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# The Role of Mandatory Building Efficiency Disclosure on Green Building Price Premium: Evidence from Australia

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**Abstract:** Extensive studies have examined the financial performance of green buildings in recent years. The results have frequently observed that the premium of green buildings is time-varying and dependent on the study period and markets being examined. Further, virtually no dedicated study has been devoted to examine the role of mandatory building energy rating disclosure policies on green building price premium. This raises the question of whether the mandatory energy rating disclosure policies would have an influence on the financial performance of green buildings. This study assesses the premium of green buildings by considering the role of mandatory energy efficiency of commercial building disclosure program (CBDP) using the MCSI/IPD NABERS data over 2005–2020. The results of the study showed that, in Australia, buildings with NABERS rating of 4 stars and above delivered a higher total return compared with buildings with lower NABERS ratings. This also supports the Freeman's (1984) social impact hypothesis in which favorable social performance will ultimately lead to favorable financial performance. In addition, our empirical modelling results also demonstrated the premium of green buildings is stronger since the launch of CBDP, reflecting the importance of mandatory building efficiency disclosure. The policy implications of our studies have also been discussed as buildings play a crucial role in achieving the United Nations Sustainable Development Goals (SDGs), particularly net-zero carbon emissions.

**Keywords:** green buildings; commercial building disclosure program; financial performance; energy; green price premium; NABERS; SDGs; net-zero carbon emissions; mandatory disclosure



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## 1. Introduction

Despite the COVID-19 pandemic, global carbon emissions have rebounded by 4.8 per cent in 2021, approaching the peak of 2018–2019 [1]. Importantly, carbon emissions from human activity have been argued as the main cause of climate change [2,3]. Climate change has resulted far-reaching adverse impacts on the natural environment and caused devasting events such as heatwaves, bush fires, flooding, drought, etc. [4]. The recent GOP26 in Glasgow has further reinforced the importance of net-zero carbon emissions as a crucial step in reducing the negative consequences of climate change and global warming. Buildings and construction activities play a key role in the decarbonization process as the buildings sector is the largest energy-consuming sector, accounting for 36 per cent of global final energy consumption and 37 per cent of energy related carbon emissions in 2020 [5]. Darko and Chan [6] expect 42.4 billion tons of GHG globally will be emitted from buildings by 2030, with an increase of 43% since 2007. IEA [7] have also called for an urgent action to be taken to improve building energy efficiency as the building sector is expected to contribute half of global energy consumption by 2050. All these highlight that buildings play a crucial role in reducing carbon emissions and enhancing sustainable development.

To promote a sustainable building sector, green buildings have emerged as a key decarbonization strategy to alleviate adverse effects on the environment and resources. Reed and Sims [8] noted the strong desire among property developers towards sustainable

development through modification of resources being used in buildings such as air conditioning and heating of buildings, energy usage, materials, and technology. In addition, transparent systematic certification systems have also been introduced to guide developers for green developments and enhance transparency of green buildings information. The use of these rating tools began in 1990 when the Building Research Establishment's Environmental Assessment Method (BREAAM) was first introduced in Europe. Comparable rating systems were also launched in other developed markets such as the US in 1998 (the Leadership in Energy and Environmental Design, LEED and Energy Star) and Hong Kong (the Building Environment Assessment Method, BEAM Plus), as well as emerging markets such as Green Building Index (GBI) in Malaysia and Sustainability in Energy and Environmental Development (SEED) in Pakistan [9].

In the context of Australia, the Commercial Building Disclosure Policy (CBDP) was introduced by the Australian government under the Building Energy Efficiency Disclosure Act 2010. The federal Australian government launched the world's first nationwide mandatory disclosure program for large office buildings with greater than 2000 square meters. As a result, large commercial building owners, lessors, and agents are compulsorily to disclose a National Australian Built Environment Rating System (NABERS) Energy rating of their buildings to their clients conspicuously in advertising materials for lease, sale, or sublease [10]. Unlike intrinsic ratings, one of the key features of this disclosure scheme is that actual energy performance will be used and audited to a common standard [11]. Generally, these energy efficiency ratings are regulatory tools that provide the relevant guidelines for property owners, managers, and tenants of buildings on ways to minimize the environmental impact. These sustainability practices are changing the supply and demand landscape of buildings [8].

There is a growing body of literature on the existence of the green price premium (e.g., Eichholtz et al. [12] and Fuerst and McAllister [13]). Although these studies, in general, have demonstrated that the magnitudes of green building premium are time-varying and dependent on the study period and markets examined [14], the mixed results could potentially be attributed to the existence of building energy rating disclosure policies. However, to the best of our knowledge, there is a significant gap in examining whether the introduction of mandatory building energy rating disclosure policies can have an impact on the green building price premium. To promote green building adoption and development, governments in major economies have offered a variety of policies (e.g., subsidies and regulations). Extensive studies have been done to examine the effectiveness of government laws on the energy efficiency disclosure of commercial buildings (e.g., Fuerst et al. [15], Kok et al. [16]). The existing literature, in general, has also shown that subsidies and regulations do enhance the diffusion of green technology in the building sector [14]. This naturally leads us to the question of whether the CBDP, the world's first mandatory building energy ratings disclosure policy, would have an influence on the premium of green buildings. Further, the connection, if any, between green buildings and the financial performance has not been fully established. How this observed relationship can best be explained theoretically remains a puzzle.

This study makes a new departure from the previous studies and assesses the impact of a mandatory building energy efficiency disclosure on green price premium. This study also goes beyond the focus of the existing literature of the effectiveness of government regulations and incentives in promoting green building developments. It exploits the social impact hypothesis to examine the effectiveness of a mandatory building energy efficiency disclosure program (i.e., the CBDP) by considering its effect on green building price premiums before and after its implementation in Australia. Specifically, this compares the performance of green buildings to non-green buildings before and after the implementation of the CBDP. It also assesses whether the post-policy period has a stronger outcome compared to the pre-period of mandatory CBDP. This comparison allows developers, investors, occupiers, and other relevant stakeholders of commercial buildings to place a closer atten-

tion to policymaking and enhance their knowledge on the grand scheme of sustainable commercial buildings.

This study, therefore, contributes to the literature in the following ways. First, to the best of our knowledge, this is the first empirical study to examine whether government intervention would have an impact on the green price premium. The finding of a stronger green building premium since the onset of CBDP would assist institutional investors to have a better understanding of green building investment, particularly the financial benefits of green buildings. As highlighted by Zhang et al. [14], the economic variability of "going green" remains controversial for developers and occupants, although they have a strong desire towards sustainable development [8]. The finding, therefore, would offer further information to market participants to involve in green building investments. Research on the green building premium and the government intervention potentially can advise the level of government intervention needed to establish a market mechanism to boost green building development. This would also be useful to international policy makers in markets without a mandatory building efficiency disclosure.

Second, our study also contributes to the limited literature on the premium of green office buildings in Australia. Extant studies have confirmed a significant premium of green buildings overseas, but no study has been devoted to the Australian commercial property market. The only exception is Newell et al. [17]. However, this early study utilized a relatively short study period. This study, therefore, extends Newell et al. [17] by considering a larger dataset in which the study period covers the COVID-19 pandemic event. In addition, our sub-period analysis offers further insights to the dynamics of green building premium for the first time. As argued by Eichholtz et al. [18], there is a need for more studies in other countries as practices differ strongly across countries, which could see differences in the supply–demand nexus. An analysis on the effect of the CBDP on building premiums would unveil important information in what has been overlooked in the literature on sustainability. Lastly, our results suggest that green price premium seems to have increased in recent years, following the implementation of the CBDP. This illuminates how social impact hypothesis can be situated in the real practical setting of green building investments.

The remainder of the paper is structured as follows. Section 2 reviews the literature on green buildings premium and the impact of mandatory disclosure on the development of green buildings. The theoretical framework is presented in Section 3. Section 4 discusses the data and methodology. The empirical results are reported and discussed in Section 5. The last section concludes the paper.

## 2. Literature Review

### 2.1. Price Premiums of Green Buildings

Much of the dedicated research on premiums of sustainable buildings was done in the US market. Using a sample of 10,000 LEED and/or Energy Star label commercial buildings and some hedonic attributes, the seminal study of Eichholtz et al. [12] found a strong relationship between commercial buildings and their premiums, creating greater impact on the eco-labelling discourse at societal level. They identified oil and banking businesses are renting more green office space than other sectors. They also found Energy Star certification increasing rent by 3% per square foot and selling price by 7–16%. These results highlighted the willingness of demanders to pay higher premiums on sustainable buildings and provided some empirical evidence of the competitiveness, legislative and environmental accountability that characterize sustainability. The study by Fuerst and McAllister [13] reinforced the notion that there are greater premiums from sustainable buildings. Their research pinpointed that LEED and Energy Star environmental labels have increased premiums for office buildings by 18% and 25%, respectively. They also found an increase in rental rates by 3–5%. Miller et al. [19] also made a comparison across eco-certified buildings and recorded a positive impact on rental, sale prices, and occupancy. A later study by Robinson and Sanderford [20] employed propensity scoring and a regression

model to examine the relationship between building premiums and eco-labelling to assess rental premiums for green buildings. Their findings are supportive of the earlier literature, further illustrating that eco-labelled commercial buildings generate higher premiums over un-certified buildings. Kok and Jennen [21] examined the emergence of green building premiums in Europe. They reveal that non-certified buildings in the Netherlands produced reduced rent by 6.5% compared to those that have a green label.

There are also studies in the residential sector. Mesthrige et al. [22] show the relationship between real estate price and green accreditation called BEAM-Plus in Hong Kong. The residential buildings with this rating system recorded an average increase of 6.61% in price premiums. Using variations of certification such as platinum, gold, and silver, platinum is shown to have a property price increase of 6.93%, and the lowest, silver, a 5.44% increase. This clearly indicates that higher-rated property would generate greater premiums and better marketability. Further, a recent study by Wang and Lee [23] evidently show air pollution has a considerable impact on residential real estate sector in China. Their study analyzed the capital gains and increased preferences for cleaner air quality of residences and their impact on housing and rental prices. This suggests that homebuyers would favor properties with good air quality especially in big and moderate sized cities, which undoubtedly indicates that sustainable buildings do matter in the European and Asian real estate sector. In the case of Australia, there has not been much research. Newell et al. [17] examined energy rating premiums in sustainable office buildings in Sydney CBD, Sydney suburban, and Canberra office markets and they concluded that higher NABERS and Green Star energy rating categories would enable additional property performance premiums. More specifically, their study noted an interesting finding, which shows that 5-star NABERS rated buildings recorded a 9.4% increase in premium compared to a lower rating, which generated a premium of around 2–4%. The study also revealed different premiums of value, net rent, vacancy, incentives, and yield for different green buildings, suggesting that higher NABERS rated buildings are becoming the benchmark for lower rated NABERS buildings. Myers and Reed [24] acknowledged the clear relationship between sustainability and market value for office building. Wilkinson et al. [25] examined contentment in sustainable buildings and found that users' efficiency can be attributed to the thermal environment and illumination of the space. Similar results were reported by Arnol and Hansz [26].

After examining previous studies on sustainable commercial building, Kok et al. [27] and Robinson et al. [28] each identified gaps in the eco-building school of thought, in the sense that their analyses focus more on the economics of green renovations, while little attention is paid to the knowledge of tenants on the effect of building premiums. Miller and Buys [29] earlier argued that, from a tenant's perspective, green buildings present financial challenges, which could explain why tenants, investors, and owners are reluctant to embrace sustainable agendas. Costs are hindering the development of green buildings, as the rental premiums exhibited are not enough to cover the premiums made [21]. Comparable evidence is found by Mohd Adnan et al. [30] and Gurun and Arditi [31] in Malaysia and the US, respectively, as cost savings is one of the key considerations. This certainly explains why people are reluctant to pay for green buildings and validates the need for further assessment of the economic benefits attributable to green buildings. Dermisi [32] found that different LEED ratings have different premiums, and Sullivan and Oates [33] found that LEED buildings face ongoing issues after certification, as it does not save as much energy as it ought to. Furthermore, Nappi-Choulet and Décamps [34], Fuerst and McAllister [35], and Bonde and Song [36] each show evidence of little gain in premiums in eco-labelled commercial buildings. However, Leskinen et al. [37] concluded that even though there are limitations in the research, the growing literature in green building premiums shows a reduction in outgoings and increased values. Halvitigala and Reed [38] find that property investors and building owners are willing to enhance space flexibility and functional efficiency of buildings by incorporating several adaptive and flexible space

design and specifications. This sees the opportunity to refurbish and renovate buildings by considering the green buildings features.

Another frontier of the literature focused on the nature and scope of green features that may increase the cost of implementing green initiatives and what energy saving measures can be rewarding. Fan et al. [39] found that the use of gross floor area concession scheme to promote green buildings can increase transaction and actual costs. However, they further noted that a 10% gross floor area concession will attract developers to engage in more green building activities. Iwan and Kenneth [40] reported that the use of coal-fired electricity in Hong Kong did not only improve air quality significantly, but it also has important public health benefits. The study by Tam et al. [41] considered construction cost, space heating, and cooling cost and identified double glazing façade to be the most cost-effective system in Sydney, but also noted the performance of masonry-veneer façade to be generally outstanding across Australia. Jeong et al. [42] found that, in South Korea, despite the additional construction cost, the average cost savings of certified 1st building energy efficiency rating (BEER) in multi-family housing complexes in categories 1, 2, and 3 were around 3.77%, 2.78%, and 2.87%, respectively.

Overall, most previous studies documented a higher premium from green or certified buildings than those that are non-certified, even though the magnitude of the premium varies across different markets and study periods. Much of these studies have also demonstrated the importance of more market transparency and information availability to the public to better measure the effects of eco-labelled buildings.

### *2.2. The Role of Disclosure Laws and Energy Ratings on Green Buildings*

In addition to empirical studies on green premiums, several researchers have examined the effect of disclosure laws and energy ratings on green buildings. In the mainstream business and sustainability literature, Guo et al. [2] found that carbon ratings are essential in raising firms' awareness of carbon reduction. Specifically, the Carbon Disclosure Program (CDP) has enhanced investment in sustainable technologies, improved organization of carbon discharges, and increased sensitivity to climate change. Moreover, Gui and Gou [43] investigated the plausible relationship between the determinants of office buildings and the energy use intensity (EUI) led by the mandatory disclosure law. Buildings with higher NABERS ratings (3, 3.5, 4, and 5.5 stars) have three factors, namely total stock, vacancy rate, and average incentive impacting the EUI of a building. As discussed by Gui and Gou [43], vacancy rate represents the proportion of unused area to total stock and it relates to office demand and occupancy density. Low vacancy rate depicts higher demand which can result in higher premiums. Average incentive refers to government policies that impact energy consumption such as building materials and green technologies. The greater these incentives, the lower will be the running costs of these buildings and this will free up cash. This explains how energy savings, energy preservation, and the economic factors are all interlinked which resulted in more premiums compared to non-green buildings.

In their analysis of green properties and their market response to the mandatory law, Aroul and Hansz [26] highlighted that mandatory building programs resulted in higher premiums and significant gains in green buildings. The empirical study of Simons et al. [44] demonstrated that it is necessary to go beyond state-level legislation as it is slower, but hasty methods such as executive orders will encourage more green buildings. As can be seen in the Australian Capital Territory (ACT), through the Environment and Sustainable Development Directorate [45], it is vividly clear that the mandatory policy has resulted in a reduction in carbon emissions and energy efficiency. It shows the implementation of new energy efficiency standards for all buildings, including the minimum performance standard of at least 6 stars for new detached dwellings, and how this contributes to the nation's environmental objectives. These studies have assisted to contextualize disclosure laws in the context of sustainability and its relationship with building premiums.

The green building tools and government intervention are also effective in other countries. Kok et al. [16] identified a positive relationship between the penetration of

eco-labelled buildings and the presence of incentives. This suggests that incentives could be an effective tool to enhance the adoption of green buildings. Drawing upon a unique database for the US commercial property, Fuerst et al. [15] found that it is only a mandatory requirement to obtain LEED certification for new buildings that could result in a significant positive effect on market penetration. Khan et al. [9] suggested that effective green building tools that were driven by the government are critical to promote green building development in Pakistan. This was seen after a review of the results from respondents who are professionals in the field of sustainable developments in the region reported that the rating tool SEED has failed to address contextual issues and challenges faced in the country. Nanda and Ross [46] further expounded on the role of property disclosure laws on values. They concluded that property disclosure influences premiums and sways buyers and dealers to sell and raise prices.

In the US, Palmer and Walls [47] identify short term impacts of energy use and disclosure laws in 10 approved US counties. The study has shown that the adoption of disclosure laws has a positive impact on the environment. The commercial buildings in the region must report their energy usage results to the government annually, which encourages owners to address problems by benchmarking their operational performance. This obviously resulted in lessened outgoings of commercial buildings and altered the commercial real estate industry to concentrate on building performance [47]. While the analysis identified that government intervention and policy form the focus of eco-labelling theory, studies of the longer-term effects, larger samples, and lack of data transparency needs to be made. Reed and Wilkinson [48] emphasize the importance sustainability has for building owners and suggests that the professional body needs to have some degree of control to facilitate building owners with the most excellent practice for the improvements of office buildings. Walls et al. [49] have shown that in the residential sector, there is evidence that people are not willing to pay a high premium, as they do not see the cost saving benefits. In Korea, Baek [50] found that the government's publicity and initiatives are critical to promote sustainable building development.

Other studies have examined the role played by green building rating systems to building and construction market. In their study on leadership in energy and environmental design (LEED), in the context of Brazil, Obata et al. [51] concluded that, due to its diverse benefits, LEED certification should be promoted in advancing sustainable development. Using a mix of qualitative and quantitative methods, Walaa [52] examined the green building rating and certification systems (GBRSs) and presented an integrated application framework that focused on energy and material credits. This framework executed systems at the individual level practices and the entire building process and concluded that differences in building types and context may cause variation in opportunities for scoring strength. By following a normalization criteria process, Saldana-Marquez et al. [53] applied the building sustainability rating system (BSRS) to examine the sustainability of different housing units built under the Funding Program for Housing Solutions. They found clear deficiencies in terms of materials, energy usage, indoor environmental quality, and management.

To sum up, many studies have been devoted toward the premium of green buildings, but these studies have shown mixed results. Further, little studies have examined whether the introduction of policies can have an impact on green premium. Even though extensive studies have been done to examine the effectiveness of government laws on the energy efficiency disclosure of commercial buildings, however, virtually no dedicated study has been done on the effectiveness of disclosure laws and energy ratings on the premium of green buildings.

### *2.3. Review of Definition: NABERS Rating*

The National Australian Built Environment Rating System (NABERS) is a sustainability measurement tool used for buildings in Australia that provides straightforward, trustworthy, and analogous data. The ratings range from 1 to 6 stars, which allows different

buildings to be compared by measuring the energy, water, waste, and internal setting. This allows owners or developers of buildings to benchmark building performance, which will help to identify various aspects of the building for savings and upgrades [54]. The ratings are valid for 12 months, after which it will need to be reassessed, which keeps the ratings relevant to current trends of sustainable performance.

As seen in Table 1, each rating is defined, and the higher the rating, the better the sustainable performance. The benefits of using the NABERS rating is, firstly, it enables owners to benchmark the energy and water usage across the board; secondly, it ensures businesses can be effective with allocating budgets and reporting data to stakeholders; thirdly, it improves and tracks sustainable objectives of a company through performance and reduction of energy and emissions; and lastly, it lessens the environmental impact with reduced outgoings and making properties more sellable [55].

**Table 1.** Definition of NABERS rating.

| NABERS Rating | Definition of NABERS Rating |
|---|---|
| One Star (*) | Making a start |
| Two Stars (**) | Below average |
| Three Stars (***) | Average |
| Four Stars (****) | Good |
| Five Stars (*****) | Excellent |
| Six Stars (******) | Market leading |

Source: NABEARS (2021).

### *2.4. Theoretical Framework and Hypothesis Development*

The previous sections highlighted the existence of green building premium. This section examines the theoretical framework, which leads to the formulation of the hypothesis of this study. Specifically, our study seeks to assess whether there is a stronger green building premium since the launch of the CDBP. It also provides an implicit test of the social impact hypothesis that was posited by Freeman [56].

The social impact hypothesis builds on the theory of stakeholders, and it postulates that stakeholders who expect favorable social performance is a business legitimacy. In other words, meeting the expectations and demands of various stakeholders, including non-shareowners (e.g., the community, the environment and society), will result in an improvement of the performance of a company [57]. On the other hand, stakeholders' disappointment may lead to an increase of risk premium for a company and higher costs and/or lose profit opportunities [58]. As such, an enhanced reputation of a company would have a positive impact on its financial performance over the long term. This confirms the social impact notion of Freeman [56] in which promising social performance will ultimately lead to favorable financial performance. It is therefore expected that social performance would have a positive link with financial performance over the long run [59]. Importantly, a positive connection between financial and social performance is also documented by numerous seminal studies such as Cochran and Wood [60], Spencer and Taylor [61], Jensen et al. [62], and Wang et al. [63].

However, there is a concern that the favorable social performance of a reporting entity does not fully reflect the true social performance of the reporting entity in which its social performance could be manipulated and biased towards an overall positive portrait. There are hopes of it being perceived favorably by the stakeholders [64]. This is also known as green washing activities in which social performance is used for impressing management purposes [3]. To address the green-washing behavior, the onset of stricter regulations of the reporting and disclosure is paramount. Wang et al. [65], for instance, offered some evidence which shows the implementation of stricter environmental regulation has a significant improvement in most of the efficiency indicators for sustainable and eco-efficiency. Comparable evidence is also documented by Guo et al. [3] for an enhanced carbon emissions

reporting system. Given the mandatory building energy efficiency disclosure under the CBDP program, it is reasonable to expect that the NABERS rating of a building would truly reflect the energy consumption competence of the building. Furthermore, one of the key features of this disclosure scheme is that actual energy performance will be used and audited to a common standard [11]. The implementation of the mandatory CBDP disclosure program, therefore, could minimize green washing activities, which, in turn, allows us to examine the association between eco-labelled buildings and their financial performance more effectively.

Importantly, the CBDP not only disseminates environmental awareness greatly, but also reduces information asymmetry in energy efficiency and general green attributes Khan and Kok [66] by offering more transparent energy efficiency buildings data to stakeholders. This also promotes an enhanced understanding of green buildings which is of great importance in addressing climate change and delivering a key social outcome in the community. The heightened awareness of eco-labelled buildings does, to a certain extent, make stakeholders realize the benefits of green buildings, as a stronger premium is documented for green buildings since the launch of CBDP program. Overall, this provides some empirical evidence on Freeman's (1984) social impact hypothesis. Following the social impact hypothesis, we formulate the following hypotheses:

**Hypothesis 1.** *A stronger connection between green building ratings and their premiums is documented in the post-CBDP program, whilst a weak association is documented in the pre-CBDP program.*

This hypothesis postulates that stakeholders do value eco-labelled buildings. Importantly, the strong association emerges since the launch of stricter reporting and disclosure policy, indicating that the heightened environmental awareness of eco-labelled buildings since the onset of CBDP. By using the unique Australian dataset, this allows us to examine the effectiveness of mandatory energy disclosure on green building premiums for the first time.

## 3. Data and Methodology

### *3.1. Data*

We collected quarterly secondary dataset from MSCI Australia/Property Council of Australia and JLL for the period Q1:2005 to Q3:2020. The MSCI index is used by major institutions globally as indicators or benchmarking tools for green buildings in Australia. The data on total return, income return and capital growth were obtained from two subgroups of NABERS ratings of commercial office buildings in Australia, namely 0–3.5 stars (non-green) and 4–6 stars (green). We also collected data on NABERS ratings for the different central business districts (CBDs) of Australia's state capitals such as Sydney, Melbourne, Brisbane, Perth, and Canberra. It is important to note that, at the time of the study, the dataset for Adelaide was inadequate for the two-submarket analysis. The assessment of the CBDs of the different state capital cities is critical because these city centers are often characterized by high performance, superior quality, and high concentration of NABERS commercial buildings in their respective states for a longer period. The interest rate and unemployment rate were obtained from the ABS, while precinct net absorption and precinct total stock were obtained from JLL.

The total return, income return and capital growth vary for different types of assets and NABERS star ratings. As such, for the CBD, the study of the pre-period spans March 2005–December 2011, while the post-period covers March 2012–September 2020. For non-CBD, pre-period covers March 2007–December 2011 and the post-period is March 2012 to September 2020. For Prime, the pre-period covers March 2005 to December 2011 and the post-period is March 2012 to September 2020. Lastly, the secondary pre-period is September 2007 to December 2011, while the post-period spans March 2012–September 2020.

For the major city analysis, the total return of assets in different cities has different study periods due to variations in dataset. In Sydney, the pre-period is June 2005 to December 2011, while the post-period covers the period March 2012–September 2020. In Melbourne, the pre-period is March 2009–December 2011, while the post-period is March 2012–September 2020. In Brisbane, the pre-period spans March 2011–December 2011, while the post-period covers March 2012–September 2020. In Perth, the pre-period is March 2010–December 2011 and the post-period is March 2012–September 2020. In Canberra, the pre-period is March 2009–December 2011 and the post-period is March 2012–September 2020.

### *3.2. Methodology*

#### 3.2.1. Performance Analysis and Sub-Period Analysis

To gauge the effectiveness of the CBDP, a sub-period risk-adjusted performance analysis was done to compare green and non-green buildings. As discussed in Section 3.1, the entire sample period was divided into pre- and post-periods of the CBDP to compare the performance of lower NABERS ratings (0–3.5 stars) with higher NABERS ratings (4–6 stars). Generally, the analysis of the pre-period will be prior to 2011 and the post-period will be after 2012 to account for assets that have just entered the market. This was done at two levels—first at the Australia level, and second, at the Australia state capital city level such as Sydney, Melbourne, Perth, Brisbane, and Canberra, as well as CBD and non-CBD, prime and secondary markets. This scope of the analysis is demonstrated in Figure 1.

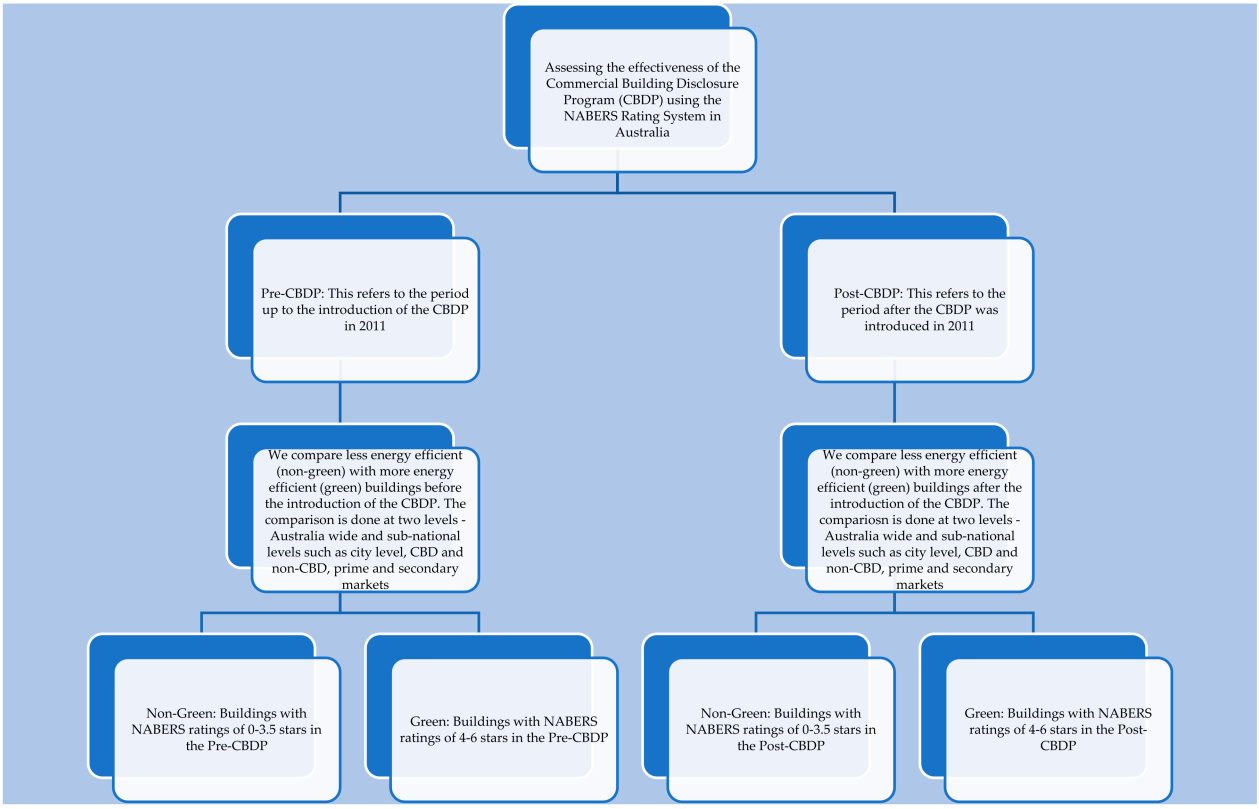


**Figure 1.** Demonstration of the analysis of the effectiveness of the CBDP.

The annualized risk and return are calculated for both sub-periods by transforming the quarterly data into a 12-month average data. A positive index means the investment is desirable, while a negative index means the investment is not worthwhile. This calculation is particularly helpful in evaluating the performance of the pre-period and post-periods. Following Lee [67], we de-smoothed the data to address issues of statistical significance of valuation-smoothing and ensure reliability and consistency throughout in the analysis.

We employed a parametric t-test to check for statistically significant difference between any chosen pair of markets. The total return is used to measure the performance of an investment over a specified period, and it is defined as follows:

$$\text{Total return} = \text{income return} + \text{capital growth} \quad (1)$$

where income return is the income generated from the property, while capital growth is the appreciation in the value of the property at the time it is sold over a specified period.

#### 3.2.2. Stage 2 Methodology: Economic Modelling

The second stage of the methodology is an econometric regression analysis to examine green building premiums after the CBDP using Sydney CBD. Apart from the limitation of data for the other cities, Sydney CBD was endorsed by the Australian Government as a major commercial hub and exemplified in Australia as a city with high-performing buildings. In addition, the city is the most populous in Australia and a third of Australia's GDP is generated in New South Wales (NSW). In addition, between 2017–2021, $87.2 billion was invested in infrastructure by the NSW state government, 44% of Australia's foreign direct investment between 2013–2018 was done in NSW, over 600 international businesses are in NSW, and the NSW state economy is steadily growing at 2.9% per annum (NSW Department of Planning, Industry, and Environment [68]; NSW Treasury [69]). Further, the NSW state government continues to transform the urban fabric of Greater Sydney. In their Metropolis Plan for Sydney, Greater Sydney Commission delineated the city into a metropolis of three cities to help promote the city's sustainability agenda (Greater Sydney Commission [70]). All these features make Greater Sydney a fascinating case study for the second stage analysis. Our regression model becomes:

$$TR_t = \beta 0 + \beta 1 IR_t + \beta 2 UNEMP_t + \beta 3 PTS_t + \beta 4 PNA_t + \beta 5 Dummy_t + \varepsilon_t \quad (2)$$

where $TR_t$ denotes total return at time t, IR denotes interest rate, UNEMP denotes unemployment, PTS denotes precinct total stock, PNA denotes precinct net absorption, and Dummy is a time dummy variable taking on the value 1 for the period of Q4,2011–Q4,2020 and zero otherwise. In other words, the time dummy variable captures the impact of CBDP. It is hypothesized that the coefficient of β5 is positive and statistically significant as the CBDP does promote building owners to disclose the actual energy efficiency of their buildings and increase environmental awareness. This time dummy variable therefore allows us to determine whether office return of green building is higher in the post-period CBDP. A similar approach has been used in previous studies to gauge the impact of a policy or new product (e.g., Lee et al. [29] and Lee and Reed [35]).

The model has two set of dependent variables—NABERS rating 0–3.5 stars and NABERS rating 4–6 stars. These variables are the major determinants of total return as documented in Hendershott et al. [71], Lizieri and Pain [72], Newell et al. [17], and Gui and Gou [43]. Unemployment and interest rate are hypothesized to be negative [43,71], while precinct total stock, and precinct net absorption are expected to be positive [17].

## 4. Results and Discussion

### *4.1. Performance Analysis and Sub-Period Analysis*

#### 4.1.1. Aggregate Performance Analysis

The first issue to be considered is the overall performance of commercial office buildings before and after the CBDP. The results of the aggregate performance indices of total return, income return and capital growth are reported in Table 2. Using the risk-adjusted performance, except for income return, the post-CBDP completely outperformed the period before the CBDP for the other two indices. The income return in the pre-CBDP far outstripped the post-CBDP. Since income return is a component of total return, the excess of total return in the post-period over the pre-period can be attributed to the increase in capital

growth over time. These results indicate a general increase in the risk-adjusted performance of commercial office buildings in Australia after the implementation of the CBDP.

**Table 2.** Aggregate performance indices.

| Performance Index | Annualised Index before CBDP | Annualised Index after CBDP | Annualised Risk before CBDP | Annualised Risk after CBDP | Annualised Risk-Adjusted Performance before CBDP (Return/Risk) | Annualised Risk-Adjusted Performance after CBDP (Return/Risk) |
|---|---|---|---|---|---|---|
| Total Return | 9.71% | 9.58% | 3.50% | 1.94% | 2.77% | 4.94% |
| Income Return | 6.89% | 6.11% | 0.21% | 0.45% | 32.81% | 13.58% |
| Capital Growth | 2.65% | 3.29% | 3.47% | 1.77% | 0.76% | 1.86% |

Overall, results here suggest that a higher risk-adjusted return is documented in the post-CBD period. A consistent picture is recorded for total return and capital growth for the Australian commercial property market. This raises the question of whether there is a difference in performance between non-green and green buildings over the study period.

#### 4.1.2. Risk-Adjusted Performance Non-Green vs. Green: A Sub-Market Analysis

The preceding section has shown that a higher risk-adjusted return is stronger in the post-CBDP period. However, this is still unclear whether both green and non-green buildings do exhibit the same return pattern over the study period. A comparative study of risk-adjusted performance of non-green and green buildings, therefore, is undertaken. By recognizing the diverse effects market fundamentals may have on capital city markets for commercial buildings in Australia, a sub-market analysis is also undertaken. These sub-national markets may also be affected varyingly by their local factors, resulting in differences in the performance of these markets Bangura and Lee [73]. Therefore, we compare the performances of buildings before and after the CBDP using several delineations such as central business district (CBD), non-central business district (non-CBD), prime market, and secondary market, as well as the state and territory capital cities of Sydney, Melbourne, Perth, Brisbane, and Canberra in this section.

To enhance the specificity of the evidence of green and non-green buildings in Australia, a comparison of both types of buildings in CBD and non-CBD areas were compared first. The results of the comparison between non-green (0–3.5 stars) and green buildings (4–6 stars) in the various CBDs of Australia are presented in Table 3. Prior to the implementation of the CBDP, using the risk-adjusted performance, within the CBDs of Australia, total return and income return of non-green buildings outperformed green buildings. The only exception is capital growth as green buildings slightly surpassed non-green buildings. The situation is completely different in the post-CBDP period, as the risk-adjusted performance of green buildings clearly exceeded the performance of non-green buildings for all the four indices. Strikingly, the 4.09% excess of the risk-adjusted income return for green buildings in the post period far exceeded the 2.24% dominance of the non-green buildings recorded in the pre-CBDP phase. Similar findings were seen for the risk-adjusted total return. The findings from the CBD markets in Australia are consistent with the previous findings of Eichholtz et al. [12] and Miller et al. [19] in the US and Kok and Jennen [21] in Europe, in which green buildings generate greater risk-adjusted performance than non-green buildings. This also supports the notion that the mandatory disclosure program has become an effective tool in promoting green commercial buildings in the CBDs of Australia since it was introduced by the Australian government in 2011.

**Table 3.** CBD market—risk-adjusted performance non-green (0–3.5 stars) vs. green (4–6 stars).

| Performance Index | Annualised Risk-Adjusted Performance before CBDP (0–3.5 Stars) | Annualised Risk-Adjusted Performance before CBDP (4–6 Stars) | Annualised Risk-Adjusted Performance after CBDP (0–3.5 Stars) | Annualised Risk-Adjusted Performance after CBDP (4–6 Stars) |
|---|---|---|---|---|
| Total Return | 2.04% | 1.98% | 4.85% | 6.78% |
| Income Return | 12.85% | 10.61% | 10.81% | 14.90% |
| Capital Growth | 0.52% | 0.57% | 2.08% | 2.95% |

In comparing non-green and green buildings in the non-CBD markets of Australia, using the NABERS rating system, the results in Table 4 show that, apart from capital growth, which is negative for both building types in the pre-CBDP, the risk-adjusted total return and income return of green buildings are more than non-green buildings. In the non-CBD market, the income return of green buildings is greater than non-green buildings both before and after the CBDP. Moreover, the negative capital growth that was recorded in the pre-CBDP period for both building types improved significantly with green buildings exceeding non-green by 0.86%. Additionally, the risk-adjusted total return for green buildings increased from 2.48% in the pre-CBDP period to 7.04% in the post-CBDP period, while for total return, this index increased from 1.25% in the pre-period to 4.81% in the post-CBDP period.

**Table 4.** Non-CBD market—risk-adjusted performance non-green (0–3.5 stars) vs. green (4–6 stars).

| Performance Index | Annualised Risk-Adjusted Performance before CBDP (0–3.5 Stars) | Annualised Risk-Adjusted Performance before CBDP (4–6 Stars) | Annualised Risk-Adjusted Performance after CBDP (0–3.5 Stars) | Annualised Risk-Adjusted Performance after CBDP (4–6 Stars) |
|---|---|---|---|---|
| Total Return | 1.25% | 2.48% | 4.81% | 7.04% |
| Income Return | 9.81% | 10.19% | 10.08% | 14.20% |
| Capital Growth | (0.58%) | (0.16%) | 1.84% | 2.70% |

These results of the non-CBD market are generally consistent with the CBD market, providing further evidence that supports the effectiveness of the CBDP in improving the financial performance of green buildings. As discussed by Leskinen et al. [37], mainstream investors would prefer properties that can fully reflect the environmental performance of properties. An enhanced energy efficiency disclosure of buildings via the introduction of CBDP would allow buildings to better reflect their environment performance [16]. As such, this is reasonable to find a higher level of green building premium in the post-CBDP period. Even though both the CBD and non-CBD markets espoused the efficiency of the CBDP, our results reveal greater performance in total return and capital growth in the non-CBD, while the CBD market marginally outperformed the non-CBD market in terms of income return and capital growth.

Our next phase of the analysis is to examine the effectiveness of the CBDP in the prime market and secondary market. The results are reported in Tables 5 and 6, respectively. Using the risk-adjusted income return, the results show that non-green buildings outperformed green buildings in the pre-CBDP period, while green buildings recorded slightly higher risk-adjusted total return and capital growth in the same period. There is a stark difference in the post-CBDP period as the risk-adjusted performance of green buildings is greater than non-green buildings for almost all the indices. There is a noticeable increase in three risk-adjusted indices for green buildings such as total return rising from 2.12% in the pre period to 7.20% in the post period, whilst capital growth increasing from 0.56% to 3.08% from the pre to post-CBDP period. These marked improvement in these indices is indicative of the effectiveness of the CBDP on commercial buildings.

**Table 5.** Prime market—risk-adjusted performance non-green (0–3.5 stars) vs. green (4–6 stars).

| Performance Index | Annualised Risk-Adjusted Performance before CBDP (0–3.5 Stars) | Annualised Risk-Adjusted Performance before CBDP (4–6 Stars) | Annualised Risk-Adjusted Performance after CBDP (0–3.5 Stars) | Annualised Risk-Adjusted Performance after CBDP (4–6 Stars) |
|---|---|---|---|---|
| Total Return | 2.05% | 2.12% | 5.38% | 7.20% |
| Income Return | 18.49% | 17.90% | 11.92% | 13.33% |
| Capital Growth | 0.48% | 0.56% | 2.19% | 3.08% |

**Table 6.** Secondary market—risk-adjusted performance non-green (0–3.5 stars) vs. green (4–6 stars).

| Performance Index | Annualised Risk-Adjusted Performance before CBDP (0–3.5 Stars) | Annualised Risk-Adjusted Performance before CBDP (4–6 Stars) | Annualised Risk-Adjusted Performance after CBDP (0–3.5 Stars) | Annualised Risk-Adjusted Performance after CBDP (4–6 Stars) |
|---|---|---|---|---|
| Total Return | 1.04% | 0.79% | 3.23% | 3.45% |
| Income Return | 8.90% | 6.10% | 6.88% | 13.50% |
| Capital Growth | (0.75%) | (0.68%) | 1.41% | 1.50% |

Table 6 depicts the results of the comparison between non-green and green buildings for the secondary market. The results show that, in the pre-CBDP phase, both total return and income return for non-green buildings outstripped green buildings. However, capital growth was negative for both green and non-green buildings in the same period. In the post-CBDP period, the risk-adjusted performance of green buildings is slightly greater than non-green buildings in terms of total return and capital growth, but significantly higher in the income return. In fact, the income returns of green building recorded a big jump, increasing from 6.10% in the pre-CBDP period to 13.50% in the post-CBDP period. This is reflected in the total return for green buildings which increased from 0.79% in the pre-period to 3.45% in the post period. The negative capital growth recorded in the pre-CBDP period for both green and non-green buildings improved to positive indices in the post-CBDP phase. These results are consistent with the prime market, and both markets have provided supplementary evidence to support the effectiveness of the CBDP on commercial buildings.

To sum up, we have analyzed the effectiveness of the CBDP by comparing non-green and green buildings for various markets such as CBD, non-CBD, prime, and secondary markets. In these submarkets, our results generally reveal a clear difference in the risk-adjusted total return, income return and capital growth between green and non-green buildings, with green buildings largely outperforming non-green buildings. As argued by Myers and Reed [24], green buildings indicate comparatively low outgoings for tenants. This could expand demand for green building type, increase its rent, and subsequently increase green price premium since the launch of the CBDP program.

#### 4.1.3. Comparison between Difference in Performance for Green and Non-Green Buildings

To further elucidate the effectiveness of the mandatory disclosure policy under the NABERs rating system, we conducted a parametric t-test to investigate if any statistically significant difference in performance exists between non-green and green buildings. The results of the parametric t test for both the CBD and non-CBD markets are reported in Table 7.

The results from Table 7 have revealed no statistically significant difference in performance between green and non-green buildings for total return, income return and capital growth in the pre-CBDP period. However, a statistically significant difference in both total return and income return is documented between green and non-green buildings in the post-CBDP period at the 1% level. Further, there is statistically significant difference in capital growth between green and non-green buildings in the post-CBDP period at the 10%

significance level. The results generally support our earlier findings of a clear difference in performance between green and non-green buildings after the execution of the CBDP. This also supports the notion of social impact in which the favorable social performance will lead to the favorable financial performance. Comparable evidence has been widely documented in the mainstream environmental literature such as Cochran and Wood [60], Spencer and Taylor [61], Jensen et al. [62], and Wang et al. [63]. Specifically, the implementation of stricter environmental regulation (i.e., CBDP) will increase the awareness of eco-labelled buildings, which make stakeholders realize the benefits of green buildings; thereby a stronger premium is documented for green buildings. The documented finding here is also consistent with the findings of Leskinen et al. [37], in which investors prefer buildings that truly reflect their environmental performance, as well as the finding of Nanda and Ross [46], as they concluded that property disclosure laws would have an impact on property value since the laws sway buyers and dealers to raise prices.

**Table 7.** CBD and non-CBD markets: parametric *t*-value of non-green (0–3.5 stars) vs. green (4–6 stars).

| Performance Index | Green vs. Non-Green in the CBD Market before CBDP | Green vs. Non-Green in the CBD Market after CBDP | Green vs. Non-Green in the Non-CBD Market before CBDP | Green vs. Non-Green in the Non-CBD Market after CBDP |
|---|---|---|---|---|
| Total Return | 0.31 | 2.62 *** | 2.91 *** | 1.62 * |
| Income Return | 1.32 | 7.78 *** | 3.89 *** | 5.92 *** |
| Capital Growth | 0.50 | 1.69 * | 1.42 | 0.58 |

*T*-values are reported. The Null Hypothesis: There is no difference in the average of each of the variables (total return, income return and capital growth) between the non-green (0–3.5 stars) and green (4–6 stars). *** denotes the difference is significant at the 1% level, ** denotes the difference is significant at 5% level, and * denotes the difference is significant at 10% level.

In the non-CBD market, from Table 7 the difference in performance between green and non-green buildings is more pronounced. We found statistically significant difference in total return and income return at the 1% level between green and non-green buildings in both pre-and-post-CBDP periods. The results can be attributed to the relatively limited office supply, particularly green buildings in non-CBD areas compared with CBDs as discussed by E&Y [74]. The city decentralization process also sees many buildings in the suburban (or non-CBD areas) to be occupied by government agencies (NSW Department of Planning [75]). For instance, the NSW government has reallocated its government agencies to non-CBD areas such as Parramatta. Importantly, the government agencies do have a requirement for buildings energy efficiency. The NSW Government agencies, for instance, have a requirement of achieving and maintaining a NABERS Energy rating of at least 4.5 stars (NSW Government [76]). Further, the National Green Leasing Policy also sets out the principles for Australian governments in all levels (i.e., Federal, State and Territory governments) to collectively work to improve environmental efficiency of buildings through government leasing (NGLP [77]). As such, this is not too surprising to find a higher level of awareness of green buildings in non-CBD areas prior to the implementation of CBDP. However, there is no statistically significant difference in capital growth in both periods. In both CBD and non-CBD markets, the results generally show statistically significant difference in performance between green and non-green buildings.

Table 8 presents the results of differences between green and non-green buildings in the prime and secondary markets. As can be seen from Table 8, the results of the parametric t test in the pre-CBDP period of the prime market show no statistically significant difference in performance between green and non-green buildings. However, the performance between these two building types is significantly different in total return and income return at the 1% significance level. This shows that the performance of commercial buildings is enhanced after the implementation of the CBDP. There is no difference in capital growth in both periods.

**Table 8.** Prime and secondary markets: parametric *t*-value of non-green (0–3.5 stars) vs. green (4–6 stars).

| Performance Index | Green vs. Non-Green in the Prime Market before CBDP | Green vs. Non-Green in the Prime Market after CBDP | Green vs. Non-Green in the Secondary Market before CBDP | Green vs. Non-Green in the Secondary Market after CBDP |
|---|---|---|---|---|
| Total Return | 0.68 | 2.65 *** | 0.49 | 1.45 * |
| Income Return | 1.00 | 5.85 *** | 2.27 ** | 6.03 *** |
| Capital Growth | 0.51 | 1.20 | 0.06 | 0.68 |

*T*-Values are reported. The Null Hypothesis: There is no difference in the average of each of the variables (total return, income return and capital growth) between the non-green (0–3.5 stars) and green (4–6 stars). *** denotes the difference is significant at the 1% level, ** denotes the difference is significant at 5% level, and * denotes the difference is significant at 10% level.

For the secondary market, statistically significant difference in income return between the two building types is documented at the 5% level during the pre-CBDP period. In the post-CBDP period, we found statistically significant differences in total return at 10%, income return at 1%. Again, there is no difference in capital growth for both periods. The parametric t test further validates our earlier findings, which highlighted the effectiveness of CBDP in Australia, as we found a significant difference in the performance of green and non-green buildings.

To further examine the effectiveness of the CBDP, we used the risk-adjusted total return to examine the difference in performance between green and non-green buildings across the key state capital cities of Australia. We scale down the analysis to the different cities since they can be determined by their local factors. As total return combines income return and capital growth, this index is used to compare the performance of these two building types in both pre-and-post-CBDP periods. The results are reported in Table 9.

**Table 9.** Total return of non-green vs. green in key cities of Australia.

| City | Annualised Total Return before CBDP | Annualised Total Return after CBDP | Annualised Risk before CBDP | Annualised Risk after CBDP | Annualised Risk-Adjusted Performance before CBDP | Annualised Risk-Adjusted Performance after CBDP |
|---|---|---|---|---|---|---|
| Sydney (0–3.5) | 8.91% | 13.65% | 4.08% | 4.16% | 2.18% | 3.28% |
| Sydney (4–6) | 8.94% | 12.19% | 4.69% | 2.36% | 1.91% | 5.17% |
| Melbourne (0–3.5) | 9.45% | 11.36% | 5.01% | 2.69% | 1.89% | 4.22% |
| Melbourne (4–6) | 8.07% | 13.01% | 3.35% | 2.27% | 2.41% | 5.73% |
| Brisbane (0–3.5) | 11.55% | 7.87% | 7.14% | 1.47% | 1.62% | 5.35% |
| Brisbane (4–6) | 11.60% | 8.08% | 1.19% | 1.41% | 9.75% | 5.73% |
| Perth (0–3.5) | 11.47% | 4.66% | 1.34% | 2.58% | 8.56% | 1.81% |
| Perth (4–6) | 3.64% | 7.20% | 4.40% | 2.24% | 0.83% | 3.21% |
| Canberra (0–3.5) | 8.71% | 5.14% | 6.04% | 1.44% | 1.44% | 3.57% |
| Canberra (4–6) | 7.49% | 9.56% | 3.43% | 1.36% | 2.18% | 7.03% |

The results from Table 9 reveal that non-green buildings outperformed green buildings before the CBDP in the cities of Sydney and Perth. However, during this same period, the performance of green buildings is greater than non-green buildings in the cities of Melbourne, Brisbane, and Canberra. The performance of green buildings ahead of non-green buildings is more evident in Brisbane, yielding a risk-adjusted index of 9.75% compared to 1.62%, respectively. These results suggest that the performance of green buildings is generally better than non-green buildings in the key cities of Australia in the pre-CBDP period. However, in the post-CBDP period, green buildings consistently outperformed non-green buildings in all the cities. This again shows the effectiveness of the mandatory disclosure program as green buildings largely outdone non-green buildings.

To encapsulate, we conducted an array of statistical analyses on the difference in performance between green and non-green buildings using the Australian market and several submarkets to gauge the effectiveness of the mandatory disclosure policy in Australia. Our

findings show a clear difference in risk-adjusted performance before and after the implementation of the CBDP. We have documented evidence that shows greater performance of green buildings over non-green buildings in total return income return and capital growth over the study period.

The findings support our hypothesis of stronger green price premium in the post CBDP period, and the results are in line with Freeman's [56] social impact hypothesis. This hypothesis stems from the notion that green office buildings help to reduce energy usage, allow developers and operators to reduce electricity bill, reduce greenhouse gas emissions, improve air quality, and gain recognition for being energy efficient. This show of superiority in performance of green buildings over non-green buildings has offered clear-cut evidence of the effectiveness of the mandatory disclosure policy that was introduced in 2011. This reinforces the importance of stricter environmental regulations as discussed by Wang et al. [53] using the Chinese dataset and Gou et al. [3] for international datasets. Further, as discussed previously, the mandatory building energy efficiency disclosure allows property investors, particularly corporate socially responsible investors, to have a more vivid picture of the energy efficiency of a building as the NABERS rating of the building would truly reflect the energy consumption competence of the building [11]. Consequently, this would minimize green washing activities and allow us to better measure the financial benefits of eco-labelled buildings more effectively.

### *4.2. Stage 2 Analysis—Regression Results*

The existence of strong green price premiums in the post-CBDP period raises the question of the role of the CBDP program on green price premiums, which has not been fully established. To shed more lights, this section investigates the effectiveness of CBDP in enhancing the green price premium using regression modelling. As discussed in the methodology, the second stage is an analysis of the regression results of two sets of panels—Panel 0–3.5 stars (non-green) and Panel 4–6 stars (green). We regress total return against interest rate, unemployment, precinct total stock, precinct net absorption, and a dummy variable that captures the impact of the CBDP by assigning 1 to the post-CBDP period and 0 to the pre-CBDP period. The descriptive statistics of these variables are reported in Table 10. The CBD of Greater Sydney is characterized by a large concentration of commercial office buildings that have been around for the longest time compared to other precincts within Greater Sydney. As such, we compare non-green with green buildings of Greater Sydney, and such disaggregation of commercial buildings would enhance our analysis of linking building greenness to performance. The results are reported in Table 11.

The variable of interest of this study, time dummy variable, is positive and statistically significant for green buildings at the 5% significance level, whilst it is insignificant for non-green buildings. The results signify that the introduction of CBDP does have a discernible impact on green price premium, and the results are consistent with the preceding findings of the strong impact of CBDP on the performance of green buildings. However, the policy does not have a noticeable impact on non-green buildings as expected. The results can be interpreted as supporting the social impact hypothesis. Specifically, the importance of energy efficient or eco-labelled buildings in reducing the climate change risk can be promoted via the implementation of stricter environment policy and disclosure. Importantly, this has also been a key ingredient in the success of the green building agenda of property investors in recent years [17]. Therefore, this is reasonable to find stronger premium is being documented for green buildings since the launch of the CBDP. This also directly supports the previous findings of government's environmental regulations. Our findings, therefore, assert that the implementation of harsher regulations does not only enhance sustainable development [65] and promote the diffusion of green technology in the building sector [15,16], but also have a noticeable impact on green building premiums.

**Table 10.** Descriptive statistics of the regression variables.

| | Interest Rate (%) | Unemployment Rate (%) | Precinct Total Stock ($m^2$) | Precinct Net Absorption ($m^2$) | Total Return (0–3.5 Stars) (%) | Total Return (4–6 Stars) (%) |
|---|---|---|---|---|---|---|
| Mean | 4.74 | 6.24 | 973,137 | 2755 | 2.11 | 2.69 |
| Median | 4.75 | 5.66 | 500,611 | 1088 | 2.47 | 2.81 |
| Mode | 4.75 | 6.16 | 282,377 | 0 | 2.46 | 2.90 |
| Standard Dev. | 2.87 | 1.68 | 1,318,330 | 16,167 | 2.45 | 1.92 |
| Minimum | 0.1 | 4.32 | 135,833 | −94,481 | −3.30 | −2.79 |
| Maximum | 16.75 | 11.18 | 4,838,502 | 93,873 | 10.54 | 6.00 |

**Table 11.** Regression results of non-green (0–3.5 stars) and green (4–6 stars).

| Dependent Variable: Total Return | Non-Green (0–3.5 Stars) | | Green (4–6 Stars) | |
|---|---|---|---|---|
| | Coefficient | t-Stat | Coefficient | t-Stat |
| Interest rate | 0.09 | 0.84 | 0.10 | 0.16 |
| Unemployment | −1.20 | −3.54 *** | −0.71 | −2.18 ** |
| Precinct total stock | 0.00 | 0.16 | 0.00 | 0.07 |
| Precinct net absorption | 0.00 | 4.60 *** | 0.00 | 3.16 *** |
| Time Dummy | 0.02 | 1.67 | 0.01 | 1.98 ** |
| Constant | 0.06 | 0.84 | 0.04 | 0.18 |
| Loglikelihood | 181.57 | | 177.47 | |

The estimated model is given as $TR_t = \beta_0 + \beta_1 IR_t + \beta_2 UNEMP_t + \beta_3 PTS_t + \beta_4 PNA_t + \beta_5 Dummy_t + \varepsilon_t$, *** denotes variable is significant at the 1% level, ** denotes variable is significant at 5% level, and * means the variable is significant at 10% level. Robust standard errors are utilized.

It is clear here that, irrespective of building types, the results from Table 10 show that precinct net absorption is a statistically significant determinant of total return at the 1% level for both non-green and green buildings. The results are also consistent with the findings of Newell et al. [17]. As an indication of demand, higher precinct net absorption would likely lead to an increase in return via increased rental income. Therefore, it is reasonable to document that net absorption rate is a key determinant of commercial office returns. Another interesting observation is unemployment rate. As hypothesized, the coefficient of unemployment rate is negative and statistically significant at the 5% level for buildings with high eco-labelled rating (4–6 stars) and low eco-labelled rating (0–3.5 starts). This suggests that, irrespective of being green or non-green buildings, unemployment rate is a critical determinant of commercial office building returns. More specifically, a higher level of unemployment rate would lead to a lower level of office building return. A deterioration of job market activities, therefore, will inevitably soften office demand. This can also be interpreted as a decline in demand for office buildings. The decline of office demand also results in a weaker rent level as the DiPasquale and Wheaton [78] theory of property demand and supply asserts that if real estate demand decreases, whilst the supply of real estate remains unchanged, a surplus of supply is expected, leading to a lower equilibrium price and vice versa [79]. As discussed by the Reserve Bank of Australia [80], an increase in cyclical unemployment rate reflects the economy is operating in a sub-optimal level; suggesting that businesses experiencing weaker demand that might reduce the number of employees that they hire. Comparable evidence in the Australian housing market in which an increase in unemployment rate indicates a shortfall of demand for aggregated goods and services [73,81]. Comparable international evidence is also documented by Hendershott et al. [71] and Gui and Gou [38], indicating that unemployment rate is also a key indicator of the demand for office buildings. As such, an inverse relationship between unemployment rate and office return should be documented.

Nevertheless, the coefficients of interest rate are statistically insignificant, indicating that interest rate plays a negligible role in explaining the return of office sector in Sydney. Similar results were documented by Abelson et al. [82] in the housing sector. This can be attributed to the inflation hedging effectiveness of office buildings. As reported by

Svensson [83], inflation targeting has been adopted in many advanced economies including Australia. Consequently, inflation rate plays a critical role to the broader economy in which its movements have been monitoring closely by the central bank, and its monetary policy will also be adjusted in response to inflation movements such as adjusting its official interest rate [84,85]. Importantly, several studies have offered empirical evidence that confirm the effectiveness of commercial property as a successful instrument of inflation hedging [86–88]. As such, unlike other assets such as stocks, it is reasonable to expect that interest rate does not have a significant impact on the return of commercial property. Comparable evidence is documented by Lee [89] for the Australian housing markets. Further, the regression results show that total stock has little impact on the return of commercial property. This could be, at least to a certain extent, attributed to low vacancy and supply in the market. Despite the pandemic, the total vacancy rate in Sydney remained low with a vacancy rate of around 9 percent as of July 2021 [90]. This suggests that total stock is not a key determinant of commercial office return in Sydney.

Overall, our empirical evidence suggests that the launch of CBDP does have a significant impact on green price premium, reflecting that the CBDP is one of the key determinants of commercial office return in Sydney. This indicates that the mandatory disclosure policy is an effective tool in promoting property environmental awareness and in enhancing green price premium.

### *4.3. Discussion*

The results, in general, are supportive of a strong and positive connection between green buildings and financial performance in which green buildings generate greater risk-adjusted performance than non-green buildings. The results are intuitively appealing and consistent with the previous findings of Eichholtz et al. [12] and Fuerst and McAllister [13] in the US and Kok and Jennen [21] in Europe, which confirm the presence of a green price premium in the Australian commercial property market. This also supports the notion of social impact in which favorable social performance would lead to favorable financial performance. Comparable international evidence has been found by Cochran and Wood [60], Spencer and Taylor [61], Jensen et al. [62], and Wang et al. [63] in the mainstream environmental literature.

More importantly, our results revealed that the premium of green building is even stronger since the introduction of mandatory energy efficiency disclosure program (CBDP). The results can be attributed to the stricter regulations on energy disclosure for buildings. As the mandatory disclosure regulations do, to a certain extent, require building owners to disclose the actual and true energy efficiency of their buildings, and make stakeholders be aware of the benefits of green buildings as a part of key social performance. The results can also be interpreted as supporting the social impact hypothesis. Specifically, the implementation of stricter environmental policy and disclosure further reinforces the role of green or eco-labelled buildings in reducing climate change risk. Further, an enhanced energy efficiency disclosure of buildings via the introduction of CBDP would allow buildings to better reflect their environment performance of properties [16]. Importantly, properties that can be fully reflected in their environmental performance would be preferred by institutional investors, particularly investors with a CSR mandate [37]. As such, a stronger green price premium should be documented for green buildings since the launch of CBDP program due to the increasing awareness of green buildings.

Our results are also in agreement with the notion that the mandatory disclosure program has become an effective tool in promoting green commercial buildings in Australia since it was introduced by the Australian government in 2011. This also shapes the green agenda of many property investors and building owners [17]. Specifically, the studies by Newell and Lee [91], Newell [92] and Hijjawi et al. [93] have shown that the increased attention paid to CSR by Australian property investors, particularly A-REITs investors, has been evident in recent years. Similar evidence is also found in Europe [94]. A-REITs is one of the most effective property investment vehicles in Australia and internationally [91].

Importantly, more than half of the office buildings in Australia are managed and owned by A-REITs [95,96]. As such, it is reasonable to see a higher level of green building premium given the increased focus on CSR by institutional investors in Australia. This also directly supports the previous findings of government's environmental regulations that have been documented by Kok et al. [15] and Fuerst et al. [16] in the US, Baek [50] in Korea and Khan et al. [9] in Pakistan, suggesting that stricter regulations are important to promote sustainable development.

However, there are two major building rating schemes are available in Australia. These are NABERS rating and Green Star schemes. The NABERS rating scheme focuses on existing buildings as it is a micro-level environmental rating scheme. The NABERS rating measures the operational impacts of a building on the environment, including carbon emissions and water consumption [17]. Specifically, the NABERS energy rating scheme has been most widely employed. This could be attributed to the CBDP mandatory disclosure program, as the program requires building owners to disclose the NABERS energy efficiency in Australia. As discussed by Gabe [11], a unique feature of this scheme is that actual energy performance is used and audited, unlike intrinsic ratings, to a common standard. On the other hand, the Green Star rating scheme is a more macro-level rating scheme. This is a voluntary performance-based rating scheme, unlike the NABERS, that evaluates the environmental design and construction of office buildings [17,97]. Both rating schemes offer a comparable environmental performance rating scheme to the international green building ratings such as LEED in the US and BREEAM in the UK.

One could make a case that both NABERS and Green Stars rating schemes have different nature of disclosure types (mandatory and voluntary). The robustness of our findings that are based on the NABERS rating system, therefore, should be further assessed. To shed more light, we re-run our performance analysis with the Green Stars rating scheme by using the MSCI/IPD Green Stars office dataset The empirical results are not reported for brevity. However, this is available on request. In general, our empirical results based on the Green Stars rating system are fairly consistent with the NABERS rating scheme. Specifically, a stronger risk-adjusted return, in general, is evident in the post-CBDP period for buildings with Green Stars certifications. This confirms that a stronger green building premium is evident since the launch of CBDP. Therefore, our baseline results are robust to different rating schemes. This also reinforces that the onset of CDBP led to a stronger association between green buildings and financial performance; supporting the social impact hypothesis of Freeman [56] in which promising social performance will ultimately lead to favorable financial performance. Importantly, the finding supports the notion that the mandatory disclosure program has become an effective tool in promoting green commercial buildings in Australia. This also supports the argument of Elliot and Sayce [98], in which an enhanced understanding from a market economic-based perspective is crucial to address sustainability issues in the commercial property stock.

## 5. Conclusions and Policy Implications

Green buildings have been widely examined in the literature. In this study, we examine the role of mandatory energy efficiency disclosure on green building price premium. Extending the argument advanced by Eichholtz et al. [12], the study analyzed the effect of Commercial Building Disclosure Program (CBDP) on commercial office buildings in major Australian cities, especially Sydney CBD. We collected quarterly secondary dataset from MSCI Australia/Property Council of Australia and adopted a two-staged methodology (risk-adjusted performance analysis and regression modelling) to examine the effectiveness of the CBDP on commercial office buildings. We delineated two subgroups of NABERS ratings of commercial office buildings in Australia, namely 0–3.5 stars (non-green) and 4–6 stars (green).

Several key findings have been identified. First, at the Australia level, we found a general increase in the risk-adjusted performance of commercial office buildings after the implementation of the CBDP. For both CBD and non-CBD markets, we found green

buildings to have greater risk-adjusted performance than non-green buildings. For prime and secondary markets, the performance of green buildings over non-green buildings is more pronounced. We also conducted a parametric t-test to find out if there is a statistically significant difference in performance between green and non-green buildings in both the CBD and non-CBD markets. Our results show evidence of statistically significant difference in performance between green and non-green buildings in both the CBD and non-CBD markets. This is a further validation of our findings on the difference in performance between green and non-green buildings. Second, at the state capital city level, we found green buildings consistently outperforming non-green buildings in all the cities in the post-CBDP period. This again shows the effectiveness of the mandatory disclosure program as green buildings largely surpassed non-green buildings.

Third, the dummy variable of the economic modelling is significant for green buildings at the 5% level, but insignificant for non-green buildings. This further shows the strong impact the CBDP has on the performance of green buildings, while no comparable evidence is found for non-green buildings. This shows stricter disclosure requirements like the CBDP to promote an enhanced building energy efficiency disclosure. The stronger awareness of the benefits of eco-labelled buildings among building owners and property investors since the launch of the CBDP will result in a stronger premium for green buildings, reinforcing Freeman's (1984) social impact hypothesis. Overall, our findings support the argument that green office buildings generate greater premiums than non-green buildings. It supports the notion that the mandatory disclosure program has become an effective tool in promoting green commercial buildings in Australia since it was introduced by the Australian government in 2011.

These findings have numerous significant investment and policy implications. Generally, the finding of stronger green building price premium after the introduction of stricter environmental policy (i.e., CBDP) allows various property stakeholders such as occupiers, government bodies, developers and operators, and investors to have an enhanced understanding on the relationship between premiums of commercial office building and the implementation of sustainability practices in real estate. Specifically, the finding will encourage these stakeholders to move toward sustainable buildings, which is a demonstration of the effectiveness of the mandatory disclosure policy in Australia. Further, the finding of green buildings consistently outperforming non-green buildings will also encourage current building owners to retrofit and renovate their buildings by considering green features, as these will lead to a higher premium. As discussed by Reed and Sim [8], developers and occupants have a strong desire for "going green", but the economic variability of it remains a key concern [14]. As such, this finding would assist market participants, not only in Australia, but also international developers to make an informed decision on their green building investments. Lastly, the finding of government intervention further reinforces the need for establishing a mandatory market mechanism to promote green building development. This would also be useful to international policy makers in markets without a mandatory building efficiency disclosure. The finding will assist international policy makers to make an informed decision on the effectiveness of introducing a mandatory building energy efficiency disclosure to promote green buildings and reduce carbon emissions from buildings in their countries. The Australian government foisted the mandatory disclosure laws to improve energy efficiency among commercial buildings. Our empirical evidence shows that mandatory regulations would spur the performance of commercial buildings, which will certainly promote the transformation of commercial buildings to become more environmentally friendly. Therefore, the findings can be rewarding to various stakeholders in the building sector in Australia and internationally. These findings could also contribute towards the attainment of the United Nation's 2030 agenda for sustainable development especially Goal 11, which seeks to promote sustainable communities. The overall findings can be linked to the concept of sustainable development goals from the United Nations, which require all countries and organizations to achieve 17 of these goals to transform the global environment by 2030. In response, governments and most countries including Australia

subscribe to these goals and developed economic, social, and environmental programs and policies that are geared toward the attainment of sustainable cities and communities.

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