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The Economics of Green Building: The Green Rental Premium in Johannesburg

Jade Bruni

A research report submitted to the Faculty of Engineering and the Built Environment, University of the Witwatersrand, in fulfilment of the requirements for the degree of Master of Architecture in Sustainable and Energy Efficient Cities.

Johannesburg, 2017

Declaration

I declare that this research report is my own unaided work. It is being submitted for the degree of Masters of Architecture in Sustainable Energy Efficient Cities to the University of Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other university.



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Jade Bruni

13 day of September 2017

Abstract

This research focuses on the green building rental premium that is associated with the Green Star SA rating tool within the commercial property sector (and particularly offices), in Johannesburg. Financial factors are integral in decision-making for investors and developers in the development and management of real estate. Simply put, increased financial benefits, decreased financial costs and low levels of risk are signals for the inception of real estate developments. The general sentiment from investors and developers is that, regarding green buildings, there is no incentive to justify moving away from a 'business as usual' approach and the development of conventional buildings. Limited research, both internationally and locally, has not assisted in rectifying these sentiments, which has hindered the growth of green building in the real estate market and the mitigation of the negative environmental effects that are associated with buildings and the built environment. Descriptive statistics and hedonic regression analyses were utilised in order to determine and calculate a rental rate premium associated with office buildings in Johannesburg which have a Green Star rating. A rental premium of 4,5% was determined by employing hedonic regression analyses from data that were collected for 30 Green Star rated buildings and 30 conventional buildings, which are multi-tenanted office buildings with Triple Net leases, in 7 geographical areas in Johannesburg. It was determined that the variables affecting rental price and the rental premium in Johannesburg are in line with international literature.

Key Words: Green Building Premium, Commercial Real Estate, Sustainability, Financial Incentives, Green Star SA

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List of Acronyms

BMS	Building Management System
CIE	Centre for International Economies
CSR	Corporate Social Responsibility
GBCSA	Green Building Council of South Africa
GLA	Gross Leasable Area
HVAC	Heating, ventilation and air conditioning
JLL	Jones Lang LaSalle Incorporated
LEED	Leadership in Energy & Environmental Design
OLS	Ordinary Least Squares
PVC	Polyvinyl Chloride
RICS	Royal Institute of Charted Surveyors
SANS	South African National Standard
UK	United Kingdom
UNCED	United Nations Commission for Sustainable Development
UNDP	United Nations Development Programme
UNSED	United Nations Conference on Environment and Development
USA	United States of America
USGBC	United States Green Building Council

Chapter 1

1. Introduction and Background to the Study

1.1. Introduction

In recent years the body of research relating to green buildings has grown substantially, particularly in the fields of design, construction and property (Reed and Wilkinson, 2005). Most researchers acknowledge the environmental and social benefits of green buildings (Falkenbach et al., 2010). These benefits will be discussed in the chapters that follow. Despite these benefits, investment in green buildings has been limited globally since the costs and financial benefits associated with green buildings are not widely researched and reported (Sayce et al., 2007). Investors and developers are prominent decision makers in the supply of green buildings, and make decisions based on the costs and financial benefits when undertaking projects (Falkenbach et al., 2010). The most commonly accepted theory for this gap in research is that it is difficult to quantify these costs and financial benefits (Windapo, 2014). In South Africa, according to the Green Building Council of South Africa (GBCSA) (2012; pg. 117 and 136), there is "a lack of compiled local data which would provide the valuable evidence of costs and financial benefits for green building in the South African context" and "the improvement in post-occupancy analysis should assist in proving the business case for green buildings".

1.2. Rationale for the Study

As will be discussed in this research, the impact of the built environment on the natural environment has become an area of focus in recent years as a result of the significant amount of global resource consumption, waste generation and carbon emissions associated with the sector (Eichholtz et al., 2010a). Throughout the lifecycle of buildings, the built environment is estimated to utilise 40% of the world's raw materials and energy, while contributing 30% of the world's green-house gas emissions (GBCSA, 2012). Although there is a growing awareness in the real estate sector of the negative effects of

the built environment on the natural environment, there are still a number of obstacles to the growth of the green building industry (Falkenbach et al., 2010).

In addition to the negative effects on the natural environment, economic burdens on owners and tenants are of particular importance, since recently in South Africa operating costs and environmentally driven taxes have increased significantly and government regulations have been developed and implemented in the industry (Jones Lang LaSalle (JLL), 2015). As a result of the increased burdens on owners and tenants and the potential to decrease infrastructure, plant and equipment costs, the demand for green buildings has increased (GBCSA, 2012).

In order to achieve the mitigation of the aforementioned environmental pressures and meet owner and tenant demand, the real estate industry decision makers, namely investors and developers, need to be incentivised by the business case of green buildings in order to increase the supply of sustainable buildings (Sayce et al., 2007). "One of the major obstacles to developers building green has been the inherent nature of the development process which results in the tendency to hold a short term view. Generally it is perceived that the benefits of a green building accrue to the tenants or longer term owners and that few benefits accrue to the developer" (GBCSA, 2012; pg. 76). The recognised benefits of green buildings are typically categorised as environmental, economic and social (Lee, 2016).

The environmental category includes benefits such as sustainable use of resources, improved indoor environmental quality and minimisation of the carbon footprint associated with buildings. The economic category includes benefits such as risk mitigation, decreased operating expenses and increased asset and market value. The social category includes benefits such as increased well-being of users (Lee, 2016). This research will focus on and examine the components within the economic benefits category associated with these buildings. Particular attention will be focused on the use value and resulting rental rates of commercial buildings within the South African real estate market.

1.3. Research Problem

There is a consensus between researchers and industry members within the built environment that the financial benefits of sustainable property development and investment are difficult to quantify, and to date, have not been comprehensively addressed. This is particularly the case in South Africa. The result is that investors and developers are largely reluctant to invest in green buildings, which has hindered development with regards to the mitigation of the built environment's negative effects on the natural environment. These negative effects include unsustainable consumption of non renewable resources, which is coupled with high levels of waste generation and carbon dioxide emissions. South Africa has a significant global carbon footprint, which can be significantly reduced through the built environment (Steyn, 2014).

1.4. Research Question

Do commercial Green Star rated office buildings in Johannesburg command a rental premium?

1.5. Sub Question

What is the rental premium that Green Star rated commercial office buildings yield over their conventional counterparts in Johannesburg?

1.6. Objectives of the Study

The objective of this research will be to determine the economic benefit of green buildings for investors and developers, by determining if there is a commercial green building rental premium that Green Star rated office buildings yield over their conventional counterparts.

In order to determine this rental premium, investigations into a number of aspects of the sustainable built environment are required. These would include, but not be limited to: the property development process, land acquisition, green buildings, procurement, tenant and occupant considerations, resources, appraisals and valuations, legislation and policies,

design, environmental considerations, conventional practices and various facets of objective and subjective value.

1.7. Theoretical Framework

1.7.1. Existing Research

In carrying out this research report, international and local literature has been investigated and utilised in order to illustrate the various economic, social and environmental conditions within the international and South African green building industries. Research pertaining to the nature of green building industries, the professionals and decision makers acting within these industries, the characteristics of the buildings within the industries and governing legislations and certifications are all investigated. While research on the financial incentives associated with green buildings is expanding, limited research that has been conducted on the topic. There are prominent research papers that are referenced in much of the available body of research. Although these do focus on the economic conditions of the green building industries in the USA and UK, these papers are being reviewed in conjunction with industry data and the limited South African research that is available. This will assist in determining how to analyse and determine the specific characteristics of the South African green building industry and how they align with international findings in order to answer the research question and sub question posed in this chapter.

1.7.2. Conceptual Framework

This conceptual framework demonstrates the structure and content covered. The key factors, concept variables and inter-relationships of this research report are depicted in Figure 1. From this framework, the key concepts have been identified and the literature review has been structured accordingly.

1.7.3. *Defining key concepts*

The key concepts that are discussed and defined in the literature review chapter of this research include, but are not limited to: sustainability, sustainable buildings, green

buildings, owners, investors, developers, tenants, the built environment, the natural environment and ecology, the economics revolution, the sustainable revolution, leases, operating expenses and the triple bottom line. The theoretical framework of this research report guides the structure and content of the research. Existing literature assists in illustrating the more effective means of carrying out this research while guiding the content and concepts that needed to be addressed in order to ensure comprehensive, accurate and non biased analysis.

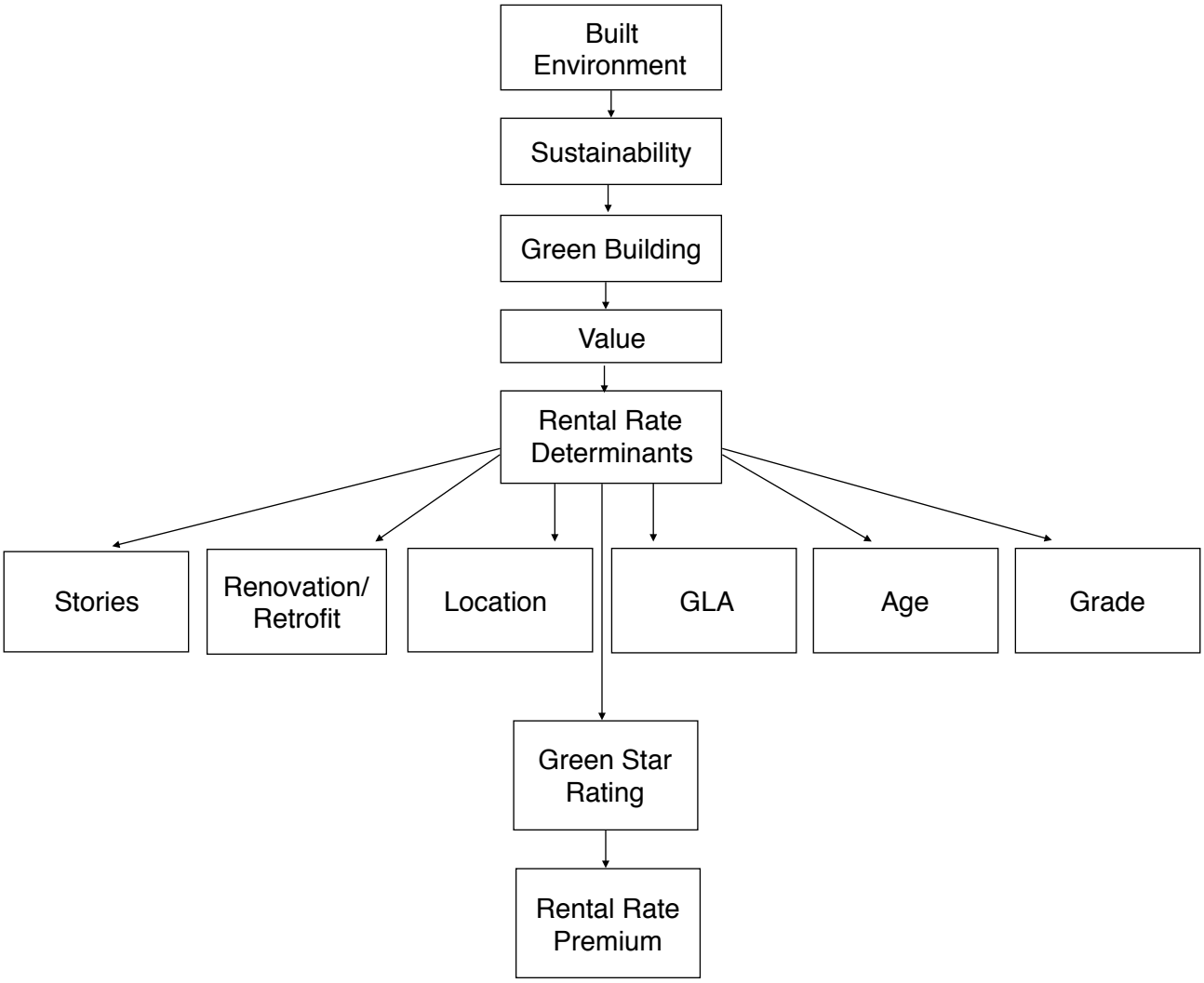


Figure 1: Conceptual Framework and Key Concepts (Source: Drawn By Author, 2016)

Various building characteristics are identified and discussed from existing literature in order to focus on the economic branches seen in the conceptual framework. Quantitative data and analysis through descriptive statistics and hedonic regression analysis are discussed and defined in the research methodology and data analysis.

1.8. Structure and Organisation of the Research Report

This research report begins by reviewing local and international research in order to gain a clearer understanding of the built environment and urban population and to ascertain the characteristics and effects of these components on the natural environment and ecology. From these characteristics and effects, it is then determined how the need for green and sustainable building practices have gained momentum in recent years. The inception of green building certifications and ratings are then investigated, particularly since they have had a significant effect on various aspects of the built environment both ecologically and economically. The key decision makers and drivers within the green building industry are identified and discussed, along with the incentives and deterrents for these decision makers to provide green and sustainable building space. Benefits, costs, risks and perceptions are then identified in order to gain a clear image of the industry and market from an economical point of view.

Following the literature review, the research methodology and methods are discussed with the various analysis methods that were utilised. The data collection and sampling methodology are outlined with the resulting ethical concerns and limitations and delineations to this research. The data are then analysed and presented with discussions of the findings and how they relate to the international findings. Finally based on the research findings, the concluding remarks are made, with industry recommendations and recommendations for future research.

Chapter 2

2. Literature Review

2.1. The Urban Population and The Built Environment

Research discusses the considerable increase in the international urbanised population, which has simultaneously created concerns regarding the sustainability of cities (Watson, 2009; Turok and McGranahan, 2013). In 2014, it was determined that 54% of the world's population lived in urban areas (United Nations, 2014). It is expected that this number will continue to rise consistently on a yearly basis, with an expected population growth of 1.84% per year between 2015 and 2020 (World Bank, 2014). A majority of this growth is seen in developing countries, which will inevitably result in the expansion of urban areas to accommodate the higher populations (UNDP, 2010). Currently the framework of most cities is considered unsustainable since they are based on high production and consumption of resources, which means that as a result of the aforementioned rapid urbanisation, consumption of resources will increase and so will the associated negative environmental and social problems (New Climate Economy, 2016).

According to Falkenbach et al. (2010), the scope of sustainability is typically blurred to account only for mitigation of environmental issues that focus on the integrity of and damage to ecosystems and diminishing natural resources. Nalewaik and Venters (2008; pg. 1) argue that sustainability is subjective and varied according to its application, particularly since it can be applied to a number of industries, markets, goods and services resulting in sustainability definitions ranging from "broad concepts that incorporate all aspects of sustainability to narrow definitions focused on one specific sustainable feature".

Sustainability of urban areas has been described in the literature as being dependent on four factors (UNCED, 1992). A sustainable urban environment can be considered sustainable only if sustainability is established in the economic, social, ecological and political environments (Allen, 2009; UNCSD, nd.). The built environment is directly

related to and shaped by these factors, which have been identified as the integral components in addressing the success and liveability of urban areas (Allen, 2009). Insightful information on each factor is fundamental for sustainability to be achieved (Anderson, 2010) and "none of them should be seen as more important than any of the others" (Falkenbach et al., 2010); pg. 204). MaCabe (2010) argues that the economic factors are what drive the focus on sustainability rather than the social and environmental factors and that "sustainability assumes longevity, longevity implies long term viability and long term viability means profitability. Inherent in sustainable investing is the belief that incorporating environmental, social and community factors sets the foundations for profit and resiliency. Incorporating these factors can lead to superior returns and competitive advantage" (pg. xi).

2.2. The Built Environment and The Natural Environment

People have an inherent dependency on the built environment, particularly since they ordinarily spend up to 90% of their lifetimes in buildings (Syed, 2012). With increases in urban population figures and expansion of urban environments, a resulting increase in the number of buildings will occur. This is in response to the increasing demand previously described that results from urbanisation growth (UNDP, 2010). The built environment is typically discussed in research as having negative effects on the environment, particularly due to its utilisation of raw materials, energy consumption and greenhouse gas emissions (RICS, 2005). The built environment has associated contributions of 23% of carbon dioxide emissions, 40% of energy consumption, 16% of water consumption, 30% of solid landfill waste and 40% of raw materials consumption (CIE, 2007; Rogerson 2014).

It is essential to address how the built environment and the natural environment function and co-exist, particularly since there are perceived differences between addressing ecology and economics, and trade-offs are often made in favour of economics (Odum and Barrett, 2005). The relationship between ecology and economics is often an area of uncertainty with regards to the built environment (Warren-Myers and Reed, 2010), although a relationship between sustainability and financial performance is becoming apparent in

new data (MaCabe, 2010). These data will be elaborated in subsequent sections. There is debate between the limits of economic growth and its link to the natural environment, "because the environment and the economy are intimately linked, improving environmental quality and sustainability is good for the economy. Thus, the 'sustainability revolution' is also an economic revolution" (Miller and Spoolman, 2009; pg. 611).

The sustainability revolution is described as "comparable in scale and significance to the industrial revolution" (Burns, 2012; pg. 1127). Environmental concerns are becoming prominent in all industries, which is creating a gradual shift from an economist-based model to a sustainability-based model in many facets and sectors of the economy (Burns, 2012). This concept is largely in line with Daly's (2005) explanation that economic growth is limited by the availability and limit of natural resources. Economics tends to be based on the assumption that there are limitless natural resources and economic decisions typically determine environmental decision making (Tahvonen, 2000). It has been commonly accepted that technological development would mitigate any obstacles to economic growth. However, the sustainability revolution is changing industry outlooks (Tahvonen, 2000). Green building is viewed as the effective means of addressing the transition to a sustainable economy in the built environment (Eichholtz et al., 2010a).

2.3. Defining 'Green'

"Sustainable buildings" are often referred to as "green buildings," and the two concepts have been used as synonyms in earlier literature (Falkenbach et al., 2010; pg. 205). While there is no distinct definition for green buildings (Bonde, 2016), green building can be defined as "the practice of creating structures and using processes that are environmentally responsible and resource-efficient throughout a building's life cycle from determining the site to design, operation, maintenance, renovation and deconstruction. This practice expands and complements the classical buildings' design concerns of economy, utility, durability and comfort" (Falkenbach et al., 2010; pg. 205). "Classical buildings", also known as conventional or traditional buildings, are constructed in

accordance with the mandatory building standards of particular countries. The synonym "brown building" is also occasionally used (Bonde, 2016; pg. 3).

"Green buildings use key resources like energy, water, materials and land more efficiently than buildings that are just built to code" (Kats, 2003; pg. 2) and are typically described "as a construction project that is either certified under any recognized global green rating system or built to qualify for certification" (Dodge Data & Analytics, 2016; pg. 64). "A sustainable building utilises design, construction and maintenance practices that cut energy costs and significantly reduce or eliminate the negative effects on its occupants and the environment" (MaCabe, 2010; pg. 2). The application of certifications and ratings are what generally distinguish a sustainable building from a green building, in that a green building's sustainability has been certified and/or rated (Lee, 2016).

According to MaCabe (2010), green buildings do not form their own asset class, but rather are part of the built environment as buildings that have sustainable features, whereby each is designed to suit individual circumstances, while still operating efficiently and meeting user needs since "there isn't a "one-size-fits-all" solution" (pg. xi). According to the GBCSA (2012; pg. 125), the following initiatives can be implemented in order to ensure green buildings: "Waste Management Plan, Natural Cross Ventilation, Gas Heating, Double Glazing, High Recycled Content, PVC/Formaldehyde and Volatile Organic Compound minimisation, Close proximity to Public Transportation and Amenities, Thermal Comfort Modelling and BMS/Technology". These initiatives are achieved through the following strategies to minimise or eliminate the negative environmental impacts of buildings, as listed by the GBCSA(2012; pg. 10):

- "Energy efficiency;
- Greenhouse gas emission abatement;
- Water conservation;
- Waste avoidance, reuse and recycling;
- Pollution prevention - noise, water, air, soil & light;
- Enhanced biodiversity and a positive impact on the ecology of the site;

- Reduced natural non-renewable resource consumption;
- Productive and healthier environments; and
- Flexible and adaptable spaces"

2.4. The Green Building Industry

In South Africa, the green building industry was recently considered to be relatively new when compared to its developed and developing counterparts; it was described by the GBCSA (2012; pg. 13) as having "relative immaturity". Fuerst and McAllister (2011; pg. 49) remark on green buildings' "relatively low proportion of the overall market" even with recent high growth rates and the known benefits of these buildings in property markets. However, it is noted by research that South Africa's green building industry began growing rapidly in comparison to green building industry growth rates in other parts of the world (McGraw Hill Construction, 2013). In recent years the green building industry in South Africa has been maturing and growing exponentially (GBCSA et al., 2016). Surveys conducted on the South African green building industry by Dodge Data & Analytics (2016) report that 61% of construction industry professionals, such as architects, engineers, contractors, owners and specialists/ consultants, expect 60% of their projects to be green buildings by 2018, with a primary focus on the commercial sector.

It is noted that the green building industry in South Africa will be a "leader in the global green market in the next three years" if the surveyed professionals do execute their planned green projects by 2018 (Dodge Data & Analytics, 2016; pg. 48). The green building development process and respective decision makers are depicted in Figure 2. The process is a circular one encompassing acquisition, design, approval, construction, sale/tenancy, operation and refurbishment. Financial related aspects such as acquisition cost, design cost, build cost, occupancy rate, rental rate, asset value, operation cost, maintenance cost and refurbishment cost are taken into account with risk mitigation measures throughout the depicted development process. This shows the emphasis that is placed on the economic aspects of projects. Financial decision makers and appraisers are predominantly involved in all stages of the development process. The green building development

process is an integrated process, in which all professionals and decision makers are involved in the project during the design phase, the construction phrase and all daily operations (USGBC, 2014). The green development process is preferential because the conventional development process often creates unforeseen problems in projects. Particularly since the process is fragmented and lacks complete collaboration between professionals and decision makers (USGBC, 2014).

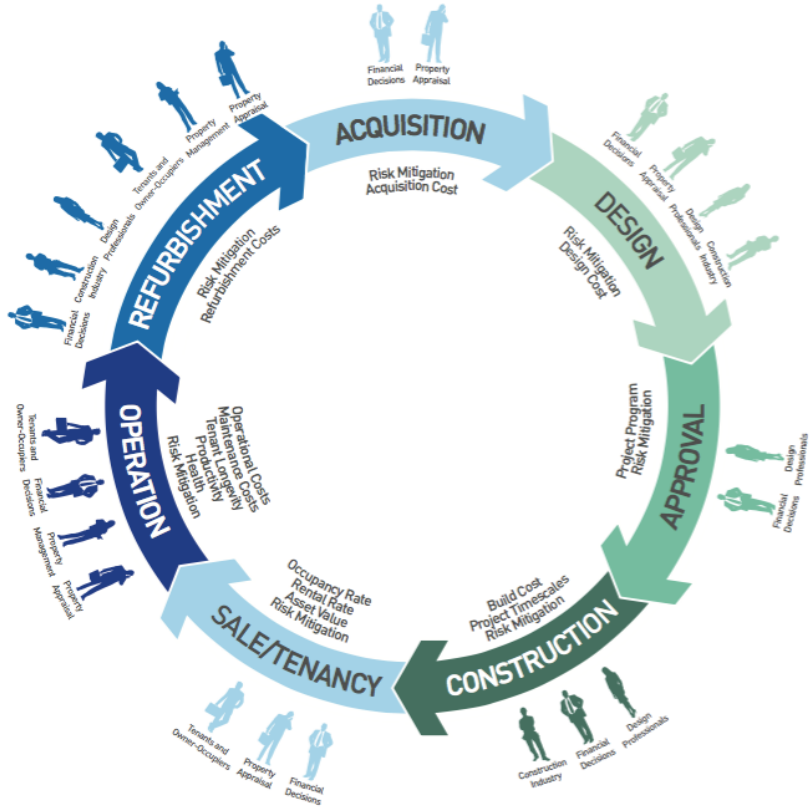


Figure 2: The Green Building Development Process and Decisions Makers (Source: World Green Building Council, 2013)

The presence of sustainable goods and services in numerous markets has increased considerably internationally, according to Fuerst and McAllister (2011). This increase is particularly as a result of the sustainability revolution, whereby consumers are found to be willing to pay a price premium for sustainable goods and services which are said to have minimised negative environmental effects through their production and consumption (Fuerst and McAllister, 2011; Bonde, 2016). It is noted by Fuerst and McAllister (2011; pg. 47) that a number of voluntary green certifications and ratings have been created in many

industries, particularly as a result of consumers' "willingness-to-pay" for sustainable goods and services.

2.5. Green Building Certifications and Ratings

The implementation of rating and certification tools are to "inform market participants about the environmental effects of the production and consumption of products and/or services" (Fuerst and McAllister, 2009; pg. 4). In terms of the built environment, "it is commonly believed that a green-rated or certified building will be more energy efficient. And the higher the rating, the greater the efficiency. Conversely, a project can meet all the sustainability objectives without receiving official certification" (MaCabe, 2010; pg. xi). However, although difficult to change into mandatory standards, voluntary ratings and certifications are said to avoid the inefficiencies that are often associated with government intervention and compulsory standards (Fuerst and McAllister, 2009). Many countries have their own voluntary ratings and certifications which are made to suit the various circumstances and environments of buildings within each country, therefore "overall accepted standards have not been reached" on an international scale (Falkenbach et al., 2010; pg. 203).

Green building councils have been established in 89 countries. Each is based on their own principles and tools which have been localised to suit each individual context (Lee, 2016). These guidelines and standards are used to evaluate and then certify the extent that buildings fulfil certain environmental benchmarks (Bonde, 2016). Some of the more established international green building councils and rating systems are depicted in Table 1.

Table 1: Summary of International Green Building Rating Systems (Source: Waidyasekara et al., 2013)

No.	Green Rating Systems	Country	Document considered	*Nr. of category	Certification Level
1	BREEAM	UK	NC 2011 SD5073	8	Pass, Good, Very good, Excellent
2	LEED	US	NC-2009	7	Certified, Silver, Gold ,Platinum
3	HK- BEAM	Hong Kong	2004 V4/04	6	Bronze, Silver, Gold ,Platinum
4	Green Star-AUS	Australia	2011 Office v3	9	Best Practice, Australian Excellence, World Leadership
5	BCA Green Mark	Singapore	NRB/V4.1/2013	5	Certified, Gold , Gold Plus, Platinum
6	GRIHA	India	2010 Volume 1	4**	1 Star, 2 Star, 3 Star, 4 Star, 5 Star
7	Green Star -SA	South Africa	2008 Office v1	9	Best Practice, South African Excellence, World Leadership
8	GBI	Malaysia	NC 2009 version 1	6	Certified, Silver, Gold ,Platinum
9	Green Star -NZ	New Zealand	Office 2009	9	Good Practice, Best Practice, NZ Practice, World Excellence
10	GreenSL	Sir Lanka	2010 Version 1	8	Certified, Silver, Gold ,Platinum
11	Pearl -BRS	Abu- Dhabi	2010 Version 1.0	7	1 Pearl, 2 Pearl, 3 Pearl, 4 Pearl, 5 Pearl

* Nr. of category counted including innovation category

** In GRIHA (Green Rating for Integrated Habitat Assessment) 34 criteria discussed under 4 main categories.

Mid 2016, the GBCSA had certified 200 new and existing projects since its inception in 2007, with most of South Africa's green building activity being focused in Gauteng (GBCSA, 2016). Rating and certification tools are at the forefront of governing green buildings, as they set a standardised benchmarking system for professionals to work towards for particular ratings (Rogerson, 2014; Warren-Myers and Reed, 2010; World Green Building Council, 2013; Eichholtz et al., 2011).

The GBCSA uses the Green Star Rating tool, which is based on Australia's Green Star rating system (Rogerson, 2014). The Green Star South Africa Rating Tool is created to suit the South African setting in order to account for topographical characteristics, climate, environmental concerns, buildings regulations, policies and legislation, which are all specific to the country (GBCSA, 2008). Green building certifications and ratings are thought to establish a common language and standard of measurement, promote integrated and whole building design, raise awareness of green building benefits, reduce the environmental impact of development and recognise environmental leadership (GBCSA, 2008). It covers a number of categories that assess the environmental impact that is a direct consequence of a project's site selection, design and construction, namely:

management, indoor environment quality, energy, transport, water, materials, land use and ecology, emissions and innovation (GBCSA, 2008).

"The categories are divided into credits, each of which addresses an initiative that improves or has the potential to improve environmental performance. Points are awarded in each credit for actions that demonstrate that the project has met the overall objectives of Green Star SA. Once all claimed credits in each category are assessed a percentage score is calculated and Green Star SA category weighting factors are then applied. The category weighting factors vary across rating tools to reflect the importance of the different environmental concerns in each tools specific market sector or building life cycle phase." (GBCSA, 2008; np.). The Green Star SA certified ratings that are available for projects are: 4 star (best practice), 5 star (South African excellence) and 6 star (world leadership) certified ratings (GBCSA, 2008) for the following categories of buildings:

- Office
- Retail
- Multi-Unit Residential
- Public And Education Buildings

Green Star SA is also available in categories pertaining to development of interiors and existing building performance (GBCSA, 2008; np.).

Numerous studies have shown evidence that certification impacts value, which drives higher investment returns from these properties (Pivo and Fisher, 2010**;** Eichholtz et al., 2009**;** Kok and Quigley, 2009). Features that make buildings green buildings have been found to add market value and according to MaCabe (2010; pg. 5), "the related performance was shown to provide extra loan security, additional income, higher rent, shorter absorption, lower tenant churn, better rental stability, higher occupancy rates and reduced tenant inducements". In order to ascertain the impact on value, investigations of the various types of value need to be made, particularly since there are a number of definitions of value.

2.6. Defining 'Value'

Two broad categories of value are distinguished by King and McLure (2014), namely "objective" and "subjective". Objective value focuses on the production of commodities rather than their exchange, whereby the "sum of the costs of production, including land and capital in addition to labour" (King and McLure, 2014; pg. 1) relative to profit were seen as the determinants of value. The inputs and outputs of goods are the focal point when assessing value. Supply and demand fluctuations are seen as momentary deviations from market price, which is determined by the land, capital and labour costs of production value (King and McLure, 2014). Market value of scarce commodities that cannot be easily reproduced are seen as the only items whose value is determined by demand and supply.

Subjective value is based on the subjective demand for items by individuals. Essentially, this value is governed by the basic economic laws of supply and demand whereby "quantity demanded for a particular good decreases with respect to the price of that good; quantity supplied for a particular good increases with respect to the price of that good; and, when one equilibrium price prevails for each particular good (the 'law of one price') in a competitive environment" (Kind and McLure, 2014; pg. 6). This value focuses on exchange value rather the production value.

'Value' has different definitions based on its application according to Collins and Ghyoot (2015). The authors present the following definitions of value that are applicable to the real estate sector (pg. 265):

- "Use value is the value of a property for a specific use.
- Investment value is the value of an investment to a particular investor based on his or her investment requirements and resources.
- Going-concern value is the value existing in a proven property operation considered as an entity with an established business.
- Insurable value is the amount of insurance that should be carried on destructible portions of the property to indemnify the owner in the event of loss.

- Liquidation value is the price an owner is compelled to accept when the property's sale must occur with less than a reasonable market exposure period.
- Assessed value is the value determined according to the income tax or property tax laws."

Other definitions of value do exist, these however are the noteworthy definitions that are applicable to this research. The value of property is typically ascertained by valuers, appraisers and surveyors in the context of market value, insurable value, going concern value, use value, liquidation value tax, assessed value and investment value (Collins and Ghyoot, 2015). Properties typically undergo valuation in one of three ways: Sales Comparison Approach, Discounted Cash Flow/Income Capitalisation Approach Analysis or Cost Approach; each of which will determine a property's market value (Collins and Ghyoot, 2015). The most common definition of 'value' in the context of the real estate sector of the built environment is the subjective market value, which is the estimated price at which a building will transact in the market place between a willing buyer and seller for owners and developers, or the rental figure that tenants are willing to pay (World Green Building Council, 2013).

The long term values of green buildings cannot be definitively concluded since there have been limited sale transactions in the market of green buildings. Furthermore the GBCSA (2012; pg. 117) affirms that "due to the relative immaturity of the South African green building market, there is at this stage still a lack of compiled local data which would provide the valuable evidence of costs and financial benefits for green building in the South African context". According to MaCabe (2010), "the higher net operating incomes due to the lower operating expenses associated with these buildings should produce higher long term values"; However, "the development of sustainable properties has 90% of the associated risks that traditional developments have, particularly location, design, access, market conditions and regulatory environment" (pg. xi)

It is argued that risk mitigation against potential changes in regulation and consumer demand make it worth developing green buildings, even if these buildings appreciate at the same rate as conventional buildings, although it is expected that they would appreciate better than their conventional counterparts (MaCabe, 2010). Evidence from studies done on commercial green buildings have revealed that green buildings do tend to have higher asset values than their conventional counterparts, reporting that green buildings, both new and renovated, command a 7% increase in asset value of their conventional counterparts (Dodge Data & Analytics, 2016). "An understanding of what defines green buildings and drives demand in each context is essential as local market conditions have a significant impact on the valuation of these buildings" (World Green Building Council, 2013; pg. 33). The World Green Building Council (2013) links the value of commercial buildings to location, prestige, operating expenses and resulting working environment, availability of other similar buildings and viability for future refurbishment; all of which result in the building's respective rental and occupancy rates since market value is commanded by the economic laws of market value.

Furthermore, Collins and Ghyoot (2015; pg. 90) outline the factors that affect property value as: subjective value of buyers and sellers, investor value versus market value, the productivity generating factors of property improvements, location and institutional attributes. "For the different market players, the drivers for developing, constructing, acquiring, maintaining, and occupying the sustainable buildings are different… However, there is not much research discussing and classifying the drivers just from a real estate investor's perspective" (Falkenbach et al., 2010; pg. 5). Decision makers and stakeholders in the green building industry are identified by the World Green Building Council (2016) as developers, owners and tenants. Each have individual incentives to develop, own or rent green buildings. These individual and overlapping incentives for the green building decision makers are depicted in Figure 3.

The identified decision makers in the green building industry would each be incentivised by the benefits they stand to gain from green buildings that best serve their individual

interests. For developers, this would include higher sales price, lower design and construction costs and quicker sales resulting from developing a green building. For tenants, it would be the health and well-being benefits and increased worker productivity resulting from leasing and using green building space. For owners, it would be slower depreciation of the asset value, increased occupancy rates and lower exit yield resulting from owning a green building. There are also benefits that overlap and serve as incentive for all of the decision makers. For owners and tenants, reduced downtime, lower operating costs and lower maintenance costs would be expected. For developers and owners, the ability to secure finance, rapid return on investment, increased market value and reduced vacancies would be expected. Lower refurbishment costs, corporate image and prestige value, compliance with legislation, corporate social responsibility (CSR) and lower transaction fees would be expected for all decisions makers.

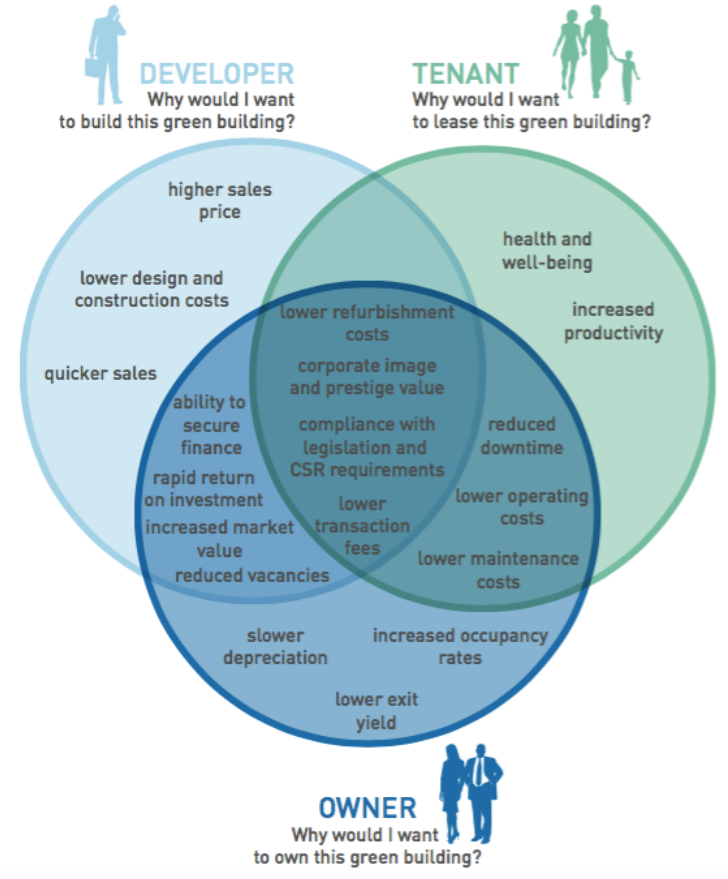


Figure 3: The Decision Makers in the Green Building Industry and Perceived Value of Green Buildings (Source: World Green Building Council, 2013)

2.7. Drivers of Green Building

The drivers of green building are a mixture of both imposed (top-down) and market (bottom-up) factors (Sayce et al., 2007). According to Falkenbach et al. (2010; pg. 204), "green building has been used as a synonym for sustainability, which has led to sustainability having been understood only from the environmental perspective, neglecting the social and economic perspectives". As a result, the drivers of green building do remain to a large degree undetermined (Bond and Perrett, 2012; Windapo, 2014). This is particularly as a result of the nature of research relating to green building, which focuses largely on design and construction aspects of the sector, with particular attention being paid to the environmental benefits of developing green buildings and the offset reduction of the negative effects that are associated with buildings (Reed and Wilkinson, 2005). Sayce et al. (2007; pg. 630) argue that "the emphasis in research and legislation provides justification for the view that, to date, sustainability has primarily been regarded as a matter for the construction sector to address. Hence, research and development have focused on construction techniques and materials despite the fact that the matter is, or should be, of vital importance to all those who are financial stakeholders in the whole building life cycle".

There is consensus that there isn't sufficient research pertaining to the development and investment of green buildings (Warren-Myers and Reed, 2010) since, as previously mentioned, most researchers agree that it is difficult to quantify the economic benefits and incentives for investors and developers to develop green buildings (Windapo, 2014), "and that the market has limited experience with sustainable properties" (MaCabe, 2010; pg. 3). According to Kauskale and Riemenschneider (2016; pg. 126) this "lack of information is a peculiarity of the real estate market, and especially affects the activities in green building construction". The drivers of green building for developers and investors are external drivers, corporate level drivers and/or property level drivers as depicted in Figure 4.

External drivers include government incentives (such as subsidies, taxes and policy,) finance incentives, customer's strategic decision, environmental and energy certificates

and national standards. Corporate level drivers include CSR, corporate image and prestige value. Property level drivers include decreased risks, increased income and decreased property costs, all resulting in increased property values. These drivers will be addressed in detail later in this literature review.

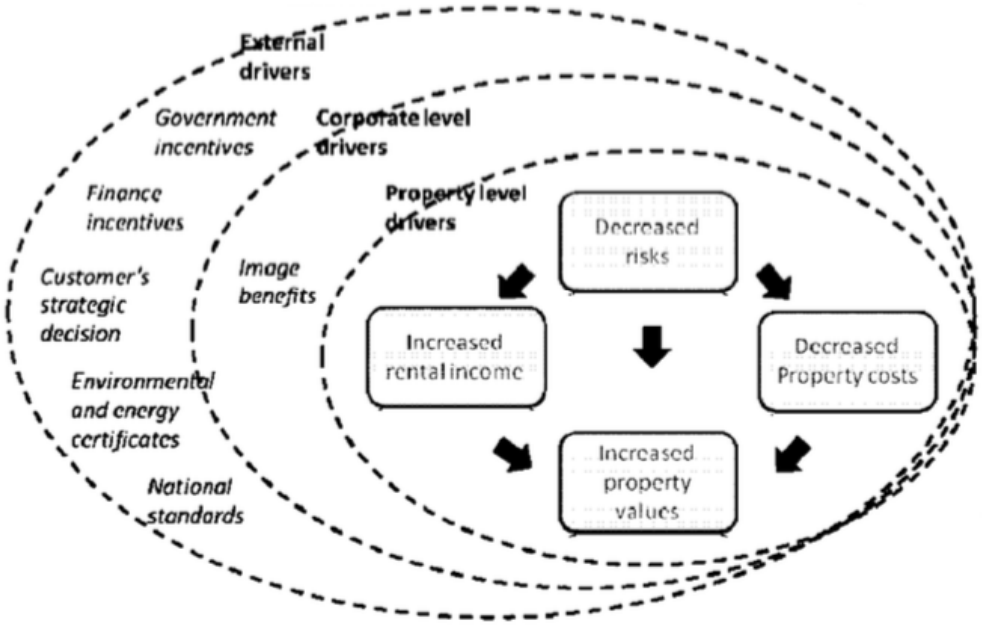


Figure 4: Drivers of Green Building and Potential Benefits for Developers and Investors (Source: Falkenbach et al., 2013)

Within these drivers, Dodge Analytics & Data (2016) elaborate the drivers of green building as: the 'right thing to do', client demands, market demands, environmental regulations and healthier neighbourhoods. Significant triggers driving green building, according to Dodge Analytics & Data's (2016) surveys of professionals in South Africa, are social and environmental reasons, with a focus on encouraging sustainable business practices, increasing worker productivity, healthier neighbourhoods, reducing energy and water consumption and protecting natural resources. However, client demands is equally significant, which indicates that professionals' decisions are economically driven. Professionals in the South African green building industry are beginning to appreciate the value of green buildings, particularly since there has been a significant increase in the perceived importance of client and market demand when compared to similar 2012 data (Dodge Analytics & Data, 2016). The social, environmental and economic triggers for green

building in South Africa and planned green building activity in South Africa are depicted in Figure 5.

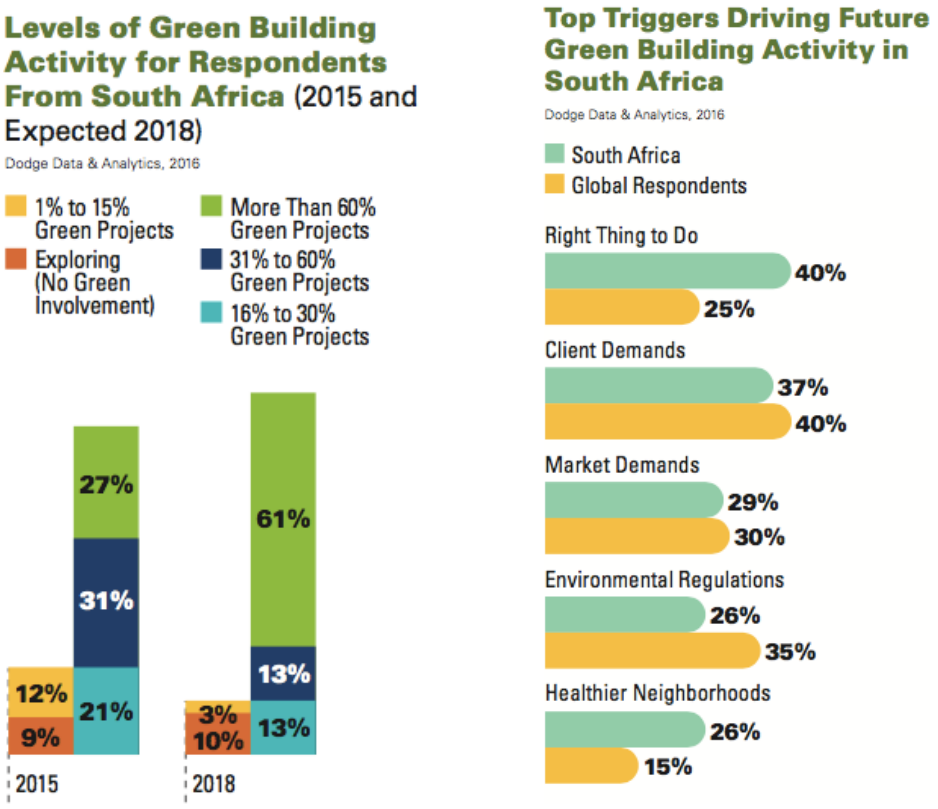


Figure 5: Expected level of Green Building Activity and the Triggers Driving Green Building in South Africa (Source: Dodge Data & Analytics, 2016)

2.8. The Commercial Property Market in South Africa

2.8.1. The Current Position of the Property Market

In the recent valuation of the South African property sector, the Property Sector Charter Council determined that the value of South Africa's entire property sector has increased to the value of R5.8 trillion in 2016 from R4.9 trillion in 2012 (Mahlaka, 2016). Commercial properties make up the second largest sector with an increased value of R1.3 trillion from R780 billion in 2012. The various percentage of investment by sector in the South African property market is depicted in Figure 6. In the commercial sector, shopping malls have the highest value at R534 billion followed by office properties at R357 billion, industrial properties at R281 billion, and hotels and other properties at R94 billion, as depicted in Figure 7. Planned development of 741,259m^2 was recorded in 2015, which is the highest planned development to date (JLL, 2015). Commercial property is defined as "property

that is suitable to be occupied for trading purposes, or for the purpose of conducting retail, wholesale or service business" (Collins and Ghyoot, 2015; pg. 5).

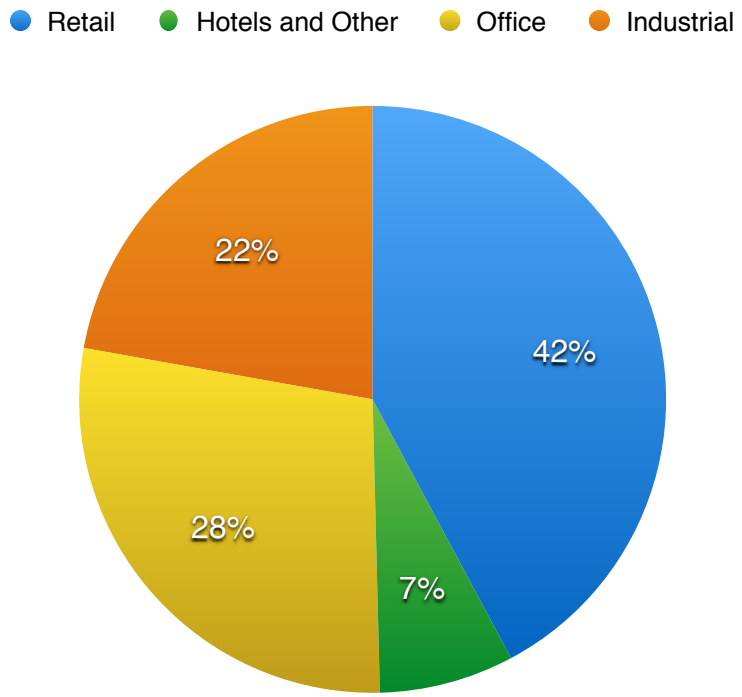


Figure 6: Percentage of Investment in Property in South Africa by Sector (Source: Drawn by Author Using the Property Sector Charter Council Data from Mahlaka, 2016)

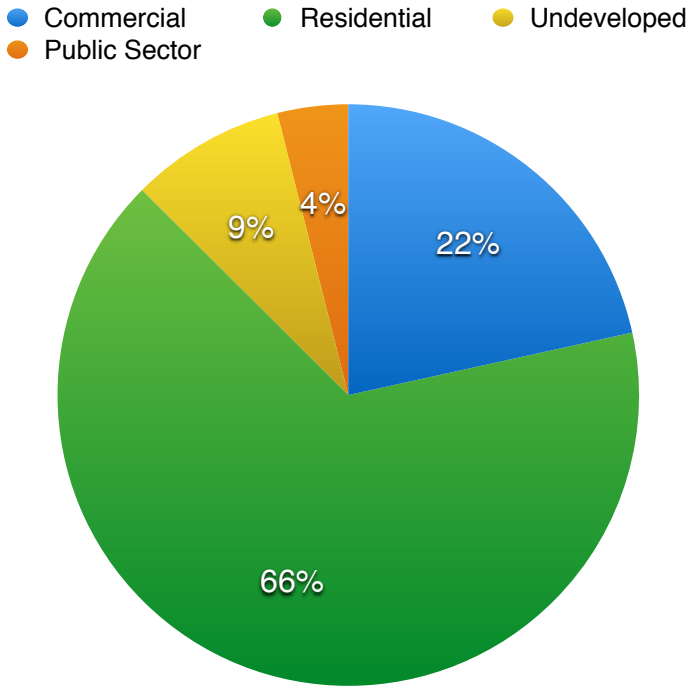


Figure 7: Percentage of Investment Within the Commercial Property Sector in South Africa (Source: Drawn by Author using the Property Sector Charter Council Data from Mahlaka, 2016)

The commercial office market is classified by: Premium Grade (Grade P) and Grades A, B and C buildings. "A number of quality parameters define a building's grade, including location, views, age, finishes, access, building services, security, amenities, parking and general condition" (GBCSA, 2012; pg. 22). Premium Grade properties are the highest quality spaces and Grade C properties are the opposite (GBCSA, 2012).

According to JLL (2015), smaller tenants are reluctant to make significant business decisions in the current economic climate in South Africa, and they prefer to renew leases or scale down existing space (Colliers, 2016). However, the opposite is said for larger corporate tenants who are taking advantage of the "low demand environment" which is supported by the low vacancy rates of Premium Grade properties (JLL, 2015; pg. 2). The vacancy rates of the various market gradings are depicted in Table 2. Grade C commercial space has the highest vacancy rates of commercial space, followed by grade B then grade A. Premium grade office space has experienced the lowest vacancy rate with a decrease in vacancies between 2014 and 2015. Overall national vacancy rate of all commercial space experienced just under a 1% decreased between the fourth quarter of 2014 to the fourth quarter of 2015.

Table 2: Vacancies by Office Grade (Source: JLL, 2015)

	Grade P	Grade A	Grade B	Grade C	Overall
Q4 2014	4.6%	11.3%	13.6%	25.5%	12.4%
Q2 2015	5.0%	8.8%	13.9%	26.5%	11.3%
Q4 2015	3.9%	8.4%	15.2%	26.6%	11.3%

JLL (2015) summarises the Johannesburg office market as follows:

- 9,600,000m^2 of commercial office space which has had 15% growth since 2010;
- Growth of 2.4% on a year to year basis of Grade A commercial office supply (depicted in Table 3);
- Growth of 2.2% on a year to year basis of Premium Grade commercial office supply (depicted in Table 4);
- The average vacancy rate is at 11.8%;

- A preference for higher quality commercial office space with Premium Grade space having a vacancy rate below 5% mark; and
- Greater tenant interest in Grade B commercial office space due to the economic environment.

Table 3: Average Gross Rental/m2 for Grade P Buildings (Source: JLL, 2015)

	Q4 2014	Q2 2015	Q4 2015	Biannual change	y/y% change
Sandton	201	202	205	1.5%	2.0%
Rosebank	207	211	211	0.0%	1.9%
Melrose Arch	183	195	195	0.0%	6.6%
Illovo	215	206	206	0.0%	-4.2%
Fourways	165	178	173	-2.8%	4.8%
Bryanston	160	175	170	-2.9%	6.3%
Waterfall	180	188	180	-4.3%	0.0%
Average	**187**	**194**	**191**	**-1.1%**	**2.2%**

Table 4: Average Gross Rental/m2 for Grade A Buildings (Source: JLL, 2015)

	Q4 2014	Q2 2015	Q4 2015	Biannual change	y/y% change
Sandton	169	174	174	0.0%	3.0%
Rosebank	149	159	159	0.0%	6.7%
Melrose	132	132	132	0.0%	0.0%
Illovo	148	137	137	0.0%	-7.4%
Fourways	120	123	123	0.0%	2.5%
Bryanston	146	145	144	-0.7%	-1.4%
Parktown	93	100	100	0.0%	7.5%
Rivonia	100	103	103	0.0%	3.0%
Midrand	128	133	133	0.0%	3.9%
Houghton	124	124	135	8.9%	8.9%
Randburg	83	88	86	-2.3%	3.6%
Average Grade A	**127**	**129**	**130**	**0.6%**	**2.4%**

The aforementioned data do not differentiate between green building and conventional commercial space. JLL (2015; pg. 3) summarises the economic conditions affecting the Johannesburg office market as follows:

- Increased inflation;

- Substantial interest rate increases;
- Decreased investor confidence in the short to medium term;
- Increase in building costs;
- Increased lending costs;
- Outflow of capital from South Africa;
- Increased capitalisation rates; and
- Anticipated reduced property values.

2.8.2. Greening the Property Market- Current and Projections

The cost of retrofitting existing conventional buildings is noted as a challenge to creating sustainable urban areas by the GBCSA (2012). Although new buildings have a larger carbon footprint than does retrofitting an existing building, the financial costs of converting existing conventional buildings into sustainable ones through retrofit are perceived to be higher than constructing new buildings (Steyn, 2014). These perceived higher financial costs result in investors and developers favouring construction of new buildings over retrofits, which has resulted in limited mitigation of the negative environmental impacts of the built environment (Steyn, 2014).

Steyn (2014; pg. 101) argues that "the financial benefits of retrofitting existing buildings in the City of Johannesburg outweigh new green energy efficient buildings. Retrofitting existing buildings contribute to the triple base line of sustainability". As the South African green building industry continues to develop, the relevant technologies and products are becoming more affordable and easily available. "South African manufacturers have been slow to create and offer green products, although this is changing now, especially following the introduction of Green Star SA in 2008." (GBCSA, 2012; pg. 103).

According to Dodge Data & Analytics (2016), the top sector for green building growth globally is commercial construction, with 46% of surveyed participants expecting to be involved in commercial green buildings in the next three years. This is noteworthy as commercial green buildings are considered to be crucial in driving green building growth

and stimulate green building into other sectors (World Green Building Council, 2013). It is expected that South African building stock will double by 2050 and that there will be a consistent high increase in the construction of green buildings and a significantly slower but steady increase in retrofitting existing buildings. This growth will be particularly seen in the commercial property sector (Steyn, 2012).

2.9. The Business Case for Green Building

When looking at the sustainability of buildings, the triple bottom line would apply. The triple bottom line for sustainable buildings is detailed as follows by Elkington (2004):

- Planet - The environmental benefits from sustainable buildings
- People - The benefits to occupants, users and tenants of sustainable buildings
- Profit - The economic utility created by sustainable buildings

Collectively these three factors are defined as the triple bottom line of sustainable buildings (Lee, 2016). Focusing on the 'profit' criteria and specifically from the landlord perspective, the economic values are considered to be manifested in return to the investor's financial bottom line. From the tenant perspective, the economic benefits can be achieved by reduced operating expenses including utility costs. In a broader context, the economic value of sustainable buildings also includes the potential effect on regional economies. A recent study conducted by Lee (2016) expands the traditional triple bottom line of sustainable buildings by considering who profits from energy cost savings. Specifically, they propose a quadruple bottom line in which the traditional "profit" category is divided into two parts: a tenant's profit and a landlord's profit.

Research shows evidence of the environmental and social benefits of green building (Kats, 2003). However, the uncertain financial and economic components are described as having impeded the development of green buildings, since investors and developers do not have sufficient incentive to carry the additional costs and risks that are associated with green buildings (Kauskale and Riemenschneider, 2016). The main stakeholders of the built environment are identified as investors, occupiers, developers and constructors (Sayce et al., 2007). Since investors and developers are considered main stakeholders and decision

makers in the built environment, the incentives for developing green buildings need to be determined, and particularly how these incentives correspond to the property development process (Windapo, 2014).

2.9.1. Green Buildings- Supply and Demand

In terms of the aforementioned laws of supply and demand which determine market value, "price signals are central to the operation of markets providing the information basis for the allocation of resources. For market based solutions to be successful, price signals need to reflect environmental costs and benefits" (Fuerst and McAllister, 2011; pg. 46). These pricing signals are governed by buyers and sellers and how they interact to make market decisions. These decisions are determined by the amount of goods or services that are supplied by producers, the amounts of goods and services demanded by consumers and the market costs for these goods and services (Miller and Spoolman, 2009; pg. 613).

In terms of the green building industry, Fuerst and McAllister (2009) determined that tenants are willing to compensate developers and investors for green building space with higher rental rates. Lee (2016), discusses that the basic assumption based on micro-economic principles is that the growing demand from tenants and owners for green buildings will lead to an increase in the rental rates and appraisal value associated with these buildings. Studies conducted by Fuerst and McAllister (2011) depict the various supply and demand curves for non-certified buildings, low certified green buildings and high certified green buildings, as depicted in Figure 8. Non-certified buildings have the highest quantity or supply in the market with the lowest demand and lowest resulting price per square foot. High certified green buildings have the lowest quantity or supply in the market with the highest demand and highest price per square foot.

The supply of green buildings is driven mainly by developers' construction costs and tenants' willingness to pay (Fuerst and McAllister, 2011). Prices are described as the core mechanism for determining the relationship between suppliers and consumers of green

buildings (Lee, 2016). The supply of green buildings in the commercial real estate market is affected by the existing stock in the market, rental rates, sales prices and vacancy rates. In order for developers and investors to supply green building space, higher rentals rates, increased property values and savings on operating costs need to be conferred (Lee, 2016). However, it is noted that these determinants vary according to locality and property sector (Chegut et al., 2014). "Comprehensively, the supply of sustainable buildings is most likely to be driven by construction costs, other certified buildings' price signals, the prices and availability of raw materials and human capital to construct green buildings, advances in green technologies, and government policies mandating energy efficiency" (Lee, 2016; pg. 19).

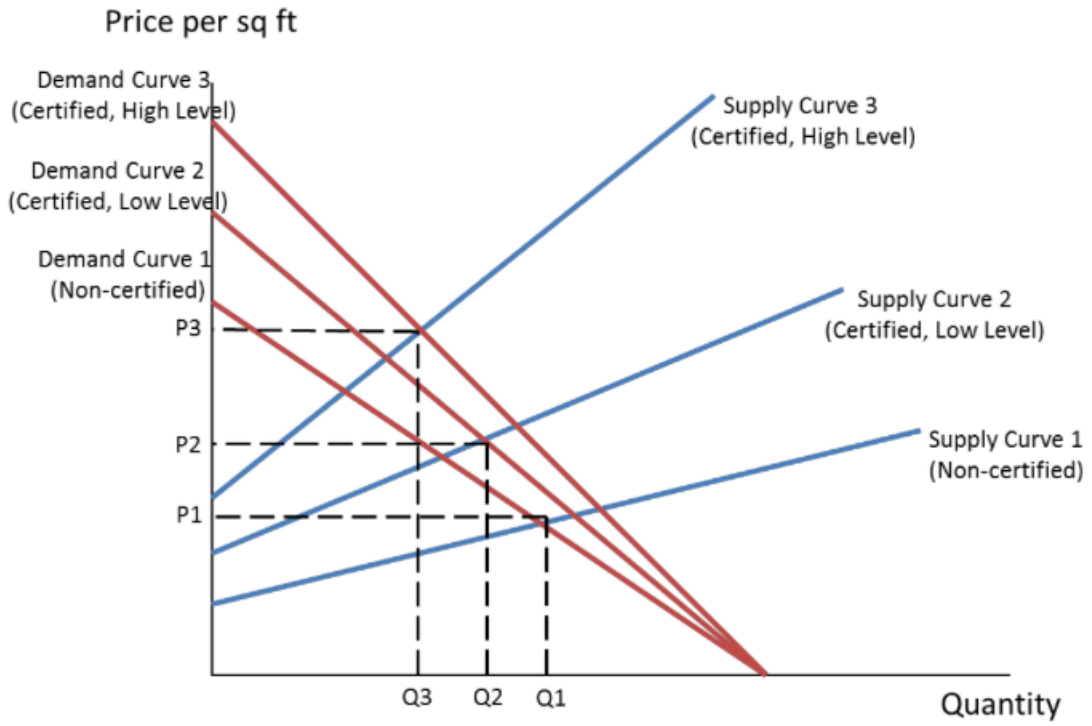


Figure 8: Supply and Demand Curve in the Sustainable Building Market (Source: Lee, 2016)

Corporate Social Responsibility (CSR) is identified as a significant determinant of the demand for green buildings (Lee, 2016). CSR is described using three categories: competitiveness, reputation and environmental responsibility (Eichholtz et al., 2010c). Competitiveness is a factor, since companies want to earn more profits by increasing their environmental performance (Lee, 2016). Certified green buildings account for decreased operating costs and increased employee productivity (MaCabe, 2010), which increase

demand, particularly since corporate financial performance is said to increase with corporate environmental performance (Eichholtz et al., 2010). Improved reputation is a benefit of green buildings in that it produces better credit ratings, improves company credibility to customers and attracts investors (Lee, 2016). Environmental responsibility is related to the non-financial benefits of green buildings in pursuing the 'right thing to do' (Lee, 2016).

2.9.2. Government Intervention and Legislation

It is highly contested whether market related or regulatory externalities are most effective in reducing the negative effects of the built environment and promoting green building (Fuerst and McAllister, 2011). There has been an increase in pressure to reduce the environmental impacts of the built environment, both internationally and in South Africa. This has led to more stringent building regulations by the government in the form of SANS 10400-XA:2011, which is enforceable by the National Building Regulations and Building Standards Act, the voluntary SANS 204 standard and possible implementation of energy performance certificates in the future (Milford, nd.). In addition, the Carbon Tax Legislation will be implemented in South Africa in 2017, whereby all companies will be taxed according to their carbon contribution, and be limited to an amount of carbon credits (National Treasury Republic of South Africa, 2016).

SANS 204 served as a basis to formulate the minimum standards defined in the National Building Regulations SANS 10400 part XA. The objective of SANS 204 is to promote the energy efficiency of and the use of renewable resources in buildings through "building design and the performance of naturally and artificially ventilated buildings, which include air tightness of building, natural air ventilation, lighting systems, HVAC mechanical systems, hot water equipment installations, and renewable energy technologies" (Steyn, 2014; pg. 15).

The carbon tax legislation is being implemented in order to facilitate the transition to a low carbon economy and reduce carbon emissions in the country by 34% by 2020 and by 42%

by 2025 (Carbon Tax Policy Paper, 2013). A carbon tax is being implemented as it was deemed by the South African National Treasury as the most appropriate short and medium term strategy for South Africa. The rationale for implementing the tax is to alter producer and consumer behaviour by encouraging changes in production patterns whereby alternative sustainable technologies will be incorporated in production; change selling prices to represent the carbon intensity of products and services so that consumers will be more likely to opt for the low carbon alternatives; and reduce the price gap through innovation, research and investment for the design and development of alternative technology (Carbon Tax Policy Paper, 2013).

In order to minimise Greenhouse Gas emissions that are caused by the built environment, The Department of Public Works in South Africa is considering implementing legislation whereby all new public spaces must be designed and built in accordance with a minimum four star rating (Milford, 2009). The built environment and its building stock is, however, made up of new and existing buildings. Therefore, as previously discussed, in order to mitigate the negative effects associated with the built environment, the sustainability of existing buildings also needs to be addressed (Steyn, 2014). In 2013 the GBCSA launched the Green Star SA Existing Building Performance pilot tool to address the efficient operation and management of existing buildings (GBCSA, 2015).

2.9.3. Voluntary Measures for Sustainability in the Built Environment

Voluntary industry sustainability standards have led to the inception of the voluntary environmental certification systems (Fuerst and McAllister, 2011), such as the aforementioned Green Star rating system. The GBCSA requires full compliance with SANS 10400 part XA as a minimum requirement for the submission of buildings for certification (GBCSA, 2012). The Green Star SA system is market driven and not mandatory in South African legislation (GBCSA, 2013). As previously mentioned, certified green buildings have been found to yield higher financial benefits than their conventional counterparts for developers, investors, tenants and owners (Fuerst and McAlliser, 2009).

2.10. The Property Development Sector and Process

Property development is stimulated by both personal and economic motives, which include "personal consumptions and satisfaction, development to earn income (rent) on a regular basis, development for profit on resale or providing a service to the public" (Collins and Ghyoot, 2015; pg. 1).

Investigations into the property development process are required in order to establish the drivers of property development (Eichholtz et al., 2010a). Collins and Ghyoot (2015; pg. 85) outline the factors that determine the demand for property as inflation levels, credit availability, interest rate levels, population growth, population migration, business growth and confidence, wealth per capita, consumer spending, taxation levels and incentives, state of the local and the national economy and the international economy and oil price. The factors that determine the supply of property are availability of developable land, local government restrictions, government efficiencies, rental versus building costs, vacancy levels, sales prices versus rentals and stock levels of land and buildings.

Property development is largely a financially driven practice, as it is considered an entrepreneurial process. It is typically described as a simple linear process, however, it has a complex and multidisciplinary nature that focuses on the financial costs and benefits of projects (Kohlhepp, 2012), namely, minimising upfront costs, maximising total return on investment over a limited period, maximising occupancy rates and risk minimisation (World Green Building Council, 2013). "Risk can be described as the possibility of a difference between the investor's expectations and what is actually realised from the property. Typically, properties with lower associated risks generate lower rates of return. Risk does play an integral role in investor's decision making" (Collins and Ghyoot, 2015; pg. 27). In simple terms, when the benefits outweigh the costs, and are within the profit margins the developer is expecting to generate, a development will be fulfilled (Kohlhepp, 2012).

Collins and Ghyoot (2015; pg. 83) posit that the following question be asked with regards to development cost: "How feasible is a development at any point in time (economic cycles) and space (location) in terms of location being ripe for development?". The economic characteristics of property are outlined by Collins and Ghyoot (2015; pg. 90) as scarcity, utility and adaptability, desire, potential in terms of highest and best use, immobility, creation of value, value as an economic product and productivity of property.

The development process of acquisition, design, appraisal, construction, sale/tenancy, operation and refurbishment, incorporates various factors with particular focus paid to the financial aspects of legislation, taxes, land appraisal, construction costs and timeframes, tenants, operational and lifecycle costs, various facets of value and general conditions of the market in terms of supply and demand (Rogerson, 2014). Collins and Ghyoot (2015; pg. 12) identify three core factors that determine the success of property as an investment: "investor/developers who provide space (sometimes with added value) over a period of time, consumers who utilise the space, and government, who provides the infrastructure and organises the economic environment within which property transactions are fostered".

2.11. Property Development and Green Building

The predominant incentives for the development of green building is that investors and developers develop green property developments in response to tenants demanding green building space (Eichholtz et al., 2010b; Windapo, 2014). This is particularly as a result of firms adopting sustainable business practice strategies, which can be substantially addressed through their real estate decisions (Eichholtz et al., 2010b). The other is based on the burdensome increasing costs and taxes that are carried by developers and owners (Eichholtz et al., 2010a). Between 2014 and 2015 operating costs in South Africa have increased by 9% in the sector, with electricity accounting for 33% and taxes accounting for 20%, it is expected that these costs will continue to increase consistently (JLL, 2015). Therefore, the associated costs and financial benefits of green building need to be

established in order to establish confidence and incentive for developers and owners to develop green buildings (Eichholtz et al., 2010a).

Research suggests that the increase in green building has little to do with ecological factors and more to do with economic factors, and particularly as a result of tenant demand (Winadpo, 2014). Green buildings have been cited as a means to elevate a company's image, reduce operating costs, increase marketing opportunities and improve employee productivity, all of which have created an increased preference and demand from tenants for green buildings. Many organisations now include sustainability in their property requirements when looking to lease constructed space (MaCabe, 2010). A number of international studies have found that the increase in green buildings is the anticipated result of the "economics of sustainability" (MaCabe, 2010; pg. 15). The results of these studies show evidence of higher rental rates and lower vacancy rates, however, the effect on property value in terms of sales and rentals is still largely unclear (Miller et al., 2008; Eichholtz et al., 2010b; Wiley et al., 2010; Fuerst and McAllister, 2011).

There are various government initiatives, in South Africa, that aim to improve the management of the built environment, which is currently uncoordinated, and would involve all levels of government and the private sector (Windapo, 2014). With various externalities such as recent changes to South African legislation to align with government sustainability strategies, it will become pertinent for developers and owners to develop green buildings. Even when taking only the costs and savings of green building into account, it is not enough to incentivise the development of green buildings (Windapo, 2014). Only with results showing that the economic benefits of green developments outweigh those of conventional developments, on a larger scale than the initial costs and operational savings, will incentive be created (Eichholtz et al., 2010a; Windapo, 2014).

2.12. Perceived and Real Barriers to Capital Investment

2.12.1. Interactions Between Green Building Decision Makers

The demand for green buildings has increased even though the "circle of blame" is still a common theme in the building industry (Falkenbach et al., 2010; pg. 205). Each decision maker blames the next as the reason that they themselves cannot supply green buildings (Högberg, 2014). This cyclical pattern is depicted in Figure 9. Construction companies claim that developers and investors do not demand green buildings even though they are willing to construct them, developers and investors claim that they are willing to supply green building space but tenants do not demand green building space and tenants claim they would rent green building space but claim there isn't enough selection (Sundbom, 2011).

The best practice, and opposite of the "circle of blame", between decision makers is depicted in Figure 10, whereby feedback is exchanged between all decision makers resulting in more favourable conditions for green building supply and demand (Högberg, 2014). This Best Practice model is also cyclical but differs in that a number of additional professionals and professional bodies are included in the decision making process. By including professionals such as advisors, educators, researchers, insurers and appraisers and professional bodies such as banks and insurers, informed decisions can be made by decision makers and knowledge effectively filtered through the industry. Implementing this practice is of particular importance since, according to the GBCSA (2012; pg. 117), "there is limited sharing of knowledge and experience about green building practices. Many in the industry are either cautious about sharing their knowledge or do not have the time and resources to collate the lessons learnt and benefits found on projects", which prevents best practice and coordination between decision makers and other professionals.

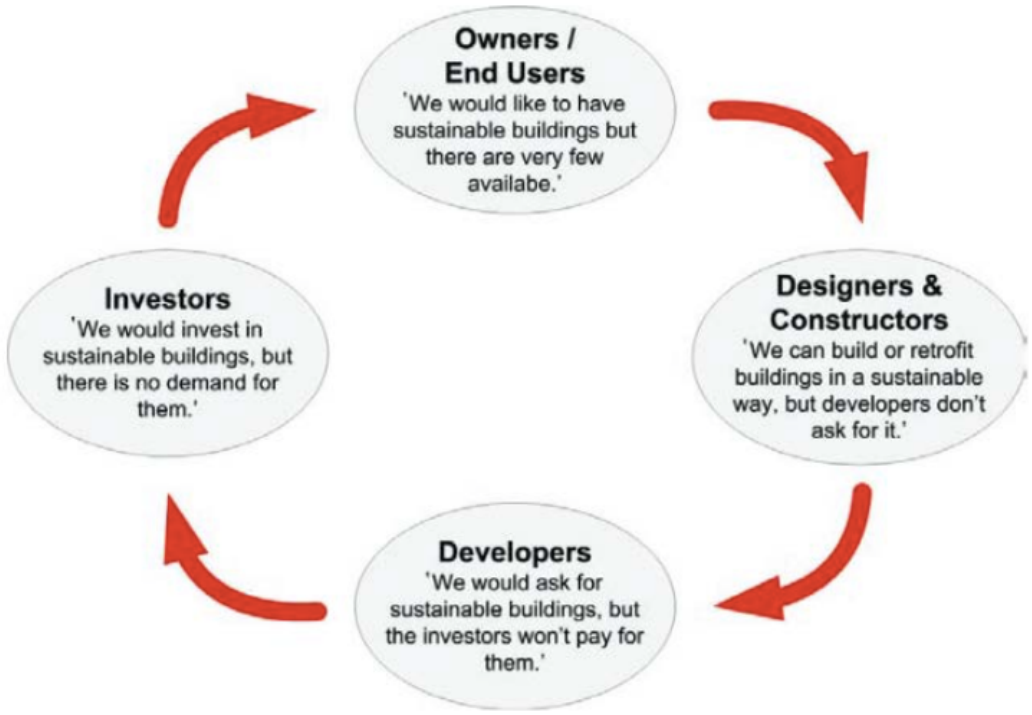


Figure 9: The Supply Chain Circle of Blame (Source: Högberg, 2014)

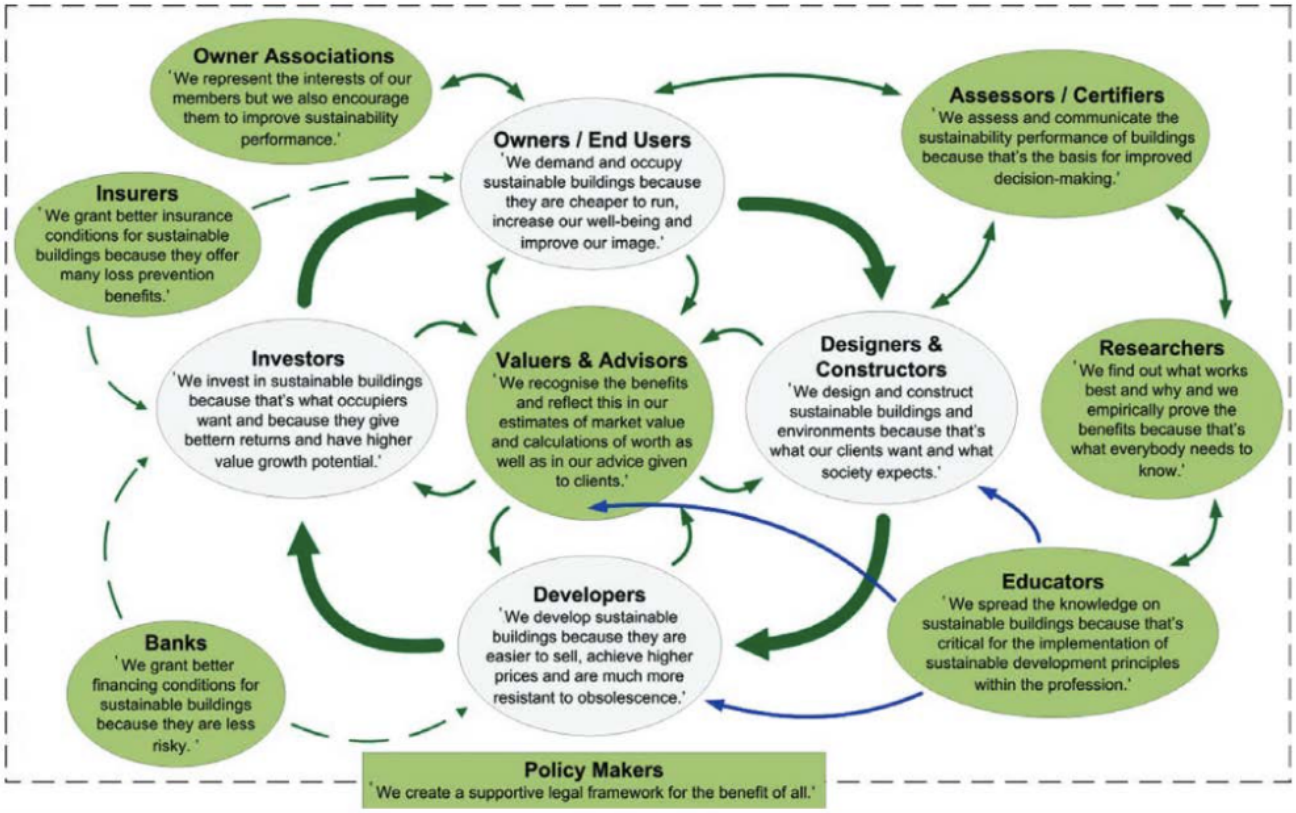


Figure 10: Best Practice to Avoid the 'Circle of Blame' (Source: Högberg, 2014)

2.12.2. Perceived and Real Costs

The green building industry, according to MaCabe (2010; pg. 31), has "two major forces, or categories of forces, that appear to limit investment in sustainable real estate: reality and perception". The perceived higher initial costs are identified as the greatest barrier to green building internationally by MaCabe (2010), while Dodge Data & Analytics (2016) identified that it was in fact the second highest perceived barrier to investment in green buildings, with 34% of South African participants considering this as an obstacle. However, it must be noted that this percentage considerably lower than the global average. Research typically associates higher costs with green building than with conventional building (Nalewaik and Venters, 2008). These higher costs are attributed to additional work, alternative materials, increased technology and a need for more specialised expertise from professionals (United States Green Building Council (USGBC), 2015). Although South Africa has been identified as a potential global leader in green building, one of its main challenges is finding enough skilled green professionals (Dodge Data & Analytics, 2016; pg. 48).

There is conflicting data in the industry with regards to the construction costs associated with green buildings and their conventional counterparts. While some international industry data indicate that the construction of green buildings is more expensive than conventional building practices, other international data indicate no additional costs (Nalewaik and Venters, 2008).Macabe (2016) argues that almost all projects have contingencies in the original budgets and vary from original estimates. There is also no data that analyse the wide variations in per square metre costs for similar conventional properties. The cost per square metre depends on a number of factors: "the materials, the skills and experience level of the architect, the developer and the contractors, the changes made prior to and during construction" (MaCabe, 2016; pg. 31). It was determined that a number of cost premiums found in green construction were as a result of "programmatic differences rather than sustainable elements" (MaCabe, 2010; pg. 31). Therefore the cost premiums are not as a result of the additional measures incorporated into the design and construction phases of a green building but rather deviations from programmes and

schedules, due to the inexperience and lack of knowledge and collaboration between professionals in the industry as depicted in the "circle of blame".

The additional costs of green buildings can often be attributed to the fact that sustainable features typically have higher upfront costs and are not integrated components of the building due to fragmented decision making, and so will increase the overall cost of the project. It has been found that decisions made during design and construction can significantly minimise the costs in other phases and over a building's life cycle, however, "a lack of value attached to the long term benefits of green buildings and too great a focus on short-term low-cost construction entrenched by a long industry history of 'build it cheap and demolish it in the future'" (GBCSA, 2010; pg. 94) adds to the cost barriers. The incorporation of sustainable features predominately need to be financed directly by developers and investors since there has been limited development of financial instruments in financing sustainable features for green buildings, thus resulting in further reluctance to add these features (Sundbom, 2011).

It is typically perceived that the additional costs associated with green building, compared to conventional building, are 17% (USGBC, 2015). However, it is argued that this additional cost, also known as the 'perception gap' (World Green Building Council 2013) is actually as low as 2% and is recouped as a result of the substantial decreases in operating costs, which makes financial sense as a long term investment (USGBC, 2015).The financial savings, environmental benefits and social benefits of green buildings have been firmly established in research (World Green Building Council, 2013). However, as previously mentioned, it is perceived that there is an uneven distribution of the costs and benefits, which are in favour of the long term owners and tenants (MaCabe, 2010).

2.12.3. Allocation of Benefits

The immediate benefits, such as decreased operating expenses, associated with green buildings, are typically not gained by the party (typically investors and developers) that has financed the sustainable features generating these benefits (GBCSA, 2012). Typically it

is the tenants that reap the benefits with immediate effect, therefore the result is that developers and investors lack incentive to carry the additional upfront expenses associated with green buildings and so the entire design and construction process is driven by short term economic considerations (MaCabe, 2010). In mitigating the uneven allocation of benefits, lease contracts need to be investigated (Sundbom, 2011).

Lease structures are important for sustainable building practice, because those who will benefit from sustainable buildings are determined by lease structure, such as Triple Net and Full Service Gross lease. "Generally, the determinants of lease structure include the size and function of leasing space, the type of tenant industries, the number of tenant companies in a building, tenant expertise, the existence of separate utility meters, general market patterns, and energy utilization patterns" (Lee, 2016; pg. 29).

Research shows that lease structures determine who benefits from the financial savings associated with energy efficient buildings (Lee, 2016). Table 5 depicts the financial benefits that owners and tenants gain from Full Service Gross lease and Triple Net lease structures. Under a Full Service Gross lease, owners benefit from energy efficient features since tenants pay a fixed rental rate irrespective of their energy consumption and the associated costs. Under a Triple Net lease, tenants benefit from energy efficient features since they are responsible for their operating costs. Owners are reluctant to increase investment in sustainable features that reduce operating costs under Triple Net leases since they do not benefit financially from the reduced operating costs and Full Service Gross leases can lead to increased operational costs for owners since tenants are unaffected by their energy consumption and would not implement energy saving practices (Lee, 2016). As a result, the type of lease used in commercial property affects property values and operating costs. It has been found that properties with Full Gross Service leases have lower market transaction values than properties with Triple Net leases (Lee, 2016).

Table 5: Application of Lease Structure to Green buildings (Source: Lee, 2016)

Definition		
Player / Lease	Tenant	Landlord
Full Service Gross	Pays a fixed rent (no additional costs)	Pays all operating expenses (tax, insurance, and maintenance)
Triple Net	Pays a base rent and all or part of operating expenses including utilities	Not responsible for tenants' operating expenses;
Application to Energy-efficient Buildings		
Full Service Gross	No direct financial benefits from reduced energy costs	Can invest in energy-efficient features and receive full benefit from energy cost savings (in the long term)
Triple Net	Benefits from energy cost savings; May have more incentive to support energy-efficiency of buildings	Less financial benefits (still responsible for common area management)

2.12.4. Business As Usual Approach

Business as usual practices in the industry form another obstacle to green building, since traditional practices are opted for which may not have the most sustainable and efficient outcomes (MaCabe, 2010). This is not only seen in building practices, but also in investment decision making approaches whereby developers and investors rely on initial capital cost approaches over life cycle costing which evaluates its design and construction costs rather than the future costs of a building's useful life (GBCSA, 2012). According to the GBCSA (2012), typically leases in South Africa are structured so that tenants are responsible for paying their own operating costs- Triple Net Lease.

Diverging from the standard business as usual practices leads to higher perceived risk. "Building codes and regulations also create obstacles for green building, because local officials are focused on safe guarding the health, safety and welfare of the public. They are cautious about integrating new concepts and technologies" (MaCabe, 2010; pg. 40). Similarly, lack of public awareness and lack of political support and incentives has been

found to be one of the main obstacles for green building in South Africa (Dodge Data & Analytics, 2016). To address this lack of political supported incentive, the GBCSA (2012) presents that the way forward to promote green building with government leadership is through setting national targets through policies such as the carbon tax and subsidies such as tax credits for sustainable buildings that meet certain sustainability standards.

2.13. The Costs, Benefits and Risks Associated with Green Building

2.13.1. Costs Associated with Green Building

The main additional costs associated with certified green buildings according to Fuerst and McAllister (2011) are the payments to the certifying body and the associated project costs to meet the required certification standards. As previously discussed, the higher costs of green building in relation to their traditional counterparts do not necessarily have to be accrued when effective costing, project management and environmental strategies are incorporated into the property development process. These higher upfront costs have been found to be "proportional to the increased level of certification or rating", however these are still typically not as high as perceptions (World Green Building Council, 2013; pg. 22). The associated increases in the upfront costs of green buildings are typically counteracted by the long term life cycle costs and the other financial benefits associated with these buildings (GBCSA, 2012). "To compensate for the additional costs of construction of certified buildings, rational investors will require a combination of higher income and/or reduced risk" (Fuerst and McAllister, 2011; pg. 50).

The GBCSA, The Association of South African Quantity Surveyors and The University of Pretoria sampled 54 Green Star SA rated projects in South Africa, with focus on projects in Gauteng, Western Cape and Kwazulu Natal, to determine the cost premiums associated with these commercial green buildings over their traditional counterparts (GBCSA et al., 2016). A summary of the results is as follows: the average green buildings cost premium was 5% of the total project cost, with the lowest cost premium at 1,1%; a marginal positive relationship was determined between base building costs and cost premium; a strong negative correlation between cost premium and construction size; no correlation between

rating level and cost premium; and higher cost premiums for multiple tenant mix compared to single corporate tenants.

2.13.2. Benefits Associated with Green Building

The World Green Building Council (2013) attributes increased asset value of green buildings to higher sales prices, which in turn are related to higher rental rates, lower operating costs and higher occupancy rates. It has been found in numerous studies that there is a rental premium associated with many green buildings which is attributed to "the attractiveness of green buildings to prospective tenants in terms of their superior, indoor environment, lower operating costs and enhanced marketability. In some markets where green buildings are more mainstream, a slightly different concept is emerging: where buildings that are not green result in lower rental and lease rates, or 'brown discounts'" (pg. 33). The lower operating costs make these buildings more attractive to prospective tenants and owner-occupiers thus increasing demand.

According to the GBCSA (2012; pg. 10), although the number of commercial green buildings in South Africa is limited and so it is difficult to quantify the financial and environmental benefits associated with green buildings are:

- "Lower Operating Costs;
- Higher Returns on Assets;
- Increased Property Values;
- Enhanced Marketability;
- Reduced Liability and Risk;
- Ability to Attract and Retain Government and Other Major Tenants;
- Responsible Investing;
- Increased Productivity;
- Competitive Edge in Attracting and Retaining Talent; and
- Minimising the Costs and Impacts of Churn" (the recurrence of building occupants being relocated internally or externally).

2.13.3. Risks Associated with Green Building

Risk plays a major role in the decision making process of any property development (Collins and Ghyoot, 2015). The various stages of a building's life cycle have a number of risks associated with each stage. In order to 'future-proof' investments, the possible risks need to be considered during the decision-making process. Particularly since, developers and investors need to ensure profits from rental income and capital values for their shareholders and other beneficiaries, which are achieved over short- and long-term periods. (World Green Building Council, 2013).

The four risks that are associated with green buildings are regulatory risks, market risks, physical risks and technology risks (World Green Building Council, 2013). Regulations, buildings codes and laws have become more focused on sustainability, which has resulted in stringent mandates with regards to building construction, operation, maintenance, renovations and demolition (World Green Building Council, 2013). Consequently, regulatory risks can greatly affect the profitability and future value of property, since developers and investors determine the success of property as an investment "over a period of time" (Collins and Ghyoot, 2015; pg. 12). The effect that future legislation and regulations have on profitability and income need to be taken into account during the initial stages of developing/investing in properties and buildings (World Green Building Council, 2013; pg. 84).

The characteristics of the portfolios of influential developers and investors will typically comprise of numerous existing building stock and a small percentage of new stock. This existing stock needs to compete with green building counterparts, which will likely be more attractive to potential tenants and buyers (MaCabe, 2010). These regulations and laws focus on new buildings predominantly, resulting in the majority of new building stock in the market being green rated or equivalent buildings (World Green Building Council, 2013). "If investors' buildings fail to meet the changing requirements of regulations, or seem to perform less favorably when compared to other buildings, then

they will suffer from increased risk of obsolescence" (World Green Building Council, 2013; pg. 84).

Market risks relate to the supply, demand and associated factors of the property market; Collins and Ghyoot (2015; pg. 69) affirm that "property is market driven because it is an economic good and that basic input and output factors in the economy affect property markets and properties". According to the World Green Building Council (2013), sustainability in the built environment affects the market perspective with regards to occupancy risk, asset purchasing and disposable risk, portfolio performance and investment sourcing risk; as depicted in Figure 11.

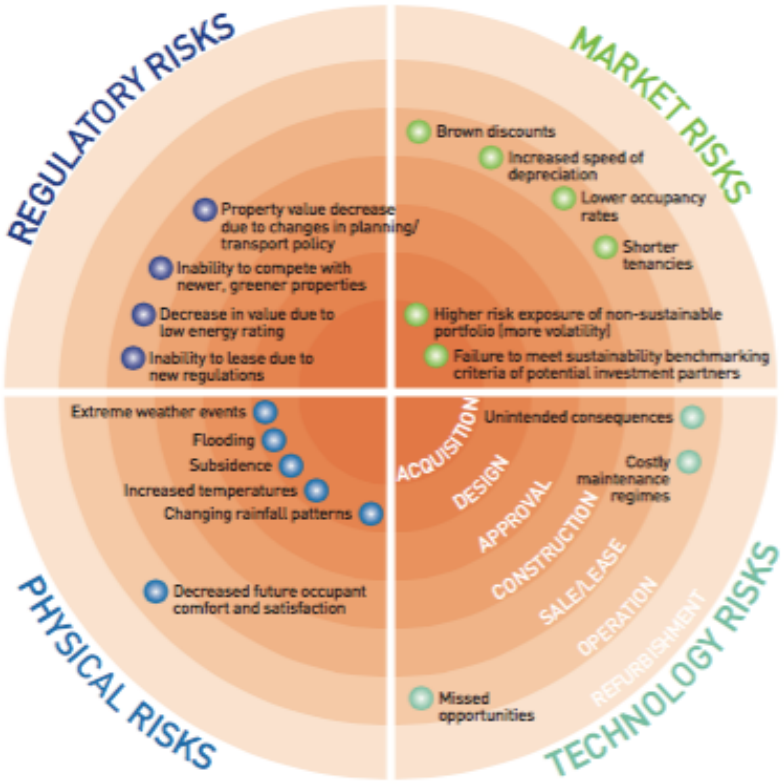


Figure 11: 'Risk Radar' (Source: World Green Building Council, 2013)

The risks associated with continued development of conventional buildings in a growing green building industry are as follows:

- Regulatory risks decrease property value, redundancy in the market compared to green buildings, decrease value due to low energy ratings and prohibit leasing due to

new regulations. These risks are mainly seen in the sale and/or lease phase of the development process.

- Market risks include brown discounts, increased and more rapid depreciation, higher vacancy rates and shorter tenancies during the sale and/or lease phase of the development process and higher risk exposure and failure to meet sustainability requirements of potential investors during the acquisition phase.
- Physical risks leave buildings susceptible to flooding, subsidence and unprotected against increased temperatures, extreme weather events and changing rainfall patterns during the design phase. This leads to decreased future occupant comfort and satisfaction during the operation phase.
- Technological risks include costly maintenance regimes and missed opportunities during the operation phase. Unforeseen consequences resulting from the decisions in the design phase can result in the operation phase.

Since risk is acknowledged as "an integral role in investor's decision making" (Collins and Ghyoot, 2015; pg. 27), consideration of the resilience and future-proofing of investments in the sector must be ensured by integrating "suitable risk management of sustainability issues and efficient portfolio, asset and property management" (World Green Building Council, 2013; pg. 90). Portfolios possessing higher numbers of green buildings have shown less exposure to market risk and improved operating performance (MaCabe, 2010).

2.14. The Green Building Premium

The limited research on the green building premium does show premiums on both selling price and rental rates (Eichholtz et al., 2010a; Eichholtz et al., 2010b; Pivo and Fisher, 2010; Wiley et al., 2010; Fuerst and McAllister, 2011; Kim et al. 2016). These studies are focused mainly on the American commercial property markets and a few studies in other international markets which tend to conclude with similar premiums. An average of a 5% rental premium and 11,6% sale premium for Energy Star and Leadership in Energy and Environmental Design (LEED) rated commercial buildings was determined in these studies, and market demands are identified as one of the main incentives for the

development of green buildings (Eichholtz et al., 2010a; Eichholtz et al., 2010b; Pivo and Fisher, 2010; Wiley et al., 2010; Fuerst and McAllister, 2011; Falkenbach et al., 2010; Sayce et al., 2007).

Eichholtz et al. (2009) found that green buildings do command a premium in both rental and sales rates over their conventional counterparts. It was determined that green rated buildings command rental rates with a premium that is 3% higher per square foot than their conventional counterparts. Kok et al. identified a 7.1% rental premium for LEED-certified buildings, Fuerst and McAllister (2011) determined a 5% rental premium for LEED-certified buildings and 4% rental premium for Energy Star labeled buildings and Wiley (2010) determined a 17% rental premium for LEED-certified buildings and an 8% rental premium for Energy Star labeled. These studies implemented regression analysis to determine and quantify these rental premiums. It was also determined that the premium increases with higher certification ratings.

The three main drivers of the price differences between conventional buildings and green buildings in the same submarkets, particularly those that are certified by the various councils, are identified by Fuerst and McAllister (2011; pg. 45) as being the "additional occupier benefits, lower holding costs for investors and a lower risk premium". Hedonic characteristics, neighbourhood controls and contract features are identified in the international research as variables that affect rental and sales rates most significantly (Fuerst and McAllister, 2011; Fuerst and McAllister, 2009; Chegut et al., 2014; Eichholtz et al., 2011). Building height, building size, location, green rating/certification and renovations are noted as premium generating building variables (Chegut et al., 2014).

2.15. Summary of the Literature

The comprehensive benefits of sustainability are well known, however "the key challenge *from a property industry and property investor perspective* is the justification of the economic rationale and business case for green buildings" (Newell et al., 2011; pg. 13). Green

buildings do in fact seem to make sense from a business perspective (MaCabe, 2010). The advantages they have over traditional buildings are:

- Marketing and public relations benefits;
- Lower risk profiles for owners and occupants over the life cycle of the building;
- Reduced cost structures;
- Increased net operating incomes;
- Decreased chance of obsolescence;
- Reduced exposure to energy price turbulence;
- Reduced exposer to future government regulation; and
- Greater return on investment.

Green buildings can be considered resilient and given current market trends can be seen as a "wise strategic decision" (MaCabe, 2010; pg. 132).

Although there are quantified results of rental and sales premiums associated with green certified/rated commercial buildings, Sundbom (2011) argues that there is a lack of clarity and cohesion between international rating systems, which makes it difficult to compare results from the various studies done in international markets. This difficulty, is a result of the "different legal aspects, environmental laws and building criteria" (Sundbom, 2011; pg. 16), that are specific to countries and guide the specifications of the certifications and ratings.

Most of the economic benefits of green buildings are difficult to quantify particularly due to the immaturity of the industry and limited transactions that have taken place within the market (Sundbom, 2011). Research shows that there are tenants that are willing to pay a premium in order to lease green building space (Fuerst and McAllister, 2011). "Therefore, it is important to understand the motivation behind the choice of choosing green buildings" (Sundbom, 2011; pg. 11). The most commonly used lease structure is the net lease, which incentivises users to economise on energy costs. However, this type of lease contract provides no incentive for a building owner to invest in energy efficiency (Lee, 2016). Research shows that the higher premium found in rental and selling prices is related

to the the energy-saving attributes of green buildings as a result of net lease contracts (Sundbom, 2011).

According to Lee (2016; pg, 14), "many commercial building tenants also consider buildings as a space for publicising their environmentally friendly visions". As a result there are a number of studies that investigate the social benefits associated with CSR. A growing body of studies examines the financial, environmental and occupant benefits of sustainable buildings, particularly since developers, owners and tenants can benefit from subsidies and tax deductions (Lee, 2016). "Hence, it is expected that the interaction of improved information, market transparency and the price mechanism will produce positive environmental outcomes" (Fuerst and McAllister, 2011; pg. 5).

In summary, this chapter reviewed the general literature on sustainable buildings and the relationship between the notion of sustainability and the sustainable building movement. Additionally, this chapter addressed both demand and supply factors of sustainable buildings and discussed the cost-benefit issue of sustainable building projects.

Chapter 3

3. Research Methods

3.1. Research Aim

The aim of this research was to determine and quantify the use value and specifically the rental premium that green buildings command over their traditional counterparts. Therefore this research focuses on the demand side of the rental market since, as discussed in the literature review portion of this report, a rental premium is a signal of tenants 'willingness to pay' a premium to occupy green building space.

Quantitative research methods were utilised in order to determine the presence of a premium and the specific quantity or amount of this rental premium in the commercial property market. Quantitative methods were best suited for this since the rental premium could be expressed in terms of quantity and a definitive amount can be calculated for a rental premium by utilising applicable statistical models and analyses. In order to calculate this quantity, data need to be generated and analysed. The inferential quantitative research approach was utilised "to form a data base from which to infer characteristics or relationships of population" (Kothari, 2004; pg. 5).

3.2. Methodology

The following analyses were utilised for this quantitative research: (1) descriptive statistics and (2) hedonic regression analysis of commercial Green Star rated buildings and their conventional counterparts.

3.2.1. Descriptive Statistics

Descriptive statistics express the characteristics of the data in a study. By using descriptive statistics, data can be summarised and broken down into measures of central tendency, measures of dispersion and measures of asymmetry (Kothari, 2004). By organising the collected data, descriptive statistics provide a clearer image of the Green Star rated

buildings and their counterparts in terms of the notable differences and proportions of all the various building characteristics. This was done by calculating the mean, median, standard deviation, skewness and kurtosis for the gross rental rate/m^2, Gross Leasable Area (GLA) and storeys of the sample buildings. The categorical data: age, grade, Green Star rating and renovation/retrofit characteristics of the building sample were represented by percentages of the total sample since these characteristics do not have numerical values that can used to calculate the descriptive statistic measures. From this data analysis, observations were made to determine the variations between the selected sample and whether there are noteworthy differences that would affect the hedonic regression results.

Central tendency was measured by calculating mean and median. These two measures show where the data tends to be most concentrated. In order to measure the dispersion of the data, standard deviation was used. The median represents the value in the middle of the data set; so half of the data values are smaller than the median and half of the data values are bigger than the median (Weiers, 2008). The mean measures the average value of the data, but can be affected by extreme values in the data set, resulting in inaccurate readings. The standard deviation becomes useful in checking the applicability of the mean since it measures the dispersion of the data from the mean. Data that are more concentrated around the mean would result in a smaller standard deviation (Kothari, 2004).

In order to measure the symmetry of the data set, a measure of asymmetry was done. When data doesn't have a normal distribution, since the mean and median are not equal to each other, the skewness of the data needs to be measured. This skewness can be positive or negative, depending on the shape of the distribution. Negative skewness indicates that the data values are skewed left and positive skewness indicates that the data values are skewed right. Kurtosis is a measure of whether the data are peaked or flat, relative to the mean value. A high kurtosis value tends to indicate that the data set has outliers and a low kurtosis value tends to indicate a lack of outliers (Kothari, 2004).

3.2.2. Hedonic Regression Analysis

A statistical approach was implemented, since hedonic modelling and regression analysis are traditionally used when comparing property rentals and are effective in solving problems with numerous variables (Monson, 2009). "Hedonic regression modeling is the standard methodology for examining price determinants in real estate research" (Fuerst and McAllister, 2009; pg. 13). Regression analysis has been utilised in much of the international research investigating sale and rental premiums of green commercial space compared to conventional counterparts, as depicted in Table 6. It has been ascertained that "the strong market performance of green office buildings was not only influenced by a single attribute. Rather, it was a result of complex interaction between various attributes" (Kim et al., 2017; pg. 7). Commercial buildings are considered heterogeneous goods and their value is dependent on a number of characteristics (Monson, 2009).

Table 6: Summary of Studies Investigating Rental Prices of Green Office Buildings (Source: Tabulated by Author from Kim et al., 2017)

Author	Research Title	Research Title	Research Title	Analytical Method	Rental Premium
Robinson, S. J. and Sanderford, A. R.	Green Buildings: Similar to Other Premium Buildings?	2016	US	Logistic regression, OLSDV regression, Propensity Score Matching technique (hereafter PSM), Kruskal-Wallies test	Y
Chegut, A., Eichholtz, P., and Kok, N.	Supply, Demand and the Value of Green Buildings.	2014	UK	Regression analysis, OLS analysis, PSM, Semi-log equation, Non-parametric comparison	Y
Eichholtz, P., Kok, N., and Quigley, J. M.	The Economics of Green Building.	2013	US	Regression analysis, PSM, Semi log equation	Y
Kok, N. and Jennen, M.	The impact of energy labels and accessibility on office rents.	2013	Nehterlands	Regression analysis, Walk Score algorithm, log-equation	Y
Reichardt, A., Fuerst, F., Rottke, N. B., and Zietz, J.	Sustainable Building Certification and the Rent Premium: A Panel Data Approach.	2012	US	Panel data regression (difference-in-differences (DID) and fixed-effects models), cross-sectional regression, Pooled OLS, Log-linear hedonic model	Y
Das, P., Tidwell, A., and Ziobrowski, A.	Dynamics of Green Rentals over Market Cycles. Evidence from Commercial Office Properties in San Francisco and Washington DC.	2011	US	Regression analysis	Y
Chegut, A., Eichholtz, P., and Kok, N.	The Value of Green Buildings New Evidence from the United Kingdom.	2011	UK	Hedonic regression analysis, Semi-log equation, Non-parametric comparisons, PSM, Kernel density estimators	Y
Fuerst, F. and McAllister, P.	Eco-labeling in commercial office markets. Do LEED and Energy Star offices obtain multiple premiums?	2011	US	Robust regression analysis, OLS regression analysis, Fractional logit models, Log-equation	Y
Fuerst, F. and McAllister, P.	Green Noise or Green Value? Measuring the Effects of Environmental Certification on Office Values.	2011	US	Hedonic regression analysis, Log-equation, Least square dummy variable (LSDV) approach	Y
Fuerst, F. and McAllister, P	The impact of Energy Performance Certificates on the rental and capital values of commercial property assets.	2011	UK	Hedonic regression analysis, Log-equation	Y
Newell, G., MacFarlane, J., and Kok, N.	Building better returns. A Study of the Financial Performance of Green Office Buildings in Australia, Sydney.	2011	Australia	Hedonic regression method, Log value analysis, Correlation analysis	Y
Pivo, G. and Fisher, J.	Income, Value, and Returns in Socially Responsible Office Properties.	2010	US	Panel regression	Y
Wiley, J. A., Benefield, J. D., and Johnson, K. H.	Green Design and the Market for Commercial Office Space.	2010	US	OLS & 2SLS analysis, T-statistics, Hedonic regression analysis	Y
Eichholtz, P., Kok, N., and Quigley, J. M.	Doing Well by Doing Good? Green Office Buildings.	2010	US	Hedonic regression analysis, Semi-log equation, PSM	Y
Eichholtz, P., Kok, N., and Quigley, J. M.	Sustainability and the Dynamics of Green Building	2010	US	Regression analysis, Log-equation, PSM	Y

It is difficult to calculate the effect of these characteristics on price when valuing property. Property valuation is based on subjective professional judgement and "is based on an assessment of influences that a valuer considers relevant to the value of the subject property" by comparing the rental values of "properties considered to be similar in nature to the subject property" (Dunse and Jones, 1998; pg. 207). According to Dunse and Jones (1998), the various characteristics affecting the commercial rental market value are categorised as follows:

- Physical accommodation: Floor area, internal accessibility, internal services and physical structure
- Location: spatial relationships, business environment, built environment
- Tenure rights

Each of these characteristics is a determining factor of the market value associated with commercial buildings. Since these characteristics combined determine the overall value, "the price paid for a particular property is the sum of the implicit prices that the market gives to the different characteristics associated with that property" (Dunse and Jones, 1998; pg. 299). Regression analysis can be used to determine the influence of each characteristic on market value and the correlation between different data points (Monson, 2007). Independent variables are determined from the internal and external building characteristics that influence the dependent price variable. Therefore "market price is a function of each tangible and intangible building characteristic and other outside influencing factors" (Monson, 2007; pg. 64).

A typical multiple linear regression analysis that uses Ordinary Least-Squares (OLS) was utilised. Once a linear model was been established using regression analysis, the 'goodness-of-fit' was analysed using the R^2 value. This value shows how closely the data are fitted to the regression line, whether the model explained the variance around the mean and if the model's predicted values were unbiased and minimal. Although it isn't always the case, it is generally accepted that the higher the R^2 value, the better the model fits the data (Kothari, 2004). The p-value was then analysed in order to ascertain whether

or not the variables were significant additions to the model. If an independent variable has a p-value that is smaller than 0,05, it indicates that the independent variable is related to changes in the dependent variable, keeping all other variables in the model constant. "In other words, the probability that these characteristics influenced price purely by chance is less than 5%" (Monson, 2007; pg. 69). Insignificant variables with a p-value higher than 0,05 were then removed from the model.

Although hedonic modelling and regression analysis is widely accepted and used for calculating the effects of the various building characteristics on property value, it isn't without its limitations and disadvantages, which must be taken into account when analysing the model outputs. The model assumes that the relationships between the dependent variable and each independent variable in the model are linear and constant. It is also assumed that the independent variables have no correlation and so no effect on each other, however this may not be the case in reality, particularly since not all of the characteristics that affect property value are being tested in the model. Qualitative characteristics, which cannot be represented by a unit of measurement or value, cannot be included in the model, so their impact on value cannot be measured.

3.3. Research Design

3.3.1. Descriptive Statistics

The aforementioned values of mean, median, standard deviation, skewness and kurtosis were calculated for the gross rental rate/m^2, storeys and GLA of the building sample. These values were tabulated and a simple graphical analysis was done. Comparisons between the Green Star rated sample buildings and conventional sample buildings were made from these values in order to ascertain the variations in the sample characteristics.

3.3.2. Hedonic Regression Analysis

By using a hedonic regression analysis, bias is minimised, reliable data can be collected and an accurate description of the population can be determined. The independent variables were selected from the various building characteristics that would affect market

value. Monson (2009) presents the following characteristics as possible independent variables to be used in the regression analysis of buildings:

- Consumer Price Indexes
- Total Building area (square metres)
- Total property area (square metres)
- Floor plate area (square metres)
- Storeys
- Renovation
- Building park or freestanding
- Presence on green rating of certification
- Fitness centre
- Food service
- Presence of atrium
- Parking ratio
- Near public transport or transportation nodes
- Surrounding urban environment
- Year built
- Construction type
- Grade or class of space
- Tenancy

Some of the aforementioned characteristics and additional characteristics are depicted in Figure 12. Kim et al. (2017) identify certification, building size, building storeys, building class and building age as the most frequently listed independent variables in international literature, which significantly influence rental rate.

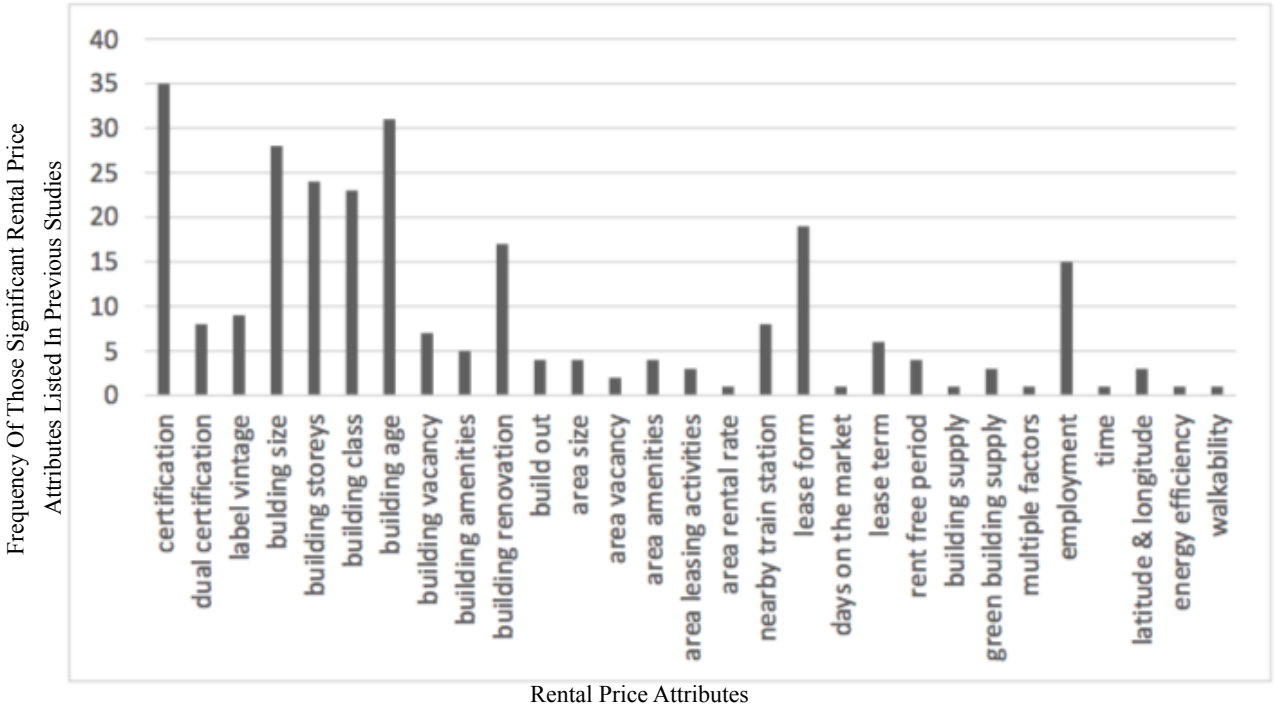


Figure 12: Significance and Influence of Independent Variables on Rental Rate (Source: Kim et al., 2017)

The data for the single dependent (Y) variable of rental rates were collected for all of the sample buildings and these values were used in the regression. The multiple independent (X) variables were assigned as follows:

- Location- the sample buildings' locations were described by areas within the Johannesburg area. Green Star rated buildings were first identified, after which similar conventional buildings within a 3km radius were identified in order to account for any changes in rental rates resulting from location. The categorical data of the seven areas of the sample were then assigned values from 1 to 7 based on industry data from Anvil Property Smiths (nd.) of the average rental rates per m^2 for premium grade commercial space. Values were assigned to the average rental rates in descending order. Illovo has the highest average rental rate per m^2 for premium grade commercial space and was therefore assigned a value of 7. Midrand had the lowest per m^2 rental rate and so was assigned a value of 1. These averages and assigned values are depicted in Table 7.

Table 7: Average Rental Rate/m^2 of Grade P Commercial Space by Location and Assigned Values (Source: Tabulated by Author, 2017)

Location	Average Rental Rate/m^2 for Grade P Commercial Space	Assigned Value
Illovo	R229,20	7
Rosebank	R217,07	6
Sandton	R200,26	5
Fourways	R169,66	4
Houghton	R157,50	3
Bryanston	R152,85	2
Midrand	R102,67	1

- Building Age- the age of the sample buildings has been described as either yes or no to being 'less than 10 years old'. If yes, 0 has been assigned and if no, 1 has been assigned.
- Renovated/Retrofit- similar to building age, the sample buildings were noted as either having been renovated/retrofit or not. If yes, 1 was assigned and if no, 0 was assigned.
- GLA- each sample building's GLA, in m^2, was collected and size intervals of 4 000m^2 were created for this categorical data. The values were assigned based on the interval each GLA was in. Values were assigned in ascending order. Larger GLAs between 40 000 and 44 000m^2 were assigned 11 and GLAs smaller than 4 000m^2 were assigned 1. These intervals and assigned values are depicted in Table 8.

Table 8: Size Intervals in m^2 and Assigned Values (Source: Tabulated by Author, 2017)

GLA Intervals	Assigned Value
≤4000	1
4000<x≤8000	2
8000<x≤12000	3
12000<x≤16000	4
16000<x≤20000	5
20000<x≤24000	6
24000<x≤28000	7
28000<x≤32000	8
32000<x≤36000	9
36000<x≤40000	10
40000<x≤44000	11

- Grading- the grading of the sample building spaces were represented as 0 for Premium grade commercial space, 1 for A grade commercial space and 2 for B grade commercial space.
- Storeys- the number of storeys of each building were used in the model as collected
- Green Star rating- the Green Star rating of each building was used in the model and 0 was assigned to conventional buildings where there is no Green Star rating.

The tabulated raw data and adjusted model data are included in Appendix A. The model and regression analysis was then completed using the previously described methodology and XLSTAT statistical analysis add-in software for Microsoft Excel 2011 (Mac). Further analysis was done to test the accuracy of the results and to generate a percentage premium value.

3.4. Sampling

In order to outline the required sample for the data collection pertaining to this research, the requirements of the hedonic regression were first identified. This was done by first identifying the various characteristics needed to conduct the hedonic regression by using

existing international literature. In order to ensure that the sample produces accurate data results that can be representative of the entire population, 30 conventional commercial buildings and 30 Green Star rated commercial buildings in Johannesburg, South Africa formed the sample.

As discussed in the literature review part of this research, voluntary ratings and certifications are at the forefront of governing green buildings internationally. Therefore when investigating the existence of the green rental premium, certified green buildings by the GBCSA are most suited for analysis of commercial green buildings in Johannesburg since all Green Star rated buildings are based on the standard of measurement set out in the Green Star rating tools, as opposed to non-rated sustainable buildings which have not been compared to any benchmarking system.

By beginning with the available rental data for Green Star rated commercial buildings, conventional commercial buildings that are similar in a number of attributes were then identified in the same areas, in order to also have comparable data by area. The majority of Green Star rated building stock is multi-tenant buildings, and so same lease type conventional buildings were also used. This would allow for the minimisation of variations and ensure that counterparts are being compared. The sample building locations are depicted in Figure 13, with green markers representing Green Star rated buildings and blue markers representing conventional buildings.

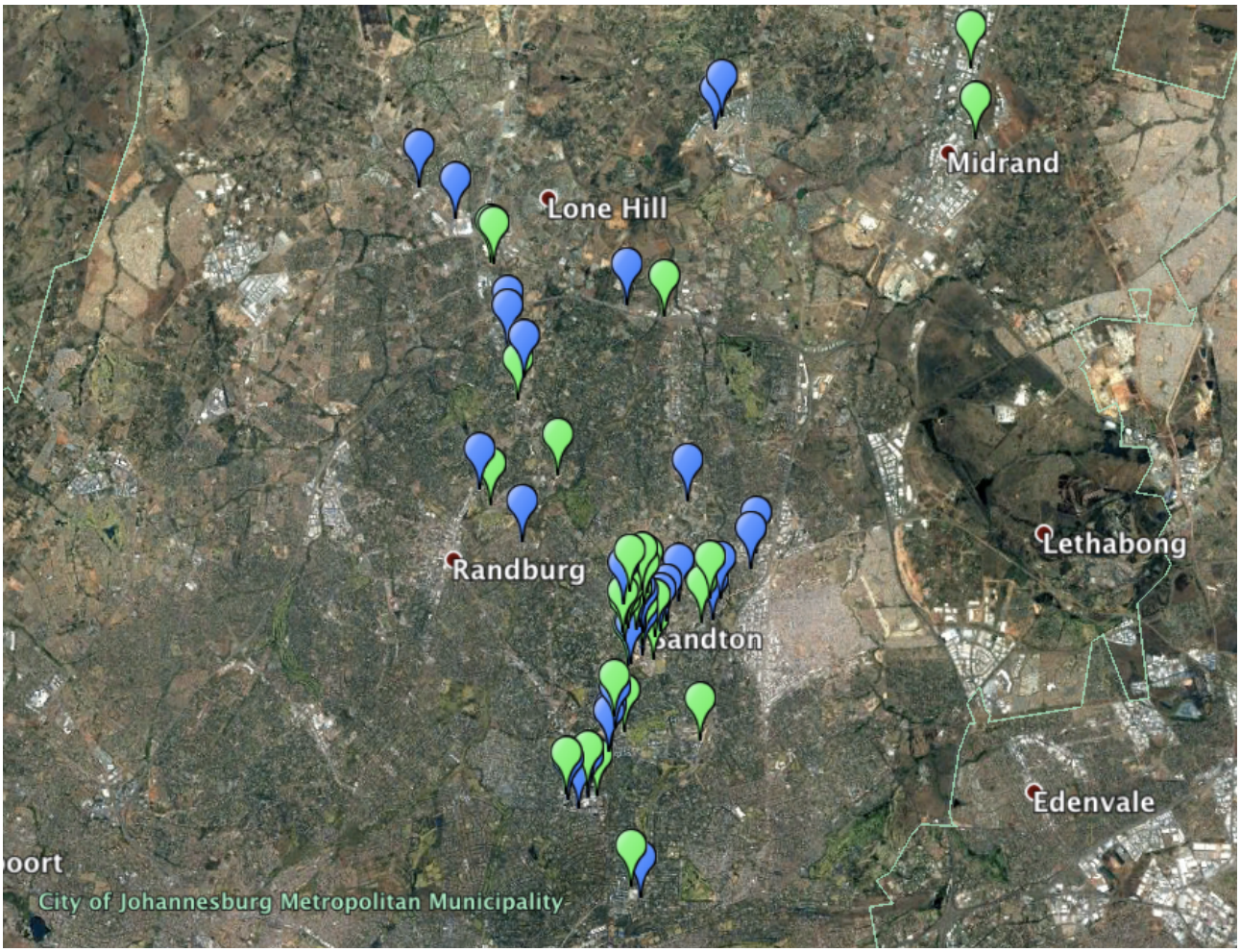


Figure 13: Locations of Sample Buildings (Source: Google Earth Pro, 2017)

3.5. Data Collection

Industry data was collected from online public property brokerage platforms (Anvil Property Smiths, Growthpoint Properties, Eris Property Group, Black Pepper Properties, Redefine Properties and Abland) and the GBCSA**.** Based on the aforementioned sampling guidelines, the 30 conventional commercial buildings and 30 Green Star rated commercial buildings were identified on these public platforms and the relevant data were recorded. These data were tabulated, as seen in Appendix A, and all the aforementioned characteristics were graphically represented with the relevant rental rates for descriptive statistics to be possible. Following this, the remainder of the statistical analysis was carried out.

3.6. Limitations and Delineations

- This research focuses on the existing commercial building stock in Johannesburg

- There is a relatively small number of existing Green Star rated buildings, which results in a limited population for sampling
- Only data pertaining to the private sector was utilised
- Overpricing leading to potential rental premiums was not tested
- Other market irregularities were not tested
- The hedonic regression assumes equilibrium throughout the property market
- Building characteristics are assumed to have the same value and price effect on all property types
- All sample data are applicable to current rental rates and do not account for any future changes to these rates
- There is limited local research on the subject
- Only multi-tenant commercial buildings were used in this study
- Only buildings with Triple Net lease tenants were used in this study

3.7. Ethical Issues

Ethical issues are very limited as a result of gathering data directly from online public platforms. All the information used in this research is readily available to the public and does not require any special consent to be accessed. No individuals have been interviewed and so there are no confidential and anonymity implications for this research report. All the data that was used is from commercial property brokers, who advertise the developer/ owner rental rate based on the current property market.

Chapter 4

4. Analysis of Data

4.1. Descriptive Statistics

Descriptive statistics were utilised on the variables of the sample with quantitative values; namely gross rental rate/m^2, storeys and GLA. The categorical data: age, grade, renovated/retrofit and Green Star rating have been presented as a percentage of the total sample. As previously mentioned, the mean, median, standard deviation, skewness and kurtosis for each variable were calculated separately for the Green Star rated buildings and the conventional buildings. Table 9 depicts the percentage values of the sample buildings' age, grade and Green Star rating and Table 10 depicts the descriptive statistics of the gross rental rate, storeys and GLA for both the conventional and Green Star rated buildings in the sample.

Table 9: Percentages of Sample Age, Renovation/Retrofit, Grade and Green Star Rating (Source: Tabulated by Author, 2017)

GREEN STAR RATED BUILDINGS				
Age	**<10 Years**	**>10 Years**		
	70%	30%		
Renovated/Retrofit	**Yes**	**No**		
	33%	67%		
Grade	**P**	**A**	**B**	
	63%	33%	3%	
Green Star Rating	**3**	**4**	**5**	**6**
	7%	73%	17%	3%
CONVENTIONAL BUILDINGS				
Age	**<10 Years**	**>10 Years**		
	17%	83%		
Renovated/Retrofit	**Yes**	**No**		
	63%	37%		
Grade	**P**	**A**	**B**	
	20%	70%	10%	

Table 10: Central Tendency and Statistical Analysis of Sample (Source: Tabulated by Author, 2017)

GREEN STAR RATED BUILDINGS			
Area	**Gross Rental Rate/m² (Excl. VAT)**	**Stories (Number of Office Levels)**	**GLA (m²)**
Mean	R178,47	6,00	14771,33
Median	R175,00	4,00	11127,50
Standard Deviation	42,5041	3,9514	11587,4458
Skewness	0,0725	1,4886	0,6443
Kurtosis	-0,4433	2,2345	-0,8610
CONVENTIONAL BUILDINGS			
Area	**Gross Rental Rate/m² (Excl. VAT)**	**Stories (Number of Office Levels)**	**GLA (m²)**
Mean	R126,63	4,00	7381,90
Median	R120,00	2,00	6427,50
Standard Deviation	33,6262	4,4567	4448,8297
Skewness	0,6174	2,9300	1,2217
Kurtosis	0,1052	8,3452	1,7109

As described in the previous chapter, the Green Star rated buildings were first chosen for the sample of this study and the conventional buildings were then chosen in order to ensure comparability of the Green Star rated sample buildings and conventional buildings. The selected conventional buildings in the sample have similar locations, lease types, uses and GLAs to the Green Star rated sample buildings. However, it is evident from the data in Tables 9 and 10 that there are some notable differences between the Green Star rated sample buildings and the conventional sample buildings.

70% of the Green Star rated buildings in the sample are less than 10 years old, while only 17% of the conventional sample buildings are less than 10 years old. This would explain why the renovate/retrofit percentage is 63% for conventional buildings in the sample and

only 33% for Green Star rated buildings in the sample. The majority of the Green Star rated sample buildings are graded as Premium grade office spaces, with 63% of the total Green Star rated building sample, and 33% of the total Green Star rated building sample is graded as A grade office space. In contrast, the majority of the conventional sample buildings are graded as A grade office spaces, with 70% of the total conventional building sample. Premium grade office space in the conventional building sample only accounts for 20%.

These differences are largely due to the fact that Green Star rated buildings tend to be newer, and many commercial projects that are planned, in progress or that have been recently completed in Johannesburg's business districts are Green Star rated buildings. Newer buildings that do not have Green Star ratings tend to have a number of sustainable features. Therefore, these buildings have not been included in this study as conventional buildings, particularly since they would not serve as accurate representatives of conventional buildings and cannot be included in the sample as Green Star rated buildings since they have not received any ratings. Similarly, the newer buildings tend to have more storeys and have higher commercial space gradings in comparison to older buildings. 73% of the Green Star rated building sample have a 4 Star Green Star SA rating and only 3% of the Green Star rated building sample have a 6 star Green Star SA rating.

Without controlling for these differences between the Green Star rated and conventional sample buildings, the following was determined:

Green Star rated buildings have a higher asking rental rate. The Green Star rated sample has an average rental rate that is R51,84 higher than the conventional building sample. The median asking rental rate is 31% higher for the Green Star rated buildings. Figure 14 graphically depicts both the conventional and Green Star rated sample buildings' gross rental rates/m^2. As previously mentioned, the average gross rental rates/m^2 vary according to their location. Figure 15 graphically represents the average gross rental rates/m^2 of the Green Star rated and conventional sample buildings, based on their location. The

average rental rates of the Green Star rated sample buildings have higher averages in all areas. The variations between the Green Star rated sample and the conventional sample buildings' rentals are not consistent and vary between areas.

The data for the Green Star rated sample buildings are less evenly distributed than those for the conventional sample buildings, which is evident from the larger standard deviation value. However both data sets have a low measure of standard deviation. Both the Green Star rated sample building data and conventional building data have moderate positive skewness. The kurtosis values indicate that both the Green Star rated and conventional building sample data do not have high peaks, although the Green Star rated building sample data values are flatter. The data do not have a normal distribution but are more concentrated around the mean and medium without any extreme outliers or high peaks.

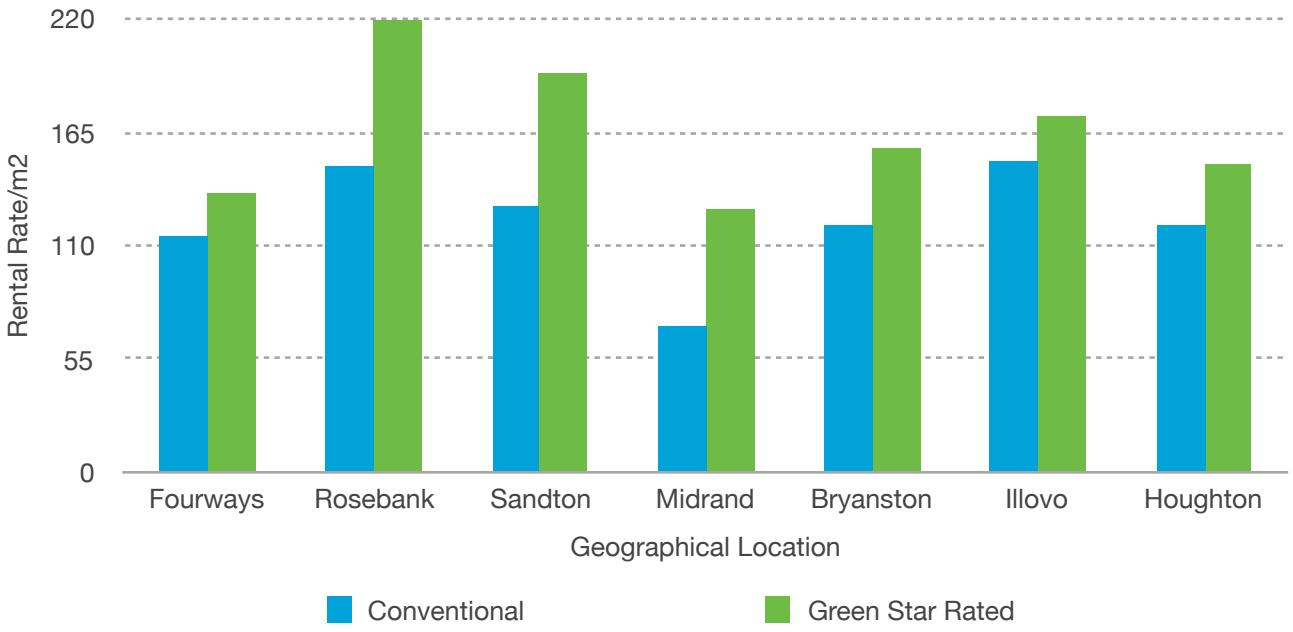


Figure 14: Graphical Representation of Green Star Rated and Conventional Sample Building Gross Rental Rates / m^2 (Source: Drawn by Author, 2017)

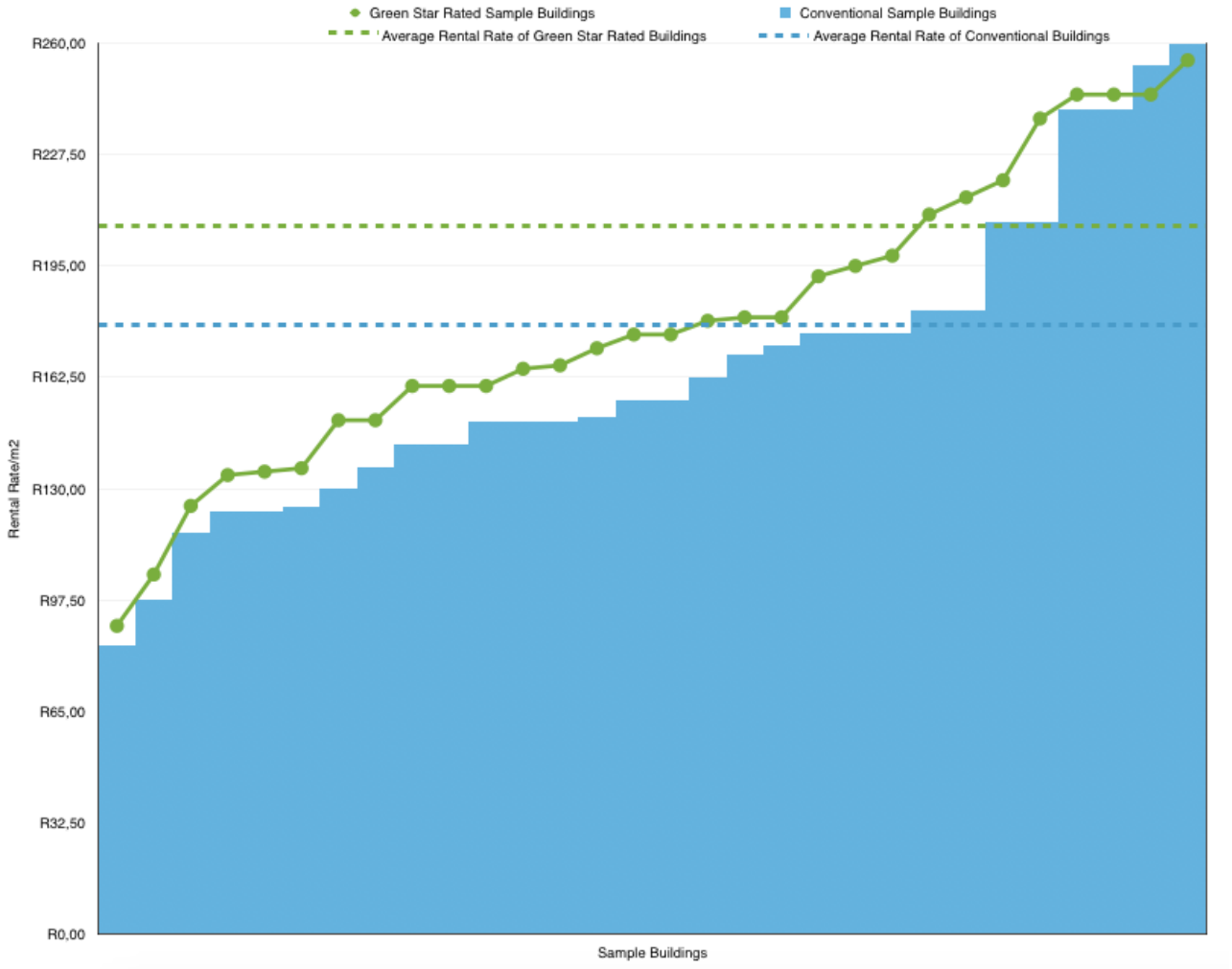


Figure 15: Graphical Representation of Average Gross Rental Rate/m^2 of Green Star Rated and Conventional Sample Buildings by Location (Source: Drawn by Area, 2017)

There is a difference between the average and median heights of the Green Star rated building sample and the conventional building sample. The Green Star rated building sample is higher than the conventional building sample by an average of 2 storeys. The median number of storeys of the Green Star rated building sample is 50% higher than the medium number of storeys of the conventional building sample. Figure 16 graphically depicts the number of storeys of both the Green Star rated and conventional sample buildings. It is evident that the conventional sample buildings are typically low-rise, with only a small number of high-rise buildings in the sample. The Green Star rated sample buildings have far more varied number of storeys, but similar to the conventional sample buildings, only a small number have a large number of storeys.

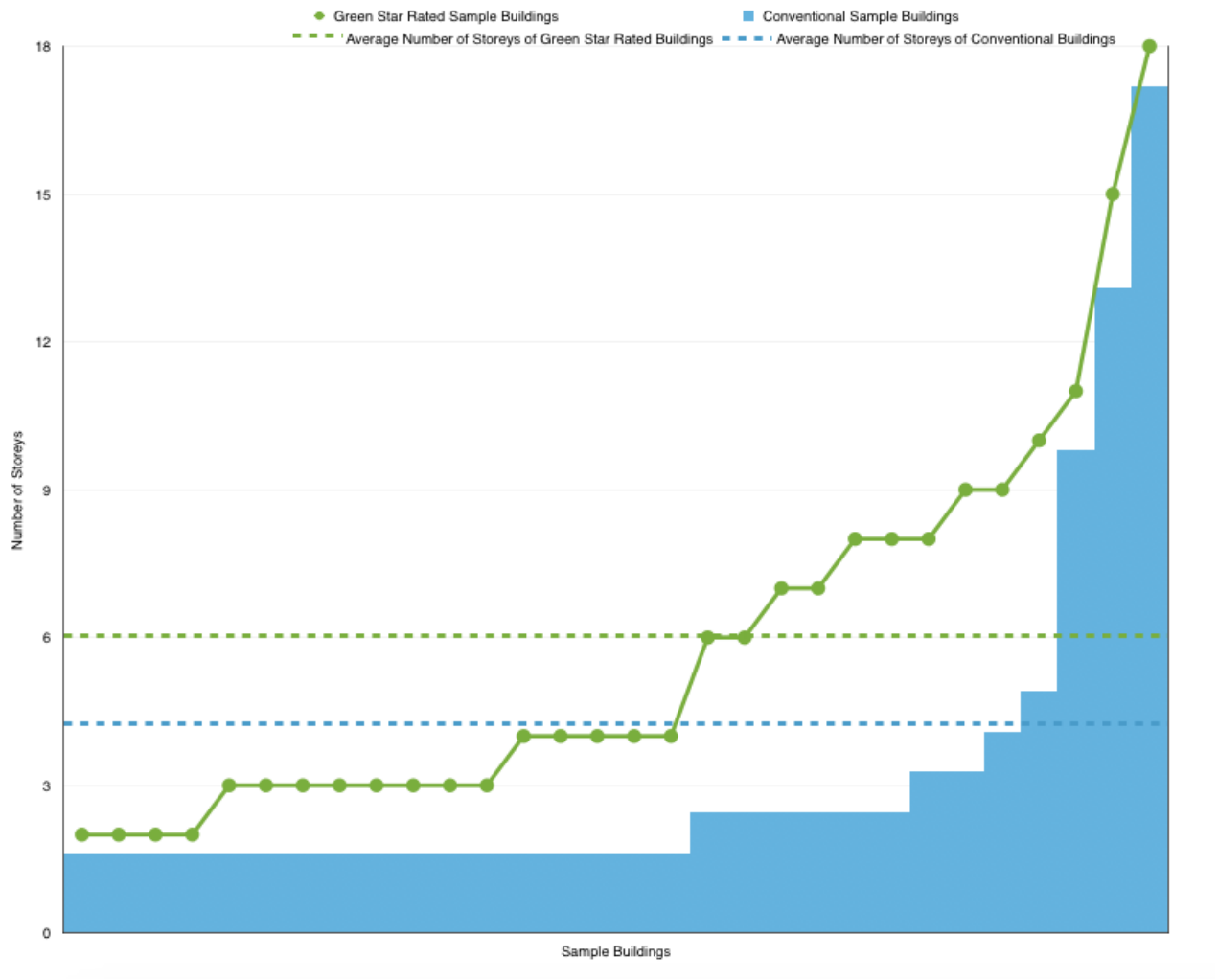


Figure 16: Graphical Representation of Green Star Rated and Conventional Sample Building Number of Storeys (Source: Drawn by Author, 2017)

The data for the number of storeys for the Green Star rated sample buildings are more evenly distributed than those for the conventional sample buildings, which is evident from the smaller standard deviation value. While the Green Star rated building sample has a low standard deviation, the conventional buildings sample has a high deviation. The Green Star rated sample building data have moderate positive skewness. The kurtosis value indicates that the Green Star rated building sample does not have high peaks and is more flat. In contrast, the conventional sample building data have a high skewness to the right and high kurtosis level indicating a high peak. These extremes can be explained due to the small number of high-rise buildings in the sample, which vary significantly from the majority of the conventional sample buildings' number of storeys. The conventional

sample data do not have a normal distribution, are not concentrated around the mean and medium and have extreme outliers or high peaks. The Green Star sample data do not have a normal distribution but are more concentrated around the mean and medium without any extreme outliers or high peaks.

The GLAs of both the conventional and Green Star rated buildings are varied. Although there is far more variation in the Green Star rated sample building data, with a number of buildings with large GLAs and a number of buildings with small GLAs. Figure 17 graphically depicts the size of the Green Star rated and conventional sample building GLAs. The Green Star rated sample buildings have a significantly higher average GLA than that of the conventional sample buildings. The average of the Green Star rated sample buildings' GLA is just over double the amount of the conventional building sample average with a difference of 7 389,43m^2. The median of the Green Star rated sample buildings is 57% larger than the median of the conventional sample buildings. Both the Green Star rated and conventional sample buildings have a low standard deviation. The Green Star rated sample building data have a moderate skew to the right with a low kurtosis value. The conventional sample building data have a high skew to the right and a low kurtosis value. The data do not have a normal distribution but are more concentrated around the mean and medium without any extreme outliers or high peaks.

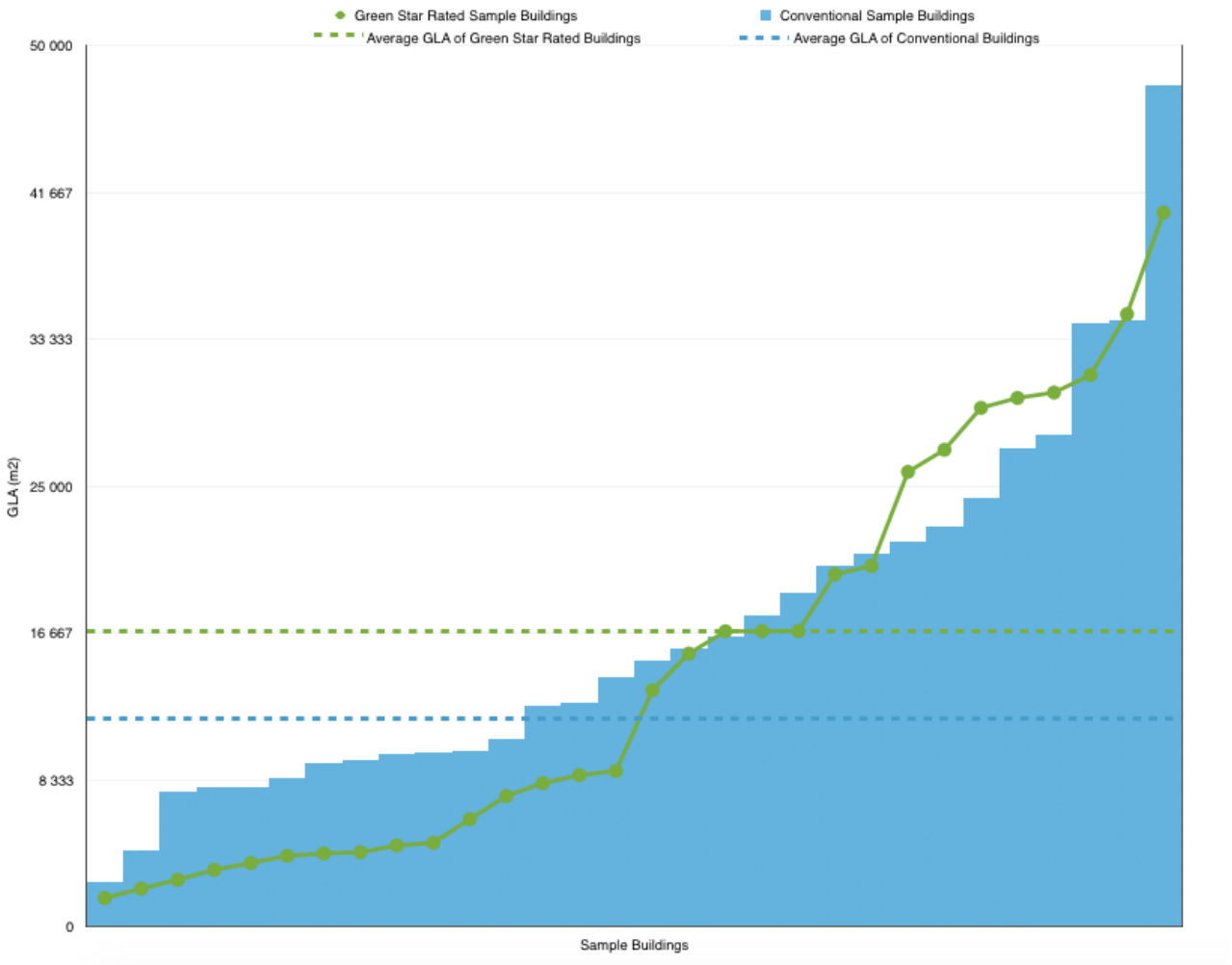


Figure 17: Graphical Representation of Green Star Rated and Conventional Sample Building GLA (Source: Drawn by Author, 2017)

From the analysis of the various building characteristics of both the Green Star building sample and conventional building sample, it is evident that Green Star rated buildings tend to be newer buildings and have higher office space gradings. The Green Star rated sample buildings also tend to have higher GLAs, number of storeys and average rental rates, without controlling for the differences between the sample buildings. Location also tends to affect the gross rental rate/m^2 for both the Green Star rated and conventional sample buildings. From the descriptive statistics, conclusive findings cannot be made from the raw data since the data for all of the variables do not have normal distribution. Any conclusions drawn from these data, in raw form, would most likely be incorrect. Although, by using descriptive statistics, the variations between the sample buildings can be better understood.

4.2. Hedonic Regression Analysis

For the first hedonic regression model, as previously described, the dependent (Y) variable was the gross rental rate/m^2. The independent (X) variables used were location, age, renovated/retrofit, storeys, GLA, grade and Green Star rating. The resulting R^2 value was 0,771. So, essentially 77% of the data's variability around the mean can be explained and this value shows that the model does effectively fit the data. This regression can be seen in Appendix B.

For the purposes of this research, the effect of each independent variable on gross rental rate/m^2 was ascertained in order to identify the existence of the green rental premium and to quantify this value. These effects on gross rental rate/m^2 were identified through the 'values' in the model parameters. Table 11 depicts what was determined in this model.

All of the Rand values in Table 11 depict the associated value added to or detracted from the gross rental rate/m^2, which results from each changes in each variable, with all other variables being kept constant. The significance of each variable is depicted in Table 12. From this data analysis it is evident that:

- the number of storeys has the most significant impact on the gross rental rate/m^2, with an added value of R71,83 for the highest value which is 22 storeys
- location has the second most significant impact on gross rental rate/m^2, with an added value of R51,35 for the highest value of 7 for being situated in Illovo
- GLA has the third most significant impact on gross rental rate/m^2, with an added value of R51,29 for the highest value of 11 for having between 40 000 and 44 000m^2 of office space
- the Green Star rating has the fourth most significant impact on gross rental rate/m^2, with an added value of R28,42 for the highest value of 6 for having a 6 Star Green Star SA rating
- the commercial space grading has the fifth most significant impact on gross rental rate/m^2, with a deducted value of R18,93 for the highest value of 2 for being B Grade space

- renovated/retrofit has the sixth most significant impact on gross rental rate/m^2, with an added value of R17,49 for the highest value of 1 for a building having been renovated/retrofit
- building age has the least significant impact on gross rental rate/m^2, with a deducted value of R12,35 for the highest value of 1 for a building being more than 10 years old

Table 11: Effect of Independent Variables on Gross Rental Rate (Source: Tabulated by Author, 2017)

Location		**Value: 7,335**
	Model Value	Associated Rand Value /m^2
Midrand	1	R7,34
Bryanston	2	R14,67
Houghton	3	R22,01
Fourways	4	R29,34
Sandton	5	R36,68
Rosebank	6	R44,01
Illovo	7	R51,35

Age		**Value: -12,348**
	Model Value	Associated Rand Value /m^2
Less Than 10 Years	0	R0,00
More Than 10 Years	1	-R12,35

Renovated/Retrofitted		**Value: 17,491**
	Model Value	Associated Rand Value /m^2
No	0	R0,00
Yes	1	R17,49

Stories		**Value: 3,265**
	Model Value	Associated Rand Value /m^2
Per Level of Office Space	1-22	R3,27

GLA		**Value: 4,663**
	Model Value	Associated Rand Value /m^2
Per Additional 4000m2	1-11	R4,66

Grade		**Value: -9,463**
	Model Value	Associated Rand Value /m^2
P	0	R0,00
A	1	-R9,46
B	2	-R18,93

Green Star Rating		**Value: 4,736**
	Model Value	Associated Rand Value /m^2
3	3	R14,21
4	4	R18,94
5	5	R23,68
6	6	R28,42

All these independent variables have an associated Rand value that affects the gross rental rate/m^2. However, not all of these variables are considered significant. In order to ascertain the significance of each variable, the p-values from the model parameters were analysed. All variables with a p-value smaller than 0,05 were considered significant, while variables with p-values larger than 0,05 were considered insignificant and removed for the second model. Table 12 depicts the p-values of the various independent variables.

Table 12: Significance of Independent Variables (Source: Tabulated by Author, 2017)

	P-Value	Significant
Location	0,001	Yes
Age	0,259	No
Renovated/Retrofit	0,054	No
Storeys	0,000	Yes
GLA	0,004	Yes
Grade	0,148	No
Green Star Rating	0,012	Yes

For the second model, the dependent (Y) variable was the gross rental rate/m^2. Only the significant independent (X) variables were used. These were area, storeys, GLA and Green Star rating. The resulting R^2 value was 0,674. Essentially 67% of the data's variability around the mean can be explained and this value does show that the model does effectively fit the data. This regression can be seen in Appendix C.

As per Table 11, all of the Rand values in Table 13 depict the associated value added to or detracted from the gross rental rate/m^2 which results from each changes in each variable, with all other variables being kept constant. The significance of each variable is depicted in Table 14. From this data analysis it is evident that:

- the number of storeys has the most significant impact of the gross rental rate/m^2, with an added value of R84,72 for the highest value, which is 22 storeys

- location has the second most significant impact on gross rental rate/m^2, with an added value of R57,16 for the highest value of 7 for being situated in Illovo
- GLA has the third most significant impact on gross rental rate/m^2, with an added value of R51,99 for the highest value of 11 for having between 40 000 and 44 000m^2 of office space
- the Green Star rating has the fourth most significant impact on gross rental rate/m^2, with an added value of R51,24 for the highest value of 6 for having a 6 Star Green Star rating

Table 13: Effect of Independent Variables on Gross Rental Rate (Source: Tabulated by Author, 2017)

Location		**Value: 8,166**
	Model Value	Associated Rand Value /m^2
Midrand	1	R8,17
Bryanston	2	R16,33
Houghton	3	R24,50
Fourways	4	R32,66
Sandton	5	R40,83
Rosebank	6	R49,00
Illovo	7	R57,16

Stories		**Value: 3,851**
	Model Value	Associated Rand Value /m^2
Per Level of Office Space	1-22	R3,85

GLA		**Value: 4,726**
	Model Value	Associated Rand Value /m^2
Per Additional 4000m2	1-11	R4,73

Green Star Rating		**Value: 8,540**
	Model Value	Associated Rand Value /m^2
3	3	R25,62
4	4	R34,16
5	5	R42,70
6	6	R51,24

All of the variables are still significant and have p-values that are smaller than 0,05, as depicted in Table 14. From these data it is evident that the Green Star rating is the most significant variable with a p-value that is smaller than 0,0001 and GLA is the least significant with p-value of 0,010.

Table 14: Significance of Independent Variables (Source: Tabulated by Author, 2017)

	P-Value	Significant
Location	0,001	Yes
Storeys	0,0002	Yes
GLA	0,010	Yes
Green Star Rating	<0,0001	Yes

The influential international literature correct the OLS linear regressions for heteroscedascticity, which is a major concern in regression analysis when present. Linear regressions calculate the smallest possible standard errors when calculating the predicted values in the model. This variance is assumed to be constant in OLS regression analysis. When heteroscedasticity is present, disturbances in the data are caused since the size of these variances differ across all values, and could result in incorrect conclusions being drawn from the data. The graphically plotted residuals would typically form a conical shape when heteroscedasticity is present. A heteroscedasticity test was done on the data and it was determined that the variance in the model did have the presence of heteroscedastic, since the variances in the calculated residual model values are not constant. This test is in Appendix D.

An added Rand value of 25,62 has been calculated for the presence of the Green Star rating. This is a premium value that is added to a rental rate, increasing as Green Star ratings increase. This value however cannot be taken as accurate since heteroscedascticity is present. In order to eliminate the presence of heteroscedasticity in the model and rectify any inaccuracies resulting from outliers and skewness in the raw data, a log-linear regression analysis was done.

The same data from the second regression was utilised for this model.. The data were included in the model in their log-transformed state by calculating the natural logarithm for each value. These data and the log-linear regression can be seen in Appendix E. The resulting R^2 value was 0,658. Essentially 66% of the data's variability around the mean can be explained. This percentage does confirm that the model does effectively fit the data. The resulting value in the regression model parameters for the Green Star rating is 0,087, which indicates that the presence of the Green Star rating generates a 4,5% premium in the gross rental rate/m^2. This value is highly significant since the resulting p-value is <0,0001. Utilising this method restricts the model and results in a conservative premium percentage that is highly significant, so the percentage can be described as accurate but somewhat underestimated due to the conservative nature of the model.

4.3. Summary of Data Analysis

From the statistical data analysis it was ascertained that the Green Star rated sample buildings have a greater average gross rental rate/m^2 than the conventional sample buildings. Rental rates of all the sample buildings are influenced by their location, as seen by the average gross rental rates/m^2, depicted in Figure 15, which are in line with the accepted industry average rental rates by area that were presented in Table 7. The Green Star rated building sample was also found to have larger GLAs and a greater number of storeys, in addition to having higher space gradings and being newer than the conventional sample buildings. The data had high variances between high and low values in all categories of the sample data. In the regression analysis, it is ascertained that location, number of storeys, GLA and Green Star rating are the most significant variables affecting the rental rate, which is in line with the international findings discussed in the literature review section of this research. The rental premium percentage associated with the Green Star rating is in line with the majority of international research findings, which calculate rental premiums between 4% on the lower spectrum and 17% on the higher spectrum.

While descriptive statistics do provide an overview of the sample, they do not fully describe and account for variations in the data, specifically with regards to the gross rental rates/m^2. Although the sample data can be analysed and average rental rates can be calculated and compared, there is no explanation for the variations in the averages in terms of the variables and buildings' characteristics that have an effect on rental rates. The high variances in the data categories can also be unrepresented in the data analysis with descriptive statistics.

In order to address these shortfalls, the regressions analysis was utilised in order to better understand the effect that each building characteristic has on the rental rate. This method of price estimating and interpretation allowed for a measure of each characteristic's effect on rental rate to be calculated. The Green Star rating had the smallest Rand value effect on rental rate but the most significance. Therefore, this value can be taken as an actual measure rather than a coincidental or accidental measure that could result from predictions in the regression model.

As, previously mentioned, there are disadvantages to linear regressions. Firstly, for data that are modelled in a linear regression, it is assumed that a linear relationship exists between two variables (the dependent Y variable and and independent X variable). Secondly, outliers or extreme values in the data can have an effect on the regression results which can result in inaccurate results. Lastly, linear regressions assume that all of the variables are independent from each other, this however, is not always the case and independent variables can have a correlation to each other, which is not measured in the linear regression. The regression using rental rate in the log-transformed state is a means of addressing and correcting the outliers, extreme values and skewness of collected sample data. The result is a conservative but realistic percentage value. In this research, no additional analysis has been done on the regression to test other possible errors.

Chapter 5

5. Conclusion and Recommendations

The aim of this research was to analyse and compare Green Star rated commercial buildings and conventional commercial buildings, in order to ascertain if Green Star rated buildings command a rental premium over their traditional counterparts.

The literature review guided this research in identifying the various factors that needed to be taken into account when investigating the determinants of the market value in the real estate rental market. Since green buildings do not yet make up their own asset class in the built environment, it is essential to first understand the characteristics of the real estate market, identify the decision makers and identify their drivers when developing, investing in, owning and using buildings. Investigations of the building industry in terms of the financial costs, financial benefits and risks associated with the industry for the various decision makers indicate that investors and developers tend to follow 'business as usual' practices in order to mitigate risk and maximise financial profits. Perceptions, lack of industry data, lack of knowledge and fragmentation in the inception process of green buildings have hindered the growth of the green building industry. This growth however is increasing, particularly as a result of the voluntary ratings and certifications that have been developed both internationally and in South Africa, and also increased use and market value.

In accordance with the economic laws of supply and demand, increasing tenant and user demand for green building space has resulted in market signals driving investors and developers to provide more green building space. However, the allocation of the benefits associated with green buildings is still perceived as uneven and mostly accruing to the tenants and users. This is where the lease structures of commercial buildings are vital in either promoting or discouraging the development of green buildings. By investigating the financial costs, financial benefits and risks associated with green buildings *from the*

perspective of investors and developers and relating these to the property development process, the various advantages of green building could serve as incentive. Premiums in both rental rates and sales values of green buildings have been ascertained internationally. The quantified rental premiums vary according to: lease structures, internal and external variables and the rating tools or certifications that are present.

In conducting this research to ascertain and quantify the existence and quantity of a green rental premium in the Johannesburg commercial property market, international data collection and analysis methods were also utilised. Many international studies implement other statistical analysis tools and analyse data using the regression method that was previously discussed. For the purpose of this research- as an introductory investigation to calculate this premium- the regression analysis tool was deemed sufficient.

A limitation to this research is the low number of certified and rated green buildings in the South African and Johannesburg commercial property markets. Thus, the number of available buildings for sampling is small and it is difficult to ascertain the applicability of the findings from the sample to the entire population. In addition, there are difficulties in establishing a control in the sample between the conventional and Green Star rated building characteristics. However, it was found that the significance and effects of variables on rental rates are in line with international findings and that a premium for green rated building space does indeed exist in the Johannesburg commercial property market.

When comparing solely the average gross rental rates/m^2 of the Green Star rated sample buildings and conventional sample buildings, there is a R51,84 higher average rental rate for the Green Star rated buildings. This translates to 40% higher rental rate value associated with Green Star rated buildings. This value however, needs to be qualified, since the differences between the buildings in the sample have not been taken into account or kept constant. The regression analysis allows for the effect of each variable on the gross rental rates/m^2 to be measured, with all other variables being kept constant. It was

ascertained that there is a premium associated with Green Star rated building rental rates since, in the model that used only significant variables and corrected for heteroscedasticity, it was found that the Green Star rated buildings have an associated 4,5% premium in gross rental rates/m^2.

In order to determine whether this premium would be significant enough to motivate investors and developers to supply green buildings, a number of factors pertaining to the property development process would need to be investigated. The premium can be described as having a negligible effect on the gross rental rates/m^2. However, when applying this premium to the entire GLA of a building, a significant effect would be seen in terms of the revenue investors and property developers could expect. Coupled with the attractiveness of green building space from tenant perspectives, investors and developers could expect higher occupancy rates. Feasibility studies and further analyses would be required in order to ascertain whether the premium and decreased vacancy rates would offset the perceived higher risks and construction costs associated with green buildings.

This research analyses only private sector data for multi-tenant office buildings in the commercial real estate market with Triple Net lease structures. The variables used in this research were identified from international research, as they were noted as the most influential factors on rental rate. As a result, the data analysis doesn't account for the other internal and external building characteristics that affect rental rates. The real estate market is not constant and so the data used and the resulting analyses apply only to the current real estate market without taking any future variations within the market into account. This research also only investigates offices in the commercial real estate sector.

There is opportunity in this field for extensive further research, which warrants investigation and determination of the existence of a premium in various cities in South Africa and the country as a whole. Comparisons should be made between possible premiums in single-tenant commercial buildings and premiums in multi-tenant buildings. The effect of lease structure on premiums should be investigated simultaneously. The

existence and quantity of sales premiums in the commercial sector and the existence of both sales and rental premiums in other real estate sectors should also be examined. Additional investigations would also be necessary to determine and measure a wider variety of internal and external variables that have an effect on the rental and sales rates of buildings.

The green building industry in South Africa is still in its infancy, but experiencing rapid growth. There has been a significant increase in the number of green buildings in the country, particularly since the inception of the GBCSA. While the environmental and social benefits of green buildings are apparent to decision makers in the industry, the financial costs and benefits are not. As the industry develops and grows, more industry data would be available. Research can simultaneously develop and accurately determine the financial costs and benefits and associated risks, to provide information that would allow decision makers to make informed decisions. These informed decisions and continued growth in the green building industry would result in the mitigation of the negative effects of the built environment on the natural environment, which is essential in promoting sustainability.

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37 Wierda Road West	• Black Pepper Properties. nd. 37 Wierda Road West. [Online]. Available at: http://www.blackpepperonline.co.za/properties/37-wierda-rd-west-sandton-offices-to-let/. [06 January 2017].
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23 Impala Road	• Anvil Property Smiths. nd. 23 Impala Road. [Online]. Available at: https://www.anvilproperty.co.za/commercial-property/office-space/to-rent/sandton-central/23-impala-road-sandton-1267/building-2-first-floors-17628. [07 January 2017].
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10 Keyes Avenue	• Anvil Property Smiths. nd. Keyes Avenue Rosebank. [Online]. Available at: https://www.anvilproperty.co.za/commercial-property/office-space/to-rent/rosebank/keyes-avenue-rosebank-2060/building-9808. [07 January 2017].
23 West Street	• Anvil Property Smiths. nd. 23 West Street Houghton. [Online]. Available at: https://www.anvilproperty.co.za/commercial-property/office-space/to-rent/houghton/23-west-street-houghton-2053/option-3-10128. [05 January 2017].
13 Baker Street	• Anvil Property Smiths. nd. 13 Baker Street. [Online]. Available at: https://www.anvilproperty.co.za/commercial-property/office-space/to-rent/rosebank/13-baker-street-rosebank-299/fourth-floor-16451. [07 January 2017].
10 Fricker Road	• Anvil Property Smiths. nd. 110 Fricker Road. [Online]. Available at: https://www.anvilproperty.co.za/commercial-property/office-space/to-rent/illovo/10-fricker-road-illovo-sandton-4323. [07 January 2017].
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28 Sloane Street	• Anvil Property Smiths. nd. 28 Sloane Street. [Online]. Available at: https://www.anvilproperty.co.za/commercial-property/office-space/to-rent/bryanston/28-sloane-street-bryanston-26/ground-floor-block-c-70. [05 January 2017].
The Forum	• Anvil Property Smiths. nd. The Forum. [Online]. Available at: https://www.anvilproperty.co.za/commercial-property/office-space/to-rent/sandton-central/the-forum-sandton-282/3rd-floor-office-401-10-1210. [07 January 2017].
1 Peter Place	• Anvil Property Smiths. nd. 1 Peter Place. [Online]. Available at: https://www.anvilproperty.co.za/commercial-property/office-space/to-rent/bryanston/1-peter-place-bryanston-80/portion-ground-floor-931-56m2-625-01m2-lhs-323. [07 January 2017].

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53 Kyalami Boulevard	• Anvil Property Smiths. nd. 153 Kyalami Boulevard. [Online]. Available at: https://www.anvilproperty.co.za/commercial-property/office-space/to-rent/barbeque-downs/53-kyalami-boulevard-midrand-701/entire-block-a-19065. [07 January 2017].
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Kildrummy Office Park	• Black Pepper Properties. nd. Kildrummy Office Park. [Online]. Available at:http://www.blackpepperonline.co.za/properties/kildrummy-office-park-paulshof-offices-to-let/. [05 January 2017].
204 Rivonia Road	• Black Pepper Properties. nd. 204 Rivonia Road. [Online]. Available at:http://www.blackpepperonline.co.za/properties/204-rivonia-road-morningside-offices-to-let/. [08 January 2017].
28 Fricker Road	• Growthpoint Properties. nd. 28 Fricker Road [Online]. Available at: http://spacetolet.growthpoint.co.za/Pages/OfficestoLet.aspx. [05 January 2017].
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Appendices

Appendix A: Tabulated Raw Data and Adjusted Data for Models 1 and 2

Raw Sample Data

Case Study	Green Star Rated Sample Buildings	Location	Gross Rental Rate/m²(Excl. VAT)	Age (Less Than 10 Years)	Age (More Than 10 Years)	Renovated/Retrofitted	Stories (Number of Office Levels)	GFA (m²)	GLA (m²)	Grade	Green Star Rating	Lease Type
1	4 Stan Road	Sandton	R165,00	Y	-	N	4	5 227	4 165	P	4	Multi Tenant
2	Thebe House	Rosebank	R166,00	-	Y	Y	4	7 763	3 622	A	4	Multi Tenant
3	Monte Circle Building B	Fourways	R179,00	Y	-	N	3	4 851	4 031	P	4	Multi Tenant
4	The Angle on Oxford	Rosebank	R255,00	Y	-	N	6	32 800	31 300	A	5	Multi Tenant
5	Alice Lane Phase 3	Sandton	R245,00	Y	-	N	18	35 000	34 755	P	4	Multi Tenant
6	102 Rivonia (EY)	Sandton	R215,00	Y	-	N	9	41 225	25 805	P	4	Multi Tenant
7	90 Rivonia	Sandton	R192,00	Y	-	N	8	43 975	29 437	P	4	Multi Tenant
8	Capital Hill	Sandton	R220,00	Y	-	N	15	9 208	8 150	P	4	Multi Tenant
9	Atholl Towers	Sandton	R180,00	Y	-	N	7	11 593	8 835	A	5	Multi Tenant
10	Ballyoaks Office Park	Bryanston	R175,00	Y	-	N	4	23 310	20 000	P	5	Multi Tenant
11	Atrium on 5th	Sandton	R180,00	Y	-	Y	10	29 533	27 061	P	4	Multi Tenant
12	Rosebank Tower	Rosebank	R238,00	Y	-	N	7	22 459	16 776	P	4	Multi Tenant
13	44 on Grand Central	Midrand	R150,00	Y	-	N	4	7 000	6 105	A	4	Multi Tenant
14	24 Peter Place	Bryanston	R125,00	-	Y	Y	3	4 770	4 233	A	4	Multi Tenant
15	25 Rudd Road	Illovo	R134,00	-	Y	Y	3	3 395	3 233	A	4	Multi Tenant
16	Fredman Towers	Sandton	R160,00	-	Y	Y	11	14 911	13 420	A	3	Multi Tenant
17	Illovo Edge Phase 3	Illovo	R175,00	Y	-	N	3	7 423	7 423	P	5	Multi Tenant
18	Inanda Greens Business Park	Sandton	R160,00	-	Y	Y	3	40 774	40 509	P	4	Multi Tenant
19	Kirstenhof Office Park	Fourways	R90,00	-	Y	Y	2	3 837	2 669	A	5	Multi Tenant
20	Monte Circle Building A	Fourways	R135,00	Y	-	N	3	5 606	4 614	P	4	Multi Tenant
21	15 Alice Lane	Sandton	R245,00	Y	-	N	3	22 459	16 776	P	4	Multi Tenant
22	37 Melrose Boulevard	Illovo	R210,00	Y	-	N	6	21 356	20 470	P	4	Multi Tenant
23	Riviera Office Park	Houghton	R150,00	-	Y	Y	2	6 452	4 770	A	4	Multi Tenant
24	The Place	Sandton	R195,00	Y	-	N	8	34 023	30 000	A	3	Multi Tenant
25	Upper Grayston Building F	Sandton	R160,00	Y	-	N	4	2 175	1 635	P	6	Multi Tenant
26	90 Grayston Drive	Sandton	R198,00	Y	-	N	9	21 069	15 500	P	4	Multi Tenant
27	Alice Lane Phase 1	Sandton	R245,00	Y	-	N	8	20 568	16 765	P	4	Multi Tenant
28	Anslow Park Phase 2	Bryanston	R171,00	Y	*	N	2	11 159	8 607	P	4	Multi Tenant
29	Central Park Office	Midrand	R105,00	-	Y	Y	2	34 185	30 305	B	4	Multi Tenant
30	19 Impala Road	Sandton	R136,00	-	Y	Y	3	2780	2169	P	4	Multi Tenant
Case Study	**Conventional Sample Buildings**	**Area**	**Gross Rental Rate/m²(Excl. VAT)**	**Age (Less Than 10 Years)**	**Age (More Than 10 Years)**	**Renovated/Retrofitted**	**Stories (Number of Office Levels)**	**GFA (m²)**	**GLA (m²)**	**Grade**	**Green Star Rating**	**Lease Type**
31	Sandown Mews	Sandton	R140,00	-	Y	Y	6	13 334	6 634	P	N/A	Multi Tenant
32	37 Wierda Road West	Sandton	R90,00	-	Y	N	2	4 321	3 696	A	N/A	Multi Tenant
33	Grayston Ridge Office Park	Sandton	R95,00	-	Y	Y	2	10 023	7 772	A	N/A	Multi Tenant
34	70 Grayston Drive	Sandton	R96,00	-	Y	Y	4	5 694	4 150	A	N/A	Multi Tenant
35	23 Impala Road	Sandton	R135,00	-	Y	Y	2	10 800	10 710	P	N/A	Multi Tenant
36	Hurlingham Office Park	Sandton	R115,00	-	Y	Y	2	25 500	15 050	A	N/A	Multi Tenant
37	Wedgewood Office Park	Bryanston	R110,00	-	Y	Y	2	16 830	9 625	B	N/A	Multi Tenant
38	Cradock Square	Rosebank	R195,00	-	Y	Y	2	10 700	9 324	A	N/A	Multi Tenant
39	10 Keyes Avenue	Rosebank	R130,00	-	Y	Y	3	6 552	4 392	A	N/A	Multi Tenant
40	23 West Street	Houghton	R120,00	Y	-	N	3	3 948	3 500	A	N/A	Multi Tenant
41	13 Baker Street	Rosebank	R120,00	-	Y	N	4	4 624	4 357	B	N/A	Multi Tenant
42	10 Fricker Road	Illovo	R132,00	-	Y	Y	3	10 592	6 944	P	N/A	Multi Tenant
43	4 Fricker Road	Illovo	R160,00	-	Y	Y	3	4 788	4 300	P	N/A	Multi Tenant
44	Sandton City Office Tower	Sandton	R185,00	-	Y	Y	21	25 641	21 000	A	N/A	Multi Tenant
45	Fourways Office Park	Fourways	R100,00	-	Y	Y	2	29 850	15 156	A	N/A	Multi Tenant
46	28 Sloane Street	Bryanston	R115,00	-	Y	N	2	8 775	4 681	A	N/A	Multi Tenant
47	The Forum	Sandton	R185,00	-	Y	Y	16	13 440	10 000	P	N/A	Multi Tenant
48	1 Peter Place	Bryanston	R135,00	-	Y	N	2	6 675	5 597	A	N/A	Multi Tenant
49	9 Kramer Road	Sandton	R116,00	-	Y	Y	5	4 760	3 500	A	N/A	Multi Tenant
50	Parc Nicol	Fourways	R110,00	-	Y	N	2	9 600	9 000	A	N/A	Multi Tenant
51	53 Kyalami Boulevard	Midrand	R75,00	-	Y	Y	2	1 305	1 136	B	N/A	Multi Tenant
52	Cedar Office Estate	Fourways	R135,00	Y	-	N	2	7 500	5 500	P	N/A	Multi Tenant
53	Sandhaven Office Park Building 1	Sandton	R105,00	-	Y	N	2	2 254	1 900	A	N/A	Multi Tenant
54	Vunani Office Park	Sandton	R125,00	-	Y	N	3	4 536	3 363	A	N/A	Multi Tenant
55	Kildrummy Office Park	Sandton	R95,00	Y	-	Y	2	12 000	11 944	A	N/A	Multi Tenant
56	204 Rivonia Road	Sandton	R115,00	-	Y	Y	2	8 231	6 221	A	N/A	Multi Tenant
57	28 Fricker Road	Illovo	R160,00	-	Y	Y	3	10 368	8 352	A	N/A	Multi Tenant
58	Sandton Eye	Sandton	R200,00	Y	-	N	12	29 520	12 300	A	N/A	Multi Tenant
59	Daisy Street Office Park	Sandton	R140,00	Y	-	N	2	7 326	7 246	A	N/A	Multi Tenant
60	34 Monte Carlo Crescent	Midrand	R65,00	-	Y	Y	2	8 337	4 107	A	N/A	Multi Tenant

Sample Data 1								
Sample Buildings	Gross Rental Rate/m² (Excl. VAT)	Location	Age (Less Than 10 Years=0, More Than 10 Years=1)	Renovated/Retrofitted (No=0, Yes=1)	Stories (Number of Office Levels)	GLA (m²)	Grade (P=0, A=1, B=2)	Green Star Rating
4 Stan Road	165	5	0	0	4	2	0	4
Thebe House	166	6	1	1	4	1	1	4
Monte Circle Building B	179	4	0	0	3	2	0	4
The Angle on Oxford	255	6	0	0	6	8	1	5
Alice Lane Phase 3	245	5	0	0	18	9	0	4
102 Rivonia (EY)	215	5	0	0	9	7	0	4
90 Rivonia	192	5	0	0	8	8	0	4
Capital Hill	220	5	0	0	15	3	0	4
Atholl Towers	180	5	0	0	7	3	1	5
Ballyoaks Office Park	175	2	0	0	4	5	0	5
Atrium on 5th	180	5	0	1	10	7	0	4
Rosebank Tower	238	6	0	0	7	5	0	4
44 on Grand Central	150	1	0	0	4	2	1	4
24 Peter Place	125	2	1	1	3	2	1	4
25 Rudd Road	134	7	1	1	3	1	1	4
Fredman Towers	160	5	1	1	11	4	1	3
Illovo Edge Phase 3	175	7	0	0	3	2	0	5
Inanda Greens Business Park	160	5	1	1	3	11	0	4
Kirstenhof Office Park	90	4	1	1	2	1	1	5
Monte Circle Building A	135	4	0	0	3	2	0	4
15 Alice Lane	245	5	0	0	3	5	0	4
37 Melrose Boulevard	210	7	0	0	6	6	0	4
Riviera Office Park	150	3	1	1	2	2	1	4
The Place	195	5	0	0	8	8	1	3
Upper Grayston Building F	160	5	0	0	4	1	0	6
90 Grayston Drive	198	5	0	0	9	4	0	4
Alice Lane Phase 1	245	5	0	0	8	5	0	4
Anslow Park Phase 2	171	2	0	0	2	3	0	4
Central Park Office	105	1	1	1	2	8	2	4
19 Impala Road	136	5	1	1	3	1	0	4
Sandown Mews	140	5	1	1	6	2	0	0
37 Wierda Road West	90	5	1	0	2	1	1	0
Grayston Ridge Office Park	95	5	1	1	2	2	1	0
70 Grayston Drive	96	5	1	1	4	2	1	0
23 Impala Road	135	5	1	1	2	3	0	0
Hurlingham Office Park	115	5	1	1	2	4	1	0
Wedgewood Office Park	110	2	1	1	2	3	2	0
Cradock Square	195	6	1	1	2	3	1	0
10 Keyes Avenue	130	6	1	1	3	2	1	0
23 West Street	120	3	0	0	3	1	1	0
13 Baker Street	120	6	1	0	4	2	2	0
10 Fricker Road	132	7	1	1	3	2	0	0
4 Fricker Road	160	7	1	1	3	2	0	0
Sandton City Office Tower	185	5	1	1	21	6	1	0
Fourways Office Park	100	4	1	1	2	4	1	0
28 Sloane Street	115	2	1	0	2	2	1	0
The Forum	185	5	1	1	16	3	0	0
1 Peter Place	135	2	1	0	2	2	1	0
9 Kramer Road	116	5	1	1	5	1	1	0
Parc Nicol	110	4	1	0	2	3	1	0
53 Kyalami Boulevard	75	1	1	1	2	1	2	0
Cedar Office Estate	135	4	0	0	2	2	0	0
Sandhaven Office Park Building 1	105	5	1	0	2	1	1	0
Vunani Office Park	125	5	1	0	3	1	1	0
Kildrummy Office Park	95	5	0	1	2	3	1	0
204 Rivonia Road	115	5	1	1	2	2	1	0
28 Fricker Road	160	7	1	1	3	3	1	0
Sandton Eye	200	5	0	0	12	4	1	0
Daisy Street Office Park	140	5	0	0	2	2	1	0
34 Monte Carlo Crescent	65	1	1	1	2	2	1	0

Sample Data 2					
Sample Buildings	Gross Rental Rate/m^2 (Excl. VAT)	Location	Stories (Number of Office Levels)	GLA (m^2)	Green Star Rating
4 Stan Road	165	5	4	2	4
Thebe House	166	6	4	1	4
Monte Circle Building B	179	4	3	2	4
The Angle on Oxford	255	6	6	8	5
Alice Lane Phase 3	245	5	18	9	4
102 Rivonia (EY)	215	5	9	7	4
90 Rivonia	192	5	8	8	4
Capital Hill	220	5	15	3	4
Atholl Towers	180	5	7	3	5
Ballyoaks Office Park	175	2	4	5	5
Atrium on 5th	180	5	10	7	4
Rosebank Tower	238	6	7	5	4
44 on Grand Central	150	1	4	2	4
24 Peter Place	125	2	3	2	4
25 Rudd Road	134	7	3	1	4
Fredman Towers	160	5	11	4	3
Illovo Edge Phase 3	175	7	3	2	5
Inanda Greens Business Park	160	5	3	11	4
Kirstenhof Office Park	90	4	2	1	5
Monte Circle Building A	135	4	3	2	4
15 Alice Lane	245	5	3	5	4
37 Melrose Boulevard	210	7	6	6	4
Riviera Office Park	150	3	2	2	4
The Place	195	5	8	8	3
Upper Grayston Building F	160	5	4	1	6
90 Grayston Drive	198	5	9	4	4
Alice Lane Phase 1	245	5	8	5	4
Anslow Park Phase 2	171	2	2	3	4
Central Park Office	105	1	2	8	4
19 Impala Road	136	5	3	1	4
Sandown Mews	140	5	6	2	1
37 Wierda Road West	90	5	2	1	1
Grayston Ridge Office Park	95	5	2	2	1
70 Grayston Drive	96	5	4	2	1
23 Impala Road	135	5	2	3	1
Hurlingham Office Park	115	5	2	4	1
Wedgewood Office Park	110	2	2	3	1
Cradock Square	195	6	2	3	1
10 Keyes Avenue	130	6	3	2	1
23 West Street	120	3	3	1	1
13 Baker Street	120	6	4	2	1
10 Fricker Road	132	7	3	2	1
4 Fricker Road	160	7	3	2	1
Sandton City Office Tower	185	5	21	6	1
Fourways Office Park	100	4	2	4	1
28 Sloane Street	115	2	2	2	1
The Forum	185	5	16	3	1
1 Peter Place	135	2	2	2	1
9 Kramer Road	116	5	5	1	1
Parc Nicol	110	4	2	3	1
53 Kyalami Boulevard	75	1	2	1	1
Cedar Office Estate	135	4	2	2	1
Sandhaven Office Park Building 1	105	5	2	1	1
Vunani Office Park	125	5	3	1	1
Kildrummy Office Park	95	5	2	3	1
204 Rivonia Road	115	5	2	2	1
28 Fricker Road	160	7	3	3	1
Sandton Eye	200	5	12	4	1
Daisy Street Office Park	140	5	2	2	1
34 Monte Carlo Crescent	65	1	2	2	1

Appendix B: Regression Analysis 1 (All Variables)

Confidence interval (%): 95

Tolerance: 0.0001

Run again:

Summary statistics (Quantitative data):

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
Gross Rental Rate/m2 (Excl. VAT)	60	0	60	65,000	255,000	152,550	46,118
Location	60	0	60	1,000	7,000	4,567	1,598
Age (Less Than 10 Years=0, More Than 1	60	0	60	0,000	1,000	0,567	0,500
Renovated/Retrofitted (No=0, Yes=1)	60	0	60	0,000	1,000	0,483	0,504
Stories (Number of Office Levels)	60	0	60	2,000	21,000	4,900	4,273
GLA (m2)	60	0	60	1,000	11,000	3,317	2,361
Grade (P=0, A=1, B=2)	60	0	60	0,000	2,000	0,650	0,606
Green Star Rating	60	0	60	0,000	6,000	2,083	2,142

Correlation matrix:

	Location	Age (Less Than 10 Years=0, More Than 10 Years=1)	Renovated/ Retrofitted (No=0, Yes=1)	Stories (Number of Office Levels)	GLA (m2)	Grade (P=0, A=1, B=2)	Green Star Rating	Gross Rental Rate/m2 (Excl. VAT)
Location	1	-0,048	0,033	0,214	0,073	-0,334	0,006	0,379
Age (Less Than 10 Years=0, More Than 1	-0,048	1	0,711	-0,275	-0,327	0,498	-0,552	-0,626
Renovated/Retrofitted (No=0, Yes=1)	-0,033	-0,711	1	0,119	0,117	-0,286	0,321	0,448
Stories (Number of Office Levels)	0,214	-0,275	-0,119	1	0,455	-0,269	0,175	0,597
GLA (m2)	0,073	-0,327	-0,117	0,455	1	-0,217	0,357	0,566
Grade (P=0, A=1, B=2)	-0,334	0,498	0,286	-0,269	-0,217	1	-0,421	-0,557
Green Star Rating	0,006	-0,552	-0,321	0,175	0,357	-0,421	1	0,547
Gross Rental Rate/m2 (Excl. VAT)	0,379	-0,626	-0,448	0,597	0,566	-0,557	0,547	1

Regression of variable Gross Rental Rate/m2 (Excl. VAT):

Goodness of fit statistics (Gross Rental Rate/m2 (Excl. VAT)):

Observations	60,000
Sum of weights	60,000
DF	52,000
R^2	0,771
Adjusted R^2	0,740
MSE	552,076
RMSE	23,496
MAPE	12,021
DW	1,727
Cp	8,000
AIC	386,235
SBC	402,990
PC	0,299

Analysis of variance (Gross Rental Rate/m2 (Excl. VAT)):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	7	96774,908	13824,987	25,042	< 0.0001
Error	52	28707,942	552,076		
Corrected Total	59	125482,850			

Computed against model Y=Mean(Y)

Model parameters (Gross Rental Rate/m2 (Excl. VAT)):

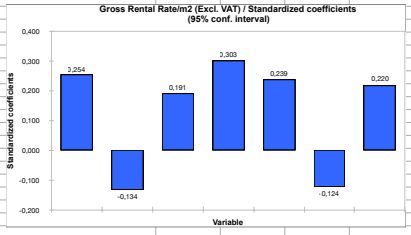
Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	99,324	14,335	6,929	< 0.0001	70,559	128,089
Location	7,335	2,097	3,499	0,001	3,128	11,543
Age (Less Than 10 Years=0, More Than 1	-12,348	10,828	-1,140	0,259	-34,075	9,379
Renovated/Retrofitted (No=0, Yes=1)	17,491	8,858	1,975	0,054	35,266	0,284
Stories (Number of Office Levels)	3,265	0,836	3,905	0,000	1,587	4,942
GLA (m2)	4,663	1,552	3,005	0,004	1,549	7,778
Grade (P=0, A=1, B=2)	-9,463	6,445	-1,468	0,148	-22,395	3,469
Green Star Rating	4,736	1,815	2,610	0,012	1,094	8,378

Equation of the model (Gross Rental Rate/m2 (Excl. VAT)):

Gross Rental Rate/m2 (Excl. VAT) = 99.32421418312 12+7.3352590659343 *Location-12.3479826196024*Age (Less Than 10 Years=0, More Than 10 Years=1)-17.4911562898094*Renovated/Retrofitted (No=0, Yes=1)+3.2646881438 8169*Stories (Number of Office Levels) +4.6633524267 4265*GLA (m2)-9.4633404337 4291*Grade (P=0, A=1, B=2)+4.7360474886132*Green Star Rating

Standardized coefficients (Gross Rental Rate/m2 (Excl. VAT)):

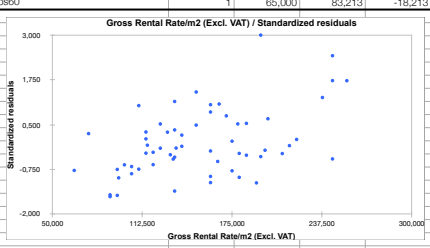
Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Location	0,254	0,073	3,499	0,001	0,108	0,400
Age (Less Than 10 Years=0, More Than 1	-0,134	0,117	-1,140	0,259	-0,369	0,102
Renovated/Retrofitted (No=0, Yes=1)	0,191	0,097	1,975	0,054	-0,385	0,003
Stories (Number of Office Levels)	0,303	0,077	3,905	0,000	0,147	0,458
GLA (m2)	0,239	0,079	3,005	0,004	0,079	0,398
Grade (P=0, A=1, B=2)	-0,124	0,085	-1,468	0,148	-0,294	0,046
Green Star Rating	0,220	0,084	2,610	0,012	0,051	0,389

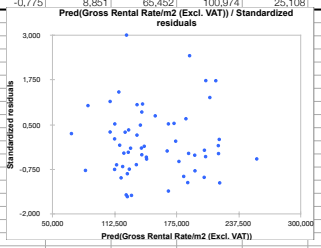


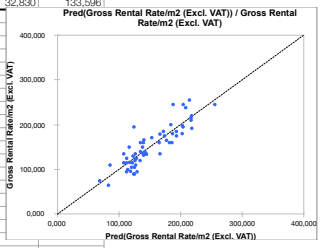
Predictions and residuals (Gross Rental Rate/m2 (Excl. VAT)):

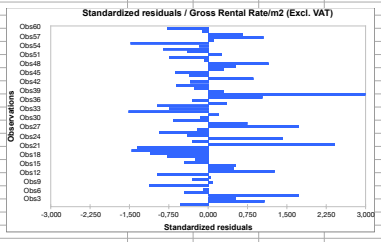
Observation	Weight	Gross Rental Rate/m2 (Excl. VAT)	Pred(Gross Rental Rate/ m2 (Excl. VAT))	Residual	Std. residual	Std. dev. on pred. (Mean)	Lower bound 95% (Mean)	Upper bound 95% (Mean)	Std. dev. on pred. (Observation)	Lower bound 95% (Observation)	Upper bound 95% (Observation)
Obs1	1	165,000	177,330	-12,330	-0,525	6,071	165,148	189,512	24,268	128,633	226,027
Obs2	1	166,000	140,700	25,300	1,077	8,736	123,170	158,229	25,068	90,397	191,002
Obs3	1	179,000	166,730	12,270	0,522	6,384	153,919	179,542	24,348	117,872	215,589
Obs4	1	255,000	214,448	40,552	1,726	10,058	194,264	234,631	25,559	163,160	265,735
Obs5	1	245,000	255,679	-10,679	-0,455	10,760	234,088	277,270	25,843	203,822	307,536
Obs6	1	215,000	216,970	-1,970	-0,084	6,396	204,136	229,804	24,351	168,106	265,835
Obs7	1	192,000	218,369	-26,369	-1,122	7,410	203,500	233,238	24,637	168,931	267,807
Obs8	1	220,000	217,905	2,095	0,089	9,548	198,745	237,065	25,362	167,012	268,798
Obs9	1	180,000	187,060	-7,060	-0,300	8,186	170,633	203,487	24,882	137,132	236,989
Obs10	1	175,000	174,050	0,950	0,040	8,286	157,423	190,678	24,915	124,056	224,045
Obs11	1	180,000	202,744	-22,744	-0,968	9,661	183,357	222,131	25,405	151,765	253,723
Obs12	1	238,000	208,450	29,550	1,258	5,626	197,160	219,739	24,161	159,968	256,931

	Obs13	1	150,000	138,526	11,474	0,488	9,168	120,129	156,923	25,222	87,915	189,137
	Obs14	1	125,000	112,757	12,243	0,521	8,423	95,855	129,659	24,960	62,671	162,844
	Obs15	1	134,000	144,770	-10,770	-0,458	9,796	125,114	164,427	25,456	93,688	195,852
	Obs16	1	160,000	165,471	-5,471	-0,233	7,846	149,727	181,216	24,772	115,763	215,179
	Obs17	1	175,000	193,472	-18,472	-0,786	8,402	176,613	210,331	24,953	143,400	243,544
	Obs18	1	160,000	186,197	-26,197	-1,115	14,543	157,015	215,378	27,633	130,748	241,645
	Obs19	1	90,000	124,236	-34,236	-1,457	9,119	105,938	142,533	25,204	73,661	174,811
	Obs20	1	135,000	166,730	-31,730	-1,350	6,384	153,919	179,542	24,348	117,872	215,589
	Obs21	1	245,000	188,056	56,944	2,424	6,185	175,644	200,467	24,297	139,301	236,811
	Obs22	1	210,000	217,183	-7,183	-0,306	7,325	202,484	231,883	24,612	167,797	266,570
	Obs23	1	150,000	116,828	33,172	1,412	7,505	101,769	131,887	24,666	67,333	166,323
	Obs24	1	195,000	204,170	-9,170	-0,390	8,631	186,849	221,490	25,032	153,940	254,399
	Obs25	1	160,000	182,139	-22,139	-0,942	8,548	164,986	199,291	25,003	131,967	232,311
	Obs26	1	198,000	202,980	-4,980	-0,212	5,566	191,812	214,148	24,146	154,527	251,434
	Obs27	1	245,000	204,379	40,621	1,729	5,238	193,868	214,890	24,073	156,073	252,685
	Obs28	1	171,000	153,458	17,542	0,747	8,289	136,824	170,092	24,916	103,461	203,455
	Obs29	1	105,000	120,674	-15,674	-0,667	13,036	94,515	146,833	26,870	66,754	174,594
	Obs30	1	136,000	139,563	-3,563	-0,152	8,691	122,124	157,002	25,052	89,293	189,833
	Obs31	1	140,000	135,076	4,924	0,210	7,722	119,580	150,573	24,733	85,446	184,706
	Obs32	1	90,000	125,382	-35,382	-1,506	8,251	108,825	141,939	24,903	75,410	175,353
	Obs33	1	95,000	112,554	-17,554	-0,747	5,243	102,034	123,074	24,074	64,246	160,862
	Obs34	1	96,000	119,083	-23,083	-0,982	5,027	108,996	129,171	24,028	70,868	167,299
	Obs35	1	135,000	126,681	8,319	0,354	8,078	110,471	142,890	24,846	76,823	176,538
	Obs36	1	115,000	121,881	-6,881	-0,293	5,993	109,855	133,907	24,249	73,222	170,539
	Obs37	1	110,000	85,748	24,252	1,032	8,550	68,591	102,906	25,004	35,575	135,922
	Obs38	1	195,000	124,553	70,447	2,998	6,215	112,081	137,025	24,304	75,782	173,323
	Obs39	1	130,000	123,154	6,846	0,291	5,866	111,382	134,926	24,218	74,558	171,750
	Obs40	1	120,000	126,324	-6,324	-0,269	8,910	108,444	144,204	25,129	75,899	176,749
	Obs41	1	120,000	134,447	-14,447	-0,615	11,426	111,518	157,375	26,127	82,018	186,875
	Obs42	1	132,000	139,953	-7,953	-0,338	8,201	123,496	156,409	24,886	90,014	189,891
	Obs43	1	160,000	139,953	20,047	0,853	8,201	123,496	156,409	24,886	90,014	189,891
	Obs44	1	185,000	193,237	-8,237	-0,351	13,791	165,563	220,910	27,245	138,566	247,907
	Obs45	1	100,000	114,546	-14,546	-0,619	5,942	102,623	126,468	24,236	65,913	163,178
	Obs46	1	115,000	108,039	6,961	0,296	9,329	89,319	126,760	25,281	57,310	158,769
	Obs47	1	185,000	172,386	12,614	0,537	11,777	148,753	196,020	26,283	119,646	225,127
	Obs48	1	135,000	108,039	26,961	1,147	9,329	89,319	126,760	25,281	57,310	158,769
	Obs49	1	116,000	117,685	-1,685	-0,072	5,688	106,271	129,099	24,175	69,174	166,195
	Obs50	1	110,000	127,373	-17,373	-0,739	8,423	110,471	144,276	24,961	77,286	177,460
	Obs51	1	75,000	69,086	5,914	0,252	9,658	49,707	88,466	25,404	18,110	120,063
	Obs52	1	135,000	144,521	-9,521	-0,405	9,059	126,342	162,700	25,182	93,989	195,053
	Obs53	1	105,000	125,382	-20,382	-0,867	8,251	108,825	141,939	24,903	75,410	175,353
	Obs54	1	125,000	128,647	-3,647	-0,155	8,232	112,128	145,165	24,897	78,688	178,605
	Obs55	1	95,000	129,565	-34,565	-1,471	12,679	104,124	155,007	26,699	75,990	183,140
	Obs56	1	115,000	112,554	2,446	0,104	5,243	102,034	123,074	24,074	64,246	160,862
	Obs57	1	160,000	135,153	24,847	1,057	7,271	120,563	149,742	24,595	85,798	184,507
	Obs58	1	200,000	184,367	15,633	0,665	9,521	165,262	203,472	25,352	133,494	235,239
	Obs59	1	140,000	142,393	-2,393	-0,102	8,721	124,893	159,894	25,063	92,101	192,685
	Obs60	1	65,000	83,213	-18,213	-0,775	8,851	65,452	100,974	25,108	32,830	133,596









Appendix C: Regression Analysis 2 (Significant Variables Only)

Confidence interval (%): 95
Tolerance: 0.0001
Run again:

Summary statistics (Quantitative data):

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
Gross Rental Rate/m2 (Excl. VAT)	60	0	60	65,000	255,000	152,550	46,118
Location	60	0	60	1,000	7,000	4,567	1,598
Stories (Number of Office Levels)	60	0	60	2,000	21,000	4,900	4,273
GLA (m2)	60	0	60	1,000	11,000	3,317	2,361
Green Star Rating	60	0	60	0,000	6,000	2,083	2,142

Correlation matrix:

	Location	Stories (Number of Office Levels)	GLA (m2)	Green Star Rating	Gross Rental Rate/m2 (Excl. VAT)
Location	1	0,214	0,073	0,006	0,379
Stories (Number of Office Levels)	0,214	1	0,455	0,175	0,597
GLA (m2)	0,073	0,455	1	0,357	0,566
Green Star Rating	0,006	0,175	0,357	1	0,547
Gross Rental Rate/m2 (Excl. VAT)	0,379	0,597	0,566	0,547	1

Regression of variable Gross Rental Rate/m2 (Excl. VAT):

Goodness of fit statistics (Gross Rental Rate/m2 (Excl. VAT)):

Observations	60,000
Sum of weights	60,000
DF	55,000
R^2	0,674
Adjusted R^2	0,651
MSE	742,707
RMSE	27,253
MAPE	14,729
DW	1,689
Cp	5,000
AIC	401,397
SBC	411,869
PC	0,385

Analysis of variance (Gross Rental Rate/m2 (Excl. VAT)):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	4	84633,963	21158,491	28,488	< 0.0001
Error	55	40848,887	742,707		
Corrected Total	59	125482,850			

Computed against model Y=Mean(Y)

Model parameters (Gross Rental Rate/m2 (Excl. VAT)):

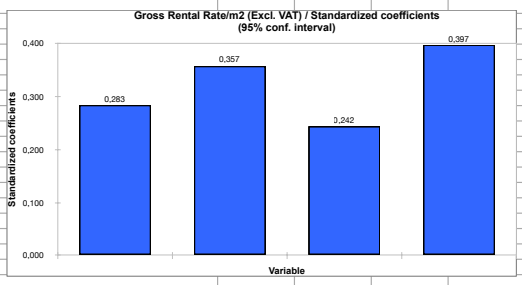
Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	62,921	11,716	5,370	< 0.0001	39,441	86,400
Location	8,166	2,274	3,591	0,001	3,608	12,724
Stories (Number of Office Levels)	3,851	0,953	4,043	0,000	1,942	5,760
GLA (m2)	4,726	1,779	2,657	0,010	1,162	8,291
Green Star Rating	8,540	1,774	4,814	< 0.0001	4,985	12,096

Equation of the model (Gross Rental Rate/m2 (Excl. VAT)):

Gross Rental Rate/m2 (Excl. VAT) = 62.9206489563685+8.16582288005579*Location+3.85129401109972*Stories (Number of Office Levels)+4.72626186337376*GLA (m2) +8.54015234726327*Green Star Rating

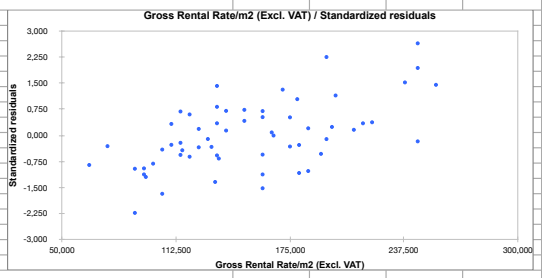
Standardized coefficients (Gross Rental Rate/m2 (Excl. VAT)):

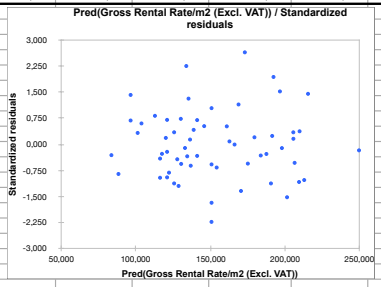
Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Location	0,283	0,079	3,591	0,001	0,125	0,441
Stories (Number of Office Levels)	0,357	0,088	4,043	0,000	0,180	0,534
GLA (m2)	0,242	0,091	2,657	0,010	0,059	0,425
Green Star Rating	0,397	0,082	4,814	< 0.0001	0,231	0,562

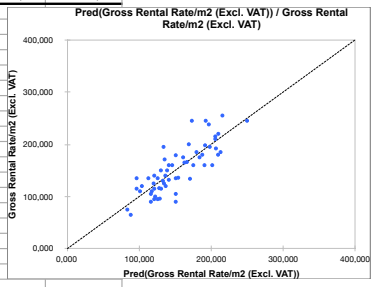


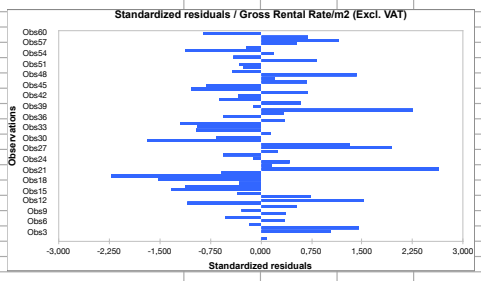
Predictions and residuals (Gross Rental Rate/ m2 (Excl. VAT)):

Observation	Weight	Gross Rental Rate/m2 (Excl. VAT)	Pred(Gross Rental Rate/ m2 (Excl. VAT))	Residual	Std. residual	Std. dev. on pred. (Mean)	Lower bound 95% (Mean)	Upper bound 95% (Mean)	Std. dev. on pred. (Observation)	Lower bound 95% (Observation)	Upper bound 95% (Observation)
Obs1	1	165,000	162,768	2,232	0,082	5,917	150,910	174,626	27,888	106,880	218,656
Obs2	1	166,000	166,208	-0,208	-0,008	7,711	150,755	181,661	28,323	109,448	222,967
Obs3	1	179,000	150,751	28,249	1,037	5,916	138,895	162,607	27,887	94,863	206,638
Obs4	1	255,000	215,534	39,466	1,448	9,273	196,950	234,118	28,787	157,843	273,225
Obs5	1	245,000	249,770	-4,770	-0,175	12,190	225,341	274,199	29,855	189,940	309,600
Obs6	1	215,000	205,656	9,344	0,343	6,765	192,098	219,214	28,080	149,383	261,929
Obs7	1	192,000	206,531	-14,531	-0,533	7,957	190,585	222,476	28,390	149,635	263,426
Obs8	1	220,000	209,859	10,141	0,372	10,887	188,040	231,677	29,347	151,046	268,671
Obs9	1	180,000	187,588	-7,588	-0,278	6,801	173,960	201,217	28,088	131,298	243,879
Obs10	1	175,000	160,990	14,010	0,514	8,442	144,072	177,907	28,530	103,814	218,165
Obs11	1	180,000	209,507	-29,507	-1,083	6,953	195,573	223,441	28,126	153,142	265,872
Obs12	1	238,000	196,667	41,333	1,517	5,836	184,972	208,361	27,870	140,813	252,520
Obs13	1	150,000	130,105	19,895	0,730	9,792	110,482	149,728	28,958	72,071	188,139
Obs14	1	125,000	134,419	-9,419	-0,346	7,979	118,429	150,409	28,397	77,511	191,327
Obs15	1	134,000	170,522	-36,522	-1,340	9,045	152,396	188,648	28,714	112,977	228,067
Obs16	1	160,000	190,640	-30,640	-1,124	6,437	177,739	203,540	28,003	134,521	246,758
Obs17	1	175,000	183,789	-8,789	-0,322	9,383	164,984	202,593	28,823	126,026	241,551
Obs18	1	160,000	201,453	-41,453	-1,521	14,428	172,538	230,368	30,836	139,656	263,251
Obs19	1	90,000	150,714	-60,714	-2,228	8,262	134,156	167,271	28,478	93,643	207,784
Obs20	1	135,000	150,751	-15,751	-0,578	5,916	138,895	162,607	27,887	94,863	206,638
Obs21	1	245,000	173,096	71,904	2,638	6,047	160,978	185,213	27,915	117,152	229,039
Obs22	1	210,000	205,707	4,293	0,158	7,964	189,746	221,668	28,393	148,807	262,607
Obs23	1	150,000	138,734	11,266	0,413	6,736	125,234	152,233	28,073	82,475	194,993
Obs24	1	195,000	197,991	-2,991	-0,110	7,990	181,979	214,002	28,400	141,077	254,905
Obs25	1	160,000	175,122	-15,122	-0,555	9,758	155,567	194,677	28,947	117,111	233,133
Obs26	1	198,000	191,477	6,523	0,239	5,757	179,940	203,014	27,854	135,656	247,298
Obs27	1	245,000	192,352	52,648	1,932	5,235	181,860	202,844	27,751	136,738	247,966
Obs28	1	171,000	135,294	35,706	1,310	7,666	119,932	150,657	28,310	78,559	192,029
Obs29	1	105,000	150,760	-45,760	-1,679	12,473	125,764	175,756	29,971	90,696	210,823
Obs30	1	136,000	154,191	-18,191	-0,667	6,979	140,203	168,178	28,132	97,812	210,569
Obs31	1	140,000	136,310	3,690	0,135	5,447	125,395	147,225	27,792	80,614	192,006
Obs32	1	90,000	116,179	-26,179	-0,961	5,726	104,704	127,653	27,848	60,371	171,986
Obs33	1	95,000	120,905	-25,905	-0,951	5,445	109,994	131,816	27,791	65,210	176,600
Obs34	1	96,000	128,607	-32,607	-1,196	5,101	118,384	138,831	27,726	73,043	184,172
Obs35	1	135,000	125,631	9,369	0,344	5,730	114,148	137,114	27,848	69,822	181,441
Obs36	1	115,000	130,357	-15,357	-0,564	6,508	117,316	143,399	28,019	74,206	186,508
Obs37	1	110,000	101,134	8,866	0,325	7,723	85,656	116,612	28,326	44,367	157,900
Obs38	1	195,000	133,797	61,203	2,246	6,677	120,416	147,178	28,059	77,566	190,028
Obs39	1	130,000	132,922	-2,922	-0,107	6,135	120,627	145,217	27,935	76,940	188,904
Obs40	1	120,000	103,698	16,302	0,598	6,435	90,802	116,595	28,002	47,581	159,816
Obs41	1	120,000	136,773	-16,773	-0,615	5,987	124,774	148,772	27,903	80,855	192,691
Obs42	1	132,000	141,088	-9,088	-0,333	7,661	125,735	156,441	28,309	84,355	197,820
Obs43	1	160,000	141,088	18,912	0,694	7,661	125,735	156,441	28,309	84,355	197,820
Obs44	1	185,000	212,985	-27,985	-1,027	15,183	182,557	243,412	31,197	150,465	275,504
Obs45	1	100,000	122,192	-22,192	-0,814	6,387	109,392	134,991	27,991	66,096	178,287
Obs46	1	115,000	96,407	18,593	0,682	7,545	81,288	111,527	28,278	39,738	153,077
Obs47	1	185,000	179,549	5,451	0,200	11,830	155,841	203,258	29,710	120,010	239,089
Obs48	1	135,000	96,407	38,593	1,416	7,545	81,288	111,527	28,278	39,738	153,077
Obs49	1	116,000	127,732	-11,732	-0,431	5,862	115,985	139,480	27,876	71,868	183,597
Obs50	1	110,000	117,465	-7,465	-0,274	5,606	106,231	128,700	27,823	61,706	173,224
Obs51	1	75,000	83,515	-8,515	-0,312	9,511	64,456	102,575	28,865	25,670	141,361
Obs52	1	135,000	112,739	22,261	0,817	5,328	102,061	123,417	27,769	57,089	168,389
Obs53	1	105,000	116,179	-11,179	-0,410	5,726	104,704	127,653	27,848	60,371	171,986
Obs54	1	125,000	120,030	4,970	0,182	5,612	108,783	131,277	27,824	64,268	175,791
Obs55	1	95,000	125,631	-30,631	-1,124	5,730	114,148	137,114	27,848	69,822	181,441
Obs56	1	115,000	120,905	-5,905	-0,217	5,445	109,994	131,816	27,791	65,210	176,600
Obs57	1	160,000	145,814	14,186	0,521	7,795	130,193	161,435	28,345	89,009	202,620
Obs58	1	200,000	168,870	31,130	1,142	8,263	152,311	185,430	28,478	111,800	225,941
Obs59	1	140,000	120,905	19,095	0,701	5,445	109,994	131,816	27,791	65,210	176,600
Obs60	1	65,000	88,242	-23,242	-0,853	9,311	69,581	106,902	28,799	30,526	145,957









Appendix D: Heteroscedasticity Test

Summary statistics:

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
Gross Rental Rate/m2 (Excl. VAT)	60	0	60	65,000	255,000	152,550	46,118
Residual	60	0	60	-60,714	71,904	0,000	26,313

Breusch-Pagan test:

LM (Observed value)	3,349
LM (Critical value)	3,841
DF	1
p-value (Two-tailed)	0,067
alpha	0,05

Test interpretation:

H0: Residuals are homoscedastic

Ha: Residuals are heteroscedastic

The risk to reject the null hypothesis H0 while it is true is 6.72%.

White test:

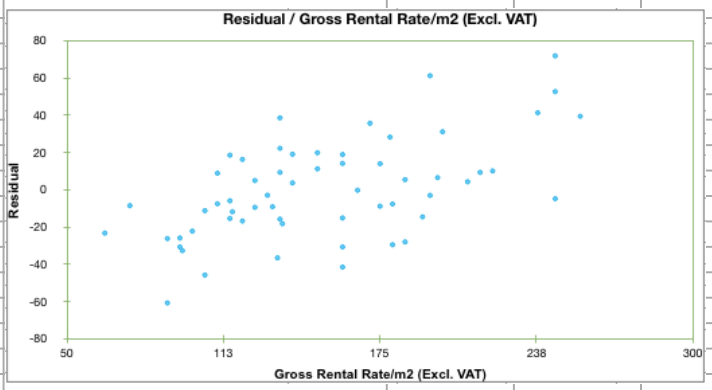
LM (Observed value)	11,290
LM (Critical value)	5,991
DF	2
p-value (Two-tailed)	0,004
alpha	0,05

Test interpretation:

H0: Residuals are homoscedastic

Ha: Residuals are heteroscedastic

The risk to reject the null hypothesis H0 while it is true is lower than 0.35%.



Appendix E: Natural Logarithm Values for Log-Linear Regression

Sample Data 3					
Sample Buildings	ln_Rentals	ln_Location	ln_Stories	ln_GLA	ln_Green Star Rating
4 Stan Road	2,22	1,61	1,39	0,69	1,39
Thebe House	2,22	1,79	1,39	0,00	1,39
Monte Circle Building B	2,25	1,39	1,10	0,69	1,39
The Angle on Oxford	2,41	1,79	1,79	2,08	1,61
Alice Lane Phase 3	2,39	1,61	2,89	2,20	1,39
102 Rivonia (EY)	2,33	1,61	2,20	1,95	1,39
90 Rivonia	2,28	1,61	2,08	2,08	1,39
Capital Hill	2,34	1,61	2,71	1,10	1,39
Atholl Towers	2,26	1,61	1,95	1,10	1,61
Ballyoaks Office Park	2,24	0,69	1,39	1,61	1,61
Atrium on 5th	2,26	1,61	2,30	1,95	1,39
Rosebank Tower	2,38	1,79	1,95	1,61	1,39
44 on Grand Central	2,18	0,00	1,39	0,69	1,39
24 Peter Place	2,10	0,69	1,10	0,69	1,39
25 Rudd Road	2,13	1,95	1,10	0,00	1,39
Fredman Towers	2,20	1,61	2,40	1,39	1,10
Illovo Edge Phase 3	2,24	1,95	1,10	0,69	1,61
Inanda Greens Business Park	2,20	1,61	1,10	2,40	1,39
Kirstenhof Office Park	1,95	1,39	0,69	0,00	1,61
Monte Circle Building A	2,13	1,39	1,10	0,69	1,39
15 Alice Lane	2,39	1,61	1,10	1,61	1,39
37 Melrose Boulevard	2,32	1,95	1,79	1,79	1,39
Riviera Office Park	2,18	1,10	0,69	0,69	1,39
The Place	2,29	1,61	2,08	2,08	1,10
Upper Grayston Building F	2,20	1,61	1,39	0,00	1,79
90 Grayston Drive	2,30	1,61	2,20	1,39	1,39
Alice Lane Phase 1	2,39	1,61	2,08	1,61	1,39
Anslow Park Phase 2	2,23	0,69	0,69	1,10	1,39
Central Park Office	2,02	0,00	0,69	2,08	1,39
19 Impala Road	2,13	1,61	1,10	0,00	1,39
Sandown Mews	2,15	1,61	1,79	0,69	0,00
37 Wierda Road West	1,95	1,61	0,69	0,00	0,00
Grayston Ridge Office Park	1,98	1,61	0,69	0,69	0,00
70 Grayston Drive	1,98	1,61	1,39	0,69	0,00
23 Impala Road	2,13	1,61	0,69	1,10	0,00
Hurlingham Office Park	2,06	1,61	0,69	1,39	0,00
Wedgewood Office Park	2,04	0,69	0,69	1,10	0,00
Cradock Square	2,29	1,79	0,69	1,10	0,00
10 Keyes Avenue	2,11	1,79	1,10	0,69	0,00
23 West Street	2,08	1,10	1,10	0,00	0,00
13 Baker Street	2,08	1,79	1,39	0,69	0,00
10 Fricker Road	2,12	1,95	1,10	0,69	0,00
4 Fricker Road	2,20	1,95	1,10	0,69	0,00
Sandton City Office Tower	2,27	1,61	3,04	1,79	0,00
Fourways Office Park	2,00	1,39	0,69	1,39	0,00
28 Sloane Street	2,06	0,69	0,69	0,69	0,00
The Forum	2,27	1,61	2,77	1,10	0,00
1 Peter Place	2,13	0,69	0,69	0,69	0,00
9 Kramer Road	2,06	1,61	1,61	0,00	0,00
Parc Nicol	2,04	1,39	0,69	1,10	0,00
53 Kyalami Boulevard	1,88	0,00	0,69	0,00	0,00
Cedar Office Estate	2,13	1,39	0,69	0,69	0,00
Sandhaven Office Park Building 1	2,02	1,61	0,69	0,00	0,00
Vunani Office Park	2,10	1,61	1,10	0,00	0,00
Kildrummy Office Park	1,98	1,61	0,69	1,10	0,00
204 Rivonia Road	2,06	1,61	0,69	0,69	0,00
28 Fricker Road	2,20	1,95	1,10	1,10	0,00
Sandton Eye	2,30	1,61	2,48	1,39	0,00
Daisy Street Office Park	2,15	1,61	0,69	0,69	0,00
34 Monte Carlo Crescent	1,81	0,00	0,69	0,69	0,00

Appendix F: Log-Linear Regression Analysis

Confidence interval (%): 95

Tolerance: 0.0001

Run again:

Summary statistics (Quantitative data):

Variable	Observations	Obs. with missing data	Obs. without missing data	Minimum	Maximum	Mean	Std. deviation
ln_Rentals	60	0	60	1,813	2,407	2,163	0,135
ln_Location	60	0	60	0,000	1,946	1,423	0,504
ln_Stories	60	0	60	0,693	3,045	1,329	0,673
ln_GLA	60	0	60	0,000	2,398	0,977	0,667
ln_Green Star Rating	60	0	60	0,000	1,792	0,709	0,721

Correlation matrix:

	ln_Location	ln_Stories	ln_GLA	ln_Green Star Rating	ln_Rentals
ln_Location	1	0,320	0,069	0,002	0,426
ln_Stories	0,320	1	0,480	0,325	0,678
ln_GLA	0,069	0,480	1	0,300	0,569
ln_Green Star Rating	0,002	0,325	0,300	1	0,552
ln_Rentals	0,426	0,678	0,569	0,552	1

Regression of variable ln_Rentals:

Goodness of fit statistics (ln_Rentals):

Observations	60,000
Sum of weights	60,000
DF	55,000
R^2	0,711
Adjusted R^2	0,690
MSE	0,006
RMSE	0,075
MAPE	2,672
DW	1,810
Cp	5,000
AIC	-305,932
SBC	-295,461
PC	0,341

Analysis of variance (ln_Rentals):

Source	DF	Sum of squares	Mean squares	F	Pr > F
Model	4	0,763	0,191	33,854	< 0.0001
Error	55	0,310	0,006		
Corrected Total	59	1,073			

Computed against model Y=Mean(Y)

Model parameters (ln_Rentals):

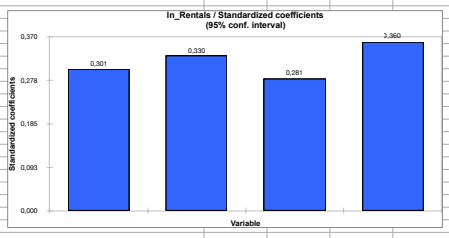
Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
Intercept	1,858	0,033	56,912	< 0.0001	1,792	1,923
ln_Location	0,080	0,021	3,891	0,000	0,039	0,122
ln_Stories	0,066	0,018	3,670	0,001	0,030	0,102
ln_GLA	0,057	0,017	3,338	0,002	0,023	0,091
ln_Green Star Rating	0,129	0,015	4,609	< 0.0001	0,038	0,097

Equation of the model (ln_Rentals):

ln_Rentals = 1,85778897533626+0,0803759313150793*ln_Location+0,0661752482049924*ln_Stories +0,0568147837029617*ln_GLA +0,0673672696732526*ln_Green Star Rating

Standardized coefficients (ln_Rentals):

Source	Value	Standard error	t	Pr > |t|	Lower bound (95%)	Upper bound (95%)
ln_Location	0,301	0,077	3,891	0,000	0,146	0,455
ln_Stories	0,330	0,090	3,670	0,001	0,150	0,511
ln_GLA	0,281	0,084	3,338	0,002	0,112	0,450
ln_Green Star Rating	0,360	0,078	4,609	< 0.0001	0,204	0,517



Predictions and residuals (ln_Rentals):

Observation	Weight	ln_Rentals	Pred(ln_Rentals)	Residual	Std. residual	Std. dev. on pred. (Mean)	Lower bound 95% (Mean)	Upper bound 95% (Mean)	Std. dev. on pred. (Observation)	Lower bound 95% (Observation)	Upper bound 95% (Observation)
Obs1	1	2,217	2,212	0,006	0,078	0,016	2,180	2,243	0,077	2,058	2,365
Obs2	1	2,220	2,187	0,033	0,442	0,024	2,139	2,235	0,079	2,029	2,345
Obs3	1	2,253	2,175	0,078	1,041	0,016	2,143	2,206	0,077	2,021	2,328
Obs4	1	2,407	2,347	0,060	0,794	0,022	2,303	2,391	0,078	2,190	2,504
Obs5	1	2,389	2,397	-0,007	-0,100	0,026	2,344	2,449	0,079	2,237	2,556
Obs6	1	2,332	2,336	-0,004	-0,054	0,019	2,299	2,374	0,077	2,181	2,492
Obs7	1	2,283	2,336	-0,053	-0,706	0,020	2,297	2,376	0,078	2,181	2,492
Obs8	1	2,342	2,322	0,020	0,270	0,025	2,273	2,372	0,079	2,164	2,481
Obs9	1	2,255	2,287	-0,031	-0,419	0,017	2,252	2,321	0,077	2,132	2,441
Obs10	1	2,243	2,205	0,038	0,505	0,022	2,161	2,250	0,078	2,048	2,362
Obs11	1	2,255	2,343	-0,088	-1,175	0,019	2,305	2,382	0,078	2,188	2,499
Obs12	1	2,377	2,315	0,061	0,815	0,016	2,282	2,348	0,077	2,161	2,469
Obs13	1	2,176	2,082	0,094	1,249	0,033	2,016	2,148	0,082	1,918	2,247
Obs14	1	2,097	2,119	-0,022	-0,294	0,020	2,078	2,160	0,078	1,963	2,275
Obs15	1	2,127	2,180	-0,053	-0,708	0,025	2,130	2,231	0,079	2,022	2,339
Obs16	1	2,204	2,299	-0,094	-1,259	0,018	2,262	2,336	0,077	2,144	2,454
Obs17	1	2,243	2,235	0,008	0,111	0,022	2,190	2,280	0,078	2,078	2,392
Obs18	1	2,204	2,289	-0,085	-1,137	0,029	2,230	2,349	0,081	2,128	2,451
Obs19	1	1,954	2,124	-0,169	-2,255	0,025	2,072	2,175	0,079	1,965	2,282
Obs20	1	2,130	2,175	-0,044	-0,591	0,016	2,143	2,206	0,077	2,021	2,328
Obs21	1	2,389	2,245	0,144	1,925	0,020	2,205	2,284	0,078	2,089	2,400
Obs22	1	2,322	2,328	-0,006	-0,076	0,019	2,289	2,367	0,078	2,173	2,483

Obs23	1	2,176	2,125	0,051	0,684	0,019	2,087	2,162	0,077	1,970	2,280	
Obs24	1	2,290	2,317	-0,027	-0,358	0,019	2,278	2,355	0,077	2,162	2,472	
Obs25	1	2,204	2,200	0,005	0,060	0,027	2,146	2,254	0,080	2,040	2,359	
Obs26	1	2,297	2,305	-0,008	-0,107	0,017	2,271	2,338	0,077	2,151	2,459	
Obs27	1	2,389	2,310	0,080	1,060	0,016	2,277	2,342	0,077	2,156	2,464	
Obs28	1	2,233	2,115	0,118	1,569	0,022	2,072	2,159	0,078	1,959	2,272	
Obs29	1	2,021	2,115	-0,094	-1,252	0,037	2,042	2,188	0,084	1,948	2,283	
Obs30	1	2,134	2,153	-0,020	-0,262	0,023	2,107	2,199	0,078	1,996	2,311	
Obs31	1	2,146	2,145	0,001	0,014	0,018	2,108	2,182	0,077	1,990	2,300	
Obs32	1	1,954	2,033	-0,079	-1,049	0,019	1,995	2,071	0,077	1,878	2,188	
Obs33	1	1,978	2,072	-0,095	-1,261	0,016	2,039	2,105	0,077	1,918	2,226	
Obs34	1	1,982	2,118	-0,136	-1,811	0,015	2,089	2,148	0,077	1,965	2,272	
Obs35	1	2,130	2,095	0,035	0,465	0,019	2,058	2,133	0,077	1,940	2,250	
Obs36	1	2,061	2,112	-0,051	-0,680	0,021	2,069	2,155	0,078	1,955	2,268	
Obs37	1	2,041	2,022	0,020	0,261	0,021	1,980	2,064	0,078	1,866	2,178	
Obs38	1	2,290	2,110	0,180	2,397	0,020	2,069	2,151	0,078	1,954	2,266	
Obs39	1	2,114	2,114	0,000	0,001	0,016	2,082	2,145	0,077	1,960	2,268	
Obs40	1	2,079	2,019	0,060	0,804	0,020	1,978	2,060	0,078	1,863	2,175	
Obs41	1	2,079	2,133	-0,054	-0,716	0,016	2,101	2,165	0,077	1,979	2,287	
Obs42	1	2,121	2,126	-0,006	-0,076	0,017	2,091	2,161	0,077	1,972	2,281	
Obs43	1	2,204	2,126	0,078	1,037	0,017	2,091	2,161	0,077	1,972	2,281	
Obs44	1	2,267	2,290	-0,023	-0,310	0,033	2,223	2,357	0,082	2,126	2,455	
Obs45	1	2,000	2,094	-0,094	-1,250	0,020	2,053	2,135	0,078	1,938	2,250	
Obs46	1	2,061	1,999	0,062	0,825	0,020	1,959	2,038	0,078	1,843	2,154	
Obs47	1	2,267	2,233	0,034	0,455	0,030	2,173	2,294	0,081	2,071	2,395	
Obs48	1	2,130	1,999	0,132	1,753	0,020	1,959	2,038	0,078	1,843	2,154	
Obs49	1	2,064	2,094	-0,029	-0,389	0,023	2,048	2,140	0,079	1,936	2,251	
Obs50	1	2,041	2,078	-0,036	-0,481	0,017	2,043	2,112	0,077	1,923	2,232	
Obs51	1	1,875	1,904	-0,029	-0,381	0,033	1,837	1,970	0,082	1,739	2,068	
Obs52	1	2,130	2,054	0,076	1,011	0,015	2,024	2,085	0,077	1,901	2,208	
Obs53	1	2,021	2,033	-0,012	-0,158	0,019	1,995	2,071	0,077	1,878	2,188	
Obs54	1	2,097	2,060	0,037	0,494	0,019	2,021	2,098	0,077	1,905	2,215	
Obs55	1	1,978	2,095	-0,118	-1,568	0,019	2,058	2,133	0,077	1,940	2,250	
Obs56	1	2,061	2,072	-0,012	-0,156	0,016	2,039	2,105	0,077	1,918	2,226	
Obs57	1	2,204	2,149	0,055	0,730	0,019	2,112	2,187	0,077	1,994	2,304	
Obs58	1	2,301	2,230	0,071	0,941	0,025	2,180	2,281	0,079	2,072	2,389	
Obs59	1	2,146	2,072	0,074	0,982	0,016	2,039	2,105	0,077	1,918	2,226	
Obs60	1	1,813	1,943	-0,130	-1,733	0,031	1,881	2,005	0,081	1,780	2,106	

