration of advanced sustainability features. Through continued investigation, the real estate market can better align with environmental goals and meet the growing demand for sustainable housing options.

6
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7
Appendix

Assumption testing

Figure A1: Residuals vs Fitted Values Plot

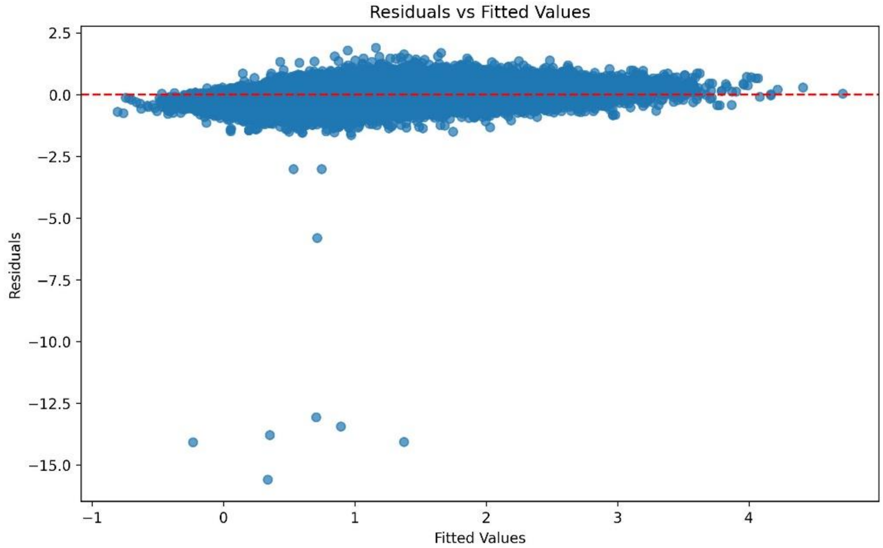

Figure A2: Q-Q Plot of Residuals

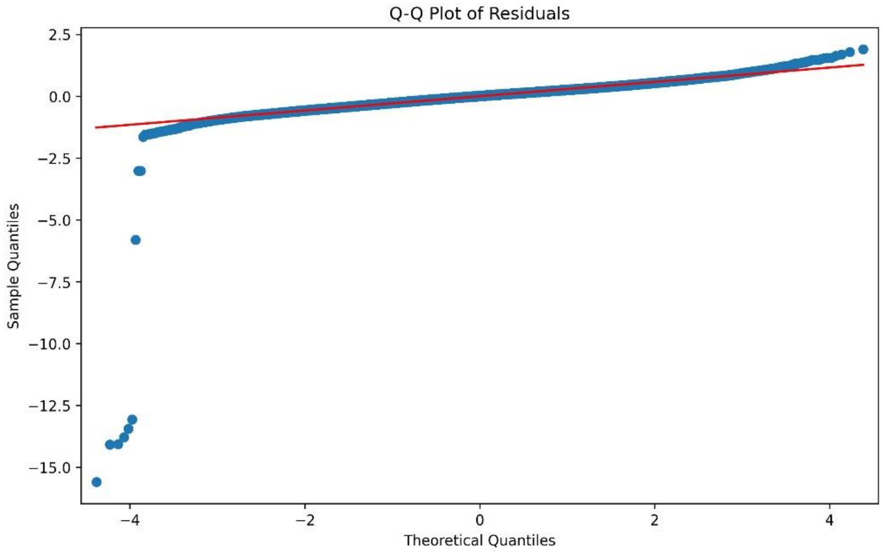

Table A1: Variance Inflation Factor (VIF) for Predictor Variables

Variable	VIF
Intercept	34,806
Certificate	1,009
Area	13,900
Gross Volume	12,516
No. of Rooms	3,277
Type 2 (semi-detached houses)	1,503
Type 3 (Detached and luxury Properties)	1,576
Year of construction (- 1959)	2,269
Year of construction (1960 - 2000)	1,977
Transaction Year - 2015	2,013
Transaction Year - 2016	2,016
Transaction Year - 2017	1,898
Transaction Year - 2018	1,798
Transaction Year - 2019	1,806
Transaction Year - 2020	1,846
City - Hague	1,538
City - Rotterdam	1,288
City - Utrecht	1,361
Distance to GP	2,275
Distance to School	2,127
Distance to Supermarket	1,511
Distance to Train Station	1,291
Crime Rate	1,072