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HOW DOES ENVIRONMENTAL EFFICIENCY IMPACT ON THE RENTS OF COMMERCIAL OFFICES IN THE UK?

A hedonic regression analysis of the impacts of BREEAM and walkability.

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ABSTRACT

The aim of this study is to investigate whether offices in the United Kingdom with an environmental label command price premiums when compared to non-labelled offices.

The *de facto* standard for sustainability in the UK is the Building Research Establishment Environmental Assessment Method (BREEAM). BREEAM is a building quality indicator that investigates a range of environmental criteria, awards credits based on the degree to which these criteria are represented in a building and then awards a rating based on the total number of credits that have been achieved.

This research investigates the effect of BREEAM ratings on observed contract rents in the UK and as such provides a potentially stronger empirical test of the hypothesis than previous appraisal-based studies. The market impact of BREEAM ratings is investigated, using a control sample of non-BREEAM rated office buildings throughout the UK. To achieve this, a dataset is used that contains 19,509 commercial office lease transactions that were completed from 2006 to 2010.

The results indicate that a premium exists for BREEAM-certified buildings. The results also indicate that the premium shows variations during the study period and that premiums vary depending on the year of construction and certification.

Key words: BREEAM, Hedonic modelling, Commercial office space, Eco-labelling

1. INTRODUCTION

As the negative consequences and impacts of environmental constraints have become increasingly visible, a global agenda that seeks to achieve environmental efficiency has increased in prominence and importance in those sectors that require significant energy and material inputs and produce waste. In the real estate sector, a number of environmental assessment benchmarking tools, or ecolabels, now exist which seek to quantify, benchmark and, ultimately, improve elements of mainly environmental efficiency, but also social and economic performance of buildings. Some key international ecolabels include LEED in the United States, GreenStar and NABERS in Australia, HK-BEAM in Hong Kong and CASBEE in Japan.

The UK has two mandatory ecolabels that investigate the energy performance of buildings. Firstly, Energy Performance Certificates (EPCs) assess the *intrinsic* performance of buildings based on their characteristics when they are constructed, sold or let. Second, Display Energy Certificates (DECs) annually assess the *operational* performance of a subset of public buildings. In addition to these mandatory tools, a key voluntary tool is the Building Research Establishment Environmental Assessment Method (BREEAM). This environmental assessment tool, or ecolabel, investigates the environmental efficiency of buildings in the UK and has been widely adopted in the UK market. Since the introduction of BREEAM in the 1990s, more than 40,000 projects (over 1 million buildings) have been registered and approximately 15,000 projects (over 20,000 buildings) have been certified[1]. Over the last decade, BREEAM has been adopted as the *de facto* standard for rating the environmental efficiency of the built environment in the United Kingdom.

This study investigates whether the preference for environmentally efficient buildings, as rated by BREEAM, is expressed by tenants through a price premium on rents for the space that they wish to occupy. The research uses hedonic pricing models to investigate whether there is a positive impact of BREEAM ratings on office rents. In the UK, a previous study by Fuerst and McAllister (2011c) finds no significant ecolabelling effects on the appraised value of buildings, although the authors find statistically significant negative effects on equivalent yields. A study by Chegut, Eichholtz, and Kok (2012) finds rental and sales price premiums for BREEAM-rated offices in London.

A key contribution of this study is therefore that it looks beyond London to other offices in the UK. The results of this study suggest that a rental premium exists for BREEAM-rated office buildings. Further results suggest that this premium exists over time and varies for different versions of BREEAM as measured by their construction year. This study also includes Walk Score as a measure of accessibility of local clusters of amenities and finds that the results are all highly significant, confirming the

[1] http://www.breeam.org/page.jsp?id=559

expectation that walkability and distance to local clusters of amenities can be a significant predictor of rent.

This paper is structured as follows: Firstly, the literature review section examines BREEAM in more detail, followed by a discussion of its importance and relevance, an overview of existing studies that investigate the effects of ecolabels on property prices, leading to the rationale for the existence of different premiums. The section that follows contains a description of the data that has been used for this study. This is followed by the methodology, a section with a discussion of the results and, finally, the conclusions and key implications that emerge from these results.

2. LITERATURE REVIEW

The drivers and proposed effects of ecolabels have been widely discussed in existing literature. Teisl, Roe, and Hicks (2002) explain that ecolabelling effectively decreases the search cost for information and may signal the importance of environmental information, which can affect behaviour by influencing the number of attributes that a consumer considers during a choice occasion. Fuerst and McAllister (2009) discuss the importance of an appropriate benchmark, the ecolabel, to compare labelled and non-labelled products. Fuerst & McAllister (2011a) explain that by providing the independently verified information of an ecolabel to investors and occupiers in property markets, these labels can potentially contribute to an increase in willingness-to-pay (WTP) for buildings that have superior environmental and/or energy performance.

2.1 BREEAM

BREEAM is one of the most prominent ecolabels for buildings in the UK. BREEAM was first introduced in the 1990s and has gone through various changes and versions over the years. Its implementation has been overseen by the Building Research Establishment (BRE), a former government agency. BREEAM assesses a wide set of environmental and social attributes of buildings. The instrument contains nine areas in which credits can be achieved and the relative breakdown of credits for each area in BREEAM New Construction version 2011 (BRE, 2011) is as follows: Management (12%), Health and Wellbeing (15%), Energy (19%), Transport (8%), Water (6%), Materials (12.5%), Waste (7.5%) Land Use & Ecology (10%) and Pollution (10%). In this version, the instrument leaves some room for innovation through an additional 10% of ‘innovation credits’. The total credits achieved in each area are eventually added together, leading to a rating that ranges from ‘Pass’ (worst rating), ‘Good’, ‘Very Good’ and ‘Excellent’ to ‘Outstanding’ (best rating). Moreover, to achieve certain rating levels, mandatory credits have to be obtained for a specific set of preselected criteria. In addition to offices, BREEAM New Construction may be used to assess the environmental performance of such assets as courts, data centres and educational, healthcare, industrial, multi-residential, prison and retail buildings. In addition to the UK, other countries such as Germany, the Netherlands, Norway, Spain and Sweden also have their own national BREEAM scheme operators.

INSERT TABLE 1 HERE

Table 1: Total offices in England & Wales and number of BREEAM Certified offices[2]

Table 1, which is included in a study by Chegut et al. (2012), provides an overview of total offices in England and Wales and London and how many of these are BREEAM-rated. A clear increase in the number of total offices can be seen over the years as BREEAM has become more widely adopted. Although the number of offices which have achieved BREEAM-certification has increased in absolute terms, certification has tended to be restricted to a relatively small percentage of total offices on a year by year basis. This percentage has been increasing steadily, but it does highlight that the proportion of BREEAM-rated buildings comprises only a smaller segment of a wider market.

2.2 Relevant hedonic ecolabel pricing Studies

An increasingly robust research base exists which investigates how buildings with ecolabels can generate significant direct and indirect benefits. Some of the key studies studies have investigated LEED, which investigates the wider environmental efficiency of buildings, and Energy Star, which focuses on operational energy consumption.

Eichholtz, Kok, and Quigley (2010) find higher rents for buildings with an Energy Star rating of 3.3% at a significant level and a premium of 5.2% for buildings with LEED certification at an insignificant level. A study by Fuerst and McAllister (2011b) finds a rental premium of approximately 4% for buildings with Energy Star certification and 5% for buildings with LEED certification and a study by Wiley, Benefield, & Johnson (2010) estimates a rent premium of 7.3% to 8.9% for Energy Star-rated properties and a premium of 15.2% to 17.3% for LEED-rated properties. Additional benefits which are measured and identified in these studies include sales premiums and higher occupancy levels.

[2] Source: Chegut et al. (2012) ; adapted from Office for National Statistics, Commercial and Industrial Floorspace and Rateable Value Statistics, 1998-2008; BRE Certified Buildings Proprietary Database.

Studies have also sought to investigate the development of premiums over time. Reichardt, Fuerst, Rottke, and Zietz (2012) use a panel dataset, which enables the authors to apply a differences-in-differences (DID) model to confirm that there is a rent premium from 2004 to 2007 for Energy Star-rated buildings and a fixed-effects model to identify premiums of 2.5% for Energy Star-rated buildings and 2.9% for LEED-rated buildings, averaged over all time periods. Das, Tidwell, and Ziobrowski (2011) examine rental rate dynamics of green commercial office properties in the San Francisco and Washington DC areas using data from quarter 1 in 2007 to quarter 1 in 2010 and find rental rate premiums for green office properties. The study also finds that this green premium is counter-cyclical: positive and significant in down-markets, but substantially reduced in up-markets.

Although the evidence base from studies based on data from the US is significant, the evidence base on the impacts of comprehensive ecolabels on prices of commercial offices in the UK has thus far been relatively limited. The most relevant study, which investigates the effect of BREEAM on prices, has been conducted by Chegut et al. (2012). This study finds statistically significant premiums for BREEAM-certified buildings, although the study area is restricted to London. Another limitation of this study is a lack of controls for building quality, which may make it difficult to clearly distinguish BREEAM-rated assets from other Grade A buildings. Fuerst and McAllister (2011c) conduct a study using data on 708 commercial property assets held by the Investment Property Databank (IPD) UK but are unable to find significant evidence that suggests that BREEAM and EPC ratings have any significant effect on market rents and market values, although the authors do find evidence to suggest that equivalent yields are affected by BREEAM and EPC ratings. A limitation of this study is that the authors had a relatively small sample and also had to split their observations over several asset classes (offices, retail and industrial), which may reduce the explanatory power of their models.

2.3 Ecolabels and the UK Property Industry

In addition to direct financial benefits, much of the debate on the property market impact of ecolabels has focused on the wider motivations of investors and occupiers. In addition to direct economic benefits (e.g. lower occupational costs, increased employee productivity), Eichholtz, Kok, and Quigley (2009) also list indirect economic benefits (e.g. reputational benefits, customer image, attracting workforce), risk avoidance (e.g. future environmental regulations) and ethical behaviour as reasons for firms to occupy ‘green’ buildings. Occupation of buildings with a favourable ecolabel can be used to demonstrate a commitment to Corporate Social Responsibility (CSR) or Corporate Responsibility (CR) principles, the benefits of which can include public image improvements and marketing benefits.

Prominent occupiers are actively setting targets for the acquisition of BREEAM-rated buildings. It is for instance a requirement for new government buildings in England to be built according to BREEAM 'Excellent' standards and refurbishments have to achieve 'Very Good'[3] standards, as the UK government wants to demonstrate a clear commitment to the sustainability agenda through the buildings that it chooses to occupy. Similarly, the Welsh government requires that all new buildings promoted or supported by the government or by sponsored bodies meet the BREEAM 'Excellent' standard or an equivalent scheme[4] and in Northern Ireland all new or refurbished buildings have to undergo BREEAM assessments or a CEEQUAL equivalent in order to meet a minimum 'Very Good' standard by 2010[5]. Fuerst, McAllister, Nanda, and Wyatt (2013) suggest that the attainment of local regulatory bodies of voluntary environmental labels as a requirement has made ecolabels such as BREEAM and LEED quasi-compulsory, as the distinction between whether they are voluntary or compulsory is becoming blurred. Other prominent occupiers, such as large corporations with comparatively much public exposure or smaller organisations which are active in sustainability-related activities may be driven to occupy certified stock to attain the image benefits which are associated with them (Van de Wetering & Wyatt, 2011). Parker (2012) conducted a survey among property stakeholders in the UK to find what drove them to adopt BREEAM. The survey finds that respondents in different sectors could have varying reasons, although such motivations as CSR and organisation policy, regulatory or procurement and planning requirements tend to be ranked relatively high. Despite being associated with higher construction costs (BRE Trust & Cyril Sweett, 2005), direct cost savings may be achieved in BREEAM-rated buildings in areas such as energy, water and waste, savings which can be obtained through their increased environmental efficiency. A BREEAM rating may thus signal to the market that buildings reduce negative environmental impacts and may be more cost-effective. BREEAM also focuses on a distinctly social dimension, as it seeks to make buildings more user-friendly by including measures that improve the indoor environment. Indirect social and financial gains can be achieved through improved occupier health and wellbeing, which can result in increased staff efficiency and productivity, reduced absenteeism rates, higher staff retention and lower staff turnover. A limitation in current research however is that the exact operational improvements which can be achieved in BREEAM-rated buildings have not yet been adequately assessed.

For investors, an environmental label may offer reputational and marketing benefits which may positively affect the public image of organisations. Some property investors have started to report sustainability matters on their websites and publish sustainability reports. Fuerst, McAllister, & Gabrieli (2012) investigate whether certain investors in the US are targeting buildings with the LEED and GreenStar ecolabels and find evidence that this appears to be the case. Pivo and Fisher (2010)

[3] http://sd.defra.gov.uk/advice/public/buying/products/buildings/new-build/standards/
[4] http://wales.gov.uk/topics/sustainabledevelopment/design/standards/?lang=en
[5] http://www.dsdni.gov.uk/dsd-sustainable-development-action-plan.doc

investigate several characteristics of Responsible Property Investment (RPI) features on property performance and find that, compared to conventional properties, buildings with RPI features had higher net operating incomes, market values, price appreciation and total returns, as well as that the buildings had lower cap rates.

2.4 Walkability

An often cited limitation of some of the previous hedonic pricing studies on the effects of ecolabels is a lack of adequate control variables, which may lead to omitted variable bias. This limitation is mentioned by McAllister (2012) in a comprehensive overview of relevant ecolabelling studies, in which the author refers to locational differences of buildings as the most important control to be used in ecolabel studies to avoid location effects being misattributed to green effects, highlighting how several studies may have suffered from a lack of adequate location controls.

Location factors are not assessed and therefore captured to a great extent by BREEAM. In BREEAM 2011 for new constructions, for instance, a maximum of nine credits are available for transport criteria, three of which are awarded for performance on public transport accessibility on the Accessibility Index and one credit of which is awarded if the building occupier provides a dedicated bus service to and from the building at the beginning and end of each shift or day, with further credits available when an office is located close to certain amenities (which should include a grocery shop or food shop, a post box and a cash machine). It would thus appear that CO_2 emissions related to transportation to and from offices, for employees, clients and suppliers, have been largely externalised from the instrument, which reduces its usefulness as a measure of transport CO_2 emissions. In addition, the minimal inclusion of location reduces the applicability of BREEAM as an indicator for the impact of location, highlighting the need for another method of assessment to control for the impact of further spatial elements in the price determination process. The need for including such elements has been widely documented. Can (1992) finds that models that incorporate adjacency effects are methodologically capable of accommodating the nature of spatial datasets and are conceptually more realistic representations of housing price determination processes.

An emerging body of research is available that looks at the impact of locations using the Walk Score indicator as a way of addressing the impact that the spatial environment may be having on property prices. The Walk Score is a score of walkability and proximity of local amenities which ranges from 0 (worst) to 100 (best). Pivo and Fisher (2011) examine the effects of location on property values and investment returns by using Walk Score ratings[6]. The authors find that a one-unit increase in the Walk Score rating respectively produces a 0.9%, 0.9% and 0.1% value premium for office, retail and apartment properties, *ceteris paribus*. Leinberger and Alfonzo (2012) use walkability measures in a sample of neighbourhoods in Washington, D.C. and find that places with higher walkability performed better commercially ($8.88/sq ft/yr more in office rents compared to a mean of $32.47) and that places with a higher walkability also achieved higher housing values. Looking at the combined effects of ecolabels and local indicators, Kok and Jennen (2012) use Walk Score and find that the Walk Score is positively and significantly related to rents.

In the UK, Walk Score assesses the walking distance to amenities in the following amenity categories: restaurants (1), coffee (2), groceries (3), shopping (4), schools (5), parks (6), books (7), pubs (8), entertainment (9) and banking (10). It should be noted that the catchment areas of these local amenities can vary significantly and that there is no measurement of their actual use by local residents. Groceries, pubs and banking facilities may well fulfil a more local function than schools, parks and entertainment facilities, for which people may be willing to travel a greater distance. Pivo and Fisher (2011) highlight a number of limitations for the use of the Walk Score ratings. Firstly, they note that the score weights all destinations equally. Secondly, they explain how the score uses broad definitions for each type of destination. Thirdly, they mention how the score does not account for other factors that have been empirically or theoretically linked to walkability. A Walk Score in the UK also does not include or measure features such as street design, safety from crime and crashes, pedestrian-friendly community design, topography and weather, nor does it include features such as police stations and medical facilities (hospitals, doctors' surgeries), proximity to major transport nodes and transit data.

2.5 BREEAM premium expectations

Existing studies have sought to theorise which factors may cause positive price effects for eco-certified stock compared to non-certified stock. The first expectation relates to the general premiums of ecolabelled versus non-ecolabelled stock. Fuerst and McAllister (2011b) explain their assumption which states that demand curves for buildings are different for certified and non-certified buildings and also different for various levels of certification within groups of certified buildings. As the cost increases with higher levels of certification, so should the WTP by occupiers for these features, leading to a premium. Fuerst et al. (2012) stress the potential significance of ecolabels as an indicator of the enhanced quality which may be associated with ecolabelled buildings when they suggest that eco-investors and eco-certification are positively correlated to the relative quality of an asset within a broad

[6]Walk Score ratings can be generated on: http://www.walkscore.com/

quality band and that, therefore, the assets with an ecolabel and/or assets that are purchased by eco-investors are the best quality assets within their class. Fuerst and McAllister (2011b) hypothesise that demand curves for certified buildings are assumed to shift outwards to compensate for the higher construction prices that may be associated with higher levels of certification, which would result in enhanced building quality. The first expectation of this research is therefore that companies are willing to pay a premium for better environmental performance and efficiency of ecolabelled buildings because of the reputational and cost benefits that they provide and because of the best practice benchmark that they represent.

A second expectation for this study relates to the performance of sustainable buildings as measured by BREEAM over time. Aroul and Hansz (2012) expand the aforementioned supply and demand model further and argue that new mandatory standards of green buildings make the existing supply of non-green buildings relatively inferior. The expectation for EPCs and DECs is that, as information on energy performance is adopted as a key market signal, the market may correct itself to reflect new pricing supply and demand equilibriums for superior labels and inferior labels, as market participants will seek to avoid those buildings with poor energy performance, because they may result in higher total occupancy costs and may increasingly expose such organisations to a legislation risks and a risk of energy- or CO_2-based taxation. Such a phenomenon may be less likely to occur for an ecolabel such as BREEAM however, as that ecolabel has remained restricted to a relatively small portion of the market which is more likely to be grade A or best practice. The rationale for the existence of a BREEAM premium is therefore likely to be based on the environmental specification differences of certified versus non-certified buildings. Das et al. (2011) argue there has been no strong reason to believe that rental premiums of green buildings remain the same across different stages of market cycles and identify that there is a lack of studies that explore whether patterns of rental rate changes are uniform across properties of varying temporal and non-temporal characteristics. Aroul and Hansz (2012) explain that that as supply of green buildings lags demand this may lead to an additional green price premium in the short term, above the premium that may exist already. Reichardt et al. (2012) find in the case of Energy Star that the longer a building has been labelled, the higher the rent premium is that it appears to command, although the authors find the opposite effect for LEED. The second expectation is therefore that, depending on the time of the BREEAM transaction and the market circumstances at that time, there are likely to be marked differences in the direction in which the premium develops itself.

A third expectation that may be worthy of further investigation relates to premium differences which exist between different versions of BREEAM as the instrument is regularly revised, adjusted and updated to reflect the most up to date state of market, legislative and environmental concerns. Different versions have included and excluded various measurement criteria through the years. Schweber (2013) argues that the meaning of ‘sustainability’ and ‘green building’ is not given, but rather is the object of ongoing negotiation. This is reflected in the changes which are regularly made to international building ecolabels. This can be illustrated by looking at the energy criteria within the BREEAM assessment, which have changed significantly over the years. BREEAM 2006 awarded up to 15 credits, the majority of credits awarded in the area of energy performance, based on whether a building demonstrated a percentage improvement above the requirement for CO_2 emissions as set out in the Building Regulations (BRE, 2006). In BREEAM 2008 this was changed so that up to 15 credits were awarded by comparing the building's CO_2 index from the Energy Performance Certificate (EPC) to a set of benchmarks (BRE, 2008). In BREEAM 2011, up to 15 credits were awarded based on the performance as calculated by using a tool called the Energy Performance Ratio for New Constructions (EPR_{NC}) and comparing the performance to a benchmark set by the BRE (BRE, 2011). Besides changes within the individual assessment criteria, other structural changes to the instrument include a number of mandatory credits and innovation credits which have been introduced over the years. Since the specifications of BREEAM have changed over the years, the third expectation is that the premiums that occupiers are willing to pay for these different specifications have changed accordingly. Newer buildings which conform to higher BREEAM specifications would be expected to achieve higher premiums because of their enhanced specifications compared to older versions of BREEAM.

3. DATA

Paucity of data has long been a barrier for conducting real estate hedonic pricing studies in the UK. A dataset containing building characteristics and a dataset containing data on transactions was made available for this study by CoStar UK. CoStar UK obtains property transaction information from real estate agents and publishes information on the availability of commercial space, lease and investment deals. Additionally, the company has an extensive in-house dataset with building characteristics.

In addition to transaction information and standard property characteristics, CoStar UK has also collected BREEAM ratings through marketing materials and agents. This sample of BREEAM-rated buildings is used to as the basis for this research. In addition, further BREEAM ratings as published on Green Book Live[7] were matched with the correct buildings whenever sufficient information was available to identify these buildings. It should be noted that only final ratings were used, as many of the ratings on Green Book Live are interim ratings. A limitation of this study is that information on BREEAM-rated buildings before the 2008 scheme has not yet been publicly released and it is not clear whether the BRE will eventually publish these ratings. Also, the information fields on BREEAM

[7] These ratings can be found at: http://www.greenbooklive.com/search/scheme.jsp?id=202

ratings are limited as the website does not provide any breakdown on how this rating was originally obtained and how well a building performed across the various environmental areas that were assessed.

These datasets were combined and used to construct a dataset with pooled quarterly observations that ranged from Quarter 1 in 2006, around the time when BREEAM began to be more widely adopted in the UK market, to Quarter 4 in 2010, when the dataset ended. The dataset contains quarterly information for buildings whenever such information was available. The rationale behind creating quarterly observations of the transaction data emerged when it was found that there were instances of duplication of observations within the dataset, with multiple recordings of transactions for the same floorspace in individual quarters, as well as avoiding overrepresentation of particular buildings in the dataset. Data was not originally provided in a structure that contained quarterly observations and, therefore, some modifications had to be made. For some quarters, multiple records existed for individual buildings. When this occurred, a weighted average based on total floorspace for the rent was calculated, so that for each building in the dataset only a single observation for each quarters would exist, thus minimising duplication. Whenever a record appeared to be duplicated, the latest, most recent record was used and all other duplicate records were omitted. Records labelled as 'withdrawn' were generally not used, although there were a few instances in which these were included in the dataset to supplement existing records.

INSERT TABLE 2 HERE

Table 2: BREEAM Sample Summary Statistics (N = 18,191)

Table 2 contains the summary statistics for the continuous variables in the sample. The mean rent is £21.25 per square foot and this rent applies to the entire UK. On average, rents in London are expected to be higher. The mean age is relatively high at 72.08 years, which could be caused by the number of historic buildings that are included in the sample. The summary statistics show that the variable of rentable building area has a relatively high coefficient of variation. This may be caused by the presence of comparatively larger buildings in the sample.

The Walk Score[8], which has been discussed earlier, is used as a proxy of the walkability and local accessibility of locations, as well as the distance of offices to local centres. Matching the Walk Score

[8] http://www.walkscore.com/

with data provided by CoStar UK involved some complications. In some cases, address information could not be matched instantly. When this occurred, individual cases were reviewed based on the address information that was available. Although the Walk Score website stated at the time of data collection that the score was not yet officially supported in the UK, the index used here is an approximation of the walkability of office buildings and their distance to the local clusters of amenities and as such supplements an approximation of the local quality of the zone in which the office is positioned.

In order to control for the variance of explanatory variables in the panel dataset, an additional time-variant variable is included. De Wit and Van Dijk (2003) find that rents are positively related to changes in GDP and GNP and that increases in stock, vacancy rates and unemployment affect rents negatively. Reichardt et al. (2012) controls for past vacancy rates, as landlords are likely to adjust their rents in response to previous vacancy rates, and other variables such as unemployment rates and changes in office stock. Eichholtz et al. (2010) uses employment growth, indicating that growth in employment levels in the service sector could contribute to growth in office rents. Early tests with a variable for regional Gross Value Added (GVA) yielded no levels of significance. Another variable for regional vacancy rates showed signs of multicollinearity. These two variables are therefore not included, although a variable for unemployment is included.

Unemployment statistics were obtained from the regional labour market statistics section on the EuroStat[9] website. Data were available at the sub-regional (Nuts II) level and these numbers were matched with subregions which were available in the CoStar dataset. Post codes were used to match the Inner and Outer London regions, which were not directly available in the dataset.

4. METHODOLOGY

This methodology section sets out how the impact of BREEAM on market transactions is measured. The expectation, which has been outlined before, is that occupiers in the UK are willing to pay a premium for enhanced environmental and social performance of buildings, as well as enhanced building specifications, which are captured by BREEAM ratings, and the importance of these properties should thus be reflected in rental bids. The market effect of BREEAM on prices is likely to come from their exposure, for instance from their use in marketing materials during the construction phases and when the property is on the market. A dataset was used with pooled observations for buildings over 20 quarterly periods that start at quarter 1 in 2006 and end in quarter 4 in 2010. Although multiple

[9] http://epp.eurostat.ec.europa.eu/portal/page/portal/region_cities/regional_statistics/data/main_tables

transactions were recorded for some buildings, the majority of observations are recorded for individual buildings.

Model 1outlines the expectation that a premium on rents for offices with an ecolabel exists in the UK in a fixed effects model. This hedonic rent model compares BREEAM-rated offices to a control sample of non-BREEAM rated offices, keeping all other property attributes equal.

$$lnAC_{it} = \beta_0 + \beta_1 BREEAM_{it} + \sum_k \beta_{2,k} BC_{k,it} + \sum_m \beta_{3,m} LC_{m,it} + \sum_p \beta_{4,p} EC_{p,it} + c_t + \varepsilon_{it} \quad \textbf{(1)}$$

The dependent variable in this model is a logarithm of the achieved rent. The independent variables include the BREEAM variable ($BREEAM$) of interest, represented in this model as a binary variable for BREEAM rated buildings which are then compared to the control sample of non-BREEAM rated buildings. In addition to the inclusion of a variable for BREEAM certification, the model also controls for building characteristics (BC) by including a grade A indicator variable, age of the building and number of stories. The model controls for the location of the building (LC) by using the region in which the building is located and the Walk Score, which indicates proximity to a concentration of local amenities and their walkability. The inclusion of Walk Scores serves two key purposes. The first reason for their inclusion is as a measure of accessibility, which, as discussed in the literature review, is an additional measure of environmental efficiency because of CO_2 emissions associated with transport. The second is to serve as a proxy for the quality of the location of the building on a local level, thus at least partially addressing the lack of adequate control variables for locations in existing research which was identified in the literature review. As mentioned before, Walk Score is not yet fully supported in the UK and to capture the potential inaccuracy of scores, Walk Scores are grouped into broader categories.

Macroeconomic changes (EC) are controlled for using unemployment rates at a Nuts 2 geographical level. Also, model specifications include controls for unobserved, time-constant variables (c_t) when applicable (Wooldridge, 2006).

$$lnAC_{it} = \beta_0 + \beta_1 BREEAM\_YR_{it} + \sum_k \beta_{2,k} BC_{k,it} + \sum_m \beta_{3,m} LC_{m,it} + \sum_p \beta_{4,p} EC_{p,it} + c_t + \varepsilon_{it} \quad \textbf{(2)}$$

Model 2 investigates the second expectation of how the BREEAM premium develops over time. The model tests the hypothesis that the level of the BREEAM premium decreases as the total percentage of BREEAM rated buildings increases and supply of green buildings starts to get closer to demand for green buildings. The dependent variable in this model is again a logarithm of the achieved rent. The model compares individual dummy variables for BREEAM rated stock ($BREEAM\_YR$) in different years to individual dummy variables for non-BREEAM rated stock over different years (captured with c_t), with buildings being exclusively assigned to either one category or the other. Years rather than quarters are thus included as time fixed effects to optimise sample sizes. The remainder of the variables of interest, building quality and location variables are the same as in model 1.

$$lnAC_{it} = \beta_0 + \beta_1 BREEAM\_CERT_{it} + \sum_k \beta_{2,k} BC_{k,it} + \sum_m \beta_{3,m} LC_{m,it} + \sum_p \beta_{4,p} EC_{p,it} + c_t + \varepsilon_{it}$$

(3)

Model 3 is a hedonic model that includes a logarithm of achieved rent and dummy variables ($BREEAM\_CERT$) for the year of BREEAM construction and therefore certification to investigate whether there are notable differences between how different versions of BREEAM with different requirements perform. Information on year of certification was not available for this research, but since BREEAM is only awarded at the beginning of a building lifespan, the year of construction or major refurbishment as recorded by CoStar UK, whichever was later, was used to provide an indication of the year of certification. The remainder of the control variables remain the same, except for the time controls, which are still annual rather than quarterly. The control variables which are used here are discussed in more detail in Table 3.

INSERT TABLE 5.3 HERE

Table 3: Description of Control Variables

Yaffee (2003) discusses the drawbacks of fixed effects models, which may include an excess of dummy variables, resulting in the models being sapped of sufficient degrees of freedom for powerful statistical testing, but also in models being plagued with other issues such as multicollinearity, heteroscedasticity or autocorrelation. The author mentions that the advantage of fixed effects models is that error terms may be correlated with individual effects.

Although the inclusion of the Walk Score provides an indicator of local accessibility, there are likely to be further spatial impacts that this variable is not able to capture. The size of the sample precluded an investigation of spatial autocorrelation among residuals for the entire sample. This issue is addressed in more detail in section 6. A further limitation of this study is the absence of reliable data on individual BREEAM ratings (i.e. Pass-Outstanding), which means it is not possible to investigate the differences in impact between higher and lower levels of certification. Another limitation is the lack of sufficient control variables for lease terms. For instance, tenants may negotiate lease terms that reduce direct rental premiums which may be payable for the most environmentally efficient space in exchange for additional security for landlords such as a shorter rent free period or a longer lease.

5. RESULTS

Turning to the results, initial diagnostic testing revealed that a semi-logarithmic model provided the most appropriate specification. The percentages included in the text are a proper representation of the percentage premiums of dummy variables in a semi-logarithmic equation which have been adjusted using the method suggested by Halvorsen and Palmquist (1980) and Giles (2011), who suggest an application of the following formula to calculate the proper representation of the proportional impact p_j of a zero-one dummy variable on the dependent variable in a semi-logarithmic regression:

$$p_j = \left[exp\left(c_j\right) - 1\right] \tag{5}$$

INSERT TABLE 4 HERE

Table 4: Impact on rents of BREEAM rated buildings

Model estimations 1a and 1b in table 4 investigate the expectation that a rental premium is paid for office space with BREEAM certification. Based on 19,152 observations for Quarter 1 2006 until Quarter 4 2010 (over 11,650 buildings), the findings appear to validate this expectation; buildings with BREEAM certification command higher rents compared to buildings without this certification, *ceteris* *paribus*. After correction, these premiums range from 23% to 26% across model estimations 1a and 1b. Model estimation 1a includes the results of a pooled regression with no time-fixed effects. This model explains approximately 53% of the variation in rents. Model estimation 1b, which includes time-fixed effects, explains approximately 54% of the variation in rents. The inclusion of time effects does not impact the magnitude of the BREEAM premium greatly and it remains significant at the 1% level.

The premium of 23-26% is relatively high, especially compared to studies conducted in the US, and it is not clear if a premium of this magnitude can be entirely attributed to the existence of higher BREEAM specifications as captured by the rating. The premium may not be fully attributable to BREEAM alone as it may be that there are additional enhanced design specifications which are not reflected in the building quality rating, which are present in all BREEAM-rated buildings but which may also be present in some other non-BREEAM rated buildings with similarly higher standards which are not observed here. Another possibility may be that an 'introduction' effect is visible which is inflating the premium above what it would otherwise be. As BREEAM is introduced in the market and supply for BREEAM-rated buildings lags demand, an additional premium may be payable in the introductory stages because of the relative scarcity of BREEAM-rated buildings.

INSERT TABLE 5 HERE

Table 5: BREEAM label by year and BREEAM by year of transaction

The second hypothesis to be tested is whether the financial performance of buildings with BREEAM certification shows variations over time. Model estimation 2 in table 5 tests how the BREEAM premium develops on an annual basis based on a sample of 19,059. Model estimation 2 tests the variables in a linear regression and this specification explains approximately 53% of the variation in rents..

When also looking at the control sample, it can be seen that the economic downturn has negatively affected property rents as these have fallen overall. In line with property rents for non-BREEAM-certified buildings, the BREEAM coefficient has also decreased. After an increase in 2007 and 2008 compared to 2006 the BREEAM coefficients experience a downturn over 2009 and 2010. Compared to the holdout category, which is that of all transactions of the non-BREEAM-rated control sample in 2006, a statistically non-significant discount is observed for BREEAM-rated transactions in 2006. Depending on the model estimation (linear regression or random effects), the premium that the BREEAM-rated sample achieves over the non-BREEAM-rated sample ranges from 28% for 2007 to 23% for 2008, 29% for 2009 to 30% for 2010. Furthermore, it can be seen that BREEAM-rated buildings consistently outperform non-BREEAM rated buildings over the following years. Das et al. (2011) found green premiums to be counter-cyclical: positive and significant in down-markets, but substantially reduced in up-markets. Based on the relative inconclusiveness of the premiums observed over time in this study, data covering a larger time period, as well as more frequent observations on the various cross-sections in this dataset which will enable the construction of a panel dataset for more robust analysis are ideally required to test whether such a trend may be identified here as well. Another explanation may be offered by the method of adoption of BREEAM in the market. Although construction and supply of BREEAM-rated buildings lag demand for BREEAM-rated buildings, especially with the lack of construction since the economic downturn, tenants may have maintained their WTP for those buildings that are on the market and this may also explain the consistency of the premium over non-rated buildings over time. It is however not clear whether the downturn would fully have taken effect yet in the last quarter of 2010 and to what extent the BREEAM rated buildings witnessed here were already in the development pipeline before it started. Although the premium is somewhat reduced for 2008, no conclusive evidence of this second expectation can be attributed to this research. There is as such no evidence that the premium starts to decrease as a result of BREEAM falling in line with market values.

Model estimations 3 in table 5 investigates whether prices are consistent for different versions of BREEAM. A binary variable indicating the year of construction is used as an approximate indicator of the version of BREEAM used to assess the building. Because of a lag in construction, it can be assumed that buildings completed before or in 2006 are likely to be certified with a pre-2006 version of BREEAM. Some overlap may exist, as buildings completed in 2006, 2007 and 2008 are likely to be labelled with BREEAM 2006 and buildings completed in 2008, 2009 and 2010 will likely have the BREEAM 2008 label. Notably, the premium is high in 2006 and shows steep a drop in 2007. After this drop, the premium starts to slowly increase again in the following years. This increase in the premium may be caused by the increase in specifications and the resulting enhanced building quality as BREEAM has become harder to comply with over the years. Early testing revealed that building quality indicators are able to explain a significant portion of the premium found for BREEAM rated-buildings, highlighting the importance of their inclusion. Model estimation 3, a linear regression, explains approximately 54% of the variation in rents.

The Walk Score results in tables 4 and 5 are all highly significant, confirming the expectation that walkability and distance to local clusters of amenities can be a significant predictor of rent. Some of the results exhibit seemingly curious patterns. Notably, Walk Scores in the three categories between 70 and 99 command increasing rental discounts as the categories reach lower scores, depending on the model estimation, being at first approximately 13% (WS 90-99), then 20% (WS 80-89), then21% (WS 70-79). Yet after this last category it appears that a tipping point is reached at which these discounts become less severe between Walk Scores of 60 to 69 (18-19%) and even less severe in the lower categories (15-16% for WS 50-59; 17-18% for WS 30-49; 17-18% for WS 0-29). It is not entirely clear why the lower score categories outperform some of the higher score categories. Possible explanations might be that the impact on rental bids of walkability becomes less severe for offices located in the periphery of cities, possibly because many offices are located in out of town business parks, where car-based transport is often the norm and walkability is of lesser importance and occupiers may consequently be prepared to pay premiums for this enhanced accessibility. Another explanation may be that offices with Walk Scores between 70 and 89 are frequently located in less desirable areas and that other external factors related to location quality not captured by Walk Scores are of importance here. An additional angle that can be explored in future research is the impact of accessibility and public transport. Seen from an environmental efficiency perspective, the hierarchy of these coefficients may be of importance as the impact of these indicators also helps to determine the degree of transport impact and the associated environmental efficiency of office buildings.

O'Sullivan (2009) explains how higher transport costs and a high opportunity cost of travel time of office users may lead to office users outbidding other users in rental bids for land that is located around the centre of a monocentric city. Another explanation, proposed by Evans (2004), demonstrates how planning constraints in the availability of land for commercial and industrial (manufacturing) uses may result in different rent gradients, which can lead to sudden jumps and falls in the rental bid curve. A combination of effects is suggested here: out of town office parks, which are affected by planning constraints, create sub centres in addition to the Central Business Districts (CBDs) that attract comparatively higher rental bids because of their comparatively higher accessibility, especially compared to those offices which exist in the periphery of the CBD.

Turning to the other significant variables of interest, age is also a significant predictor of rent. Increases in age (categorised by age group) negatively affect rents. This negative effect stabilises at a discount of around 25-27% at the age categories of 40-49 and 50-59 years. Buildings that are 60 years or older outperform all categories between 20 and 59 years. An explanation for this may be that occupiers are expressing their preferences for older, possibly historic buildings through a rental premium. This finding is especially notable when considering the longevity of these older buildings and their embodied CO_2 and materials, features which are not currently captured to a great extent by any mainstream environmental assessment tools.

An increase in building height by one floor leads to an increase in rent of 2.7-2.8%. Taller buildings often tend to require an increasing number of services which could explain this increase in rent, although it may be more likely that such increases would be captured by a higher service charge. There is also a possibility that a micro location premium is at work here, as taller buildings with a large number of stories are often located in city centres of larger cities where higher rents are achieved, although such locations should be at least partly controlled for with the Walk Score. Finally, the variable for Rentable Building Area (RBA) achieves a negligible coefficient at low significance levels and the unemployment rate is inversely linked to rents, indicating that an increase in employment causes a reduction in rents, although this variable is only significant at a 5% level in most model specifications, except for model estimation 1a, where it is significant at a 1% level. The regional variables and time-fixed effects perform mostly as expected, the significance of the latter showing some signs of uncertainty regarding the direction of coefficients during the economic downturn.

6. CONCLUSIONS

This research has investigated whether premiums on market rents are paid for space in BREEAM-rated buildings, how these premiums develop over time and whether there are different impacts for different versions of BREEAM. The results show that buildings that have been BREEAM-rated do command rental premiums which range from 23-26%, on average, at a 1% level of significance compared to the control sample of non-BREEAM-rated buildings. These results are in line with previous studies that use data from the US, where rental and sales premiums are found for offices with favourable ecolabels such as LEED and Energy Star. Looking at the premium over time, BREEAM-rated buildings consistently outperform non-BREEAM-rated buildings in 2007, 2008, 2009 and 2010, indicating that there appears to be little to no shift in the size of the premiums before or after the economic downturn.

Several explanations may account for the existence of these premiums. Certain companies may want to pay a premium to occupy environmentally efficient space to follow internal CR policies or to align their business model with the space that they occupy. Additionally, an ecolabel for these buildings may represent a more general benchmark of enhanced quality of additional characteristics of grade A buildings for which occupiers are willing to pay more rent. It should be noted that key lease details, such as type of lease and lease length were not available for this research and future research may benefit from the inclusion of such variables.

Although the inclusion of the Walk Score goes some way towards addressing the impact of the spatial environment and this paper has made a contribution in addressing the need for further spatial controls which has been highlighted in the literature review, this single variable has its limitations and is unlikely to sufficiently capture all spatial characteristics that influence the price determination process. Because of the size of the sample and limitations of current statistical software packages, the authors were unable to test the wider impact of spatial autocorrelation among residuals for the entire sample in this paper. Further testing on smaller randomly selected subsamples of 1,000 observations suggested the possibly existence of further spatial autocorrelation patterns and this is an issue that should be addressed in more detail in future research.

The Walk Score results also provide an interesting perspective. Although the highest rents are paid for what are the most walkable buildings in the top category selected here, which are likely to be the most centrally located ones, some of the lower categories achieve higher rents than those above them. This may reflect a WTP for out of town offices compared to offices closer to the CBD. From an environmental perspective, this poses challenges as it highlights the preferences of some occupiers for offices in locations which may have significant transport CO_2 emission footprints attached to them. Out of town offices may have poor public transport accessibility and may rely on individual car-based transport, resulting in a higher CO_2 footprint. Other key features which can be investigated in future studies include the impact of accessibility, as measured by public transport and car-based transport, and proximity to transport nodes.

Depending on the nature of their business and its requirements, occupiers may be looking to achieve different levels of BREEAM in their space. While some may be actively targeting buildings that have the highest BREEAM rating to set a best practice example, others may be content as long as the space that they occupy is BREEAM-certified and they may be willing to make the concession to pay less for a lower BREEAM rating. The impact of different levels of labelling (i.e. pass-outstanding) is a key issue that should be examined in more detail in future research, as adequate information on the levels of various BREEAM ratings becomes available.

This research has discussed how BREEAM has evolved over the years and how it is likely to continue to change. These changes over time could signify that a building that may perform well in one version of the BREEAM tool would not necessarily achieve the same amount of credits in another version. To understand this is essential, as these changes will not only affect the outcome of the BREEAM rating, but they may diminish the relevance of older ratings, as different BREEAM ratings are not necessarily compatible and interchangeable.

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Table 1: Total offices in England & Wales and number of BREEAM Certified offices

	Total Commercial Offices per year		Total BREEAM rated per year	
Year	England & Wales	London	England & Wales	London
1998	241,464	72,035		
1999	243,343	71,983	21	11
2000	248,931	74,976	50	15
2001	253,778	75,492	66	20
2002	260,115	76,728	97	31
2003	266,022	77,882	84	20
2004	271,653	79,934	95	32
2005	275,527	80,797	98	24
2006	285,738	83,114	127	26
2007	294,099	83,532	165	27
2008	300,268	84,200	364	59

Table 2: BREEAM Sample Summary Statistics (N = 18,191)

	Mean	Standard Dev	Observations
Achieved Rent (£psf)	21.25	14.94	20,494
Age (yrs)	72.08	67.83	18,384
Rentable Building Area (sq ft)	33610.67	78279.61	19,818
Number of Floors	4.77	3.61	19,695
Walk Score	84.29	20.04	20,014
Unemployment (%)	6.98	1.58	20,490

Table 3: Description of Control Variables

Independent variables	
Age	Binary variable of the age of the property, grouped into categories (categories are: 0-9 yrs; 10-19 yrs; 20-29 yrs; 30-39 yrs; 40-49 yrs; 50-59 yrs; 60 yrs and onwards, age unknown)
Number of floors	Continuous variable of the number of floors of the property
RBA	Continuous variable of the rentable building area (RBA) of the building in square feet
Building quality 4 or 5 Star	Binary variable that indicates buildings of the highest building classes that CoStar UK assigns (4 and 5 Star rated buildings)
BREEAM Rated	Binary variable that indicates whether the building has a BREEAM rating
Year of BREEAM Certification	Binary variable that indicates the year of construction and therefore certification of the building (categories: 2006, 2007, 2008, 2009 and 2010)
BREEAM labelled transaction (yr)	Annual binary variable indicating the use of BREEAM labelled rent transactions from designated year (2006-2010)
Non-BREEAM labelled transaction (yr)	Annual binary variable indicating the use of non-BREEAM labelled rent transactions from designated year (2006-2010)
Region	Binary variable for the region of the property, with an additional reference category that indicates whether the office is located in central London
Walk Score	Binary variable that indicates the Walk Score of the building (categories: Unknown, 0-29, 30-49, 50-59, 60-69, 70-79 80-89, 90-99 and 100)
Unemployment rates	Continuous variable which indicates annual levels of unemployment throughout regions in the UK for 2006-2010.
Quarterly time controls	Binary variable indicating quarter and year of the transaction (2006Q1-2010Q4)
Year of transaction	Binary variable indicating year of the transaction (2006-2010)

Table 4: Impact on rents of BREEAM rated buildings

	1a	1b
	Linear regression	Linear regression (time fixed)
Constant	3.870	3.548
	[139.02]***	[101]***
BREEAM rated	0.209	0.228
	[6.65]***	[7.29]***
Age of building		
0-9 yrs	Holdout Category	Holdout Category
10-19 yrs	-0.125	-0.126
	[-10.33]***	[-10.47]***
20-29 yrs	-0.191	-0.189
	[-14.71]***	[-14.63]***
30-39 yrs	-0.258	-0.256
	[-17.84]***	[-17.77]***
40-49 yrs	-0.312	-0.307
	[-18.61]***	[-18.36]***
50-59 yrs	-0.302	-0.291
	[-15.63]***	[-15.2]***
60 yrs or more	-0.171	-0.164
	[-15.42]***	[-14.86]***
Unknown	-0.245	-0.245
	[-15.35]***	[-15.45]***
RBA	0.000	0.000
	[-0.51]	[-0.66]
Number of floors	0.028	0.027
	[20.65]***	[20.31]***
Building Quality 4 or 5 Star	0.154	0.152
	[15.69]***	[15.6]***
Walk Score		
100	Holdout Category	Holdout Category
90-99	-0.144	-0.144
	[-13.79]***	[-13.96]***
80-89	-0.223	-0.217
	[-15.1]***	[-14.84]***
70-79	-0.235	-0.234
	[-13.43]***	[-13.41]***
60-69	-0.213	-0.204
	[-11.15]***	[-10.69]***
50-59	-0.176	-0.165
	[-8.47]***	[-7.95]***
30-49	-0.197	-0.186
	[-10.62]***	[-10.06]***
0-29	-0.201	-0.189
	[-8.1]***	[-7.71]***
Unknown	-0.158	-0.149
	[-6.28]***	[-5.99]***
Unemployment rate	-0.041	-0.008
	[-16.08]***	[-2.23]**
Region		
Central London	Holdout Category	Holdout Category
East Midlands	-1.090	-1.007
	[-41.82]***	[-37.71]***
East of England	-0.934	-0.815
	[-29.44]***	[-24.83]***
Greater London	-0.415	-0.391
	[-30.85]***	[-29.29]***
North East	-0.941	-0.910
	[-34.98]***	[-33.7]***
North West	-0.924	-0.844
	[-65.37]***	[-55.72]***
Northern Ireland	-1.067	-0.930
	[-12.58]***	[-10.82]***
Scotland	-0.865	-0.791
	[-41.2]***	[-36.16]***
South East	-0.779	-0.653
	[-51.19]***	[-37.37]***
South West	-0.989	-0.853

	1a	1b
	Linear regression	Linear regression (time fixed)
	[-53.88]***	[-41.34]***
Wales	-0.998	-0.925
	[-43.45]***	[-38.61]***
West Midlands	-0.870	-0.862
	[-57.07]***	[-58.33]***
Yorkshire and the Humber		-0.892
		[-52.12]***
Transaction quarter		
2006Q1		
2006Q2		0.028
		[1.48]
2006Q3		0.023
		[1.16]
2006Q4		0.032
		[1.65]
2007Q1		0.073
		[3.86]***
2007Q2		0.101
		[5.03]***
2007Q3		0.123
		[5.99]***
2007Q4		0.109
		[5.62]***
2008Q1		0.136
		[7.05]***
2008Q2		0.110
		[5.51]***
2008Q3		0.116
		[5.78]***
2008Q4		0.110
		[5.59]***
2009Q1		0.050
		[2.32]**
2009Q2		-0.009
		[-0.4]
2009Q3		-0.047
		[-2.28]**
2009Q4		-0.037
		[-1.85]*
2010Q1		-0.087
		[-4.26]***
2010Q2		-0.069
		[-3.38]***
2010Q3		-0.076
		[-3.6]***
2010Q4		-0.051
		[-2.08]**
Number of observations	19,509	19,509
R-squared	0.527	0.536

*** significance at 1% level; ** significance at 5% level; * significance at 10% level
White heteroskedasticity consistent standard errors & covariance

Table 5: BREEAM label by year and BREEAM by year of transaction

	2	3
	Linear regression (time fixed)	Linear regression (time fixed)
Constant	3.570	3.570
	[108.16]***	[108.11]***
BREEAM labelled transaction (yr)		
2006	-0.090	
	[-0.53]	
2007	0.310	
	[4.88]***	
2008	0.287	
	[5.37]***	
2009	0.225	
	[3.87]***	
2010	0.186	
	[4.12]***	
Non-BREEAM labelled transaction (yr)		
2006	Holdout	
	Category	
2007	0.078	
	[7.97]***	
2008	0.096	
	[9.79]***	
2009	-0.039	
	[-3.46]***	
2010	-0.097	
	[-8.41]***	
Year of Certification		
2006		0.351
		[7.01]***
2007		0.128
		[3.07]***
2008		0.170
		[2.97]***
2009		0.229
		[3.94]***
2010		0.237
		[3.57]***
Age of building		
0-9 yrs	Holdout	Holdout
	Category	Category
10-19 yrs	-0.128	-0.129
	[-10.56]***	[-10.64]***
20-29 yrs	-0.189	-0.190
	[-14.63]***	[-14.7]***
30-39 yrs	-0.257	-0.257
	[-17.84]***	[-17.88]***
40-49 yrs	-0.308	-0.309
	[-18.46]***	[-18.52]***
50-59 yrs	-0.293	-0.293
	[-15.31]***	[-15.33]***
60 yrs or more	-0.164	-0.165
	[-14.91]***	[-14.97]***
Unknown	-0.247	-0.247
	[-15.55]***	[-15.58]***
RBA	0.000	0.000
	[-0.67]	[-0.65]
Number of floors	0.027	0.027
	[20.24]***	[20.31]***
Building quality 4 or 5 Star	0.152	0.152
	[15.57]***	[15.57]***
Walk Score		
100	Holdout	Holdout
	Category	Category
90-99	-0.144	-0.144
	[-13.93]***	[-13.91]***

	2	3
	Linear regression (time fixed)	Linear regression (time fixed)
80-89	-0.217	-0.218
	[-14.88]***	[-14.9]***
70-79	-0.234	-0.234
	[-13.42]***	[-13.42]***
60-69	-0.205	-0.205
	[-10.73]***	[-10.73]***
50-59	-0.165	-0.165
	[-7.93]***	[-7.93]***
30-49	-0.186	-0.187
	[-10.11]***	[-10.14]***
0-29	-0.188	-0.188
	[-7.66]***	[-7.67]***
Unknown	-0.150	-0.150
	[-6]***	[-6.01]***
Unemployment rate	-0.008	-0.008
	[-2.19]**	[-2.21]**
Region		
Central London	Holdout Category	Holdout Category
East Midlands	-1.008	-1.008
	[-37.83]***	[-37.84]***
East of England	-0.816	-0.816
	[-24.83]***	[-24.83]***
Greater London	-0.391	-0.391
	[-29.24]***	[-29.22]***
North East	-0.909	-0.910
	[-33.61]***	[-33.62]***
North West	-0.842	-0.842
	[-55.56]***	[-55.53]***
Northern Ireland	-0.935	-0.936
	[-10.88]***	[-10.89]***
Scotland	-0.789	-0.788
	[-36.08]***	[-36.05]***
South East	-0.653	-0.652
	[-37.31]***	[-37.29]***
South West	-0.853	-0.854
	[-41.33]***	[-41.37]***
Wales	-0.926	-0.925
	[-38.69]***	[-38.59]***
West Midlands	-0.860	-0.861
	[-58.18]***	[-58.18]***
Yorkshire and the Humber	-0.891	-0.891
	[-52.06]***	[-52.04]***
Year of transaction		
2006		Holdout Category
2007		0.079
		[8.1]***
2008		0.096
		[9.9]***
2009		-0.037
		[-3.31]***
2010		-0.095
		[-8.24]***
Number of observations	19,509	19,509
R-squared	0.535	0.535

*** significance at 1% level; ** significance at 5% level; * significance at 10% level

White heteroskedasticity consistent standard errors & covariance