The Economic Value of End of Trip Facilities for Cyclist Commuter in an Office Building

Qiulin Ke *

Posted Date: 6 March 2024

doi: 10.20944/preprints202403.0374.v1

Keywords: rent premiums; office building; cycling to work; bike storage; shower facility

Article

The Economic Value of End of Trip Facilities for Cyclist Commuter in an Office Building

Qiulin Ke

Bartlett School of Planning, University College London; q.ke@ucl.ac.uk

Abstract: The benefits of cycling as a sustainable transportation mode are widely recognized. Cycling to work offers numerous advantages for individuals, employers, the environment, and society, ranging from improved physical health, wellbeing, and productivity to enhanced public health and reduced carbon emissions. Many governments around the world have implemented various policy measures, interventions, and initiatives to promote cycling. Some cities and towns have encouraged workplaces to provide bike-friendly amenities, such as secure bike parking/storage and shower and changing facility (referred to as end-of-trip facilities), to accommodate cyclists and motivate more employees to embrace sustainable transportation options. However, the presence or absence of such amenities has been found to both positively influence cycling behavior or deter some individuals from cycling to work. Despite the desirability of these amenities, the number of office buildings equipped with bike storage and shower/changing facility remains small, and their economic value is not well understood. In this paper, we aim to investigate whether the presence of cycling-supportive facilities could add value to office buildings. Specifically, we conduct a study using data from office buildings across England as of the end of 2021. We employ hedonic techniques to examine whether office buildings with bike storage and/or shower facility command a rent premium and whether the existence of a rent premium for bike storage and/or shower facility vary by location and across regions in England, independently from any premium associated with BREEM certification. We find that the buildings with bike storage and shower facility secure rent premiums respectively. The level of rent premiums varies with location and regions. The variations of premium are driven by the shortage of the supply of these facilities.

Keywords: rent premiums; office building; cycling to work; bike storage; shower facility

1. Introduction

The paper investigates the economic value of end-of-trip facilities (namely, bike storage and shower/changing facility) in the context of office buildings and explores whether these sustainable features could lead to rent premiums for office buildings in England. In recent years, commuting by bike has attained significant attention from the transportation, environmental, and health sectors. Cycling increases physical activity levels, leading to a multitude of health benefits [1,2], while also mitigating air pollution, carbon emissions, congestion, noise, and other detrimental impacts associated with car use [3–6]. Consequently, cycling and walking are recognized as sustainable transportation modes. Government agencies in many countries, cities, and towns have actively promoted cycling by investing in travel-related infrastructure, programs, and policy interventions aimed at encouraging bicycling [7]. Over the last three decades, cycling has experienced significant growth [8].

The Cycle to Work scheme was introduced by the U.K. government in the 1999 Finance Act. This initiative effectively reduces the purchase price of a new bike for employees through a tax exemption. The primary aim of the scheme is to promote commuting to work by bike, encouraging physical exercise while simultaneously reducing pollution. The benefits of cycling to work extend beyond

 doi:10.20944/preprints202403.0374.v1

improvements in health and fitness, ultimately leading to increased employee productivity. Currently, the scheme has garnered participation from over 40,000 employers' nationwide, facilitating more than 1.6 million commuters cycling to work, as reported by the Cycle to Work Alliance, a coalition of the five largest providers of the Cycle to Work scheme in the U.K.

There is a consensus regarding the importance of providing quality bike parking/storage for cyclists, particularly secure and sheltered facilities to prevent theft and protect bicycles from harsh weather conditions. Bicycle parking, storage, and shower rooms, collectively referred to as end-of-trip facilities, play a crucial role in offering convenience and security to cyclists at their destinations. The lack of adequate facilities at destinations and concerns about theft are recognized as significant deterrents to bicycle transportation [9,10]. For instance, the absence of bicycle parking/storage is cited as a barrier to cycling to work in London [11].

Commuters who cycle to work often face challenges such as arriving wet or sweaty. Providing employees with access to shower, changing rooms, and storage facilities can encourage bicycle commuting. These amenities also benefit employees who engage in exercise during breaks or may occasionally require shower and changing facilities for other reasons. To effectively promote the cycle-to-work initiative, employers should prioritize providing facility support. This involves ensuring the availability of secure and convenient bicycle storage on-site, as well as facilities like shower and changing rooms, by integrating them into new or retrofitted buildings to enhance convenience for employees who opt to cycle to work. As such, there exists an extensive and rapidly growing body of literature advocating for the facilitation of cycling to work through appropriate end-of-trip facilities [12–14].

The benefits of the cycling-to-work initiative for employers are widely acknowledged. Therefore, to incentivize more employees to cycle to work, employers may be willing to occupy buildings equipped with end-of-trip facilities for cyclist employees. Consequently, there is a strong demand for these amenities in office buildings. However, despite their perceived benefits, the economic implications of these amenities in a building remain unknown.

On-site amenities such as bike storage, shower and hanging room, electric vehicle charging station, and green space for outdoor recreation are integral components of green building criteria. These amenities not only promote sustainable transportation options but also contribute to fostering a healthier work-life balance for tenants. The presence of these green features can significantly enhance the desirability and value of office space, potentially leading to rent premiums for landlords. However, while many studies in commercial real estate focus on the impact of green certificates such as BREEM or LEED on the value of office buildings [14–17], there is a limited body of research examining the value of individual green amenities within a building.

Studies focusing on green building certifications such as BREEM or LEED provide evidence that these certifications increase rental income while decreasing operating expenses, vacancy rates, and property risks, thereby enhancing property value. Green buildings have the potential to positively impact occupants' health, satisfaction, and productivity. Consequently, employers may be willing to pay higher rents or prices for workplaces that can improve their employees' wellbeing, health, and productivity [18,19]. However, the findings regarding the relationship between buildings with BREEM or LEED certification and occupiers' productivity and wellbeing are inconclusive [20,21], although there is strong evidence supporting the existence of price/rent premiums in buildings certified with BREEM or LEED. This underscores the importance of studying individual characteristics or green amenities of buildings that could influence occupant's wellbeing and productivity independently of green certification. It is crucial to examine which green amenities occupants are willing to pay a premium for.

Certain building amenities have been identified as impacting the value of commercial real estate. For instance, features such as daylighting and electric vehicle (EV) charging station have been found to influence the value of U.S. commercial real estate independently of LEED certification [22–24] . However, research into the impact of individual building amenities on occupant wellbeing, productivity, and overall building value remains relatively scarce.

 doi:10.20944/preprints202403.0374.v1

Research on building amenities in the U.K. predominantly focuses on the BREEM certificate [15,25–27] as well. However, there is limited research exploring the value of individual green amenities within buildings. BREEAM serves as a building quality indicator, assessing various environmental criteria and awarding credits based on their representation within a building. Ratings are then assigned based on the total number of credits achieved. All standards promoted by BREEAM encourage sustainable commuting (walking, cycling, and public transport). Bike storage and shower/cloth-changing facility earn credits in BREEM assessment criteria, aimed at promoting sustainable commuting.

However, the presence of bike storage and/or shower and changing facility may not necessarily correlate with a BREEM certificate; a building without such BREEM certificate may still provide these amenities to its occupants. Therefore, it is essential to investigate the individual impact of bike storage and shower/ changing facility on rental value. To our knowledge, this study is the first attempt to focus on end-of-trip cycling facilities within a building as separate green building features in the context of commercial real estate.

In this paper, we aim to investigate whether office buildings with green amenities such as on-site bike storage and shower/changing facility could enhance the value of the office space. Given the compelling evidence suggesting that cycling to work improves employee health and productivity, tenants may be willing to pay price/rent premiums for office buildings equipped with such green amenities. Using a sample comprising 12,469 office buildings in England as of the end of 2021, we employ hedonic technique to address the following objectives: (1). Exploring whether office buildings with bike storage and/or shower facility can secure rent premiums. (2). Investigate whether the presence of rent premiums for bike storage and/or shower facility varies by location and across regions in England, and whether it is independent from the premium associated with a BREEM certificate.

Through these analyses, we seek to shed light on the potential economic implications of providing cycling-supportive facilities in office buildings and to offer insights into the market dynamics surrounding green amenities in commercial real estate.

Our study finds that buildings with bike storage or shower facility command rent premiums. Furthermore, we observe variations in these premiums across different regions. Interestingly, the rent premiums for bike storage and shower facility outside of the London market are higher compared to those within the London market. Upon examination at the regional market level, we find that the observed premiums are primarily driven by markets characterized by a limited supply of buildings offering such green amenities. This suggests that the availability of these amenities plays a significant role in determining the value of office space within specific regions.

The findings of this study hold significant relevance for commercial real estate investors and property managers. The installation of on-site bicycle storage and shower and changing room facility within a building results in rent premiums for office spaces. Given the widely recognized benefits of cycling to work and the increasing encouragement from employers for their employees to adopt this mode of transportation, these amenities are viewed as essential for such initiatives by employers and tenants alike.

The research provides robust evidence that the provision of bike storage and shower facility, as green features of office buildings, not only benefits the environment and occupant well-being but also offers tangible financial advantages to landlords and tenants. As sustainability continues to drive the real estate market, investing in green building practices is not only morally commendable but also a smart business decision.

The remainder of the paper is structured as follows. Next, relevant literature is reviewed, followed by a discussion of the data and methodology employed, and the subsequent presentation of test findings. Finally, conclusions are drawn based on the results of the study.

2. Literature Review

Research indicates that cycling, as a form of physical activity, can significantly enhance both mental and physical health [28–31]. Moreover, by substituting for car trips, cycling can effectively

 doi:10.20944/preprints202403.0374.v1

reduce greenhouse gas emissions and contribute to improving air quality. Consequently, cycling and walking are recognized as sustainable transportation modes and are actively promoted by governments and their agencies in many countries.

An expanding body of evidence underscores the benefits of bicycling. Consequently, numerous government agencies and public health organizations actively promote increased bicycling as a means to improve individual health and address various environmental challenges. Bicycling is recognized as a solution to mitigate air pollution, carbon emissions, congestion, noise, traffic hazards, and other negative impacts associated with car usage [32–35].

To encourage cycling, various transportation policies and strategies have been implemented, incorporating a wide range of infrastructural interventions [36]. These interventions include measures such as separating cyclists from motor vehicles, implementing two-way travel on one-way streets, incorporating separate traffic signal phases for bicycles at intersections, establishing car-free zones, and introducing bicycle boxes, among others [7].

However, infrastructure alone may not suffice to promote active cycling. Demographic and socio-economic characteristics also influence travel behaviour [37]. For instance, research [38] discovered a correlation between lower incomes and a decreased share of cycling for commuting in London. Additionally, studies on bicycle commuting have found that factors such as age, physical fitness, gender, employment status, education, car ownership, and cultural influences are significantly related to cycling for commuting purposes [47–49].

The strategies implemented by the U.K. government include initiatives to enhance cycle safety, develop cycle-friendly infrastructure, provide adequate cycle parking, reduce theft, reallocate travel incentives, and raise public awareness [39]. Over the past few decades, significant investments have been made in bicycle-friendly infrastructure throughout the U.K. [40,41]. These initiatives encompass a combination of capital investment, such as the construction of cycle lanes, and revenue investment, such as cycle training programs, tailored to the specific needs of each city or town. These efforts have led to a notable increase in cycling to work across the country [42].

For instance, in London, the cycle network expanded from 90km in 2016 to over 340km in 2023 [43]. This expansion means that more than one in five Londoners now live near the Cycleway network. The infrastructure and interventions aimed at promoting bicycling have proven effective in increasing the number of people cycling to work [44,45]. From 2000 to 2008, the total number of bicycle trips doubled in London. Furthermore, the coronavirus pandemic acted as a catalyst for cycling, leading to renewed growth in 2020. In 2022, there were 1.2 million daily cycle journeys in London. However, despite these advancements, barriers remain that prevent more people from cycling, with the lack of cycle parking identified as one of the key obstacles [43].

Research investigating the factors influencing the propensity for cycling to work has identified end-of-trip facilities, such as secure indoor bike storage, showers, and places to store a change of clothing, as significant influencers [13,46]. Achieving substantial increases in cycling rates necessitates an integrated package of various complementary workplace infrastructures. Multivariate analysis of the U.K National Travel Survey by Wardman et al. (2007) [13] demonstrated that compared to a base bicycle mode share of 5.8% for work trips, outdoor parking would raise the share to 6.3%, indoor secure parking to 6.6%, and indoor parking plus showers to 7.1%. This analysis provides strong evidence that end-of-trip facilities at the workplace have a significant impact on the decision to cycle to work.

The provision of these facilities in buildings has been increasing due to building codes in some cities that mandate such facilities and are encouraged by green building codes such as LEED and BREEAM, which award credit points for such amenities. For example, in the transport section of BREEM assessment criteria, 1 credit can be obtained for installing bike storage to meet BREEAM regulations, while an additional credit is available by incorporating at least two of the following criteria: showers (1 for every 10 bike parking spaces), changing facilities and lockers, and drying facilities for clothes [50].

However, the number of buildings with BREEM or LEED certification remains relatively small within the total existing building stock. Concurrently, the demand for facilities catering to pro-cycling

 doi:10.20944/preprints202403.0374.v1

to work is increasing as more individuals opt to cycle to work. Therefore, the provision of such facilities at the workplace is crucial. Office tenants may express interest in building features such as safe bicycle storage and shower facility that align with the preferences of their employees, who are often highly educated and environmentally conscious. Moreover, many office buildings are situated in central business districts (CBDs) or urban areas with excellent accessibility, further incentivizing tenants to invest in these features.

While existing literature suggests that buildings certified with BREEM or LEED provide financial benefits such as premiums on sales price or rent [15,51,52], there is limited research examining the value of individual green features or amenities within office spaces in the U.K. For example, Robinson et al. (2017) [19] studied the impact of 15 green features of office buildings on rental values in the U.S. market and found that on-site bicycle storage had no significant impact on rental value, whereas on-site showers did, even though bicycle parking facilities are typically associated with showers. Additionally, Robinson et al. (2016) [22] analyzed the demand for green office building features among office tenants in the U.S. through a survey. While 18 green features were included in the survey and ranked by participants, on-site showers ranked seventh to last, and bike racks at the building ranked fourth to last in desired green building features.

However, it's worth noting that the desirability and usage levels of bicycle storage and shower facility may vary significantly across countries, regions, and cities. Therefore, the findings from studies conducted in the U.S. market may not necessarily apply directly to the market dynamics in England [53]. Further research specific to the U.K. context would help to better understand the implications of such amenities in the commercial real estate market.

3. Data and Methodology

3.1. Data

Office building data in England were collected from CoStar. The CoStar dataset comprises a comprehensive range of information, including the building's address, physical characteristics such as size, number of floors, year of construction, renovation history, and various amenities such as food service, bicycle storage, skylights, showers, etc. Additionally, the CoStar dataset contains information on the BREEM rating of the building. However, the data on Energy Performance Certificates (EPC) are incomplete. To address this, we supplemented the EPC data from the Department for Levelling Up, Housing and Communities for the office buildings.

For the purposes of our study, owner-occupied buildings have been excluded. The buildings with incomplete information were also excluded in the test. Our dataset consists of 12,469 office buildings occupied by tenants across eight regions in England, all of which have complete information and are included in our analysis.

The rents are asking rents per square foot of office buildings as of the end of 2021. The independent variables of interest include bicycle storage (Bike) and shower facility (Shower), which are binary variables coded as 1 if a building has bicycle storage or a shower facility, respectively. Additionally, we control for building size, measured by square footage, and building age, measured as the age of the building up to the end of 2021 adjusted by the renovation year. We also account for accessibility by measuring the direct distance of a building to the nearest tube or train station in meter.

We perform logarithmic transformations on both the dependent and independent variables in the regression analysis. To control for green building certifications, binary variables are created for buildings with BREEM or Energy Performance Certificate (EPC) ratings, respectively. Other variables included in the analysis are renovation since 2000, represented as a binary variable coded as 1 if the building was renovated since 2000. The location variables include urban area versus suburban area, with a binary variable coded as 1 if the building is located in an urban area including the central business district (CBD), and 0 otherwise. To account for regional effects, binary variables are created for East England (EE), East Midlands (EM), West Midlands (WM), South East (SE), South West (SW), North East (NE), North West (NW), and Yorkshire and the Humber (YH), with East Midlands (EM) serving as the reference group.

 doi:10.20944/preprints202403.0374.v1

Table 1 presents the descriptive statistics of the study variables. Panel A summarizes the full sample, indicating that 1,246 buildings (10%) have bike storage, and 1,496 buildings (12%) have shower facility. Additionally, 1,495 buildings (12%) are certified with BREEM, and 8,600 buildings (69%) possess Energy Performance Certificates (EPCs). Notably, 49% of the buildings are situated in urban areas, including central business districts (CBDs), with London constituting the largest office market, encompassing 39% of the total sample.

Green building practices, such as eco-certification, are influenced by attitudes prevalent in specific markets [54]. To examine whether this statement holds true in the U.K commercial real estate market, we conducted parametric t-tests with unequal variances for these variables. The results are presented in Panel B of Table 1.

Panel B outlines the outcomes of the parametric t-tests with unequal variances for these variables. Distinct differences are observed between properties with and without bike storage. Buildings with bike storage exhibit significantly higher rents, larger sizes, younger ages, and closer proximities to the nearest tube/train station compared to those without bike storage. Moreover, a higher proportion of buildings with bike storage (35%) are certified with BREEM, compared to the ones without bike storage (9%), reflecting the incorporation of this feature in BREEM assessments. However, the proportion of buildings with Energy Performance Certificates (EPCs) is lower (63%) among those with bike storage, compared to the ones without bike storage (70%). Additionally, more buildings with bike storage have shower facility (71%), are renovated since 2000 (38%), and are located in urban areas (79%) compared to their counterparts without bike storage.

Furthermore, we compared the London market, the largest one, with other regions, and the results are also reported in Panel B of Table 1. Office rents in London are significantly higher than those outside London. Buildings in London are larger but older than those outside London, and a greater proportion of buildings in London are located closer to the nearest tube/train station compared to those in other regions. Additionally, the proportions of buildings in London with bike storage (19%) and shower facility (21%) are higher than the ones with bike (6%) and shower facility (8%) in other regions. More buildings in London possess BREEM certificates (16%) and EPCs (72%) than those outside London (BREEM: 10%, EPC: 68%). Moreover, a larger proportion of buildings in London have been renovated since 2000 (20%) and are located in urban areas (86%) compared to those outside London (renov: 11%; urban: 11%), indicating significant differences in property attributes across different markets in England.

Table 1. Descriptive statistics tests of study variables.

	Mean	Min.	Max.	Std. Dev
Panel A: Summary of full sample (N=12,465)				
Rent	26.58	1.31	189	19.57
Size	31797.37	30	1400000	65484.07
Age	64.88	0.00	671	63.568
Dis	1452.03	0.19	9223.37	2076.35
Bike	0.10	-	1.00	0.30
Shower	0.12	-	1.00	0.33
Renov	0.16	-	1.00	0.37
BREEM	0.12	-	1.00	0.32

 doi:10.20944/preprints202403.0374.v1

EPC	0.69	-	1.00	0.46
Urban	0.49	-	1.00	0.50
London	0.31	-	1.00	0.46

Panel B: *t*-test results

	Bike	Non-Bike	London	Non-London
Rent	42.65***	28.81	48.41***	16.87
NIA	83289.42***	26126.46	48776.01***	24247.38
Age	48.89***	66.65	80.46***	57.97
Dis.	732.56***	1531.26	348.51***	1942.74
Bike			0.19***	0.06
Shower	0.71***	0.06	0.21***	0.08
Renov	0.38***	0.14	0.27***	0.11
BREEM	0.35***	0.09	0.16***	0.1
EPC	0.63***	0.70	0.72***	0.68
Stars	3.56***	2.92	3.29***	2.85
Urban	0.79***	0.46	0.86***	0.33
No. of Obs.	1237	11232	3838	8631

Note: *** indicates significance at 1%.

3.2. Methodology

The hedonic modelling technique has been predominantly employed in previous studies analysing rent or sale premiums for green commercial buildings. Consistent with the literature review [15,23,26], we utilize a hedonic pricing model.

The hedonic pricing theory assesses the value of differentiated products by considering the utility derived for the tenant from the building. The model operates under the assumption that individual building components contribute independently to the overall rent. Equation (1) presents the functional form of the hedonic model specification.

$$LogRent_i = a + \lambda D_i + \beta B_i + \delta L_i + \mathcal{E}_i \quad (1)$$

Where *LogRent* represents the natural logarithm of the rent for a particular property *i*; *D* denotes the presence of bike storage or shower facility in building *i*. *B* represents the hedonic features of building *i*, including size, age, renovation status, BREEM certification, and Energy Performance Certificate (EPC). *L* represents the locational characteristics of building *i*, such as the logarithm of the distance to the nearest tube/train station, urban versus suburban location, and whether the building is situated in London or in one of the regions outside London: East England (EE), West Midlands (WM), South East (SE), South West (SW), North East (NE), North West (NW), and Yorkshire and the Humber (YH). East Midlands (EM) serves as the reference group and is not included in the model. $\mathcal{E}$ denotes the error term.

 doi:10.20944/preprints202403.0374.v1

4. Discussion

To assess the value of bike storage and shower facilities in an office building, we utilize a hedonic model that dissects the value of buildings into their individual building and locational characteristics. Rent represents the economic value that a tenant is willing to pay for a building with a combination of features, with specific attention given to bike storage and shower facility. Table 2 presents the results of the hedonic model regression specified in equation 1.

Table 2 reports the incremental development of the multiple linear regression model across three columns. Each column introduces a new set of variables. In column (1), the two variables of interest, Bike and Shower, are included. In column (2), we incorporate the regions, and in column (3), we add the attributes of the building and their locational characteristics.

The coefficients of Bike and Shower are statistically significant in all models, indicating that buildings with bike storage and shower facility have rent premiums of 3% and 5%[1], respectively, compared to those without them. In column (4), we introduce the interaction terms of BREEM with Bike and Shower to replace BREEM and assess whether BREEM certification and bike storage or shower jointly contribute to rent premiums. The coefficient of bikexBREEM is statistically significant, suggesting that bike storage in a building certified with BREEM can increase the rent premium by 5% [2] compared to its counterparts without BREEM certification. However, the coefficient of showerxBREEM is not statistically significant, indicating that the rent premium for shower facilities exists independently of BREEM certification.

The results of the control variables align with expectations. The size of the building exhibits a positive association with rent and is statistically significant in models 3 and 4. Age demonstrates a negative relationship with rent, while the square of age shows a positive relationship with rent; both are statistically significant in models 3 and 4. The coefficients of renovation are statistically significant in models 3 and 4, indicating that renovation adds value to the building. Additionally, the coefficient of distance to the closest train/tube station is negative and statistically significant, suggesting that accessibility has a significant impact on rent.

As expected and consistent with the literature, the coefficient of BREEM certification is statistically significant, indicating that buildings with BREEM certification secure a rent premium compared to conventional buildings [51]. However, the coefficient of the EPC label is insignificant. Properties located in urban areas generally achieve higher rents compared to the ones at suburban locations.

Table 2. Regression test results.

	1	2	3	4
Bike	0.179***	0.083***	0.025***	0.018**
	(0.01)	(0.007)	(0.006)	(0.007)
Shower	0.138***	0.075***	0.048***	0.045***
	(0.009)	(0.006)	(0.006)	(0.006)
Log NIA			0.039***	0.007**
			(0.003)	(0.003)
LogAge			-0.097***	-0.118***
			(0.014)	(0.014)
LogAge^2			0.043***	0.047***
			(0.005)	(0.005)

[1] The coefficient for Bike in table 2 is 0.025, which translates into (exp(0.025)-1) =3%. The coefficient for Shower in table 2 is 0.048, which translates into exp(0.048)-1) =5%.

[2] The coefficient for BikexBREEM in column 4, table 2 is 0.045, which translates into (exp (0.045)-1)=5%.

 doi:10.20944/preprints202403.0374.v1

Renev			0.044***	0.046***
			(0.004)	(0.004)
Log dis.			-0.021***	-0.022***
			(0.004)	(0.004)
BREEM			0.067***	
			(0.005)	
EPC			0.006	0.001
			(0.003)	(0.003)
BikexBREEM				0.045**
				(0.014)
ShowerxBREEM				0.009
				(0.014)
Urban			0.075***	0.075***
			(0.004)	(0.004)
WM		-0.091***	0.004	-0.066
		(0.017)	0.008	(0.015)
SE		0.091***	0.117***	0.117***
		(0.016)	(0.015)	(0.015)
London		0.416***	0.343***	0.341***
		(0.016)	(0.015)	(0.015)
NW		-0.046***	-0.036***	-0.037***
		(0.015)	(0.014)	(0.014)
SW		-0.034***	-0.01	-0.011
		(0.017)	(0.015)	(0.015)
EE		0.036**	0.068***	0.066***
		(0.017)	(0.015)	(0.015)
NE		-0.15***	-0.148***	-0.15***
		(0.018)	(0.016)	(0.016)
YH		-0.105	-0.010	-0.09
		(0.017)	0.009	(0.01)
Cons.	1.290	1.196***	1.001***	0.997***
	(0.003)	(0.016)	(0.026)	(0.026)
Adjusted R^2	0.093	0.614	0.671	0.66
F	647.031	1801.593	1344.412	1321.339
No.	12,469	12,469	12,469	12,469

Note: ***, ** and * stand for the significance at 1%, 5% and 10%.

People are more inclined to cycle to work in urban areas than in suburban areas. As indicated in Table 1, 79% of office buildings with bike storage are located in urban areas compared to 46% in suburban areas. To examine the locational variation in commuting behaviour and the desirability of bike storage and shower facility at the workplace to facilitate cycling to work initiatives, we conducted hedonic regression tests by location. The results of these tests are presented in Table 3.

Interestingly, the coefficients of bike storage (0.039) and shower facility (0.06) in suburban area are higher than the ones in urban area (0.018 for bike and 0.031 for shower). The coefficients of Bike (0.045) and Shower (0.051) in regions are higher than the ones in London (0.015 for Bike and 0.029 for

 doi:10.20944/preprints202403.0374.v1

Shower). This indicates higher rent premiums for buildings with such facilities in suburban areas and regional markets outside London than the ones in urban area and in London. One explanation for this phenomenon could be the shortage of supply of buildings with bike storage and shower facility in suburban areas and regions outside London. As shown in Table 1, the number of buildings with bike storage and shower facility in suburban area and outside London is significantly lower than in urban area and London. The test results indicate that tenants are more willing to pay rent premiums for buildings with such attributes, especially in areas where the supply of such facilities is insufficient.

The coefficients of EPC in Table 3 become significant in urban and London markets, but not in suburban and regional markets. Rents in urban area are significantly higher for the ones in both London and regional markets.

Table 3. Regression tests by location.

	(1). Urban	(2). Suburban	(3). London	(4). Region
Bike	0.018**	0.039***	0.015*	0.045***
	(0.008)	(0.012)	(0.009)	(0.009)
Shower	0.031***	0.06***	0.029***	0.051***
	(0.007)	(0.009)	(0.008)	(0.007)
LogNIA	0.009**	-0.002	-0.009	0.01***
	(0.005)	(0.004)	(0.006)	(0.004)
LogAge	-0.101***	-0.083***	-0.062***	-0.116***
	(0.019)	(0.02)	(0.022)	(0.017)
$LogAge^2$	0.055***	0.022***	0.05***	0.037***
	(0.006)	(0.006)	(0.007)	(0.006)
Renev	0.04***	0.035***	0.025***	0.056***
	(0.005)	(0.007)	(0.006)	(0.006)
LogDis.	-0.051***	-0.011***	-0.046***	-0.024***
	(0.006)	(0.004)	(0.009)	(0.004)
BREEM	0.071***	0.062***	0.078***	0.065***
	(0.007)	(0.008)	(0.008)	(0.007)
EPC	0.012***	-0.003	0.016***	-0.001
	(0.005)	(0.004)	(0.006)	(0.004)
Urban			0.175***	0.047***
			(0.008)	(0.004)
WM	-0.203***	-0.007		-0.069***
	(0.025)	(0.019)		(0.015)
SE	-0.021	0.179		0.108
	(0.024)	(0.018)		(0.014)
London	0.226***	0.307***		
	(0.023)	(0.019)		
NW	-0.178***	0.03*		-0.041***
	(0.022)	(0.017)		(0.013)
SW	-0.135***	0.045**		-0.015
	(0.024)	(0.019)		(0.015)
EE	-0.078***	0.133***		0.06***
	(0.025)	(0.019)		(0.015)

 doi:10.20944/preprints202403.0374.v1

NE	-0.261***	-0.094***		-0.147***
	(0.025)	(0.022)		(0.016)
YH	-0.161	-0.042		-0.083
	(0.025)	(0.019)		(0.015)
Cons	1.56***	1.038***	1.273***	1.069***
	(0.709)	(0.033)	(0.037)	(0.029)
Adjusted R^2	0.709	0.335	0.354	0.342
F	779.907	226.118	189.893	232.914
No.	6,170	6,299	3,838	8,631

Note: ***, ** and * stand for the significance at 1%, 5% and 10%.

Finally, considering that our data are cross-sectional and that the office market is highly heterogeneous, it is likely that the error term does not meet these assumptions. Therefore, we conducted tests for heteroscedasticity using the Breusch-Pagan and White's tests. Table 4 reports the results of the heteroscedasticity tests for the full sample. The Breusch-Pagan test rejects the null hypothesis of homoscedasticity, while the White test cannot reject the null hypothesis of homoscedasticity. As White's test is more general, this still supports adopting robust standard errors in the model estimates presented in Table 2. Separate heteroscedasticity tests were also conducted for different locational rents. The results of the Breusch-Pagan and White's tests are largely similar to the ones presented in Table 4, but are not reported here.

Table 4. Heteroscedasticity tests for the full sample.

Panel A: Modified Breusch-Pagan Test		
Chi-Square	df	Sig.
0.072	1	0.788
Panel B: White Test		
Chi-Square	df	Sig.
438.921	138	0.001

5. Conclusions

Cycling is widely recognized as an environmentally friendly and healthy mode of transport. Individuals benefit from cycling as it is not only a healthy but also a cost-effective form of transportation. Additionally, for society at large, cycling offers advantages such as the absence of direct emissions of pollutants, CO2, or noise, along with requiring inexpensive infrastructure and contributing to improvements in public health. Policies and interventions aimed at promoting cycling as a sustainable and active travel option have led to a significant increase in cycling levels over the past three decades across many countries. However, the lack of safe bike storage and shower facility at destinations has been identified as two factors hindering more people from cycling to work.

A building can play a crucial role in city decarbonization and sustainability efforts by not only reducing energy consumption but also by offering amenities that encourage sustainable commuting practices, such as bike storage and shower/changing rooms in the workplace. Active commuting, including walking and cycling, is promoted by various standards, with assessments like BREEM offering credits for the provision of bike storage and shower facility. Consequently, bike storage and shower amenities have become desirable features in office buildings. However, there is a shortage of such amenities in office buildings, and their economic value has not been explored in previous literature.

This paper investigates whether sustainable features such as bike storage and shower facility in office spaces can increase rent values using data from existing office buildings in England as of the end of 2021. Despite being desirable amenities in office buildings, the supply of end-of-trip facilities

 doi:10.20944/preprints202403.0374.v1

for cyclist employees is limited. In our sample, only 10% of buildings have bike storage, and 12% have shower facility, the end of trip facilities. The proportions of buildings with bike storage (19%) and shower (21%) in London are higher compared to regional markets, where the figures stand at 6% for bike storage and 8% for shower, respectively.

The empirical findings strongly indicate that buildings with bike storage and shower facility command rent premiums of 3% and 5%, respectively, compared to those without such amenities. Additionally, we observe higher rent premiums for bike storage and shower in regional markets compared to the London market, and higher premiums in suburban markets compared to urban ones. The primary driver behind these higher rent premiums in these regions and markets is the scarcity of such features in office buildings. Furthermore, we find that bike storage in buildings with BREEM certification secures higher rent premiums than the non BREEM certified building with bike storage, while the rent premium for shower exists independently of BREEM certification.

These findings hold significant implications for commercial real estate investors, designers, developers, and property managers. They underscore the desirability of these green amenities among occupiers. With the U.K. being committed to achieving net-zero emissions by 2050, promoting greener forms of transport, including cycling, is paramount. Providing end-of-trip facilities for cyclists not only benefits employees and employers but also property investors, leading to positive financial outcomes. Ultimately, these initiatives benefit society as a whole.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Conflicts of Interest: The authors declare no conflicts of interest.

References

1. Cavill, N., Kahlmeier, S., Rutter, H., Racioppi, F., & Oja, P. (2008). Economic analyses of transport infrastructure and policies including health effects related to cycling and walking: a systematic review. *Transport policy*, 15(5), 291-304.
2. Oja, P., Titze, S., Bauman, A., De Geus, B., Krenn, P., Reger-Nash, B., & Kohlberger, T. (2011). Health benefits of cycling: a systematic review. *Scandinavian journal of medicine & science in sports*, 21(4), 496-509.
3. Brand, C.; Goodman, A. & Ogilvie, D. (2014). Evaluating the impacts of new walking and cycling infrastructure on carbon dioxide emissions from motorized travel: A controlled longitudinal study. *Applied Energy*, 128 (1), 284-295.
4. Götschi, T., Garrard, J., & Giles-Corti, B. (2016). Cycling as a part of daily life: a review of health perspectives. *Transport Reviews*, 36(1), 45-71.
5. Brand, C., (2021). Cycling is ten times more important than electric cars for reaching net-zero cities. Accessed at https://theconversation.com/cycling-is-ten-times-more-important-than-electric-cars-for-reaching-net-zero-cities157163.
6. Brand, C., Dekker, H. J., & Behrendt, F. (2022). Cycling, climate change and air pollution. In Advances in Transport Policy and Planning, Vol. 10, 235-264. Academic Press.
7. Pucher, J., Dill, J., & Handy, S. (2010). Infrastructure, programs, and policies to increase bicycling: An international review. *Preventive Medicine*, 50, S106-S125.
8. Buehler, R., & Pucher, J. (2021). International overview of cycling. *Cycling for sustainable cities*, 11-34.
9. Nkurunziza, A., Zuidgeest, M., Brussel, M., & Van Maarseveen, M. (2012). Examining the potential for modal change: Motivators and barriers for bicycle commuting in Dares-Salaam. *Transport policy*, 24, 249-259.
10. Fowler, S. L., Berrigan, D., & Pollack, K. M. (2017). Perceived barriers to bicycling in an urban US environment. *Journal of Transport & Health*, 6, 474-480. doi: 10.1016/j.jth.2017.04.003.
11. Transport for London (2023). Cycling action plan 2. Available on https://content.tfl.gov.uk/cycling-action-plan.pdf.
12. Hunt, J. D., Abraham, J.E. (2007). Influences on bicycle use. T*ransportation*, 34, 453–470.

 doi:10.20944/preprints202403.0374.v1

13. Wardman, M.; Tight, M. & Page, M. (2007). Factors influencing the propensity to cycle to work. *Transportation Research Part A* 41, 339–350.
14. McArthur, J. & Powell,C. (2020), Health and wellness in commercial buildings: Systematic review of sustainable building rating systems and alignment with contemporary research. *Building and Environment*, 171, 106635.
15. Chegut, A.; Eichholtz, P. & Kok, N. (2014) Supply, demand and the value of green buildings. *Urban Study*, 51 (1), 22–43.
16. Holtermans, R., & Kok, N. (2019). On the value of environmental certification in the commercial real estate market. *Real Estate Economics*, 47(3), 685-722.
17. Leskinen, N.; Vimpari, J. & Junnila, S. (2020), A review of the impact of green building certification on the cash flows and values of commercial properties. *Sustainability*, 12(7), 2729; https://doi.org/10.3390/su12072729.
18. Miller, N.; Pogue, D.; Gough, Q. & Davis, S. (2009), Green buildings and productivity. *Journal of Sustainable Real Estate*, l (1), 65-89.
19. Robinson, S.J.; Simons, R.A. & Lee, E. (2017). Which green office building features do tenants pay for? A Study of Observed Rental Effects. *Journal of Real Estate Research*, 39, 467–492.
20. Khoshbakht, M.; Gou, Z.; Lu, Y., Xie, X. & Zhang, J. (2018). Are green buildings more satisfactory? A review of global evidence. *Habitat International*, 74 (April), 57-65.
21. Nurick, S. & Thatcher, A. (2021). The Relationship of green office buildings to occupant productivity and organizational performance: A Literature Review. *Journal of Real Estate Literature*, 29 (1), 18-42.
22. Robinson, S. J. & Sanderford, A. (2016). Green buildings: similar to other premium buildings? *The Journal of Real Estate Finance and Economics*, 52, 99–116. https://doi.org/10.1007/s11146-015-9498-z
23. Turan, I.; Chegut, A.; Fink, D. &Reinhart, C. (2020). The value of daylight in office spaces. *Building and Environment*, 168, 106503.
24. Freybote, J. (2023). The evolution of green building amenities: The case of EV charging stations. *Journal of Real Estate Research*. 45 (2), 228-242.
25. Fuerst, F. & McAllister, P. (2011). Green noise or green value? Measuring the effects of environmental certification on office values, Real Estate Economics, 39 (1), 45-69. https://doi.org/10.1111/j.1540-6229.2010.00286.
26. Fuerst. F & Van De Wetering, J. (2015). How does environmental efficiency impact on the rents of commercial offices in the UK? *Journal of Property Research*, 32 (3), 193-216.
https://doi.org/10.1080/09599916.2015.1047399
27. Ghosh. G. & Petrova, M. (2023). Building sustainability, certification, and price premiums: evidence from Europe, *Journal of Real Estate Research*, 1-24. DOI: 10.1080/08965803.2023.2267717.
28. Stamatakis, E., Ekelund, U., & Wareham, N. J. (2007). Temporal trends in physical activity in England: the Health Survey for England 1991 to 2004. *Preventive medicine*, 45(6), 416-423.
29. Bauman, AE. & Rissel, C. (2009). Cycling and health: an opportunity for positive change? *Medical journal of Australia* 190 (7), 347.
30. Martin, M.; Goryakin, Y. & Suhrcke, M. (2014). Does active commuting improve psychological wellbeing? Longitudinal evidence from eighteen waves of the British Household Panel Survey. *Preventive Medicine*, 69 (December), 296-303.
31. Ma, L.; Ye, R.& Wang, H. (2021). Exploring the causal effects of bicycling for transportation on mental health. *Transportation Research Part D: Transport and Environment*, 93, April, 102773.
32. Godlee, F. (1992). On your bikes. *BMJ: British Medical Journal* 304.6827, 588.
33. Banister, D. (2008). The sustainable mobility paradigm. *Transport policy*, 15 (2), 73-80.
34. Rissel, C. (2015). Health benefits of cycling. *Cycling futures*, 43-62.
35. Giles-Corti,B.; Gunn, L.; Hooper, P.; Boulange, C.; Diomedi, B.; Pettit, C. & Foste, S. (2019), Built environment and physical activity. *Integrating human health into urban and transport; planning: a framework*, 347-381.
36. Graham-Rowe, E., Skippon, S., Gardner, B., & Abraham, C. (2011). Can we reduce car use and, if so, how? A review of available evidence. *Transportation Research Part A: Policy and Practice*, 45(5), 401-418.
37. Pucher, J. & Buehler, R. (2006). Why Canadians cycle more than Americans: a comparative analysis of bicycling trends and policies. *Transport Policy*, 13 (3), 265-279.
38. Martin, A.; Morciano, M.; and Suhrcke, M (2021). Determinants of bicycle commuting and the effect of bicycle infrastructure investment in London: Evidence from UK census microdata. *Economics & Human Biology*, 41, May, 100945.
39. Department for Transport 2005, Department for Transport Annual Report 2005 (CM 6527). Available: https://assets.publishing.service.gov.uk/media/5a7b9011e5274a7318b8f78e/6527.pdf

 doi:10.20944/preprints202403.0374.v1

40. Powell, J., Dalton, A., Brand, C., & Ogilvie, D. (2010). The health economic case for infrastructure to promote active travel: a critical review. *Built Environment*, 36(4), 504-518.
41. Song, Y., Preston, J., Ogilvie, D., & iConnect Consortium. (2017). New walking and cycling infrastructure and modal shift in the UK: A quasi-experimental panel study. *Transportation research part A: policy and practice*, 95, 320-333.
42. Goodman, A., Sahlqvist, S., Ogilvie, D., & iConnect Consortium. (2013). Who uses new walking and cycling infrastructure and how? Longitudinal results from the UK iConnect study. *Preventive medicine*, 57(5), 518-524.
43. Transport for London, (2023). Cycling action plan 2, Available at https://content.tfl.gov.uk/cycling-action-plan.pdf.
44. Moudon, A. V., Lee, C., Cheadle, A. D., Collier, C. W., Johnson, D., Schmid, T. L., & Weather, R. D. (2005). Cycling and the built environment, a US perspective. *Transportation Research Part D: Transport and Environment*, 10 (3), 245-261.
45. Yang, L., Sahlqvist, S., McMinn, A., Griffin, S. J., & Ogilvie, D. (2010). Interventions to promote cycling: systematic review. *Bmj*, 341.
46. Winters, M.; Davidson, G.; Kao, D.; Teschke, K. (2010). Motivators and deterrents of bicycling: Comparing influences on decisions to ride. *Transportation* , 38, 153–168.
47. Moudon, A. V., Lee, C., Cheadle, A. D., Collier, C. W., Johnson, D., Schmid, T. L. & Weather, R.D. (2005) Cycling and the built environment: a US perspective, *Transportation Research Part D*,10, 245–261.
48. Heinen, E.; van Wee, B. & Maat, K. (2010) Commuting by Bicycle: An Overview of the Literature, *Transport Reviews*, 30:1, 59-96, DOI: 10.1080/01441640903187001.
49. Aldred, R, & Jungnickel, K. (2014). Why culture matters for transport policy: the case of cycling in the UK. *Journal of Transport Geography*, 34, 78-87.
50. BREEAM In-Use technical manuals, 2020: BREEAM In-Use International Technical Manual: Commercial, version 6.0.0. available at https://bregroup.com.
51. Eichholtz, P., Kok, N., & Quigley, J. M. (2010). Doing well by doing good? Green office buildings. *American Economic Review*, 100(5), 2492-2509.
52. Ferreira, A., Pinheiro, M. D., de Brito, J., & Mateus, R. (2023). A critical analysis of LEED, BREEAM and DGNB as sustainability assessment methods for retail buildings. *Journal of Building Engineering*, 66, 105825.
53. Kazemzadeh, K., Laureshyn, A., Winslott Hiselius, L., & Ronchi, E. (2020). Expanding the scope of the bicycle level-of-service concept: A review of the literature. *Sustainability*, 12(7), 2944.
54. Dippold, T., Mutl, J., & Zietz, J. (2014). Opting for a green certificate: The impact of local attitudes and economic conditions. *Journal of Real Estate Research*, 36(4), 435–474. https://doi.org/10.1080/10835547.2014.12091405.