



ENVIRONMENTAL CERTIFICATION SCHEMES AND PROPERTY VALUES: EVIDENCE FROM THE HONG KONG PRIME COMMERCIAL OFFICE MARKET

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Received 24 April 2017; accepted 27 April 2018

Abstract. A barrier to green-building development is the uncertainty and scepticism about the financial implications. This study aimed to investigate whether the green-certification schemes help buyers to recognize the benefits of green office buildings by their willingness to pay a premium for such buildings. The study used a hedonic-model based on a sample of 67 prime office buildings (including non-green comparables) certified by HKBEAM, BEAM-Plus and LEED in Hong Kong. The empirical findings suggest that green certification schemes add extra value to an office property. The rental value of office properties certified by HKBEAM, BEAM Plus and LEED is about 10.9% higher than for non-certified office buildings. More specifically, tenants/users are willing to pay a premium of 10.9% for green-certified office properties. The findings have practical implications in encouraging green building development in Hong Kong and elsewhere. The findings indicate that the higher rental income from green office buildings can cover the additional cost of obtaining green certification within a period of 22-months (22.32 months) in Hong Kong. The results provide references for various stakeholders (developers/investors/users) in establishing the business case for green-office buildings, because of the ability of the market to capitalize the environmental benefits of green office properties.

Keywords: green certification, office rental value, green-premium, HK-BEAM, BEAM Plus and LEED.

Introduction

In order to address climate change and global warming issues, policy makers and property investors consider buildings as one of the most important vehicles (Chegut, Eichholtz, & Kok, 2014), as buildings account for nearly one-third of overall CO₂ emissions and constitute the largest climate change offender. Similarly, buildings also possess great potential for green-house gas (GHG) abatement (Heinzle, Yip, & Xing, 2013). As increasing demands to address climate change and global warming are voiced, the entire real estate industry has an imperative role to play in achieving energy efficiency (Wadu Mesthrige & Wan, 2013), GHG emissions abatement and corporate social responsibility (CSR) in realizing a low-carbon society. Numerous organizations, particularly in the real estate and construction sector are setting targets for themselves to minimize the environmental impact of the various activities they perform in order to demonstrate that their CSR credentials are in line with broader sustainability goals.

There is however, a notable degree of uncertainty and scepticism underlying the financial implications of green

buildings, and this is considered to be a barrier to their development. Researchers believe this is mainly due to the misalignment of incentives for green buildings or a “vicious circle of blame” (Falkenbach, Lindhol, & Schleich, 2010; RICS, 2008). Investors’ reluctance to pay additional costs for green buildings often prevents developers from constructing green buildings. The reluctance of investors stems from their perception that there is insufficient demand for green buildings from property buyers. Hence, construction firms are barred from constructing those properties as developers do not want them to do so (Heinzle et al., 2013). As a result, those property buyers, who are willing to buy or rent green properties, are frustrated by the insufficient supply (Heinzle et al., 2013). This is known as “asymmetry of incentives” among stakeholders, or ‘vicious circle of blame’ (Falkenbach et al., 2010).

One way to address this incentive gap is to disclose and disseminate information about the environmental performance of buildings. This incentive asymmetry can be overcome through dissemination of environmental information about buildings (Reichardt, Fuerst, Rottke,

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& Zietz, 2012). Various professional building assessment schemes and awards have been introduced across the globe to overcome this information asymmetry over the years. In line with the growing interest in various environmental building rating schemes and certifications, Hong Kong has also initiated various green incentive schemes over the past two decades. For example, in order to promote and guide stakeholders in the real estate market towards the best sustainable practices, private and government sectors in Hong Kong have developed a series of professional assessment schemes and practice codes (Jones Lang LaSalle, 2009). Many stakeholders still consider that green buildings and sustainable buildings are synonyms. Green buildings include only environmental aspects. The sustainable building concept however is much broader and include several classes of criteria related to environmental, societal and economic aspects (Haapio & Viitaniemi, 2008; Castro, Mateus, & Bragança, 2015; Raslanas, Kliukas, & Stasiukynas, 2016). Although within the context of Hong Kong, there are different challenges to develop a green building project including high rise dense urban morphology, intensive use of air-conditioning, artificial lighting and lack of concerns for water and electricity saving (Gou & Lau, 2014). Several government initiatives over the past decade to encourage property developers to incorporate more green features are: (1) the standard environmental performance system (ISO 14001), which was initiated by the Hong Kong Quality Assurance Agency (HKQAA); (2) Indoor Air Quality (IAQ) rating scheme, implemented by the Environmental Protection Department (EDP); (3) the Buildings Energy Codes (BECs), initiated by the Hong Kong Electrical and Mechanical Services Department (EMSD); and the Joint Practice Notes 1 (JPN1) and 2 (JPN2), jointly implemented by the Buildings Department (BD), the Lands Department (LD) and the Planning Department (PD).

Besides these government initiatives, in order to provide greater recognition and better awareness of the benefits of green buildings, various non-governmental organizations have also introduced numerous green building certification schemes and awards. Three such locally well-schemes are:

- a) The HK-BEAM (Hong Kong Building Environmental Assessment Method) Certificate by the HK-BEAM Society Limited – since 1996.
- b) The BEAM Plus Certificate by the HKBEAM Society Limited – since April 2010.
- c) The Green Building Award by the Hong Kong Green Building Council – since 2006.

In addition to these local certification schemes, the LEED (Leadership in Energy and Environmental Design), well-known green-building certification scheme initiated by the US Green Building Council is also famous and well received by the construction industry in Hong Kong. Likewise, well known other overseas certifications include, BREEAM (Building Research Establishment's Environmental Assessment Method) in the UK, and CASBEE (Comprehensive Assessment System for Built Environ-

ment Efficiency) in Japan. Certainly, real estate provider stakeholders would see all these initiatives as incentives to incorporate more green elements into their new developments. Despite these initiatives, however financial benefits and other implications of green building developments, relative to conventional buildings are not yet certain. As the cost premium for a green development is relatively high, questions arise about the effects of green developments on the cost-benefit ratio (Shimizu, 2010). Compared to conventional buildings, the green development cost premium is in the range of 5–20% (Gomez, 2008). Miller, Spivey, and Florance (2008), and Kats (2006) report a cost premium of 2–4%; whilst Kats (2003) also reports that it costs 1.8% more to design and develop environmentally friendly buildings. Hence, investors and developers often question the financial implications of green design and buildings. In particular, they are uncertain whether incorporating green elements into property developments would actually enhance building occupancy, rents and selling prices (Wiley, Benefield, & Johnson, 2010).

Previous researchers have critically analyzed and compared application of different sustainability assessment methods including LEED, BREEAM, CASBEE and Green Star etc. in different types of buildings. For example, in general buildings (Haapio & Viitaniemi, 2008), office buildings (Lee & Burnett, 2008), public residential design schemes (Gou & Lau, 2014), healthcare buildings (Castro et al., 2015), and recreational buildings (Raslanas et al., 2016). Gou and Lau (2014) demonstrated that thermal performance of a building's envelop is largely ignored in the Hong Kong building codes and green building rating system. Due to different environmental requirements and evaluation criteria not all sustainability assessment methods could be applied to a variety of buildings and most of the methods are not covering social and economic aspects (Raslanas et al., 2016). Recently few researchers have highlighted the importance and the potential for revenue premiums in various green certification systems in the US, the UK and Australia (e.g., Robinson, Simons, Lee, & Kern, 2016; Robinson & Sanderford, 2016; Robinson & McAllister, 2015). However, the present study is unique, in the sense of being the first covered with commercial properties in Hong Kong, and because it is a comprehensive study in the high-rise context in Asia. This is significant as the Asian perception about the living and working in a green building may differ substantially in substance from the Western perception. In Asia, economics still precedence over sustainability goals; and factors such as location and accessibility may be the primary considerations rather than green features in the choice of a commercial buildings (Addae-Dapaah & Chieh, 2011). Secondly, awareness and attitudes towards green buildings in the market and among people in Asia are still at an early stage. A comprehensive analysis of the impact of green certification schemes in Asia is therefore a pre-requisite if we are to encourage investors/developers to incorporate green elements/practices in property development. For Hong Kong, hardly any research has been done on the

commercial office property market. Thirdly, Hong Kong is a high-density compact city with few green and open spaces, very different from the US and the UK contexts. Fourthly, only very limited knowledge and information is available about the demand for green commercial office buildings, particularly on the premium that property buyers and users would be willing to pay for green certification. This study aims to fill this research gap by answering two questions: (i) “Would buyers be willing to recognize the benefits of green buildings by paying a premium for them?”; and (ii) “How would the market value green commercial office buildings?”. It is hypothesized that green certifications would help to address “incentive asymmetry” among real estate stakeholders, and act as incentives to offset the higher green development costs by narrowing the disparity between cost and benefit. Fifthly, this study addressed the weaknesses due to the omitted variables issue in hedonic price modelling, by adopting a fixed effects approach to reduce biases among the estimates.

In the study, commercial office properties certified by HK-BEAM, BEAM Plus and LEED were recognized as “green buildings”. These are awarded by the HK-BEAM Society Limited and the US Green Building Council, respectively. In the study, bases of property value is specified according to the definition given by the International Valuation Standards Council [IVSC], 2017: Market Value (Section 30), Market Rent (Section 40), Equitable Value (Section 50), Investment Value (Section 60). The scope of the study was limited to private commercial office developments as market forces determine the prices of private properties, whereas in the public sector market signals are not that efficient. Section 1, below, provides an overview of the sustainable initiatives with special reference to construction and real estate industry, along with a review of previous studies mainly of environmental certification schemes in the commercial property market. Thereafter, Section 2 describes the data sources, including the modelling of the hedonic price method (HPM). The penultimate section analyzes the empirical results obtained from the HPM, while the last section concludes with findings and implications.

1. Literature review

1.1. Hong Kong context: trends and sustainable initiatives

Over the last two decades, an increasing trend has emerged in that organizations and governments all over the world are seriously concerned about the natural and social environment in which they work and live (Wetering & Wyatt, 2011). There are a number of reasons for this, but climate change and global warming is a prominent concern, which the real estate and construction industry has an imperative role to play in addressing and achieving energy efficiency and carbon abatement in the realization of a low-carbon society. The construction industry, in particular new construction, has an adverse impact on the environment as it

consumes a vast amount of energy resources (Dimoudi & Tompa, 2008; Mohammad & Amato, 2006). The life cycle of this industry, which includes construction, operation, maintenance and demolition, consumes around half of the total energy demand, and is also responsible for a significant amount of GHG, and almost 50% of the CO₂ emissions to the environment (Yan, Shen, Fan, Wang, & Zhang, 2010; Dimoudi & Tompa, 2008).

While the building industry globally accounts for a little more than 1/3 of GHG emissions, the figure for Hong Kong is remarkably high; at nearly 70% (WBCSD, 2008). This is mainly due to heating and cooling, especially the air-conditioning and the lighting and ventilation of buildings (Metha, 2007). The building industry in Hong Kong is responsible for the largest component of energy consumption accounting for the largest GHG emissions (Gorer, Lawson, Loh, Botelho, & Leao, 2008). Key sustainability elements of the building sector in general and the commercial sector in particular need to be clearly studied and integrated in order to fully implement sustainable development goals of Hong Kong (Mohammad & Amato, 2006). The commercial office sector in Hong Kong is a major constituent of the building industry, particularly in relation to operational energy consumption. As seen in Figure 1, the operational energy consumption of the commercial sector (compared to other sectors) is very high, and shows an increasing trend over the last two decades. In other words, the commercial sector is responsible for most of the electricity consumption in the built environment in Hong Kong. According to the Environment Bureau (2011), buildings electricity consumption accounts for 60% of Hong Kong’s total GHG emissions; and in 2008, commercial buildings alone were responsible for 65% of the total energy consumption of buildings. This clearly demonstrates that office buildings, as the main constituent of the commercial sector, contribute largely to GHG emissions in Hong Kong. Therefore, the commercial office sector in particular has a pivotal role to play in the realization of a sustainable built environment and a low-carbon society.

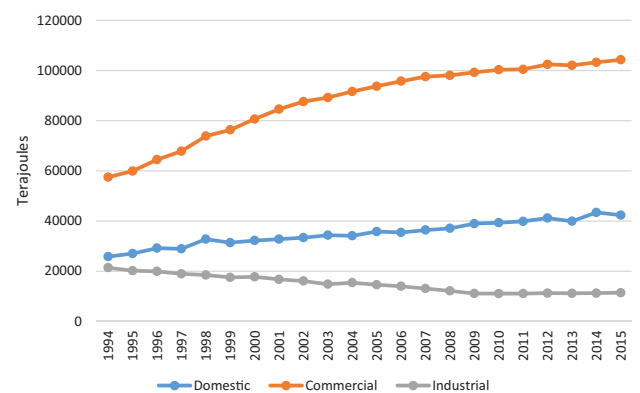


Figure 1. Sectoral breakdown of electricity consumption 1994–2015 (sources: Census and Statistics Department, Hong Kong Energy Statistics-Annual Reports (various issues))

Sustainable initiatives

Over the past two decades, the global ideas of a “low-carbon society” and “sustainable development” have been at the forefront in the main global forums. In line with the global trend of setting targets to minimize the environmental impact of buildings, the real estate sector in Hong Kong over the past few years has begun to appreciate the importance of labelling the environmental performance of buildings. For example, numerous building assessment schemes, codes and ratings have been put in place to encourage real estate stakeholders to practice best sustainability principles (Jones Lang LaSalle, 2009). The Hong Kong government, demonstrating its commitment in line with “Agenda 21”, has been very active in identifying and implementing various policies and mechanisms for achieving overall sustainable development goals (Chan, Esther, & Yung, 2004). However, the majority of these initiatives and incentives to enhance sustainability practices are voluntary.

An early government initiative was the Considerate Contractors Site Award Scheme (CSAS), set up in 1995. This was jointly initiated with the Development Bureau (DevB) with the intention of promoting awareness of good site safety and health and environmental practices on construction sites (HKSAR Development Bureau, 2011). Similarly, in another significant move to provide builders with incentives to incorporate new green features into new developments, the government introduced two important practice notes: JPN1 (Joint Practice Note 1) and JPN2 (Joint Practice Note 2) in 2001 and 2002, respectively. The main aim of these Notes was to encourage developers to adopt a holistic life cycle approach for the entire construction process so as to minimize usage of non-renewable energy and demolition waste. It was expected that these incentives would encourage developers to incorporate more green elements in the form of balconies, sky gardens and utility platforms. In 2003, demonstrating further commitment to a green building industry, two more important initiatives were taken by the government. First, the government established the indoor air quality management (IAQ) scheme, and second, the government established the “Council for Sustainable Development”. This institution was expected to identify and advise the government on sustainable development priority areas. In order to promote public awareness of sustainability practices, the government also established a fund, known as the “Sustainable Development Fund” with a starting fund of HK\$ 100 million.

Some serious efforts by the private sector to promote green features and buildings are also evident in Hong Kong. For example, one of the very early initiatives was the “Business Environment Council (BEC)”, established in 1989, with the intention of promoting corporate sustainability (CS) and environmental sustainability (ES) (Business Environment Council [BEC], 2011). Another such private sector initiative established to promote sustainable development is the “Hong Kong Sustainable Development Forum”, set up in 2001.

These initiatives have increased public awareness of the importance of sustainable construction in Hong Kong and have led to a variety of building assessment schemes to rate building environmental performance. Two well-known examples are the HK-BEAM and BEAM Plus certification schemes, awarded by the HKBEAM Society Limited. Among these two professional certification schemes, on a per-capita basis HK-BEAM is the most commonly used voluntary building rating scheme of its kind in the world (BEC, 2011). As the most popular local building certification scheme in the industry, approximately 150 major property developments, including 36,000 housing units, have been certified by HK-BEAM for improved performance since its establishment. This scheme was greatly inspired by BREEAM (Building Research Establishment’s Environmental Assessment Method) in the UK, (Jones Lang LaSalle, 2009). BEAM Plus, which was introduced in 2010, was a revamped version of BEAM. BEAM Plus widened the coverage of issues, further defining the quality and sustainability of building features (BEAM Society, 2012b). See Table 1 for a brief description of the assessment criteria of HK-BEAM and BEAM Plus. Another scheme, the HK-GBC award, was jointly established in 2006, by the Professional Green Building Council (PGBC), the Construction Industry Council (CIC), and the Business Environment Council (BEC), and aims to promote the adoption of green building standards for a more sustainable Hong Kong.

These schemes are instrumental in quantifying the environmental impact of buildings. Green-labelling or certification schemes, however, are relatively new to the commercial office sector compared to the residential sector in Hong Kong. As shown in Table 2, out of the total green certification schemes, only 18% and 42% of new commercial properties have been certified by BEAM Plus and HKBEAM, respectively. In the case of LEED, however the figure is about 80% as LEED was designed mainly for commercial properties. However, not a single study has been conducted in Hong Kong focussing on the impact of such schemes on commercial office property values, vacancies or rents. A comprehensive study focussing on the effects of eco-labelling of office buildings will help us understand whether buyers consider green certification schemes as reliable in their ability to recognize the benefits of green office buildings, and hence are willing to pay premiums for such buildings.

1.2. Green building certificates and property values

Buildings that possess a green certification award are expected to bring various benefits to the tenants and to society equally, which include the use of low-resource renewable materials and lower CO₂ emission, (Fuerst & McAllister, 2011; Reed & Wilkinson, 2008; Wilkinson, Reed, & Cadman, 2008), healthy living space through cleaner air quality (Pitts & Jacksons, 2008; Dunckley, 2007), the use of less water (Roper & Beard, 2006), cost savings to tenants through the efficient use of energy (Reichardt et al., 2012;

Table 1. Assessment criteria and benefits of HK-BEAM, BEAM Plus and LEED (sources: extracted from Mohammad and Amato (2006), Table 1; WBCSD (2008); Ahankoob, Morshedi, and Rad (2013); Hong Kong Green Building Council (2016); US Green Building Council (2016a))

Assessment tool	Criteria	Benefits
HK-BEAM	<p>Global issues and use of resources (energy efficiency, deforestation and loss of biodiversity, ozone depletion, environmental management, depletion of natural resources)</p> <p>Local issues (ecological impacts and landscaping, wind and micro climate, noise/air/water impacts of operation, construction management, waste management, and waste conservation)</p> <p>Indoor issues (thermal comfort, air quality, lighting, noise, hazardous materials)</p>	<p>Cost savings – more efficient use of energy and resources (both construction and use of buildings)</p> <p>Better buildings – provide healthy and productive accommodation</p> <p>Reduced risks – through best management practice</p> <p>Effective markets – assurance of the green credentials of the buildings and tenants and buyers are able to communicate their preferences</p> <p>Regulatory preparedness for both local and international standards</p>
BEAM Plus	<p>Management (policies, procedures and strategies implemented to ensure buildings are operated in a sustainable manner)</p> <p>Site aspects (site location, emissions from the site, greenery, site amenities)</p> <p>Materials and waste aspects (materials in (green purchasing) and out (waste disposal) of the building)</p> <p>Energy use (energy performance, energy management and analysis, commissioning, energy efficient improvement, enhancement)</p> <p>Water use (quality and features that improve the utilisation and reduce effluent)</p> <p>Indoor environmental quality (health, comfort, or well-being of the occupants, as well as aspects of performance that improve quality and functionality)</p> <p>Innovations and additions (introduces innovative designs, construction or operational provisions that enhance performance)</p>	<p>Cost-savings through the more efficient use of energy and resources</p> <p>Increasing occupant satisfaction from healthy and productive accommodation</p> <p>Enhancing corporate profile and marketability to potential building users</p> <p>Providing a tool to improve purchaser choice and information</p> <p>Integrating local and international best practice into new designs</p> <p>Providing increased protection against environmental liability</p> <p>Establishing a clear direction for continuous improvement and optimised performance</p>
LEED	<p>Water efficiency – indoor and landscaping water use reduction and wastewater strategies</p> <p>Energy and atmosphere – to ensure that energy-efficient systems are installed, calibrated and customer's desired results are provided by producing following items, to minimize the level of energy consumption so as to minimize environmental and economic impacts resulting from excessive energy use and refrigerant management to reduce stratospheric ozone depletion</p> <p>Materials and resources – to use durable goods and materials to minimize the effects on environment, maintenance of facilities of buildings and to reduce the degree of toxic waste</p> <p>Innovation and design process</p> <p>Indoor environmental quality – to enhance indoor to improve and enhance the health and well-being of the occupants</p>	<p>Provide a competitive differentiator – sustainability leads to market differentiation and improved financial performance</p> <p>Make for happier employees and occupants – increased recruitment and retention rates and increased productivity benefits for employers</p> <p>Attract tenants – tenants understand and are looking for the benefits that LEED-certified spaces have to offer</p> <p>Save energy and resources, lower operating costs – firms that built green to achieve lower operating costs and to gain a branding/public relations advantage</p> <p>Be cost-effective – LEED-certified facilities annually opened up 458 more consumer deposit accounts and had more consumer deposit balance per facility per year and increased revenue</p> <p>Provide public relations community benefits – not only did it reap great publicity, but had garnered a net present value return of almost 20 to one on its initial investment</p> <p>Increase rental rates – the overall vacancy rate for green buildings was 4% lower than for non-green properties</p> <p>Optimize health – by bringing the good in and keeping the bad out, LEED creates healthy spaces. Buildings that optimize wellbeing are more important than ever</p>

Table 2. Number of projects certified by green certifications (as of 1 March 2016) (sources: Hong Kong Green Building Council (2016); BEAM Society (2012a); US Green Building Council (2016b))

	Total number of certified projects	Total number of projects in commercial sector
BEAM Plus	348	63
HKBEAM	279	119
LEED	174	139

Fowler, Rauch, Henderson, & Kora, 2011; Kats, 2003), and increased tenants' satisfaction through a healthy living environment (Miller, Progue, Gough, & Davis, 2009). From the business point of view, the benefits include increased business productivity through best management practices and an improved corporate profile (Orlitzky, Schmodt, & Rynes, 2003), increased employee productivity and retention rates of employees (Miller et al., 2009; Lucuik, 2005) and enhanced marketability to potential tenants. Various stakeholders, including the real estate business community now tend to believe that embracing sustainability elements within the heart of the business does enhance competitiveness and marketability (Jones Lang LaSalle, 2009). Thus, good green energy labelling certification can be regarded as providing an advantage over competitors.

For these economic, social and environmental benefits to be fully realized in the market, it is necessary for the benefits of green features to be presented as a total package to the real estate stakeholders (Shimizu, 2010).

Most of the literature concerning the economic implications of green labelling in commercial office properties is grounded in the US (Robinson et al., 2016; Robinson & McAllister, 2015; Das & Wiley, 2013; Kok, Miller, & Morris, 2012; Fuerst & McAllister, 2011; Eichholtz, Kok, & Quigley, 2010). A significant number of studies have examined the extent to which property values are enhanced by the LEED and Energy Star (ES) certifications in the US commercial property market. In a recent study, Kok et al. (2012) found a 7.1% rental premium compared to non-LEED certified buildings. In another study of 6518 commercial buildings in Colorado, Grippe, Martel, and Lewandowski (2012) reported a \$3.54/square ft. rent premium for LEED certified properties, and \$2.87/square ft. for ENERGY-STAR properties. Using a mixed-methods approach, Philbrick, Scheu, and Evens (2014), in a study of the financial benefits of energy efficiency upgrades in multi-family residential buildings, reported a rental income premium of \$0.34/square ft. Fuerst and McAllister (2011) also found a 5% rental premium for LEED-certified properties and 4% for ENERGY-STAR (ES) properties. In a similar study, Das, Tidwell, and Ziobrowski (2011) investigated the rental rate dynamics of 123 green commercial office buildings in the Washington DC and San Francisco metropolitan areas. They found a rental premium of 2.4% for LEED certified properties in down markets, and a 0.1% premium for up markets, indicating that LEED certified properties maintain relatively stable rental rates in real estate down cycles. In their study of Class A Office Data from 46 US office markets (with 7,308 properties), Wiley et al. (2010) not only supported the fact that green buildings yield a rental premium, but they also found green buildings sustain significantly higher occupancy rates. They reported that LEED properties yield premiums of 15.2–17.3%, and Energy Star labelled properties achieve 7.3–8.6%. Another recent attempt by Fuerst and McAllister (2011) reported a price premium of 25% and 26% and a rental premium of 5% and 4% for LEED and ES, respectively. In 2009, the same authors, using a larger sample of 127 LEED and 662 ES-certified office properties, estimated a 35% and 31% price premium for LEED and ES,

respectively, and around 6% rental premium for both LEED and ES. The effects of green building schemes in the US has been studied by many other researchers.

A few non-US studies are also available in the literature. For example, a recently concluded study by Chegut et al. (2014) found a price (rent) premium of 14.7% for BREEAM-certified office properties in London (in comparison with non-certified properties). The same authors Chegut, Eichholtz, and Kok (2011), based on another UK-based green building scheme, *Eco Homes*, reported an 8% price premium for EcoHomes properties, and a 16–20% rental premium. Besides these well-known schemes, Hyland, R. C. Lyons, and S. Lyons (2013) studied a less-known "Ireland energy efficiency rating scheme". Results reveal that prices of high-energy efficient properties (grade A) are about 9% greater than low-rated (grade D) properties.

Nevertheless, comprehensive studies on green certification schemes of commercial properties in Asia have been limited to general discussion, except for one recent study focussed on the Shanghai office rental market (i.e. Hui, Chan, & Yu, 2015). Their results, in line with western studies, suggest that office properties certified by LEED are 12.8% more valued than those of properties without LEED certification. The study reported in this paper is unique in the sense of being the first on commercial properties in Hong Kong, and a comprehensive in the high-rise context in Asia. This is significant as the Asian perception of living and working in a green environment differs substantially in substance from the Western perception. It is true that Asian appreciates the advantages of the green revolution, but there is a significant fear that a full pledge to the green philosophy may scamp the Asian economic revolution. In Asia, economics still supersedes sustainability goals; and factors such as location and accessibility may be the primary considerations rather than green features in the choice of a commercial buildings (Addae-Dapaah & Chieh, 2011). This is in contrast to the West, where corporate and institutional investors highly appreciate green property space for reasons such as enhancement of public image (Orlitzky et al., 2003), enhanced employee productivity and less employee absenteeism (Miller et al., 2009), cost savings through efficient energy consumption (Fowler & Rauch, 2008). Thus, understating of the Asian perspective in relation to the green premium is significant.

The literature on the financial implications of green labelling schemes generally indicates a positive correlation between green building certification schemes and property values in the market place. Nevertheless, very little market implication analysis of green-certified commercial office properties has taken place in Hong Kong. The authors' research is perhaps the first of its kind in Hong Kong, and contributes to the limited amount of Asian literature and offers some insights and references for the benefit of real estate stakeholders in the expanding Chinese office property market. The research may also help to arouse awareness of the financial implications of green certification and stimulate market sentiment towards green properties which in turn will increase the demand for green buildings in the market.

2. Methodology and data

2.1. The model

To examine the financial implications of BEAM, BEAM Plus and LEED certifications on the value of rental office space in Hong Kong, the study deployed a hedonic price model through a fixed effects approach. Despite some weaknesses (assumptions), the hedonic model (HPM) is regarded as an effective tool in the area of property valuation analysis (Hui et al., 2015; Hui, Tse, & Yu, 2017). For example, using HPM, the effects of structural attributes such as floor area, age and size of the unit, etc. (Tse & Love, 2000), landfills (Nelson, J. Genereux, & M. Genereux, 1993), views (Benson, Hansen, Schwartz, & Smersh, 1998), and noise and air pollution (Espey & Lopez, 2000) on residential property values have been well documented in the literature.

Rosen (1974) offered a formal conceptual interpretation of the hedonic functions. As described by Rosen (1974, p. 1), “goods are valued for their utility-bearing attributes or characteristics”. Accordingly, the rental value of an office property is said to be a function of physical attributes (P), locational attributes (L), and neighbourhood attributes (N). These main attributes can further be disintegrated into smaller characteristics such as size, location, floor area, floor level, view, floor-to-ceiling height etc. making the real estate property a heterogeneous commodity (Sirmans, Macpherson, & Zietz, 2005). The hedonic model, in the form of linear regression modelling, is able to disaggregate the value of a property into quantifiable implicit prices for each individual attribute (Ki & Wadu Mesthrige, 2010).

Thus, the standard HPM models the effects of physical (P), locational (L) and neighborhood (N) attributes, plus the effect of environmental certification ($GREEN$), the main interests of this research, as follows:

$$\ln RENT_{it} = \lambda + \beta P_{it} + \gamma L_{it} + \delta N_{it} + \Omega GREEN_{it} + \varepsilon_{it} \quad (1)$$

where: β , γ and δ are coefficients that represent the implicit prices of the physical (P); locational (L) and neighborhood (N) attributes of the property, respectively, under standard assumptions (Rosen, 1974). The main coefficient of interest (green certification) is Ω ; and ε_{it} is an error term. $RENT$ is the rental prices of office units for 2009–2015. With the given data on physical, locational, neighborhood and green certification, the model estimation is quite straightforward. In the model, the coefficient Ω represents changes in property value due to green certification. It is hypothesized that obtaining green certification entails a rental premium for office properties, which enhances property values. An enhancement in rental premium is expected to occur because of the above advantages that green buildings possess.

Nevertheless, the estimates in equation (1) may be biased for various reasons. First, it is not rationale to assume in a cross-sectional study that estimated (observed) price/rental premia are only caused by green certification. There can be unobserved variables/characteristics that

subsequently cause both certification and higher prices. For example, certified properties tend to have superior building features but two are not necessarily linked (Reichardt et al., 2012). Thus, one would expect relatively higher rents/prices in such properties even without certification. The second cause of potential bias are local trends. Having a certified building in the neighbourhood may bring positive price enhancements to the nearby properties. Such gentrification diverges the property values. This happens when property prices are not mean-reverting. In this case, the coefficient of green certification may be upward biased. Generally, anticipation of future property trends influences the current local property value. These local trends may have correlations with levels and trends in property values. Omitting local amenities therefore may lead to biased results. The final cause of potential bias is that property characteristics may change over time, causing changes to coefficients on characteristics. Thus, if we assume that these characteristics and respective coefficients remain unchanged (in equation 1), the coefficients of other variables would be biased.

Taking these issues into account, the error term of equation (1) was decomposed into two components: a component that is correlated with independent variables, ϑ_{it} (see equation 2), and a component that is not correlated with independent variables, ε_{it} .

$$\ln RENT_{it} = \lambda + \beta P_{it} + \alpha L_{it} + \delta N_{it} + \Omega GREEN_{it} + \vartheta_{it} + \varepsilon_{it} \quad (2)$$

Omitting the component, ϑ_{it} from the regression model would bias the estimates. In the model, ϑ_{it} is expected to account for unobserved characteristics including local property value trends. The model therefore allows for controlling unobserved effects, and mitigating a potential omitted variable bias in the model. These types of fixed effects model are able to produce estimates of the dynamic behaviour of rental price premium over time (Reichardt et al., 2012). The approach to addressing such local trends was to add a control to the equation. Accordingly, to control for the systematic difference in rental price values between certified and non-certified properties and local property value trends, two observations were used for each property: one before certification and one after certification. An interaction term of fixed effects was also then included in the model (equation 3).

The proposed hedonic equation is:

$$\begin{aligned} \ln(RENT)_{it} = & \beta_0 + \beta_1 (GREEN)_{it} + \beta_2 (GREEN)_{it} * T_{it} + \\ & \beta_3 \ln(AGE)_{it} + \beta_4 \ln(AREA)_{it} + \beta_5 \ln(FLOOR)_{it} + \\ & \beta_6 \ln(CEIL)_{it} + \beta_7 (R_FLOOR)_{it} + \beta_8 (I_CPARK)_{it} + \beta_9 \ln(D_CBD)_{it} + \\ & \beta_{10} \ln(D_MTR)_{it} + \beta_{11} \ln(CLUSTER)_{it} + \beta_{12} (B_VIEW)_{it} + \\ & \beta_{13} \ln(S_VIEW)_{it} + \beta_{14} (VAC)_{it-i} + \beta_{15} (UE)_{it-4} + C_i + C_t + \varepsilon_{it} \end{aligned} \quad (3)$$

where: $\ln(RENT)_{it}$ is the logarithm of the rental price of an office unit. $GREEN_{it}$ is an indicator (dummy) variable, where it takes 1 if a property is certified (certified group), and 0 otherwise. Properties belong to the certified group if the transaction took place after the property had received certification. T is also an indicator variable, which takes

1 if the rental price was measured after the green certification, 0 when the rental price was measured before the certification. The interaction variable $GREEN_{it} * T_{it}$ captures the effects of certification on rental prices, and GREEN captures any separate effects of certification. The interaction variable is also capable of accounting for the effects of property characteristics that may change over time. To control for the past vacancy rates in buildings, a variable VAC_{it-i} was introduced in the model. Generally, property owners tend to adjust rents in response to past vacancy rates. Further, in order to control for the effects of economic conditions on property values, the unemployment rate (UE_{t-4}) was also included in the model. Building fixed-effects (C_i) were incorporated in the model to account for time-invariant attributes/variables. Likewise, C_p , which represents time-fixed effects, was included in the model to control for changes in macroeconomic conditions over time that may have influence on all properties. Details of other variables are shown in Table 3. A monthly price index, obtained from the Government's Rating and Valuation Department, was used to convert nominal rents into real rental values to remove inflation effects. The most important variable in the study is GREEN. This refers to those office buildings, which have been certified by HKBEAM, BEAM PLUS and LEED in Hong Kong. In addition to the main focussed variable, thirteen other important office property variables are incorporated in the model.

2.2. Data description

To investigate if buyers are willing to recognize the benefits by paying a premium for a green commercial of-

fice unit, transaction records of office properties with and without green building certifications were studied. In 2010, there were 2327 commercial office buildings in Hong Kong (LegCo, 2010). Of these, 321, as of 2016, have been awarded green certifications, as seen in Table 2. A sample of 46 of these certified commercial office buildings, or 14.3%, a good representation of the total population, from the three different districts of Central and Wanchai, Quarry bay and Kwun Tong, was selected for the study. Grade "A" office properties certified by HKBEAM, BEAM Plus and LEED were regarded as green buildings. 37 non-green buildings (without green certifications) within 150 meters of the selected certified green buildings (within the same geographic area as the certified properties), similar in age to green buildings, were also included in the sample. In the sample, no building has more than one certification. Properties with more than one certification are not common in Hong Kong. This is mainly because green certification is still not the norm in Hong Kong. Table 4 summarizes the attributes of the properties in the sample. The total number of valid office property transactions was 7697, and the transactions were obtained randomly from buildings in the sample. Further, any transaction was only counted once. The property transactions data for all properties (not-certified as well as certified) included such attributes as age, floor area, floor level, building view and sea view were obtained from Economics Property Research Centre (EPRC) Limited, Midland Realty and Centaline property consultants databases. EPRC, established in 1991, is a wholly owned subsidiary of Hong Kong Economic Times Holdings. The

Table 3. Description of property attributes in the model

Attributes	Abbreviation	Characteristics	Definition	Expected sign (+/-)
Rental price	$Ln (RENT)$	Unit transaction rental price	Real rental transaction price of the office unit (HK\$) in log form	/
Physical/ structural	$Ln (AGE)$	Building age	Age of the office unit in years in log form	-
	$Ln (AREA)$	Saleable floor area	Saleable area of the unit in square meters in log form	+
	$Ln (FLOOR)$	Floor level	Number of floors above the ground in log form	+
	$Ln (CEIL)$	Ceiling height	Ceiling height (the difference between the floor to ceiling) in meters in log form	+
	R_FLOOR	Raised floor	A dummy variable: 1 if the unit has a raised floor; 0 otherwise	+
	I_CPARK	Internal car park	A dummy variable: 1 if the building has an internal car park; 0 otherwise	+
Location	$Ln (D_CBD)$	Distance to CBD	Distance to central district from the property in meters in log form	+
	$Ln (MTR_STATION)$	Distance to the train (MTR)	The minimum walking distance between office unit and the nearest MTR station (measured in meters)	-
	$CLUSTER$	Situated in the office cluster	1 if the building is located inside a main office centre	+
Neighbourhood	B_VIEW	Building view	1 if unit has a building view and 0 if otherwise	-
	S_VIEW	Sea view	1 if unit has a sea view and 0 if otherwise	-
Green certification	$GREEN$	Green certifications	1 if the office building is BEAM, BEAM Plus or LEED certified; 0 otherwise	To be estimated
Market/ macro-economy	UE	Unemployment	Annual unemployment rate	-
	VAC	Vacancy rate	Grade A annual office vacancy rate	-

Table 4. Summary of building attributes

Green buildings					Non-green buildings			
Building name	Year of completion	No. of storey	Floor area (Sq. fts)	Year of certification	Building name	Year of completion	No. of storey	Floor area (Sq. fts)
Elite Centre	2012	19	11875	2015	Rykadan Capital Tw.	2013	26	12000
Enterprise Square 3	2004	41	16100	2009	T G Place	2014	30	12732
Enterprise Square Five – Tower 1	2007	15	18000	2009	YHC Tower	2013	32	12528
Millennium City 1 Standard Chartered Tower	1998	30	21449	2012	C-Bons International Centre	2009	20	16824
Sun Hung Kai Centre	1982	54	16600	2011	Office Tower – Convention Plaza	1990	52	16518
Central Plaza	1992	78	20000	2011	Harbour Centre	1983	33	14500
One Kowloon	2006	39	23959	2014	AXA Centre	1982	26	12750
Manulife Financial Centre- Tower A	2007	19	31378	2011	Telford House	1994	20	16300
Manulife Financial Centre- Tower B	2007	20	31378	2011	Billion Centre – Tower A	2009	25	13815
The Rays	2015	13	8587	2015	Millennium City3	2002	26	8140
Millennium City 5 – BEA Tower	2004	27	26000	2014	MG Tower	2011	21	29275
Landmark East – AIA Kowloon Centre	2008	34	28000	2007	EGL Tower	2007	30	12029
Landmark East – AXA Tower	2008	36	15000	2007	Kin Sang Commercial Ctr.	2013	23	6309
Pioneer Place	2014	12	230000	2015	Chuang's Tower	1973	22	3940
Standard Chartered Bank Building	1990	40	7500	2009	1 Lyndhurst Tower	1994	22	3428
One International Finance Centre	1998	39	20000	2011	Asia Standard Tower	1979	28	5621
Two International Finance Centre	2003	88	24500	2011	Century Square	1984	20	4057
AIA Central	2006	37	3300	2012	8 Wyndhamstreet	1997	30	3586
Charter House	2002	29	18500	2010	China Building	1978	23	8000
Man Yee Building	1999	33	10600	2010	Citibank Tower	1992	50	17300
Prince's Building	1965	29	20000	2012	Crawford House	1976	22	6001
Alexandra House	1976	36	11000	2012	100 Queen's Road	2006	25	6740
York House	2006	14	8275	2012	New World Tower 1	1978	41	13800
Edinburgh Tower	1983	47	12500	2012	The Centrium	2001	41	4230
Gloucester Tower	1980	47	2479	2012	Bank of East Asia	1990	25	7857
One Exchange Squ.	1985	52	13000	2012	Fortis Bank Tower	1982	32	6350
Two Exchange Squ.	1985	51	13000	2012	Shui On Centre	1987	32	6285
Three Exchange Squ.	1988	33	11000	2012	The Sun's Group Ctr	1996	24	7388
Hong Kong ClubBldg	1984	24	8688	2011	Hopewell Centre	1980	64	15450
Wing On House	1967	31	15946	2012	Time Square Tower2	1993	39	19000
Great Eagle Centre	1983	25	13500	2009	Berkshire House	1998	28	13300
Sunlight Tower	1998	34	10589	2016	Kornhill Plaza – Office Tower	1988	13	8750
3 Pacific-Place-Pha3	2004	36	15000	2016	China United Centre	1997	31	13000
28 Hennessy Road	2012	28	4935	2012	633 King's Road	2007	30	10045
China Resource Bldg.	1983	39	20500	2011	Chinachem Exchange Square	1997	35	9432
Hysan Place	2012	17	16000	2013	Prosperity Millennia Plaza	1999	32	8100
Oxford House	1999	40	11300	2010	Olympia Plaza	1999	25	7683
Lincoln House-Taiko	1998	23	14300	2010				
Cambridge House	2003	36	6767	2010				
Devon House	1993	29	27500	2010				
Dorest House	1994	39	14700	2010				
One Island East	2008	59	21550	2010				
1063 King's Road	1999	31	3546	2010				
Kerry Centre	2010	32	16690	2009				
AIA Tower	1998	43	14280	2008				

main business focus is to provide property information to market-related industries. EPRC is the largest and most respectable property information provider in Hong Kong. Floor-to-ceiling heights were obtained from the building plans held by the Buildings Department. Walking distance to the MTR was measured using Google Map. Property transaction records related to the period 1st January 2009 to 1st September 2015. This is the most suitable period as BEAM Plus assessment mechanism was launched in 2010.

3. Results and discussion

Descriptive statistics of the property attributes in the model are summarized in Table 5. Table 6 gives the results of the HPM¹ estimates, which were then subjected to regression diagnostics. The estimates were corrected for heteroscedasticity based on White's heteroscedasticity consistent standard errors. The variance inflation factor (VIF) test was employed to test for multicollinearity problems in the model. The results showed that our model was free of multicollinearity problem. VIF figures varied from 1.09 to 2.39 (with Mean VIF 1.67)¹, which is well below the conventional rule of thumb of 10 (Neter, Wasserman, & Kutner, 1989). As reported in Table 6, all (except one) selected independent variables were statistically significant at the 1 and 5% levels. All the variables also, except one, carry the expected theoretical positive/negative signs. The explanatory power of the model, represented by R^2 of 0.798, suggests that approximately 80% of the total variation in office rental value is explained by the chosen independent variables. This shows that the model performed well in explaining the variation of office rental value in the selected sample.

The most important subject of this study, GREEN* T was found to be statistically significant at the 1% level, with a positive coefficient of 0.109 and p -value 0.000. This means that if an office property is certified with HK-BEAM, BEAM Plus or LEED, the rental value increases by 10.9%. In other words, office tenants are happy to pay 10.9% more for an office unit with green features certified by HK-BEAM, BEAM Plus or LEED. More specifically, office properties possessing these environmental certifications are, in general, clearly valued by tenants, who are willing to pay 10.9% premium. The time fixed effect is also significant at the 5% level.

Besides GREEN, all the physical and locational attributes of the selected office properties (except B_VIEW) were also found to be statistically significant at the 1 and 5% levels. As for physical attributes, the results reveal that office rental values (RENT) are positively related with saleable area (AREA), floor level (FLOOR), floor-to-ceiling height (CEIL), indoor car-parking (I_CPARK) and raised-floor (R_FLOOR). For locational attributes, rental value is positively related to distance to CBD (D_CBD), proximity to an office cluster (CLUSTER) and sea view (S_VIEW),

Table 5. Descriptive statistics of the office property data

	Mean	σ	Minimum	Maximum
Ln (RENT)	10.0741	0.9568	3.8500	10.9350
Ln (AGE)	3.0176	0.6588	2.2500	4.2900
Ln (AREA)	7.7566	0.8447	5.1245	9.8730
Ln (FLOOR)	2.9127	0.6001	1.8100	3.9800
Ln (CEIL)	0.9959	0.0557	1.0021	1.5510
R_FLOOR	0.1820	0.3861	0.0000	1.0000
VAC	0.4680	0.0024	0.0370	0.0620
I_CPARK	0.8010	0.3991	0.0000	1.0000
Ln (D_CBD)	1.7788	0.4406	0.6900	2.6400
Ln (D_MTR)	1.2479	0.8949	0.3671	1.9780
Ln (CLUSTER)	0.8780	0.3271	0.0000	1.0000
B_VIEW	0.3950	0.4889	0.0000	1.0000
S_VIEW	0.3950	0.4889	0.0000	1.0000
GREEN	0.4150	0.4928	0.0000	1.0000
UE	4.0638	0.0812	0.0370	0.0620

Table 6. Results for the HPM

Independent variable	Coefficient	t-statistic	p-value
Constant	1.182 (0.540)	2.188	0.0290
<i>Physical attributes</i>			
Ln (AGE)	0.108*** (0.024)	4.501	0.0000
Ln (AREA)	0.971*** (0.039)	24.897	0.0000
Ln (FLOOR)	0.141*** (0.027)	5.222	0.0000
Ln (CEIL)	1.083*** (0.175)	6.188	0.0000
R_FLOOR	0.322*** (0.053)	6.075	0.0000
I_CPARK	0.019** (0.009)	2.117	0.0343
VAC _{t-4}	-0.032*** (0.005)	-6.401	0.0000
<i>Locational attribute</i>			
Ln (D_CBD)	-0.040** (0.016)	-2.442	0.0147
Ln (D_MTR)	-0.091*** (0.019)	-4.789	0.0000
Ln (CLUSTER)	0.028*** (0.012)	2.333	0.0171
B_VIEW	-0.005 (0.009)	-0.588	0.5540
S_VIEW	0.115*** (0.021)	5.476	0.0000
<i>Environmental attributes</i>			
GRREN* T	0.109*** (0.019)	5.746	0.0000
GREEN	0.092*** (0.013)	7.076	0.0000
UE _{t-4}	-0.021** (0.008)	-2.625	0.0170
C_t	-0.017** (0.007)	2.476	0.0130
R^2	0.798		
Adj. R^2	0.789		
F -stat.	2696		
N	7697		

Notes: Robust standard errors are in parentheses; (***), and (**) denote that the significant level 1%, and 5%, respectively.

¹ The full VIF table is not reported in the study for space consideration, but will be available upon request.

and negatively related with distance to the nearest MTR station (D_MTR). These findings are in line with the results of previous studies (e.g. Heinzle et al., 2013; Tse & Love, 2000). However, though the age of the property was expected to be inversely related to rental value, the results suggest otherwise. This may be attributable to the fame of the office properties chosen for the study. All the selected buildings are grade A and most are located in prestigious areas with relatively old office properties, but with very good accessibility and the necessary support services. Building age, therefore, seems to be an irrelevant factor in this study sample. All three locations in the sample are premier office locations. Specifically, two of the three districts are prestigious office centres with relatively old office buildings. Except for Kwun Tong, there are substantial numbers of relatively old but prestige office buildings in clusters in the study area. The positive sign of the “Age” variable may be largely attributable to this locational factor. This result is in accordance with some previous findings (e.g. Ozus, 2009; Gat, 1998).

The positive coefficient of 0.141 (of FLOOR) suggests that for units of the same size, the higher the office is situated, the higher its value. This is very much relevant to a place like Hong Kong, where lower level units experience so much noise and air pollution. Tenants are willing to pay a premium for a better view and cleaner air. This finding is consistent with some previous office market research (e.g. Slade, 2000; Bollinger, Inlandfeldt, & Bowes, 1998). Similarly, a positive relationship was found between office rent and the saleable area of the office unit (AREA). This is expected and in line with previous studies, although few studies (e.g. Brennan, Cannaday, & Colwell, 1984), suggest a negative relationship can exist since larger companies have greater bargaining power in lowering rent. However, as the Hong Kong office market is very dynamic and competitive, that bargaining power may not be so significant. As a larger office space facilitates effective business operation and enhances face-to-face interactions with clients, tenants are willing to pay more for a larger unit (Gat, 1998). The ceiling-to-floor height (CEIL) was also significant in the study, suggesting that tenants value offices with higher ceilings. It is said that a higher ceiling improves the office proportions giving employees a sense of spaciousness, which is psychologically uplifting. It might also provide additional storage (e.g., space for taller filing cabinets) compared to a low ceiling office unit, which feels cramped and closed in. Higher ceiling can improve space efficiency and enhance the workplace (Sev, Ozgen, & Basarir, 2011), as they improve storage space and provide a sense of comfort to the eyes of employees. Likewise, the raised floor design (R_FLOOR) is another physical attribute found to have a positive effect on the rental value. Offices with newly designed raised floor systems are better able to accommodate new advanced technologies (such as electric and other HVAC cables and pipes), so that tenants are happy to pay more for such units. Similar to some previous studies (Mills, 1992; Hough & Kratz, 1983), office units with internal car parking (I_CPARK) are highly val-

ued compared to units without such parking. The findings reveal that the rental value of an office unit with parking facilities, in general, is 0.019% higher than that of a unit without such facilities in the sample office buildings.

As a significant locational/spatial attribute determining the rental price of an office unit, closer proximity to a good transportation mode has been documented in the literature (Ozus, 2009; Enström & Netzell, 2007). The findings of this research study indicate that an increase in distance between the selected office unit and the nearest MTR Station decreases rental value. Closer proximity to a prestigious office cluster is another significant element determining the rental value of an office unit. The variable CLUSTER, which was found to be highly significant, implying that the rental price of an office unit closer to an office cluster is approximately 2.8% higher than that of a unit situated outside a cluster area. Lastly, a “view” influences the rental value of an office unit. Empirical results suggest that a unit with a sea view (S_VIEW) yields a rental premium of about 11.5% while a unit with a building view (B_VIEW) is not appreciated by potential clients, other things being equal.

Propensity Score Matching (PSM)

To check the robustness of variables, the PSM in the “MatchIt” package in R constructs (Ho, Imai, King, & Stewart, 2011) was used for treatment effects estimation. Accordingly, a binary logistic regression model, using the same explanatory variables used in the fixed effects model, was used to estimate the propensity score. The employed matching method was that of ‘optimal’ matching. To investigate the potential treatment effect, means for each explanatory variable in full sample and matched sample were compared, and found that matching greatly enhances the balance of covariates. The treatment effect estimation revealed that the price value of certified properties (green properties) was 11.2% higher than those without certifications, *ceteris paribus*. This value premium estimation (provided by the PSM) is very much consistent with the fixed effects model regression results of 0.109.

All in all, the empirical findings show clearly that tenants/users appreciate quality green office spaces certified with environmental certification schemes and are willing to pay a premium for those properties. Green-certified (HKBEAM, BEAM Plus or LEED) office buildings, in general, have rental values approximately 10.9% higher than buildings without such certification. This rental premium is very similar to that estimated, 16–20%, by Chegut et al. (2011) in their UK study. The premium however is larger than some seen in previous US-based studies (e.g. Reichardt et al., 2012; Eichholtz et al., 2010; Fuerst & McAlister, 2011). Possible reasons could be: (a) certified properties generally tend to also have better building features than to non-certified properties. Thus, the lack of control for these qualities could inflate the rental premium; (b) the green concept, especially green environmental certification schemes are relatively new to Asia and to Chinese territory. Therefore, not much information about the financial implications and possible impacts of the environmental

Table 7. Green costs payback period (sources: (a) Cost data from Langdon and Seah (2018), “Quarterly construction cost review”, various issues; (b) Rental data from “Hong Kong Property Reviews”, Hong Kong Rating and Valuation Department (n.d.), various issues)

Year	Building cost* HK\$/Sq.ft.	Green development cost (at 7% of total costs) HK\$/Sq.ft.	Average rental price (HK\$/sq.ft.)			Green costs payback period (months)		
			Central/ Wan	QB	KT	Central/ Wanchai	QB	KT
2010	1808	126.6	58.7	30.1	--	8.69	4.45	---
2011	1991	139.4	73.2	35.7	--	10.83	5.28	---
2012	2374	166.2	80.2	38.0	--	11.87	5.62	---
2013	2930	205.1	80.5	43.2	30.7	11.91	6.39	4.54
2014	2944	206.1	79.5	44.4	32.2	11.77	6.57	4.77
2015	3061	214.3	81.8	43.8	34.6	12.11	6.48	5.12
2016	3107	217.5	87.7	47.4	34.9	12.98	7.02	5.17
2017	3187	223.1	90.7	47.6	35.6	13.42	7.04	5.27

Note: * high-rise office, prestige quality; QB = Quarry bay; KT = Kowloon Tong.

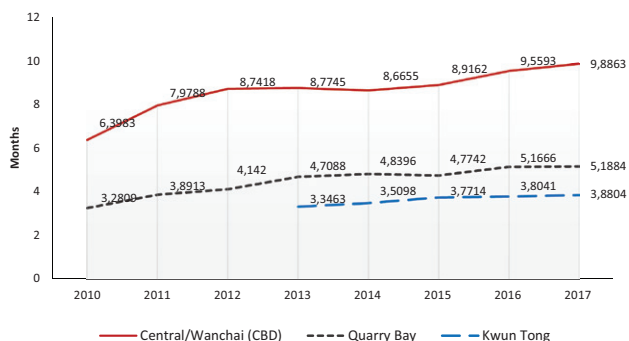


Figure 2. Green costs payback period (in months)

performance of buildings or green building certification schemes are readily available to real estate stakeholders. Hence, those investors (developers/owners) the first to adopt green properties are able to capitalize and tap into this new market without much competition, generating greater rental premiums; and (c) Hong Kong is a high-density compact city with fewer green and open spaces, very different from the US and the UK contexts.

4. Implications

The findings hold practical implications for green building development in Hong Kong and elsewhere. Taking the rental premium as 10.9% for green certifications schemes and the average monthly rental of the study sample at HK\$76.2/sf² into account, the study finds that the average monthly rent for green-certified (HKBEAM, BEAM Plus and LEED) office buildings is approximately HK\$8.31/sf² greater. According to cost data available in Hong Kong, the green development cost premium for prime (grade A) office buildings is around 7% of the total cost, which averages around HK\$ 2650/sf² (as of 2015) for high quality building. Based on this information, the additional cost of

obtaining green certification is about 22 months of rent. In other words, the higher rental income generated by a certificated green building pays back the additional green development costs within about two years only.

The market implications of green certification are further explored in Table 7 and Figure 2. Taking the rental premium of 10.9% as the base, green development costs and pay back periods for the additional green costs were calculated for the period 2010–2017. The results indicate that the payback period is positively associated with time. This may be due to the increasing building costs over the years. Another most important finding is that the payback period is relatively high for properties located in the CBD compared to those some distance from the CBD. This finding is an incentive for investors and developers to invest in green properties.

Conclusions

The study, using a hedonic model, investigated the impact of the environmental certification schemes (HKBEAM, BEAM Plus, and LEED) on the rental price level for the grade A commercial office market in Hong Kong, one of the most dynamic commercial office markets in the region. Based on a sample of 67 commercial office buildings, the empirical findings suggest that certified commercial office properties yield a rental price premium of 10.9%. The results suggest that office tenants/users do recognize the financial and other benefits of buildings of superior environmental performance and are willing to pay a premium for those properties when certified by recognized standard green environmental certification schemes. For example, a tenant is ready to pay HK\$ 54,500 more for an office unit with green features (certified by the above schemes), on top of rental costs which would otherwise be HK\$ 500,000.

A few important conclusions can be drawn. Firstly, that these certification schemes can be regarded as an impor-

tant marketing tool for real estate investors and developers as they act as a guarantee of building quality performance. Thus, higher returns are guaranteed from such certified buildings, as properties certified by these schemes will enhance the corporate image of the owning companies particularly among environmentally friendly investors and tenants. Furthermore, as the empirical findings of this study favour the notion that green-certified properties can command a higher rental premium, the business case is well established for more and more stakeholders to embrace CSR thinking and attitudes at the heart of their businesses. Secondly, this revelation of higher returns/performance for environmentally friendly buildings can help overcome the prevailing scepticism concerning the financial implications of green buildings. Consequently, this should result in an increase in the supply of green buildings. Thirdly, though an awareness of the importance of green buildings prevails in society, in particular in the eyes of industry practitioners, the latter are not convinced of the financial value and this caution prevents green building development. The finding of this study, however, may help to overcome this caution as it affirms the benefits of green buildings, when certified by such as HKBEAM, BEAM Plus, and LEED. Perhaps the attitude towards green buildings in Hong Kong will move to a higher level.

The findings should convince the business community to take account of the environmental quality certification attached to a building when renting or buying. Tenants or users may see office properties certified by these schemes as having good quality environmental and building standards. Green environmental features can be treated as a property attribute as they add intrinsic value to the property, just as do some key physical attributes. In future, it can be expected that office rental prices will be influenced by the demand for and supply of green features. This suggests that rental incomes, vacancy rates, and the selling prices of commercial office properties will be positively influenced by property environmental and energy performance indicators. Hence, HK-BEAM, BEAM Plus, and LEED certification should be well received by the real estate community in Hong Kong. The business case for environmentally friendly buildings is therefore well proven.

Acknowledgements

The principal author, Wadu Mesthrige Jayantha, gratefully acknowledges the funding support given by the Hong Kong Polytechnic University (grant code: 4-ZZGC). The authors also would like to gratefully acknowledge the valuable comments given by the anonymous reviewers. A special thanks to Prof. Mike Anson for his editing and valuable comments on an earlier draft of this research paper.

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