
Risk Parity Diversification



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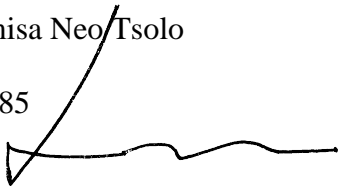
Declaration

I declare that this Research Report is my own, unaided work. It is submitted in partial fulfilment of a Master of Science in Building (MSc) in the field of Property Development and Management at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination in any other university.

Signature of Candidate:

Leemisa Neo/Tsolo

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A handwritten signature in black ink, appearing to be 'Leemisa Neo/Tsolo', written over the printed name. The signature is stylized with a long, sweeping stroke that starts under the 'L' and extends across the rest of the name.

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I would like to thank my supervisor for the continued support, patience and assistance throughout this journey. My most heartfelt gratitude also goes to my parents, mummy Ketj and nate Thokoane; to my sister Mosonngoa and to my extended family for their support; and to my late grandmothers, nkho Moroesi and nkho Khechi who wanted to see me graduate. To my girlfriend Moratua Mosenene who has been my most ardent cheerleader from the day from day-1 of this journey. A special thanks to mme Makhomo Macheli who helped get into the school, to the staff at the department, Claudia Abrahams, Mrs Tiny Sithole, Ruth Billet and Professor Samuel Azasu who have been my other family with me on this journey, their support will forever be appreciated. To my syndicate partner Boitumelo Ramushu, who has been a brother throughout this journey. If your name is not written in this report, please note that it is an error in omission. To my employer City Property and colleagues who have supported me through this period thank you.

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List of Abbreviations

Abbreviation	Description
AIC	Akaike Information Croterion
ASX	Australian Stock Exchange
CAPM	Capital Asset Pricing Model
CBD	Central Business District
CRE	Commercial Real Estate
DF	Dickey Fuller
DSAA	Dynamic Strategic Asset Allocation
ERC	Equal Risk Contribution
FTSE	The Financial Times Stock Exchange
GARCH	Generalised Autoregressive Conditionally Heteroscedastic model
GDP	Gross Domestic Product
GFC	Global Financial Crises
GNP	Gross National Product
IFRS	International Financial Reporting Standards
IRR	Internal Rate of Return
JREIT	Japan Real Estate Investment Trusts
JSE	Johannesburg Stock Exchange
LSM	Living Standard Measure
MD	Maximum Diversification Portfolio
MTP	Modern Portfolio Theory
MV	Minimum Variance
NAREIT	National Association of Real Estate Investment Trusts
RE	Real estate
REIT	Real Estate Investment Trust
RP	Risk Parity
SA	South Africa
SAA	Strategic Asset Allocation Strategy
SAPY	South African Property Index
SBIC	Schwarz Bayesian Information Criterion
SIC	Schwarz Information Criterion
TAA	Tactical Asset Allocation Strategy
UK	United Kingdom
USD	United States Dollar
VaR	Value at Risk model
VAR	Vector Autoregressive model
ZAR	South African Rand

Abstract

The South African Listed property sector has been in existence for over twenty years, and on 1st April 2013 Section 25BB of the Income Tax law allowed property companies to convert into Real Estate Investment Trusts (REITs). The 2008 Global Financial Crises (GFC) revealed flaws in traditional portfolio allocation strategies, and the subsequent periods revealed how correlated assets were, and especially property assets. This study proposes an alternative portfolio construction paradigm borrowed from finance namely, the concept of Risk Parity (RP). RP portfolios derive their logic from portfolio diversification which originates from the Modern Portfolio Theory (MPT). This study employs a vector autoregressive (VAR) model as an asset selection tool, and proposes a RP portfolio as a better risk adjusted portfolio, which will be suitable to be a core portfolio strategy. Limitations of the proposed Risk Parity strategy is that it has not found its place in main stream financial product offerings on the market, partly due to the extant literature on the subject, though it is based on a more quantifiable risk as a guiding principle. The VAR model is ideally usable in the medium. Findings were that Listed companies in South Africa still allocate their investments in the traditional property assets and they either diversify geographically and sectorally. The paper proposes that investors consider the implications of the business cycle stages when making real estate allocations, and even further when investors consider listed real estate, the exploration of more robust models such as the RP strategy will reduce the potential losses that were seen in the aftermath of the 2008 GFC.

Keywords: Listed Property, Diversification, Risk Parity, Vector Autoregressive Model

1 Introduction

Risk Parity (RP) very loosely defined, RP attempts to create a portfolio in which the various assets in the portfolio contribute equally to the overall risk of the portfolio (Chaves, Hsu, Li, & Shakernia, 2011). Risk parity is a portfolio construction strategy that aims to minimise the risk of a portfolio, by equalising the risk contribution of each asset in the portfolio, therefore limiting the risk posed by an overweighted asset.

1.1. Background to the Study

The significance of property to individuals and institutions, beyond the basic need for shelter, is the value derived from holding property as an asset class for its intrinsic value; in this regard, commercial property constitutes a large share of global wealth and is anticipated to have reached USD 13.7 trillion in 2015 (Leone & Ravishnakar, 2017; Corney, Lauder & McElreath, 2016; Fiorilla, Kappas & Liang, 2012).

As part of an investor's general objective, a property investor's focus is to understand the relative size of the markets in which they are invested or are considering to investing in both locally and internationally, so that they can anticipate where growth or a downturn is likely to come from in the future. Investors considering international property portfolio holdings are advised to group the countries based on their economic status into developed and developing countries as defined by the World Bank (Corney, *et al.*, 2016). Since real estate markets do not exist in isolation, the literature has discussed their importance in national economies and in the capital markets; they have also been in those markets as privately-owned (i.e. direct property ownership by individuals) and as publicly-traded real estate assets (i.e. as listed shares of companies such as real estate investment trusts (REITs) traded on a stock exchange) (Akinsomi, Mkhabela & Taderera, 2018; Liow & Schindler, 2011).

Furthermore, real estate markets are characterised by several investment instruments held by individuals (natural persons), institutional investors and companies (legal persons). The property market portfolio includes non-financial assets obtained directly (investment property) and indirectly through acquired financial instruments of the real estate market (Smietana, 2014).

The role of property in a mixed-asset portfolio is an important research topic for academics and property investors. There are numerous studies on the allocation of weights to property in multi

asset portfolios, however, the research around the decision-making process involved in how real estate assets are allocated, is limited (Newell, 2012; Reddy, 2012). To add to this predicament, for an investor to gain exposure to real estate, there are often multiple layers of investment management and costs between the investor and the assets, and thus the true performance of real estate investments may be different from what empirical studies on the performance of real estate suggest (Andonov, Kok & Eichholtz, 2013), (Reddy, et al., 2013). Similarly, investors have to navigate decisions such as: “how much investment funds must be allocated to a given property and how should one allocate funds between asset classes such as shares and cash in the investment portfolio to receive maximum returns?” It is crucial for an investor to know, firstly, if real estate ought to be included into an investment portfolio, and secondly, how much real estate and what type of property is to be included in an investment portfolio (Joubert, 2015). As investors seek to limit and to mitigate the risks inherent in investing in property, there have been extensive discussions around the differences with investing in direct privately held property and in publicly listed properties. Investors can hold ownership positions in commercial real estate (CRE) either through direct private investment or through public real estate securities, or both. Purchasing individual properties directly in the private market gives investors complete control of the asset, in matters relating to: who leases it, who manages it, how much debt financing is used and for how long the property is held before being sold. With publicly traded real estate securities, individuals and institutions invest capital in a real estate company which, in turn purchases, manages and holds title to the real estate. In contrast to private real estate markets, exchange-traded real estate securities provide investors with a relatively high degree of property diversification, liquidity, transparency and relatively low transaction costs (Falk, 2012; Ling & Naranjo, 2015).

Reddy *et al* (2013) sets out to discuss the optimal property allocation and the investment decisions of Australian pension funds, the author defines what a property fund as “an investment vehicle that specialises in acquiring, developing and managing property investments on behalf of other institutions and investors.” The author further defines the property allocation process and discusses three strategies employed by property fund managers namely; Strategic Asset Allocation (SAA), also known as a long term property investment strategy, Dynamic Strategic Asset Allocation (DSAA), which is a medium term review of long property positions in order to respond to market extremes and lastly Tactical Asset Allocation (TAA), which is the short term opportunistic strategy, typically conducted annually and mostly used by listed funds. In concluding the author highlighted that investors categorise listed property assets in the same basket as equities and direct property assets are grouped with unlisted property assets.

The nature of property investments and their idiosyncrasies have meant that there is no straightforward rule of thumb as to how practitioners and investors alike, analyse, decide on strategies and execute investment objectives. According to Moss and Farrelly (2015), depending on the type of investor that one is, fundamental to any investment is the liquidity of the asset and costs of executing the investment. In broader terms and under the right conditions, both direct and indirect property investments can result in capital gains (from the profit from disposal or sale of assets), growth (from appreciation of assets as determined by market values) and recurring income (from rental of investment property or through dividend distributions) as well as allowing investment risk to be managed through property derivatives (which are derivative financial instruments in the real estate market) (Smietana, 2014).

1.2. Substantiation of the Problem

Diversification in multi asset portfolios has been the subject of discussion in more than just the property literature and practice, the discussion is rooted in financial theory since 1952 when Henry Markowitz released a paper of portfolio selection, which is generally considered by a wide section of the literature as the foundational paper on diversification (Elton & Gruber, 1997).

According to Mwanza (2013) and Akinsomi, Pahad, Nape and Margolis., (2015), as an asset class real estate in Africa represents around 1% of the global asset value of REITs. The role of emerging markets in real estate portfolio diversification strategies has begun to take precedence and is becoming more prevalent today. In this regard, fund managers with global portfolios seek to optimize portfolio allocations into developing countries to capitalise on the diversification benefits that stand to be achieved by allocations made in emerging markets which have lower correlations than developed markets (Pham, 2012). The literature reveals that there is a trend towards the inclusion of emerging markets in global real estate portfolios (Pham, 2012; Akinsomi, *et al.*, 2015; Fiorilla, *et al.* 2012 and Corney, *et al.*, 2016). Proponents of the inclusion of emerging markets cite the differences in country profiles, regional economic differences and local property market differences that bode well for diversification, but also note that the recent financial crisis of 2008 revealed the existence of latent correlations that are attributable to the interconnectedness of globalisation.

The recent global financial crisis (GFC) of 2008 revealed some of the failings of asset allocation strategies such as the mean-variance (MV) portfolios and the traditional 60/40 portfolios typical of institutional portfolio regimes. The shortcomings of these strategies were in the high correlations of returns due to effects from macro-economic factors (Thiagarajan and Schachter, 2011). Empirical returns estimates based on historical data are often far too noisy to be useful, especially if risk premiums and correlations for asset classes are time-varying. Additionally, the possibility of "paradigm shifts" in the capital market makes historical data is far less relevant for forecasting the future evolution of asset returns (Chaves, *et al.*, 2011). The effects of macroeconomic factors such as the 2008 GFC had ripple effects across all investment segments including property assets. Some authors have cited the limitations of forecasting property returns, Black and Litterman (1992), introduced investor views also known as; perspectives such as the country's economic situation as a constraint in multi-asset-international portfolios (Beach & Orlov, 2007); and more recently, Sebehela (2016) states that the analysis of volatility has its drawbacks and proposes the adoption of realised variance analysis which is more accurate in predicting the random variability in asset performance, especially in the REIT industry. With the lower risk tolerance of investors, a new risk-based investment style has emerged since the subprime crisis. Although the importance of risk considerations in asset allocation is widely acknowledged, the idea is often simplified to volatility minimization as described in classical portfolio theory (Bruder & Roncalli, 2012).

Research has revealed these key issues;

Real estate assets are not easily incorporated into mixed asset portfolios, because of asset class being heterogenous.

Securitized real estate assets are more correlated to stock markets than they are to direct real estate.

From a South African perspective there is no evidence of the listed property sector using Modern Portfolio strategies to make investment decisions.

1.3. Problem Statement

Listed real estate market in South Africa (SA) has increased in size (i.e. in market capitalization) and geographical spread. According to Akinsomi and Ntuli (2017), the listed RE market's historical track record has had an inverse relationship with South Africa's gross domestic product (GDP). Traditional investment strategies have a concentrated risk profile, with their future returns hard to forecast and their individual assets have become more correlated in a globalised world.

A case needs to be made for an alternative real estate portfolio formation and diversification strategy to academics and for investors alike.

1.4. Primary Research Question

The main research question is;

What are the alternative portfolio diversification strategies that real estate investors can apply when making investment decisions regarding listed property assets?

This question has been adapted from Rodrigues (2009), who posed the question, however under the ambit of Modern Portfolio Theory and mixed asset portfolios.

1.5. Secondary Research Questions

- What are the returns or performance measures used by South African property asset managers?
- How does the performance of real estate compare to other investment assets on the Johannesburg Stock Exchange?
- Which diversification strategies are applicable to listed property assets?
- What are the alternative investment measures apart from returns focused regimes that can be used to inform portfolio composition?
- How are listed property returns influenced by business cycle stages?
- Do South African listed property companies invest in South Africa only?
- Which foreign countries do SA listed companies invest in?

1.6. Research Aim

Lack of a clear investor understanding of real estate as an asset could severely affect an investing firm's future growth and success. Diversification benefits and growth potentials are not efficiently capitalised on. Without more robust methods of efficiently including property assets in investment portfolios there are three major implications;

- The study is going to focus on listed property companies that reside in SA.
- Property specific risks are not investigated, analysed and quantified.
- Real estate allocations in portfolios are not efficiently diversified. Retail products such as SA property index or a variant of index trackers according to risk, do not effectively minimise portfolio risk.

The results in essence should provide an alternative investment tool that can be useful for short-term and medium-term investment decisions:

- To explore an alternative portfolio composition strategy.
- How do property companies perform during different business cycle stages?
- To consider risk as opposed to returns as a portfolio construction consideration.
- What are the returns or performance methods used by South African real estate companies?
- How do listed real estate companies diversify among the property segments?

1.7. Research objective

From the aim of research the following research objectives are identified:

- To review literature on the importance of property assets and their relation to the economic activity, under different business cycle stages.
- To investigate how have the property companies performed over different business cycles.
- To gather the relevant information of listed property companies, and analyse the data, to understand if the companies are using MPT techniques to make portfolio allocation decisions.
- Introduce the concept of a risk parity portfolio to create a securitised real estate portfolio that is compared to products such as the all property index funds.

1.8. Hypothesis

Hypothesis 1: Heterogeneity in property increases risk, and therefore the listed real estate companies that have a property type focus will perform better over time.

Hypothesis 2: A risk parity portfolio strategy can be applied to listed real estate portfolios. Moreover, how do risk parity portfolios compare to indices or market benchmarks in terms of the risk profile?

1.9. Limitations

The following limitations have been identified in this study:

Time; Initially the study was going to focus on both listed and direct real estate assets, the motivation was to present an all encompassing risk driven strategy for listed property companies that hold both direct property assets and indirect property assets.

Data availability; Direct property returns information is not freely available and as mentioned above the lack of time meant that exploration for this data source would have delayed the completion of this thesis paper.

Financial resources; this paper was done part time and while working and that should sufficient funds being available one would have been able to fully explore the research topic and insights from the body of knowledge.

1.10. Assumptions

The following assumptions have been made in this study:

- The risk features of different commercial property types such as; industrial, retail and office, differ at an individual property level, from one another and understanding the differences in the listed company portfolios has been made all-the-more difficult by the fact that their risk dynamics are aggregated (Leone and Ravishnakar, 2017).
- GARCH has limitations in forecasting future variations; however, realised variance seems not to have limitations in forecasting future variations (Sebehela, 2016). Some volatility

models require a high degree of econometric fluency, and the models adopted in this paper are simple and relatively easy to operationalise.

2 Literature Review

2.1. Introduction to the literature review

The aim of this section is to review the literature around modern portfolio theory and risk parity diversification; and in this regard to focus on both the financial and real estate bodies of knowledge. The paper attempted to uncover how the concepts inherent in modern portfolio theory and risk diversification could be applied to real estate investments assets in the context of mixed asset portfolios' diversification. The review sought to understand the methodologies that academics and practitioners are currently using in their discussions and during the course of their day-to-day work. Furthermore, the review pursued to understand the knowledge gaps that may or may not exist in the application of risk parity diversification to real estate investment portfolios, and if it is indeed ideally applicable to real estate portfolios and to investment strategies used to fulfil investment objectives in the real estate investment environment.

2.2. Methodology of literature review

The scope of the literature will focus on research conducted globally and will focus on trends that have propelled the debate to date. The research emphasis was limited to listed real estate sectors. Where possible, specific preference was given to research conducted in South Africa or on South African real estate, in the context of South Africa as an emerging markets country.

2.2.1 Diversification

Financial institutions have seen dramatic changes in the last three decades. Historically property investment decisions have been made within the portfolio diversification paradigm that has sought to balance the risk and returns of the portfolios in which they are held (Jones, *et al.*, 2017). In general, pairs of assets that do not move together provide greater diversification benefit when they are combined in a portfolio – the underlying assumption is that the volatility of such assets will tend to cancel out when they are combined in a portfolio (Geltner, Miller, Calyton & Eichholtz, 2007). This in essence is the central principle of diversification – not to put all your eggs in one basket – and is synonymous with investment portfolio construction.

(a) Diversification in Bull Markets

A bull market can be described as a period of economic expansion or recovery where share prices are on a concerted upward trend. The term “bull market” refers to the collective of assets that are being traded, i.e. stocks, bonds, real estate, currencies and commodities, etc. In most financial markets, asset prices rise and fall in a seemingly erratic manner in a given space of time. A bull market refers to periods of continued increase in share prices over a specific period (See; Brounen & Koning 2012, Geltner *et al.* 2007, and Edwards & Caglayan 2001). It is a period when the price of a substantial group of shares or when most shares on a stock exchange increases over an extended period. The period can last anything from months to years (See; Brounen & Koning 2012, Geltner *et al.* 2007, and Edwards & Caglayan 2001). Participants in bull markets have optimistic expectations about the market and tend to perpetuate the increases in share prices. Psychological traits such as herd behaviour and speculation, influence the market and thus makes predicting the market trends challenging, Brounen and Koning, (2012), Geltner, *et al.*, (2007), Edwards and Caglayan, (2001), DiPasquale and Wheaton, (1992), highlight the differences between myopic or irrational behaviour by markets participants that extrapolate current trends and project into the future which potentially leads to market or economic bubbles.

A bull market takes place when the economy is strengthening. Though there is no specific measure or ratio that is used to identify a bull market, it is typified by a situation or conditions where share prices increase by one or more percentage points over a sustained period of months and even years (See; Edwards & Caglayan, 2001, and Kaushik & Pennathur, 2013). The strengthening typically occurs concurrently with a growing gross domestic product (GDP), a consistently low unemployment rate, and increases in corporate profits as reflected in the share prices on stock exchanges. Furthermore, investor confidence normally improves during the duration of the bull market period, and a general increase in initial public offering (IPO) announcements occurs during the period, Brounen and Koning, (2012), Geltner, *et al.*, (2007), Edwards and Caglayan, (2001). Some of the quantifiable elements of the market conditions will be reflected in statistics such as low unemployment and increases in company output, however, it is harder to gauge the general market sentiment for the period based on the statistics.

The economic dynamics of bull markets are such that the supply of most assets are constrained, while demand for them is on the increase; thus resulting in a situation where there are more investors willing to buy than there are willing to sell. The shift or increase in the number of

buyers' is reflected in a shift of the demand curve. The last notable bull market was in period from 2003 to 2007 just before the 2008 Global financial crisis (GFC), (Edwards & Caglayan, 2001).

Some of the investigations extend the research conducted by Conover, Friday, and Howton (2000) and Hoesli and Moreno (2007) who found that the variances and performance of securitised real estate can be explained by the variances of the stock market or states of the financial market as a bull market (Su, Huang & Pai, 2010). Macroeconomic variables cited in literature as being known to determine the occurrence of, or to aide economic recovery include personal income growth, increase in economic output (GDP), increase in number of households, interest rates, favourable tax laws and availability of development financing (Edwards and Caglayan, 2001). Leading fund managers in the top quintile by size, turnover ratios, expense ratios, cash holdings, and returns are known to be able to consistently and positively time the market in bull periods and therefore able to maximise returns for their investors (Kaushik & Pennathur, 2013).

The effects that the movements of economic drivers have on the property markets are described by DiPasquale and Wheaton (1992) in their introduction and application of their Four Quadrant model. The model (figure 1 on page 11) provides a framework for understanding or describing how movements in the macro-economic environment impact on the real estate market. In it, the authors introduce two concepts: the property market for the use of space i.e. the demand side of the market (in the quadrants on the right of the model) and the market for the ownership of real estate i.e. the supply side of the market (in the quadrants on the left of the model). The model has four parts of asset valuation, the market for space, the construction sector and the stock of available space. In brief, it shows what happens to asset valuations when there is a change in any other portion of the model or vice versa for any other change.

The rentals are determined in the north east quadrant, which has two axes for rent (per unit of space) and for the available stock of space (measured in square metre). The demand curve is found in this quadrant and is the line along which rent and the supply of space interact and converge at equilibrium (where demand for space is equal to the stock of available space); demand for space is a function of rent and conditions in the economy (DiPasquale & Wheaton, 1992).

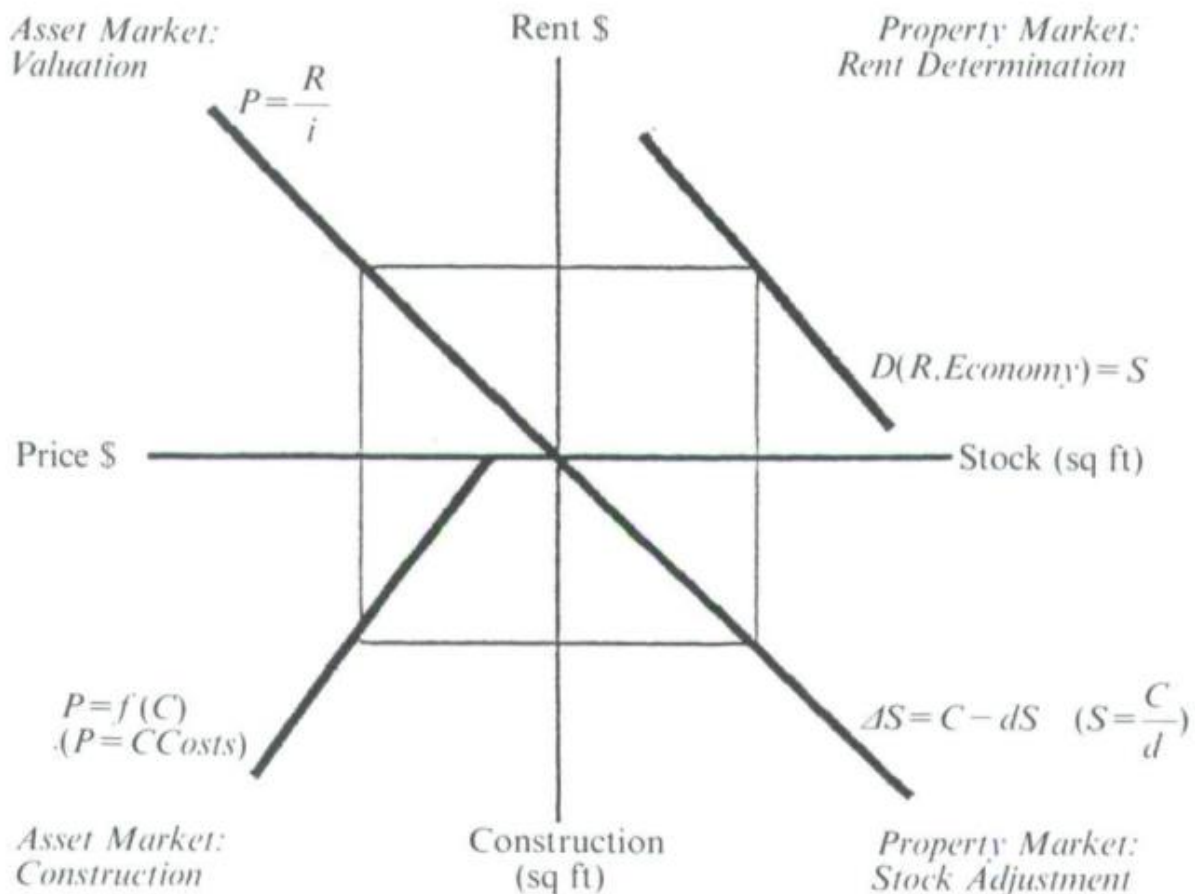


Figure 1: The four quadrant model (DiPasquale & Wheaton, 1992)

The next part of the model is called the asset market which has two axes; rent and prices (per unit of space). This part of the model introduces the capitalisation rate for real estate assets which is a ratio of rent or price (DiPasquale & Wheaton, 1992). This constitutes the yield that investors demand for investing in real estate assets. The factors that contribute to the formulation of the capitalisation rate are; the long term interest rate in the economy, the expected growth in property rentals, and the risks associated with rental income stream and the tax implications of holding real estate assets. Lastly the capitalisation rate is an exogenous factor that is driven by interest rates, prevailing capital market returns for all assets (stocks, bonds, short term deposits) (DiPasquale & Wheaton, 1992). The third quadrant of the asset market is where the construction of new assets are determined. This is where the replacement cost curve is found, and this is the curve along which the cost of construction is assumed to increase with more building activity (DiPasquale & Wheaton, 1992).

The difference of this quadrant to other quadrants, is that the curve intersects the price axis at the minimum required amount to get some level of construction started, if construction is possible regardless of the costs then the curve will be vertical. The factors that influence the tilt or angle of the curve are scarce land, zoning regulations and other constraints that lead to inelastic supply. The take away from this quadrant is that the lower the levels of construction leads to higher profits and the inverse will be that the higher the level of construction the lower the profits will be (DiPasquale & Wheaton, 1992). Lastly the south easterly quadrant, is where the annual new construction is converted into the long run stock of real estate space. The curve in this quadrant can be considered as the change in stock which is a factor of new construction minus the losses due to depreciation or the removal rate (DiPasquale & Wheaton, 1992). In conclusion regarding the four-quadrant model; the stock of available space intersects the property market where the rents are determined which then get converted into property prices in the asset market. The asset prices, driven by the yields prevailing at the time, will generate new construction back in the property market, which will be reflected in the new level of stock. The model is in equilibrium when the starting and ending levels of stock are the same. If the ending and beginning stock differ, then the values emanating from the four quadrants (rent, prices, construction and the stock) are not in equilibrium (DiPasquale and Wheaton, 1992).

The above discussion was meant to articulate the fundamental variables at play in any property market, which in the context of this study represent fluctuations in the property market, which are considered booms or bust cycles as the model regulates itself. In economically mature markets, economic growth will be relatively low, and so will the growth in property demand. Some emerging markets exhibit higher economic growth rates compared to developed economies, the growth spurs increases in property demand. This phenomenon implies that economic growth goes hand in hand with property demand (Kaushik & Pennathur, 2013). A characteristic of emerging economies is rapid urbanization and as urban communities grow, there is a need for residential, retail, industrial and office properties to accommodate the growing population (Geltner *et al.* 2007).

The establishment of real estate investment trusts (REITs) in Japan in 2001, spurred rapid growth in the sector across Asia. Asian REITs as investment vehicles have seen much interest from international funds seeking portfolio diversification (Newell, et al., 2005); Ooi, Newell, and Sing, 2006). The success of REITs in the developed markets of Japan, Hong Kong and Singapore over the last decade has spilled over into other emerging Asian REIT markets, such as Malaysia,

Taiwan, Thailand and South Korea. This growth has been underpinned by increased property developments and favourable demographic statistics. Regardless of strong growth prospects and increased importance, investors have little information and knowledge of these emerging Asian markets (Pham, 2012).

The importance of interest rate movements in relation to securitised real estate is explained by performing the analysis for the Japanese and U.S. markets. Su, *et al.* (2010) in their paper include an assessment of the changes in the expected interest rate on REIT returns, and find that the influences present a stabilised and negative relationship with the JREITs market but not in the U.S. market. The authors further find that fund managers can successfully time the market during bull months, as measured by increases in the NAREIT Composite Index, but not during bear months. Furthermore, consistent with previous research on mutual funds for example, Jiang, (2003), find no significant differences in timing for the broader definition of market conditions. Finally, they find that funds with lower returns exhibit significant negative timing across all market conditions (Su, *et al.*, 2010).

(b) Diversification in Bear Markets

As a national economy starts to slowdown, there will be a contraction in the economy's output and employment, but there are usually increases in short term interest rates as well (Geltner, *et al.*, 2007). According to Edwards and Caglayan (2000) a bear market is characterised by falling prices, and in their paper, they referred to the decline of the Standard and Poor 500 by one or more percent and the market participant's behaviour in such conditions are that of caution and pessimism about the market. The bull and bear analogy used to describe the market are taken from the way animals attack, a bull thrusts its horns in the air, while a bear swipes its paws downwards (See; Brounen & Koning, 2012, Geltner *et al.* ,2007, and Edwards & Caglayan ,2001). However, top-quintile funds for size and more interestingly returns both show negative timing in bear markets (Kaushik & Pennathur, 2013). In their paper which analyses monthly returns of hedge funds and commodity funds, found that commodity funds provide better downside protection than hedge funds in bear markets and that commodity funds have an inverse relation with stock market returns in bear markets (Edwards & Caglayan 2001).

The linkages between real estate and local stock markets in the Asia-Pacific economies are (significantly) higher than the corresponding regional and global linkages, while the non-Asia-Pacific public real estate markets are generally more correlated with the regional stock markets than with their respective local stock markets. Real estate and stock markets become more correlated in periods of high volatility, as the recent 2008 GFC indicated for all markets including the Asian crisis in 1997 and 1998 in particular. Causality analysis revealed that there were instances of contemporaneous and lead-lag interactions in return and volatility between real estate and stock markets; however, the causality relationship were weak. Further, the mean and variance causality linkages between the real estate and stock markets were found to be unstable over the “pre-crisis” and “crisis / post-crisis” periods. Lastly the integration analysis implied that the real estate markets had, on average, slowly become more integrated with the regional and global stock markets, and in the long run, less with the local stock markets (Liow & Schindler, 2011).

2.2.2 Investment Strategies

A fundamental point of departure for any real estate investor starts with the desired outcome and clear definition of the intended results for investing, as supported by Ori, (1995). The author begins by clearly defining the investment objectives, which is further supported and Smietana, (2014), who tabulates the different stages of active real estate portfolio management, and the first step is to define the investor’s investment objective. The portfolio management process as discussed by other authors, such as and Ducoulombier (2007), includes statements of objectives and answers to questions such as; what is the desired rate of return and the investment horizon? Assets selection also known as portfolio composition asks; which assets to include in a portfolio? The next step is the selection of an appropriate benchmark to allow the investor to monitor their performance as compared to the market, an extrinsic measure? This process involves defining the objectives of return against the benchmark, and defining the acceptable risk tolerance, and the investment horizon suitable to achieve the objectives outlined for the establishment of performance evaluation metricise, as confirmed by Ori (1995).

The next step would be the analysis of the existing portfolio, by comparing the current portfolio allocation relative to the chosen benchmark and comparing the performance. The assessment of the ability to reach objectives without allocation or selection changes; for allocation, forecasts of relative performance, of tracking error of the portfolio in relation to the benchmark. Attributing

the decisions based on performance and to tracking error. The evaluation of achieving targeted objectives without allocation changes. The setting of constraints; identifying buildings with value increasing potential, high lot size and non-divisibility of real estate hinder quick reallocations. The challenge of diversifying specific risk dictate the establishment of a maximum investment amount to a specific building relative to the portfolio size and the cost of managing a unit will require a the establishment of minimum allowable amount. The review of such decisions beyond an annual timeline due to illiquidity and transaction costs (Ducoulombier, 2007).

Allowances for other practical considerations, the timing and modification considerations typically short term adjustments, cash flow considerations for disposals or reinvestment purposes. The state of real estate markets in relation to the real estate cycles, supply and demand dynamics, vacancies and transaction volumes. Management capacity with regards to qualified real estate professionals and adaptability to changing environments. Finally definition of new strategies; new allocation, buy, sell and hold positions, building type and location considerations, property management needs (See; Ducoulombier, 2007 and Smietana, 2014). The process of portfolio management has not changed drastically over the last two decades, Ori (1995), discusses themes, which are still relevant to date as supported by Ducoulombier (2007) and more recently Smietana (2014).

The long versus short term considerations of optimal portfolio investments, as described by Hauss (2004); the specification of assets to be included in a portfolio is categorised as a strategic allocation decision and typically requires investors hold long term views of the portfolio, this is between five to ten year horizon. Specification of capital market expectations and the readjustment of a portfolio to market changes, this is considered a tactical allocation strategy which is typically a short term typically done annually (Hauss, 2004). The construction of efficient frontier which is a technical strategy that seeks to continually gauge the performance and the analysis of the optimal asset mix is considered an active portfolio strategy versus a passive strategy which is done through the use of benchmark indices or a portfolio that simply tracks an index (Moss & Farrelly, 2015). Rodrigues (2009), in his paper attempts to shed light on the applications of MPT in the South African context, he reflects on the significance of MPT as strategic diversification tool. The author used a mixed method research to firstly confirm if the data can support the application of MPT and whether industry practitioners are in fact using MPT to drive investment decisions (Rodrigues, 2009).

The widely known strategy used by investors to take advantage of bull markets is to buy early before prices rise and to sell at the peak of the cycle. The challenge in that strategy is being able to determine when the bottom and peaks take place. There are some strategies that can be adopted to take advantage of bull market conditions; however these strategies do come with associated risks. Full Swing Trading; This is for expert investors with high risk tolerance, still under a tactical strategy of short selling and other techniques that attempt to extract the most gains from the changes in share prices in the context of a bull market. Retracement additions; Retracement is the temporary reversal in the movement of a stock's price, (Webster's dictionary definition). During bull markets there will be instances where share prices will drop, if only temporarily. These temporary drops occur and share prices continue on their upward momentum again. Typically, tactical, investors will be on the lookout for retracements within bull market in order to capitalise on lower or discounted prices as the upward trend continues in the share price. (Investopedia, LLC, 2018)

American Bull and Bear Markets; In American history the bull market happened after the stagflation era in 1982 and extended to the end of the dotcom bust in 2000 and the recorded average growth was 16.8%. The subsequent bear market that followed was from 2000 to 2009 recorded an average return of -6.2%. The bull and bear market conditions discussed above reveal the nature of the phenomena of bull and bear markets which; are that they can happen over extended periods of time and can include more than one business cycle, and they are hard to predict and are only revealed after they occur. (Investopedia, LLC, 2018)

2.2.3 Real Estate Investments

There are two overarching categories for real estate investments, one being direct real estate investments and listed real estate investments, both have different characteristics and implications to investors Falk (2012) and Hauss (2004). Direct real estate investments are considered immobile, capital intensive, require extended periods of time to transfer and information costs are considerably high. Listed real estate assets resemble financial assets and they can be traded daily, liquid, meaning that they are easily exchanged, information about assets is considered to be reflected in the price, the is perceived transparency (Ang, et al., 2013). Further to this, return opportunities can be structural, relating to economic development, relative capital scarcity and demographics, and return opportunities abroad may be of a cyclical nature, possibly providing

opportunities for market timing. The investor's home market may be at the top of the property cycle, with big boost returns beckoning from switching to another market at the bottom of the cycle (Geltner, et al., 2007).

Regional economic base analysis and forecasting is an inexact science dealing with an ever shifting world, properties' geographical immobility and functional inflexibility make futures more difficult to predict than those of the typical industrial or service corporation whose shares trade in the stock market (Geltner, et al., 2007). There is another view from Graff and Young (1996), that state that sector correlations are volatile that statistical tests do not prove that geographic and property type diversification are more advantageous to a naïve diversification strategy. They recommend that experience and rational thinking rather than variance-covariance matrix and quantitative optimisation model to weigh the costs of diversification especially when an investors does not have the expertise to understand the fundamentals of the asset.

The authors posit that real estate fund managers have an informational advantage that allows them to accurately predict market cycles and quickly reorganise their portfolios. Funds with lower returns exhibit significant negative timing across all market conditions (Kaushik & Pennathur, 2013). Edwards and Caglayan, (2001) in their paper regarding the differences in the performance of hedge funds and commodity funds, categorise four hedge fund styles; market neutral, event driven, global macro and short selling and found that they perform reasonably well in bear markets; which also depends on how they are measured, equally weighted or value weighted. In bull markets the hedge fund styles perform well except for short selling, and the authors further add that the styles perform best over longer periods, and this also true of commodity funds. Commodity funds were found to be better diversifiers during bear markets (Edwards and Caglayan, 2001).

2.2.4 Risk Parity

Risk parity diversification has been introduced in the advent of the financial crises which saw market correlations spill-overs on a global scale. Thiagarajan and Schachter (2011), state that the difference of risk parity and the typical institutional 60/40 portfolio is that it has a lower Sharpe ratio and lower returns, and the author postulates that in order for the risk parity portfolio to achieve the same returns the solution is to leverage the risk parity portfolio. This leveraging adds an element of short term timing risks due to the leverage effects. The author concludes that risk

parity concept is the motivation for diversification as investors seek to spread and minimize risk in their portfolios (Thiagarajan and Schachter, 2011). In their review of the extant literature on risk parity the authors cite Qain (2011), “The author examines diversification through three matrices of risk parity using;

- Correlations to stocks and bonds,
- Beta to underlying assets and,
- The loss contribution.

An RP portfolio can be thought of as a policy portfolio, an allocation strategy, where the sum of the portfolio risk contributions is equal to 1, and each asset weight is a ratio of the portfolio’s total risk (Thiagarajan and Schachter, 2011). The rationale for this allocation strategy proposes that an investor selects a portfolio based on risk contributions and ignores returns contribution (Lee, Spellar & Bouchev, 2013). As a portfolio allocation strategy literature compares its robustness to other return based allocation strategies such as the CAPM - mean variance (MV) portfolios. The CAPM models are of practical importance for at least three major macro-level investment decision applications. Equilibrium pricing models can help investors understand; what are reasonable expected returns, going forward into the future, on investments in different asset classes or types of investment products. Such models can help identify specific types of assets or investment products (or “sectors” of asset markets) that are currently mispriced relative to long run equilibrium.

By understanding how capital markets price risk, asset pricing models can be used to adjust portfolio returns to reflect the amount of risk in the portfolio, thereby helping to control for risk. The motivation of holding a risk parity portfolio is to have equal risk contributions from all asset classes in a portfolio. Risk parity represents a way to limit the economic impact or the loss caused by any one asset in the portfolio. Equally weighting risks in a mixed asset portfolio that comprises of equity, real estate, credit spreads, commodities, and inflation bonds, removes its dependence on bonds as the major source of returns or diversification (Lee, *et al.*, 2013). Economic factors such as interest rates and inflation are important in risk parity strategies as assets that respond differently, for instance, rising interest rates resulting from economic stability and prosperity are good for a risk parity approach. Bonds typically underperform in such market conditions however growth assets like equities, real estate and credit spreads will experience above average

performance. Similarly changes in inflation will benefit assets sensitive to inflation such as commodities and inflation like bonds (Lee, *et al.*, 2013).

Risk parity has been criticised for the use of leverage, to align the total required level of volatility in a portfolio and in order to meet investor's objectives, risk parity may employ economic leverage in the form of futures contracts and financial leverage in the form of repurchase agreements and over-the-counter swaps. Managing leverage is critical, diversification has to be considered at a portfolio level and among the individual assets that are levered within the portfolio and may require daily liquidity. The operational experience of managing leverage is key to risk parity managers, their expertise are to range from real-time monitoring of leverage levels, develop managing plans for risk parity strategy in challenging conditions (Lee, *et al.*, 2013). The article evaluates the performance of the different hedge fund and commodity fund investment styles using safety-first performance criteria that emphasises limiting downside risk, and compare the results obtained to the conventional Sharpe ratio performance criterion, the authors construct both equally-weighted (EW) and value-weighted (VW) monthly return indexes for the various investment styles using the returns of individual hedge fund and commodity funds (including non-survivors) during a nine year period from 1990 to 1998 according to Edwards and Caglayan (2001).

The objectivist conceptual approach of risk parity portfolios can be described as follows; Information about uncertainty is captured by estimates of an asset's variances and covariances derived from historical data and the estimates are subject to estimation error. The errors are then analysed, addressed through the application of various error reduction methods. Two approaches used in deriving the data are a bottom-up approach, where the focus begins on the individual assets class indicators or a top-down approach where the portfolio correlations and variances are targeted or simply put, the portfolio risk is budgeted (Thiagarajan and Schachter, 2011). In the second approach, which is called a subjectivist approach; uncertainty is embodied in the different groups of variances and covariances across a discrete set of economic scenarios (or regimes) specified by the manager. These scenarios may be identified with the aid of statistical tools or are entirely dependent on the manager's subjective evaluation, Beach and Orlov (2007). As this second approach may be less familiar, an example may help to illustrate.

(Chaves, *et al.*, 2011) compare RP portfolios with four different types of asset allocation strategies; equal weighting, minimum variance, and mean - variance optimization and the 60/40 portfolio. They look at performance, consistency, and diversification. While the mean - variance optimization and 60/40 portfolios are well-known options as policy portfolios, they also include equal weighting and minimum variance due to their growing popularity. Equal weighting is a naive portfolio that is mean-variance optimal only under restrictive conditions, but it is an easy one to construct. Minimum variance can be constructed using just the covariance information and is MVO only if all the expected returns are the same (Thiagarajan & Schachter, 2011). The topic of RP portfolio construction has been advocated through different lenses and the above is meant to compare and highlight the differences of the strategies typically thought to be efficient.

An alternative concept of RP is a Risk Factor Framework; the investor start by defining the risk. Risk in this case is more comprehensive than any measure of volatility. Particularly in a levered portfolio there are many facets of risk: kurtosis (fat tails), illiquidity, counterparty, contagion, and so on. The second task is the cataloguing of the different sources of risk and development of a covariance structure for the different sources of risk. Some risks are systemic and cannot be controlled—these are the ones that the portfolio manager has to learn to live with, others can be controlled, diversified, and hedged in different ways. More importantly making a clear distinction between controllable and uncontrollable risks according to Thiagarajan and Schachter (2011). At a high level, the two engines of nominal returns are real economic growth and inflation. The manager may then assume four possible scenarios, related to combinations of high/low inflation/growth and express an opinion (however derived) on the performance of each asset class in each scenario. Based on this set of potential outcomes (or states of the world), the manager can select risk contributions that are (approximately) equal Thiagarajan and Schachter (2011).

RP with a risk factor framework; this method is highlights the importance of developing a comprehensive model of risk that the investor can understand which explains the different sources of risk. Vineer Bhansali (2011), discusses sources of risk from a factor-modelling perspective and postulates looking at asset risks rather than focusing on expected returns. The author demonstrates that a portfolio that would be deemed highly diversified, with allocations to nine different classes (out of which only three with about 35% capital allocation are in equities), poses a huge equity concentrated risk factor exposure (nearly 81% of the risk, in his sample), using a

principal component analysis. The risk factors are stable over the long term and mean reverting and can be modelled as a function of factor risk premia. The risk premia for certain factors are then adjusted in response to the prevailing conditions. Bhansali remarked, based on Page and Taborsky (2010), that though asset returns are highly correlated, risk factors provide better diversification in terms of correlations with other assets. Measuring factor exposures requires technical skill to model the estimates and for them to be robust and with stand shocks. The limitation to this method is that it does not incorporate equity specific risk, which reduces the benefits of market neutral and arbitrage portfolios. The author argues that the non-linear cost function of leverage and its impact on risk parity portfolios that use leverage on the lower risk equities (Bruder & Roncalli, (2012).

2.3. Key Findings of the Literature Review

The key findings can be summarised as follows:

- The application of risk parity diversification strategies has not received the same attention as with returns focused strategies that seek to forecast asset returns both academically and in practice. Thiagarajan and Schachter (2011) review the discussion and reveal some important thoughts around the subject,
- The RP method has been criticised because it lacks theoretical basis as opposed to CAPM and MTP.
- CRE is closely linked to the macroeconomic events and through globalisation, the ripple effects of the 2008 GFC are still being experienced across the planet.
- Diversification in the property context can be achieved through property type selection, geographic.
- REIT diversification is similar with regard to property type diversification, geographic diversification, which can either be nationally and international.

3 Research Design

A functionalist research paradigm that was employed in the research will be deductive; it will develop hypotheses and design a research strategy and tests the hypotheses. The focus will be on the data which will then be analysed, synthesised and propose a possible innovative methodology that could be applied to property asset diversification.

- The hypothesis to be tested, please see the literature questions in the section below;
- Expressing the hypothesis in operational terms.
- Testing the hypothesis
- Examining the specific outcome of the inquiry
- If possible modify the theory in light of the findings.

3.1. Research philosophy and approach

The philosophy of my research is going to be that of a positivist, choosing to take the view of a “natural scientist” (Saunders, et al., 2007) approaching the research and information gathering process with an objective inclination, without assuming or making any predetermined opinions about the anticipated results or conclusions which will be informed by the data and the results derived from the data.

Approach is going to be deductive, replicating the structure discussed in previous papers, such as the company information from (Mueller, 1998)

Strategy is going to be grounded in theory, (Saunders, et al., 2007) and attempt to add to the body of knowledge by applying a financial concept to portfolio asset selection to listed property assets.

3.2. Methodology

The literature reveals that there are two overarching theories to real estate and its inclusion in mixed asset portfolios; namely the management of assets in a portfolio which has been done through the use of surveys sent to real estate investment practitioners, Akinsomi, *et al.* (2015), Cook (2012) Hartzell and Webb (1988) and Reddy (2012). The other aspect is the construction of optimal portfolios which discusses the practicality of analysing real estate assets in from a

financial real estate asset analyses in-terms of returns and risks concepts, Liow and Schindler (2011), Palazzi, et al. (2008), Hoesli and Lekander (2007), this paper will focus on the later, and the construction of optimal portfolios.

- Mixed methods that use statistics to make inferences from model results and synthesis of the data.
- Time series data and its challenges vs cross sectional data
- Diversification
- Traditional methods of diversification
- RP diversification

3.3. Research methods

3.3.1 Vector Autoregressive Model

A VAR is a dichotomous regression model, which can have more than one dependent variable, and is a hybrid between a univariate time series model and a simultaneous equation model. VAR models have been preferred over large-scale simultaneous structural models. The key feature of this model is its flexibility and simplistic derivation. The model has been used to analyse moving average errors and can expand to include transformed variables that have equations. The model is also preferred, (Brooks, 2014,), for the simplicity of its notation. In a case where $k = 1$ and $k = 1$, and that every variable depends on the previous values of γ_{1t} and γ_{2t} with an error term, which can be written in the form below;

$$\begin{aligned} \gamma_{1t} &= \beta_{10} + \beta_{11}\gamma_{1t-1} + \alpha_{11}\gamma_{2t-1} + u_{1t} \\ \gamma_{2t} &= \beta_{20} + \beta_{21}\gamma_{2t-1} + \alpha_{21}\gamma_{1t-1} + u_{2t} \end{aligned} \tag{1}$$

Please note the following definitions as per Ling and Naranjo (2015). Where $\gamma_{1t(2t)}$ is a $k \times 1$ vector of endogenous variables, $\beta_{10(20)}$ is $k \times 1$ vector of intercepts; β_{11} , α_{11} and β_{21} , α_{21} are $(k \times k)$ matrix of coefficients, with all eigenvalues of β or α having moduli less than one so that the VAR is stationary. $u_{1t(2t)}$ is a vector of uncorrelated structural shocks or $(k \times 1)$ vector of white noise innovations. Alternatively according to Brooks (2014);

$$\begin{pmatrix} y_{1t} \\ y_{2t} \end{pmatrix} = \begin{pmatrix} \beta_{10} \\ \beta_{20} \end{pmatrix} + \begin{pmatrix} \beta_{11} & \alpha_{11} \\ \alpha_{21} & \beta_{21} \end{pmatrix} \begin{pmatrix} y_{1t-1} \\ y_{2t-1} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \end{pmatrix} \quad (2)$$

An even simpler alternative;

$$y_t = \beta_0 + \beta_1 y_{t-1} + u_t$$

$g \times 1 \quad g \times 1 \quad g \times g \quad g \times 1 \quad g \times 1$

(3)

In the equation above the condition is such that $g = 2g = 2$ variables in the model. The model can be extended further to incorporate k lags in each variable of each equation;

$$y_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \dots + \beta_k y_{t-k} + u_t$$

$g \times 1 \quad g \times 1 \quad g \times g \quad g \times 1 \quad g \times g \quad g \times 1 \quad g \times g \quad g \times 1 \quad g \times 1$

(4)

The model has the ability to get extended to incorporate a scenario that has first difference terms and co-integrating relationships also known as a vector error correction model (VECM).

Advantages of VAR modelling;

- VAR models have advantages compared to univariate time series models and simulation equations structural models;
- All variables are considered endogenous, the researcher does not have to specify the variables in the model. (Brooks, 2014).
- VARs are flexible than univariate AR models, because they can depend on any number of the variable's lags or combinations of white noise. VAR's allow the researcher to capture more features about the data.
- On condition that there are no contemporaneous terms on the right-hand-side of the equation, OLS can be used separately on each equation. Variables on the right hand side are pre-determined and are known and can include all exogenous variables and lagged values of endogenous variables as well.
- VAR's are said to forecast better than structural models, as large scale structural models cannot forecast with required level of accuracy. McNees (1986) uses VARs to forecast US unemployment rate and, real gross national product (GNP).

Challenges with VARs;

- VARs are a-theoretical, as theory does not inform the correlations between the variables nor inform the specification of the model. Due to the scant theoretical foundation its analysis becomes a challenge and as such cannot be implemented as a policy portfolio.
- What is a reasonable lag term per variable?
- With the number of parameters that can be added, the estimation of these parameter increase with the sample size and reduce the confidence intervals even in cases of small sample sizes.

According to (Ling & Naranjo, 2015) in their paper where they examine return dynamics between private and public real estate returns provide insights on the application of the VAR model to real estate data and economic data in order to derive or explain the relationship between REIT returns and the private property returns. They begin by defining the model as discussed above, they then compare both returns adjusted by transforming the data, in order to make like for like comparisons, the first part regresses the model based on the return series and the second part of their analysis they incorporate exogenous asset pricing variables into the model (Ling & Naranjo, 2015).

Ling and Naranjo (2015) highlight the critical tests used to ensure that the model is robust, namely the Akaike Information Criterion (AIC) for the various choices of p and confirm that they lag selection. The model is then tested for the likelihood ratio selection criteria and the Schwarz Bayesian Information Criteria (SBIC). The data they use is REIT returns which come levered and net of management fees, and NCREIF TBI which is the return time series of transaction based index of returns. Their model also includes asset pricing variables which are namely; the yield on three month U.S Treasury securities (TBILL3M), the slope of the treasury term structure of interest rates measured by the difference between ten year and three month constant maturity U.S Treasury yields (TERMSPREAD), the spread between yields on BAA rated and AAA rated corporate bonds (DEFSPREAD), the rate of inflation (INFL), and the excess return on the market portfolio (MKT). The authors also incorporate Fama – French risk factors, SMB which is the return of portfolios of small minus big stocks, the HML which represents returns on portfolios of high book to market minus low book to market stocks and they augment the data by a return momentum factor, MOM. They further include a liquidity innovation factor (proposed by Pastor and Stambaugh, 2003). Lastly the authors include control variables namely, dividend yield (DIVYLD), on equity REITs and the aggregate capitalization rate (CAPRATE), this variable defined as the ratio between the property's annual net rent and its price, which is a proxy for the

yield (Ling & Naranjo, 2015). The framework for the success of the model are that the variables are stationary, the augmented Dickey Fuller (DF) and Phillips-Perron unit roots tests are used to analyse the model (Ling & Naranjo, 2015).

3.3.2 Risk Parity

MV Portfolio and maximum diversification (MD) portfolio are related to risk parity, and they are orientated towards controlling portfolio loss where a downside risk measure is used or a guiding threshold to limit loss. Risk Parity has been discussed into three main avenues namely;

- Very strict form: an equal risk contribution (ERC) portfolio on bonds and equities,
- Limited: all the assets have the same risk contribution,
- In a wider sense: a risk budgeting portfolio.

Weight budgeting (WB) and Performance budgeting (PB) can be considered traditional portfolio construction method (Roncalli, 2012). Risk budgeting (RB) or risk targeting. ERC portfolio, all the assets have the same risk budget. Two condition are to be held that Ex Post and Ex Ante are not equal, and the (RB is equal to PB). And $x = (x_1, \dots, x_n)$ represents the weights in n assets in a portfolio. $R(x_1, \dots, x_n)$ is the condition that the risk measures are coherent and convex.

$$\begin{aligned} \mathcal{R}(x_1, \dots, x_n) &= \sum_{i=1}^n x_i \cdot \frac{\partial \mathcal{R}(x_1, \dots, x_n)}{\partial x_i} \\ &= \sum_{i=1}^n RC_i(x_1, \dots, x_n) \end{aligned} \quad (5)$$

$b = (b_1, \dots, b_n)$ is the vector of budgets such that $b_i \geq 0$ and $\sum_{i=1}^n b_i = 1$. The formulas that get derived become, weight budgeting (WB)

$x_i = b_i$, risk budgeting (RB) $RC_i = b_i \cdot R(x_1, \dots, x_n)$. Where Σ is the covariance matrix of the asset returns, the risk measure is $R(x) = \sqrt{x^T \Sigma x}$ is the volatility of the portfolio $\sigma(x) = \sqrt{x^T \Sigma x}$ the formula derived becomes;

$$\begin{aligned}
\frac{\partial \mathcal{R}(x)}{\partial x} &= \frac{\Sigma x}{\sqrt{x^\top \Sigma x}} \\
RC_i(x_1, \dots, x_n) &= x_i \cdot \frac{(\Sigma x)_i}{\sqrt{x^\top \Sigma x}} \\
\sum_{i=1}^n RC_i(x_1, \dots, x_n) &= \sum_{i=1}^n x_i \cdot \frac{(\Sigma x)_i}{\sqrt{x^\top \Sigma x}} = x^\top \frac{\Sigma x}{\sqrt{x^\top \Sigma x}} = \sigma(x)
\end{aligned} \tag{6}$$

The risk budgeting portfolio is defined by the following system of equations;

$$\begin{cases} x_i \cdot (\Sigma x)_i = b_i \cdot (x^\top \Sigma x) \\ x_i \geq 0 \\ \sum_{i=1}^n x_i = 1 \end{cases}$$

Risk Budgeting has been used by Bruder & Roncalli. (2012), as a method to manage sovereign bond portfolios by budgeting the risk of each country in proportion of the country's GDP. Equal risk contribution portfolio where individual asset risks are equalised, based on the estimates of their correlations and variances, in essence the risk contribution determines the allocation weight of the asset (Bruder & Roncalli, 2012), (Thiagarajan and Schachter, 2011). Maillard, Roncalli and Teiletche(2010) illustrated that the portfolio is somewhere in between minimum variance and equally weighted portfolios (Bruder & Roncalli, 2012). In their paper they focus on volatility risk measure. In a two asset case, let ρ be the correlation and $x = (w, 1-w)$ be the vector of weights. The ERC portfolio is;

$$w^* = \frac{1}{\sigma_1} \bigg/ \left(\frac{1}{\sigma_1} + \frac{1}{\sigma_2} \right)$$

The RB portfolio with $(b, 1-b)$ as a vector of risk budgets is;

$$w^* = \frac{(b-1/2)\rho\sigma_1\sigma_2 - b\sigma_2^2 + \sigma_1\sigma_2\sqrt{(b-1/2)^2\rho^2 + b(1-b)}}{(1-b)\sigma_1^2 - b\sigma_2^2 + 2(b-1/2)\rho\sigma_1\sigma_2} \tag{7}$$

The equations above introduce some convexity with respect to b and ρ . In the case of uniform correlation $\rho_{ij} = \rho$; ERC portfolio $b_i = \frac{1}{n}$

$$x_i(\rho) = \frac{\sigma_i^{-1}}{\sum_{j=1}^n \sigma_j^{-1}}$$

RB portfolio

$$x_i\left(-\frac{1}{n-1}\right) = \frac{\sigma_i^{-1}}{\sum_{j=1}^n \sigma_j^{-1}}, \quad x_i(0) = \frac{\sqrt{b_i} \sigma_i^{-1}}{\sum_{j=1}^n \sqrt{b_j} \sigma_j^{-1}}, \quad x_i(1) = \frac{b_i \sigma_i^{-1}}{\sum_{j=1}^n b_j \sigma_j^{-1}} \quad (8)$$

The general case becomes;

$$x_i = \frac{b_i \beta_i^{-1}}{\sum_{j=1}^n b_j \beta_j^{-1}}$$

3.4. Population and Sampling

The South African Property sector has been one of the country's best performing sector, and according to Akinsomi, *et al.*, (2015), from 2007 until 2013 the property industry had grown by 128%. The population has been selected from the, the SA REIT Association, (2011 and 2019) chartbooks, which revealed the companies that had been in existence during this period when the property market experienced the growth mentioned above, (The SA REIT Association, 2019).

The data is geographically focused to companies that reside within South Africa. The companies selected were chosen with the following considerations;

- The companies have to be listed on the Johannesburg Stock Exchange (JSE) similarly to (Ro & Ziobrowski, 2011).
- The company's historical weekly closing prices data from 18 February 2006 to 21 December 2018. Which represents a twelve year period, which encompasses atleast two business cycles and is in line with previous research (Sebehela, 2009)
- The shortlist was made available from the SA REIT website, the 2011 chart book.
- Please refer to the 2018 Chart book (The SA REIT Association, 2019).

It should be noted that most companies changed REIT status after 1 April 2013 Section 25BB of the Income Tax Act legislation.

3.5. Development of the Research Instrument(s)

The data collected were of the following companies in order of size as discussed by Mueller (1998) and Ro and Ziobrowski (2011). *Growthpoint Properties*, is the largest South African REIT, in both size measured by gross lettable area and with regard to sectoral diversification. The company has direct property ownership in Australia and is listed on the JSE, FTSE and ASX. *Redefine Properties*; this company has kept its local operations to the traditional property sectors, namely retail, offices and industrial. The company has shared interests in Europe, majority being focused in Poland. *Resilient Properties*; a pure retail focused REIT. It has subsidiaries namely Fotress A and B and has direct joint venture holdings with assets in Nigeria and Portugal. The REIT has diversified geographically in South Africa, area of expertise is the lower LSM locations. *Hyprop Investments*; this is another Retail focused REIT. Its portfolio can be considered focused to the higher LSM markets, it has foreign interests in Ghana, Nigeria and Zambia, South European

interests as well in Bulgaria, Croatia, Serbia, Montenegro and Macedonia. *Vukile Property Fund*; though its portfolio is predominantly retail, it has some holdings in industrial, offices. Its approach has been to diversify geographically with interests in Namibia, Spain (retail and offices) and in the United Kingdom as well as stakes in local REIT companies. *South African Corporation*; is one of the oldest real estate company in South Africa. Sectorial diversification is composed, in order of size Industrial, retail and residential. It also has investments in Zambia's retail segment. *Emira Property Fund*; the firm's strategy has been to diversify equally in the traditional real estate sectors, retail, offices and industrial. The other interesting aspect of this company is that it has interests in the United States in partnership with Rainer and US based REIT with the intention to focus on retail segments on various location. *Hospitality Group*; this is a hospitality focused REIT, and is the property arm of Sun International. The portfolio is focused within South Africa, and has diversified through different income groups. *Octodec Investments*; perhaps the only REIT, with geographical focus of Gauteng, the sectoral spread is equal retail, offices, industrial and residential. The core focus of the company has been to operate in the CBD's of Pretoria and Johannesburg. *Fairvest Properties*; this REIT has a focus on retail and as seen with other retail REITs, the company has a geographically spread portfolio to various locations in South Africa and their assets are situated in the lower LSM locations.

3.6. Data collection Protocol

The criteria for selection was that companies analysed had weekly share price data for a minimum period of 10 years. The latest date used was from 11 February 2006 until 22 December 2018. The important implication of the data range is that it incorporates the South African business cycles and the sub-prime mortgage crisis of 2008 and subsequent periods after. The returns were logged to convert the data into continuous time series and enabled the data to be modelled in a vector autoregressive framework. The data is ordered as discussed by Mueller (1998), regarding the market capitalization of the firms on the list.

3.7. Ethical Risks and Mitigation Strategy

The ethical considerations for any research are that the research population cannot be embarrassed, harmed or be disadvantaged in any form, anonymity and confidentiality are paramount when conducting research with participants (Saunders, et al., 2007).

The ethical risk criteria was mitigated by only selecting companies that are listed on the JSE and that, information used is publically available information sourced from the company websites.

Data collected from the online libraries, were freely available to researchers and represents disclosed information which is an element of the companies consenting to disseminate the information about their historical performance.

3.8. Validity and Reliability

Below are tables of the information extracted from the annual integrated reports of the companies selected. It should be noted as referred to in his paper Ducoulombier (2007), that financial data analysis cannot be limited to the first moments namely the mean and median but it is also important to include the second order moments which are namely; (i) mean, also known as the average figure of the data and has been viewed as a benchmark. Secondly, the median is simply the middle number and both are measures of central tendency. The other statistics used to analyse the data are the measures of spread, which is the standard deviation; which cannot be explained without the mention of variance, where variance is the average deviation of every data point in relation to the mean. Standard deviation is the square root of the variance; the former is preferred to the latter purely due to the fact that the units will reflect the same units of the variable being measured according to Brooks (2014). Skewness measures the distribution of the data; in a normally distributed data set the skewness will be equal to zero. Investors want the skewness to be positive, in cases of long holding periods, because this means higher risk, information asymmetries which could lead to above average returns. The kurtosis measure reveals the height or fatness of the distribution tails to be analysed. A high kurtosis figure means that there are extreme outliers. A normal distribution kurtosis value is 3, any figure above 3 represents a leptokurtic distribution which is characteristic of real estate or economic time series which has the potential of extreme values, Brooks (2014).

3.9. Data Analysis

Table 1: Market Capitalisation Rate and Investor information

	Market cap:	EPS:	P/E ratio:	Dividend yield:	Last dividend:	Return on equity:	Return on assets:	Net asset value:	Authorised shares:	Issued shares:
GRT	82,597,799,587	179.64	15.67	6.96%	1.01	10.73%	7.35%	2,518.00	4,000,000,000	2,934,202,472
RDF	61,832,110,440	83.63	13.01	8.46%	0.47	6.32%	8.50%	1,022.53	10,000,000,000	5,683,098,386
RES	45,899,281,540	1764.87	6.12	5.59%	3.06	41.86%	6.35%	10,075.00	1,000,000,000	424,954,000
HYP	27,408,041,789	644.39	17.12	6.30%	3.48	11.04%	6.89%	9,978.00	500,000,000	248,441,278
VKE	15,797,346,968	125.42	16.05	8.04%	0.73	13.42%	7.45%	1,917.00	1,500,000,000	784,766,367
SAC	12,400,377,751	43.56	11.25	8.97%	0.22	13.68%	11.81%	511	4,000,000,000	2,530,689,337
EMI	7,646,621,824	101.11	14.47	9.79%	0.74	8.06%	6.66%	1,734.70	2,000,000,000	522,667,247
HPB	6,417,511,698	122.52	9.06	11.54%	0.27	3.46%	4.48%	2,009.00	2,000,000,000	578,154,207
OCT	4,816,900,958	171.25	10.54	11.25%	0.98	8.78%	7.18%	2,933.00	500,000,000	266,864,319
FVT	1,765,255,297	19.23	10.66	8.94%	0.09	17.52%	14.69%	218.18	3,000,000,000	861,100,145
Mean	26,658,124,785	325.56	12.40	8.58%	1.11	13.49%	8.14%	3,291.64	2,850,000,000	1,483,493,776
Median	14,098,862,360	123.97	12.13	8.70%	0.74	10.89%	7.27%	1,963.00	2,000,000,000	681,460,287
STD Dev	27,741,454,120	535.61	3.49	1.96%	1.19	10.74%	2.96%	3,647.44	2,819,081,805	1,750,629,179
Skewness	1.1743	2.6342	-0.3236	0.0630	1.5114	2.3792	1.4442	1.5452	2.0619	1.8428
Kurtosis	0.2395	7.1364	-0.6325	-0.7633	1.0291	6.5223	1.9827	0.9682	4.9706	3.1982

Table 1 represents publically available information of the companies; market capitalisation, earnings per share, price to earnings ratios, dividend yield, last dividend amount, it should be noted that the last dividend paid by companies was in 2017 except for Resilient which paid in 2018, return on equity invested in the company, return on assets, net asset value, registered shares and the shares in issue. The means serve as an implied benchmark to compare the companies in relation to each other. The standard deviation reveals the variance of the data in relation to the mean, implying the risks associated in the sector. The skewness and kurtosis for all points are positive except for Price to earnings ratios which reveal that there are possibilities that extreme events are possible. It should be noted that the earnings per share, return on equity and authorised shares are reporting excess kurtosis synonymous with real estate assets.

Table 2: Financial Information

	Total Revenue	Share Price	Shares Out	Market Capitalization	Total Enterprise Value	Total Capital
GRT	10,926,000,000	2,500	2,971,000	7,427,453,200	7,481,254,200	131,394,000
RDF	8,686,800,000	1,042	5,765,800	6,007,963,400	6,037,115,900	94,273,100
RES	3,866,900,000	6,483	425,000	2,754,976,800	2,770,038,000	39,806,900
HYP	3,160,400,000	9,000	2,559,000	2,303,050,600	2,310,310,500	34,280,200
VKE	2,343,600,000	2,096	898,200	1,882,687,200	1,896,893,400	32,766,500
SAC	2,272,000,000	374	2,530,700	946,477,700	952,219,800	19,391,500
EMI	1,824,400,000	1,521	522,700	794,976,900	800,537,100	14,638,200
HPB	866,900,000	950	578,200	549,246,500	0	0
OCT	1,865,300,000	1,985	266,200	528,402,100	532,554,700	12,670,900
FVT	435,200,000	208	1,005,900	209,235,600	209,369,700	3,231,400
Mean	3,624,750,000	2,616	1,752,270	2,340,447,000	2,299,029,330	38,245,270
Median	2,307,800,000	1,753	952,050	1,414,582,450	1,424,556,600	26,079,000
STD Dev	3,444,706,526	2,861	1,731,965	2,473,788,869	2,539,563,748	42,320,811
Skewness	1.5276	1.6758	1.5324	1.4052	1.3470	1.5546
Kurtosis	1.3741	2.0426	2.3427	0.9165	0.8114	1.7601

In Table 2 above, the total revenue column represents the turnover the company recorded in ZAR, the share price the denomination in cents, shares out simply put are the shares the company has issued, the market capitalisation rates as reflected on the Bloomberg database as the total enterprise value as calculated in the IFRS format. The descriptive statistics here are quite muted compared to the previous, the mean again serving as the data benchmark to indicate the top performing companies to be Growthpoint and Redefine. The standard deviation also reveals the variability of the data, which merits the notion of reviewing portfolio weightings from a strategical asset allocation perspective. The positively skewed data points are good for investors; there are no signs of excess kurtosis in this instance.

Table 3: Property Sector Allocations (Gross Lettable Area)

	Retail	Value Centres	Offices / Commercial	Industrial	Storage	Specialised	Residential	Hotel	Total Property SA
GRT	1,390,878	231,171	1,791,626	2,254,812	-	-	-	-	5,668,487
RDF	1,400,000	-	1,300,000	1,800,000	-	100,000	-	-	4,600,000
RES	1,096,890	-	-	-	-	-	-	-	1,096,890
HYP	653,258	48,848	20,354	-	-	-	-	-	722,460
VKE	852,177	-	28,093.74	37,458.32	-	9,365	-	-	936,458
SAC	353,524	-	61,483	737,790	30,741	-	353,524	-	1,537,063
EMI	322,065	-	318,524	348,699	-	-	-	-	989,288
HPB	-	-	-	-	-	-	-	9,001	9,001
OCT	349,633	95,009	413,581	253,396	-	139,171	393,643	-	1,644,433
FVT	227,019	-	10,946	-	-	-	-	-	237,965
Mean	664,544	37,503	394,461	543,216	3,074	24,854	74,717	900	1,744,205
Median	503,391	-	44,788	145,427	-	-	-	-	1,043,089
STD Dev	498,548	75,121	634,345	823,602	-	50,858	157,800	-	1,873,008
Skewness	0.4368	2.3217	1.7150	1.5425	-	1.9079	1.7947	-	1.5383
Kurtosis	-1.2597	-	1.8651	1.1160	-	0.0000	-	-	1.3338

Table 3 shows the sectoral spread of the different companies, please note that specialised has been used as the sector not considered as traditional investment sector, for example here these were either motor dealerships or logistical and distribution, the notable difference here is that Growthpoint has consolidated into industrial or offices, for some of their more specialised property portfolio. The industrial mean is higher than all other sectors; this could be an indication of the South African economy still reliant on the manufacturing industry. The retail also follows quite closely and is a product of consumer spending patterns in the country. The standard deviation again is far much higher in the industrial real estate sector, the data driven mostly by the top two companies namely Growthpoint and Redefine, these two companies have a larger geographically diverse portfolio than the rest of the firms in the data. The skewness is positive for all the measured sectors; however the retail segment is perhaps alluding to the saturation and proliferation of shopping centre. The kurtosis is highest for the industrial segment and a negative kurtosis in retail revealing the likelihood of extreme outcomes are not as pronounced as in the share price and panels.

4 Research Execution Plan

- The plan was to gather the data.
- Review and synthesis the data.
- Analyse the data.
- Interpret the results.

4.1. Research Constraints

Time; Initially the study was going to focus on both listed and direct real estate assets, the limited time available meant that the listed property would be analysed.

Data availability; Direct property performance information is not freely and readily available.

Financial resources; the research paper was conducted while working.

4.2. Research Timeline

- The process took four months to prepare a document.

4.3. Resources Required

- Time and support from my supervisor.

5 Data Analysis

The information gathered and analysed has been of the REITs listed on the South African stock exchange. The information has been sourced from the the SA REIT Association, (2019). The companies were selected based on the following criteria; the company has to have been in operation for longer than ten years, to incorporate different economic business cycle as mentioned by Malpezzi and Wachter, (2005). The companies have to be listed on the johannesburg stock exchange as similarliy done by Cook, (2012), who also cites that listed companies are easier to compare as they all have to comply to the listing requirements. The data is derived from weekly closing prices of the listed companies, starting from 2006 to 2018. The companies closing share prices have been logged for the data to conform to a vector autoregressive model.

The application of a vector autoregressive model to the data of listed property companies is in an attempt to examine the relationships between the companies, through a joint estimation scheme such as the vector auto-regression model (Bjørnland and Leitemo, 2009). This section first presents the vector autoregressive results of one period lag (1:1) returns / prices and the test applied to the confirm the results of the coefficients and the t- statistic are the Cholesky graphs. The tests applied to the data tables are the F-statistic for hypothesis testing, it is the generalisation of the t-test, the bigger the F-values the smaller the probability value, a value closer to 1 means that the null hypothesis is true (Sharpe, et al., 2012). The next is the Akaike information criterion (AIC) which measures the goodness of fit of a model, it is suitable for logged data sets, and is useful for comparing two or more models and the lowest AIC figure is usually chosen. The Schwarz information criterion (SIC), like the AIC it imposes a penalty on the inclusion of a large number of variables in a model, the lowest SIC value is preferred when comparing models (Gujarati, 2012).

It should be mentioned that it is relevant to present all the graphs in the Cholesky decomposition sections for greater representation of the data, the assets are combined and analysed against each other inorder to determine assets that are best to suited to be included in a risk parity portfolio strategy. The last part of the chapter discusses an equal risk contribution portfolio (ERC). The vector autoregressive section is an asset selection tool assessing the relationship between individual assets, the ERC in this study is considered to be a portfolio construction tool. The steps

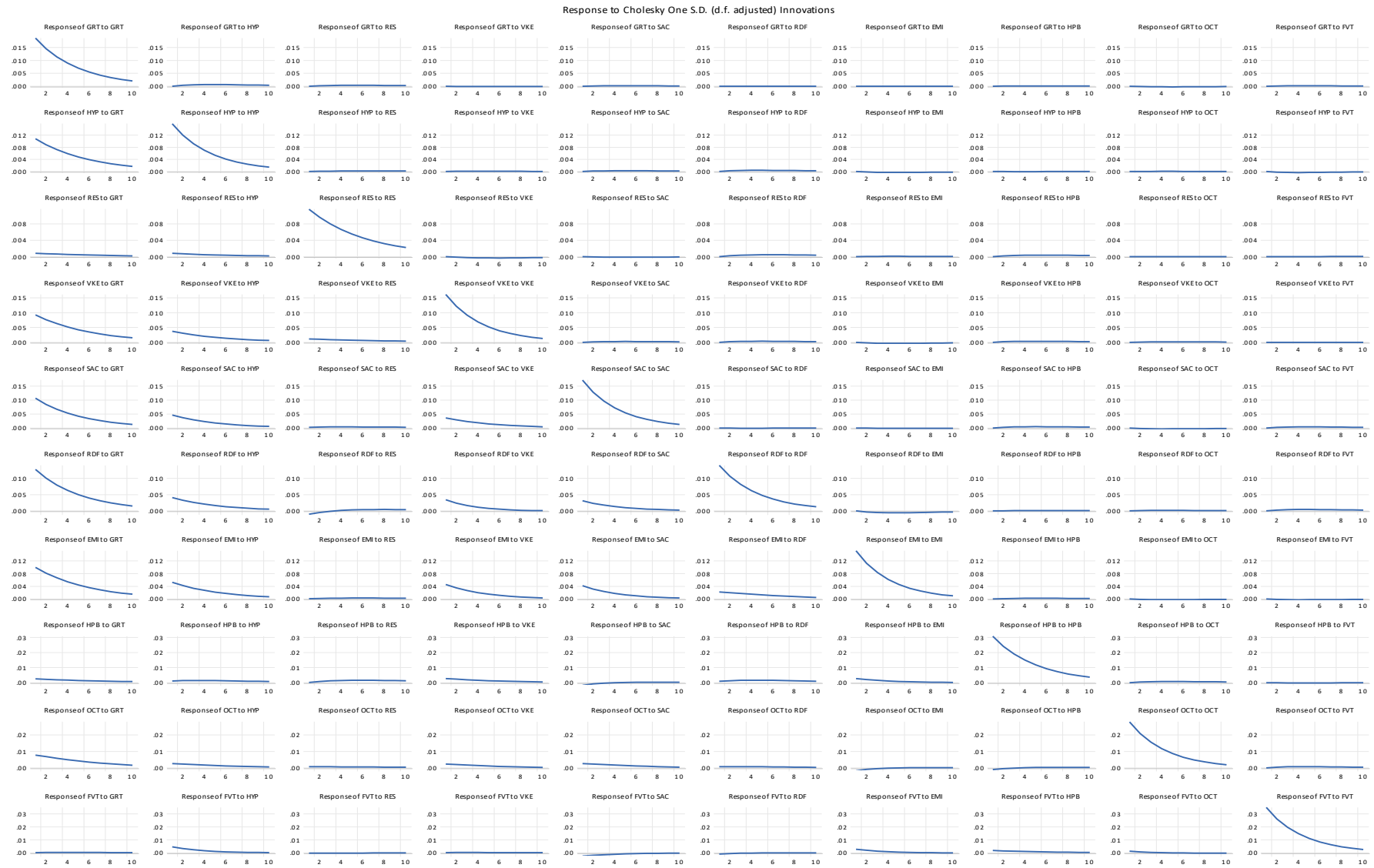
taken for the construction of an ERC portfolio were; the correlation matrix was created from the logged returns of the data. The standard deviations of all the assets were derived and a covariance matrix was created. The previous steps allowed for the creation of the portfolio, the results are presented and discussed below. **VAR (1;1)**

Table 4: VAR (1;1)

	GRT	HYP	RES	VKE	SAC	RDF	EMI	HPB	OCT	FVT
GRT (-1)	0.770217 (46.8167)	0.025498 (1.50416)	0.000647 (0.06266)	0.019548 (1.16392)	0.017141 (0.91675)	0.021464 (1.21692)	0.017304 (0.97614)	-0.042381 (-1.53433)	0.017776 (0.6828)	0.014083 (0.44734)
HYP (-1)	0.021567 (1.46358)	0.759233 (50.0038)	0.000633 (0.06845)	0.013042 (0.867)	0.006917 (0.41304)	0.011789 (0.74624)	0.015031 (0.94666)	0.014011 (0.56631)	-0.001492 (-0.06398)	-0.013181 (-0.46743)
RES (-1)	0.014873 (0.95856)	0.006062 (0.37916)	0.830863 (85.2963)	0.012414 (0.78373)	0.010649 (0.60391)	0.028239 (1.6976)	0.011786 (0.70495)	0.06092 (2.33851)	0.016214 (0.66036)	-0.004096 (-0.13793)
VKE (-1)	-0.005619 (-0.40095)	0.002263 (0.15668)	-0.013266 (-1.50768)	0.751734 (52.5418)	0.013912 (0.87345)	-0.008412 (-0.55986)	0.001191 (0.07886)	-0.004645 (-0.19739)	0.002324 (0.10477)	0.007378 (0.27508)
SAC (-1)	0.008262 (0.62995)	0.005934 (0.43909)	-0.006961 (-0.84544)	0.00877 (0.65504)	0.753955 (50.5842)	0.003685 (0.26209)	-0.002605 (-0.18434)	0.017174 (0.77997)	0.017341 (0.83555)	0.002056 (0.0819)
RDF (-1)	-0.000965 (-0.06395)	0.016829 (1.08243)	0.014687 (1.55047)	0.014836 (0.96318)	-0.002347 (-0.13688)	0.767196 (47.4259)	0.024696 (1.51897)	0.0446 (1.76051)	0.016388 (0.68631)	0.014078 (0.48754)
EMI (-1)	-0.001569 (-0.11194)	-0.011094 (0.7679)	0.00139 (0.15788)	-0.015484 (-1.08188)	-0.0068 (-0.42678)	-0.023899 (-1.58997)	0.742936 (49.1779)	-0.005213 (-0.22147)	0.022029 (0.9929)	-0.012197 (-0.4546)
HPB (-1)	0.001007 (0.15594)	-0.000512 (-0.07697)	0.005312 (1.30978)	0.005712 (0.86607)	0.007436 (1.0128)	0.001558 (0.2249)	0.004631 (0.6652)	0.785869 (72.4516)	0.009314 (0.91104)	0.006192 (0.50087)
OCT (-1)	-0.004901 (-0.64468)	0.001186 (0.15135)	-0.000969 (-0.20306)	0.002958 (0.38117)	-0.007132 (-0.82653)	0.003022 (0.37073)	-0.00443 (-0.54082)	0.013242 (1.03741)	0.747715 (62.1497)	-0.008506 (-0.58462)
FVT (-1)	0.00321 (0.53154)	-0.006397 (-1.02806)	-0.0000593 (-0.01565)	-0.001391 (-0.22559)	0.006921 (1.00844)	0.007016 (1.08362)	-0.00395 (-0.6071)	-0.004246 (-0.4188)	0.01357 (1.42004)	0.750578 (64.9495)
F-Statistic	532.2038	532.3254	747.4540	511.3535	474.9927	506.2039	498.2195	561.2639	473.9782	429.6765
Akaike AIC	-5.1285	-5.0686	-6.0596	-5.0872	-4.8726	-4.9893	-4.9791	-4.0921	-4.2105	-3.8305
Schwarz SC	-5.1084	-5.0485	-6.0395	-5.0671	-4.8525	-4.9692	-4.9591	-4.0720	-4.1904	-3.8104

Table 4 presents the data for all the companies included in the model. Each column presents the coefficients of each company and the rows represent the one period lagged returns and the results provide an indication of the influence each lag has on a particular company. The highlighted areas represent the lagged returns of the same asset and its influence on the current prices; the coefficients are significantly close to 1 which implies that there is a possible non-stationarity in the data. The figures in brackets represent the t – statistic which indicates the level of significance and any figure above 2 means that the effect is statistically significant. Apart from the diagonal logical relationship of the variables the Resilient Properties and Hospitality Group display some level of significance 2.34, the influence especially coming from the one period lagged returns of Resilient properties. The logical explanation is that both portfolios have a geographically diverse portfolio with a near representation in all nine South African provinces, however from a sector perspective they operate in different sectors, Hospitality is a leisure and hospitality company which owns hotels and differs from Resilient, which is a retail only REIT, where they have hotels and resorts in the Western Cape. Resilient does not own any properties in that region of South Africa. The F-values are so high that one cannot reject the hypothesis that all combined, the lagged terms are statistically significant.

Figure 1: VAR (1;1): Cholesky Decomposition



The Cholesky decomposition results above indicate whether firms provide diversification benefits or if they are better suited for risk parity minimization strategy. The graphs with curves that slope indicate that there are contemporaneous effects to shocks of the company in the column heading. Similar to the (1;1) table the biggest or steepest curves occur within the same company lagged period. The interpretation of the graphs are that, the shocks happen in the column and the various rows of lagged company prices are either affected or not affected as in cases where the graphs have flat slopes, for example a shock in the price of the Growthpoint share price will affect the lagged term over a period of two months, or as indicated in the graphs 8 periods, (recall our data is of weekly closing prices and a period of 4 is equal to a month).

As can be seen in the Growthpoint vector, it reveals that there could be contemporaneous effects in lagged period prices of Hyprop, Vukile, SA Corp, Redefine and Emira property and Octodec Investments, it should be noted that the effects stem from all companies having the majority of their real estate portfolios geographically focused in Gauteng. The two companies that do not exhibit any contemporaneous effects of shocks to Growthpoint are Resilient and Hospitality.

This could be due to the companies having more geographically diverse portfolio across the country. The rest of the matrix reveals that the relationship of the other firms can be included in risk minimisation strategies. The graphs that are flat indicate a risk parity potential between assets. The Hospitality share seems to only have some responses to shocks of its own lagged term, due to it being the only hotel and leisure focused REIT, indicating that its inclusion in the overall portfolio will add to a risk minimisation strategy. The other company that exhibits similar characteristics is Fairvest with a retail focus, it has a geographically diverse portfolio with its highest revenue coming from Kwazulu Natal, and it has a slight response to a similar retail REIT being Hyprop.

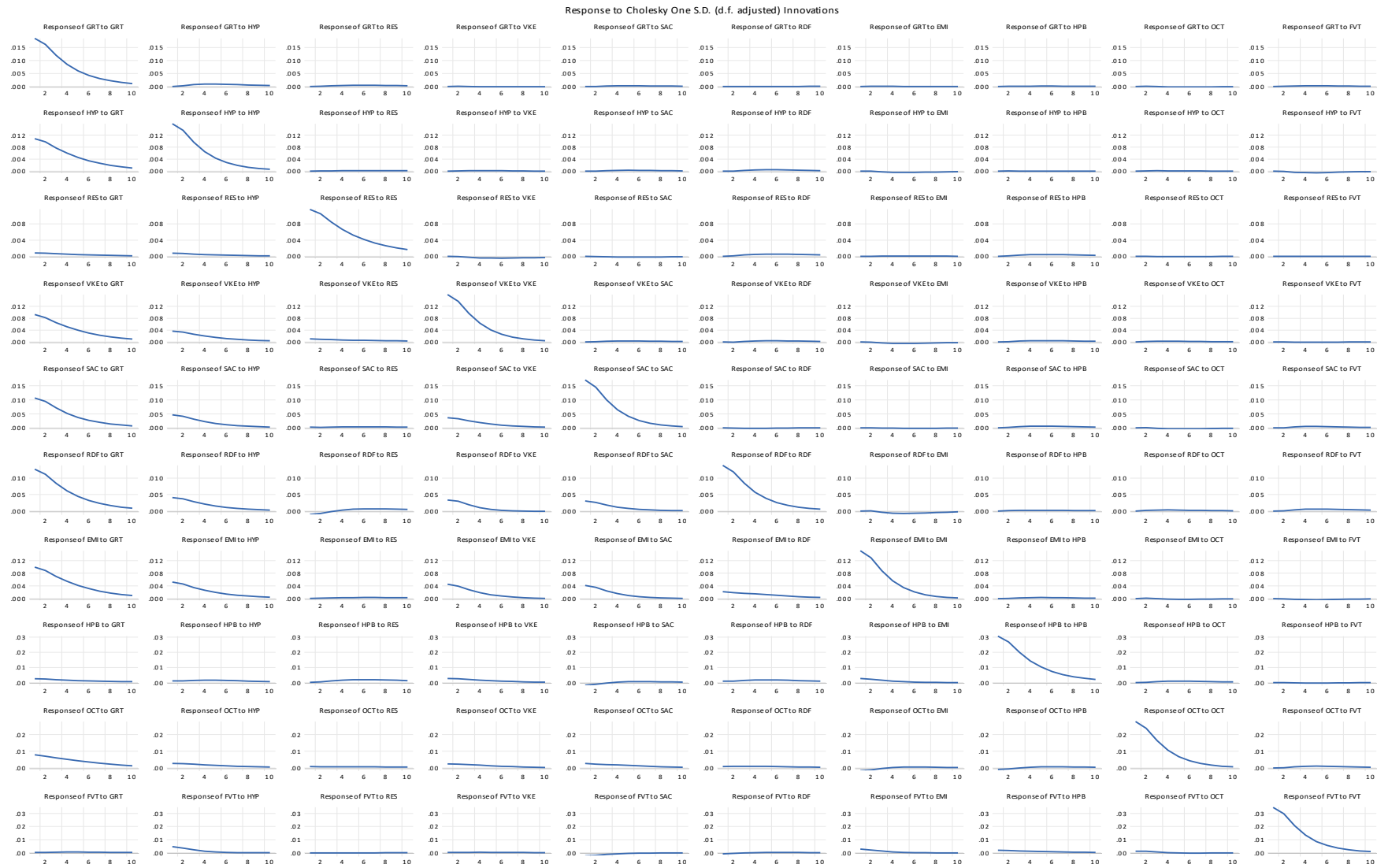
5.2. VAR (1;2)

Table 5: VAR (1;2)

	GRT	HYP	RES	VKE	SAC	RDF	EMI	HPB	OCT	FVT
GRT (-2)	-0.126171 (-5.07866)	0.016984 (0.66368)	0.000929 (0.0594)	0.017042 (0.67254)	0.012726 (0.41548)	0.020447 (0.76839)	0.01006 (0.37629)	-0.036277 (-0.8696)	0.022113 (0.56377)	0.009083 (0.19158)
HYP (-2)	0.012893 (0.58277)	-0.136379 (-5.9844)	0.0017 (0.12199)	0.008045 (0.35653)	-0.000215 (-0.00856)	0.004112 (0.17354)	0.01129 (0.47419)	0.01698 (0.045707)	-0.007687 (-0.22007)	0.00185 (0.04382)
RES (-2)	0.012785 (0.46084)	0.002656 (0.09296)	-0.092257 (-5.28039)	0.015139 (0.53499)	0.013339 (0.42375)	0.022747 (0.76549)	0.010329 (0.34595)	0.044256 (0.94998)	0.014488 (0.33076)	-0.007311 (-0.13808)
VKE (-2)	-0.009162 (-0.43203)	-0.000215 (-0.00982)	-0.009771 (-0.73156)	-0.143816 (-6.6486)	0.007794 (0.32391)	-0.010917 (-0.4806)	0.001112 (0.04871)	-0.004096 (-0.11501)	-0.003454 (-0.10316)	0.010184 (0.25162)
SAC (-2)	0.009557 (0.48351)	0.006091 (0.29919)	-0.005695 (-0.4575)	0.004752 (0.23572)	-0.13726 (-6.12065)	0.006615 (0.31249)	-0.002828 (-0.13298)	0.008316 (0.25057)	0.020339 (0.65178)	-0.005797 (-0.15368)
RDF (-2)	0.000411 (0.01773)	0.017495 (0.73305)	0.008863 (0.60739)	0.018598 (0.78697)	0.001734 (0.06598)	-0.125334 (-5.05044)	0.029457 (1.1814)	0.039995 (1.02799)	0.007983 (0.21824)	0.003873 (0.0876)
EMI (-2)	-0.004684 (-0.22026)	-0.012875 (-0.58771)	0.001737 (0.12973)	-0.015459 (-0.71267)	-0.007082 (-0.29351)	-0.027594 (-1.21138)	-0.15145 (-6.61749)	-0.004046 (-0.1133)	0.022687 (0.67568)	-0.004401 (-0.10843)
HPB (-2)	0.000438 (0.042140)	-0.00275 (-0.2568)	0.00269 (0.41081)	0.003403 (0.3209)	0.003642 (0.30873)	-0.00218 (-0.19573)	0.002216 (0.1981)	-0.119078 (-6.82123)	0.005171 (0.31507)	0.005226 (0.26342)
OCT (-2)	-0.007546 (-0.65936)	-0.001658 (-0.14066)	-0.001266 (-0.17566)	-0.00043 (-0.0368)	-0.010853 (-0.83577)	-0.001773 (-0.14464)	-0.009238 (-0.75006)	0.008634 (0.44925)	-0.144742 (-8.01028)	-0.012489 (-0.57179)
FVT (-2)	0.003071 (0.3355)	-0.0051 (-0.54086)	-0.00000454 (-0.000079)	-0.001454 (-0.15578)	0.006872 (0.66168)	0.006513 (0.6643)	-0.00295 (-0.29951)	-0.005151 (-0.33513)	0.013897 (0.96156)	-0.143758 (-8.22907)
F-Statistic	271.9312	271.9317	377.5014	262.1632	244.3120	259.5061	255.7471	286.5579	244.0020	222.1176
Akaike AIC	-5.1377	-5.0785	-6.0625	-5.0982	-4.8851	-5.0004	-4.9909	-4.1011	-4.2244	-3.8452
Schwarz SC	-5.0994	-5.0401	-6.0242	-5.0598	-4.8468	-4.9620	-4.9526	-4.0627	-4.1860	-3.8068

Table 5 reveals that the biggest causal effects occur against the variable itself. However in this period lag, the coefficients are below significance levels of 10, which implies that the coefficients fit better in under this lagged term. The F-statistic reveals that the Resilient Properties Vector is the highest, which reveals structural breaks. Similarly to the previous table they are high but in this instance it is much smaller figures than previously. The Akaike AIC and the Schwarz SC variable do not change that significantly from VAR (1-1) to VAR (1-2), with regard to this criteria that enable one to choose the better lagged term, the VAR (1;1) has the lower of the two figures and will have to be model analysed (Gujarati, 2012).

Figure 2: VAR (1;2) Cholesky Decomposition



In Figure 2, The Chelosky decomposition reveals similar results to the previous lagged term. The vector of Growthpoint has contemporaneous effects on most of the property companies except for Resilient, Hospitality and Fairvest. The non-contemporaneous effect of Resilient shares are mainly due sectoral focus with a geographical diversification difference, Resilient is a wholly retail REIT, which owns the majority of its retail centres outside of Gauteng province. The other interesting aspect is that the Resilient ownership model has centres located in the middle to lower income markets of lower population of the living standards measure (LSM). Hospitality as mentioned earlier is a hotel and leisure REIT, so the sectoral difference and differing demand and supply dynamics make company shares neutral to shocks in Growthpoint shares. Fairvest though has some property portfolio in Gauteng (the second highest allocation of its portfolio), it has a similar strategy of focusing on centres that serve the lower LSM market. The Chelosky graphs point to the biggest factor that contributes to contemporaneous effects are due to geographic diversification and secondly sector differences or in some cases sector similarities are important considerations.

5.3. Equal Risk Contribution

Table 6: Portfolio Strategy Comparison

Panel A: Equal Risk Contribution					
	Company Ticker	Portfolio Weight	Volatility	Contribution to Portfolio Risk	Risk Weight
1	GRT	11%	2.99%	3.62%	10.00%
2	RDF	11%	3.16%	3.62%	10.00%
3	RES	16%	2.10%	3.62%	10.00%
4	HYP	11%	3.08%	3.62%	10.00%
5	VKE	11%	3.02%	3.62%	10.00%
6	SAC	10%	3.28%	3.62%	10.00%
7	EMI	11%	3.16%	3.62%	10.00%
8	HPB	7%	5.10%	3.62%	10.00%
9	OCT	7%	4.57%	3.62%	10.00%
10	FVT	6%	5.37%	3.62%	10.00%
Total		100%	3.33%	36%	100%
Panel B: Index Tracker Allocation					
	Company Ticker	Portfolio Weight	Volatility	Contribution to Portfolio Risk	Risk Weight
1	GRT	25.16%	2.99%	8.49%	23.43%
2	RDF	15.09%	3.16%	5.38%	14.84%
3	RES	15.44%	2.10%	3.65%	10.09%
4	HYP	17.11%	3.08%	5.95%	16.43%
5	VKE	4.38%	3.02%	1.49%	4.11%
6	SAC	4.39%	3.28%	1.63%	4.49%
7	EMI	4.06%	3.16%	1.45%	3.99%
8	HPB	7.07%	5.10%	4.07%	11.24%
9	OCT	1.89%	4.57%	0.97%	2.69%
10	FVT	5.19%	5.37%	3.15%	8.69%
Total		100%	3.21%	42%	100%
Panel C: South African Property Index					
	Company Ticker	Portfolio Weight	Volatility	Contribution to Portfolio Risk	Risk Weight
1	GRT	23.00%	2.99%	8.39%	23.17%
2	RDF	16.00%	3.16%	6.16%	17.02%
3	RES	15.86%	2.10%	4.06%	11.21%
4	HYP	10.79%	3.08%	4.06%	11.21%
5	VKE	11.03%	3.02%	4.06%	11.21%
6	SAC	10.13%	3.28%	4.06%	11.21%
7	EMI	10.53%	3.16%	4.06%	11.21%
8	HPB	1.00%	5.10%	0.62%	1.72%
9	OCT	1.34%	4.57%	0.75%	2.06%
10	FVT	0.00%	5.37%	0.00%	0.00%
Total		100%	2.97%	49%	100%

The table above (Table 6) presents an ERC portfolio (Panel A), an Index tracking portfolio (Panel B) and a recreated South African property index (Panel C also known as the SAPY). The portfolio weight refers to the asset's allocation weight in the portfolio, as is seen with the other tables, companies like Growthpoint and Redefine have the biggest weight, and the selection is motivated by market cap size. The volatility is synonymous with standard deviation of each and does not change in all three tables. The contribution to portfolio risk is where the differences

between the tables will be found, the column is a function of the asset weight multiplied by its volatility. The risk weight is the result of the asset weights its standard deviation and the total volatility. The table vary due to the allocation weights made to the individual assets. Both the index tracker and the recreated SAPY index, have significant weightings on Growthpoint, Redefine and Resilient, this will mean that the biggest changes in these assets will drive the volatility in the entire portfolio, in the similar light the risk contribution to the portfolio becomes high, as seen in panel B and C, they exhibit higher risk contribution on a portfolio level. The ERC portfolio can be considered to be a fully diversified portfolio which distributes risk equally to all assets in the portfolio, which results in a better total risk contribution to the portfolio.

5.4. Conclusion to Analysis

The data analysis has revealed very interesting results, the f-statistics for both tables for the one period lag and the two period lag, reveals that the second model was closer to 1 and yet still large in this context, to reject the null hypothesis and infer that the model does possess some forecasting ability in predicting the effects a company's share price will have on another company share. The goodness of fit tests applied to the model do reveal that the one period lag model was the better model. The t-statistics coefficients of the companies when modelled against their lagged terms were high in the one period lag model, revealing that the one period lag was the better to model to use. The Cholesky decompositions provide an indication of the interactions of the company share prices. The notion of contemporaneous effects the companies have when modelled together has to be understood under the lens of how each company is affected by the other on a one-on-one basis and should not be viewed from the perspective of the effects of an entire portfolio. The graphs that have curves, highlight the possibility of a co-movement of the assets, the flat graphs reveal the risk parity possibility which means that the effect of one company share price will not affect the other company share. The elegance of the VAR model can be understood under the lens of tactical asset allocation strategy where the Cholesky decompositions provides insights into the number of periods a company's share will be affected but unwanted shocks. The ERC section of this study adds to the overarching theme of this study which has been to use risk diversification as the guiding principle. The ERC portfolio is a tool suited for strategical asset allocation applications because it considers assets in-relation to the entire portfolio. The results have point to a lower risk portfolio, the immediate benefits to this strategy is that movements in one assets share price will not significantly affect the entire portfolio's performance.

6 Conclusions, Recommendations and Further Work

6.1. Summary

This study focused on the listed real estate companies, from the point of an investor seeking the benefits of diversification, by spreading their investment risk. Listed property shares are advantageous especially due to fact that they have differing investment objectives. In South Africa the available REITs can be categorised into; equity retail, real estate operating and development companies, equity industrial and office REITs and diversified REITs. All these have differing investment strategies. In this study the REITs were either diversified or retail REITs, following the classification criteria employed by Ro and Ziobrowski (2011), that classified REITs according their property segment portfolio allocation. The critical aspect of these differences is that investors have to understand the risks associated in the company's portfolio allocation.

This study discussed alternative investment strategies and literature has revealed mixed results regarding, the data and the forecasting ability models that analyse property returns data, Smietana (2014) Rodrigues (2009), Beach and Orlov (2007). Risk parity strategy literature has revealed that traditional mean-variance return models have limitations and are subject to asset over-allocations which are not representative of the implicit risks associated with investments, Chaves *et al.* (2011), Bruder and Roncalli (2012), Mantilla-Garcia (2016). This paper focuses on a model that guides investors into which assets when combined in a portfolio will provide a risk minimization benefit.

6.2. Conclusions

6.2.1 Methodology

VARs are a-theoretical, as theory does not inform the correlations between the variables nor inform the specification of the model. Due to the secant theoretical foundation its analysis becomes a challenge and as such cannot be implemented as a policy portfolio. The framework for the success of the model are that the variables are stationary. The augmented Dickey Fuller (DF) and Phillips-Perron unit roots tests are used to analyse the model (Ling & Naranjo, 2015), alternatively the contemporaneous relationships between

assets included in a model assists in determining the best assets or variables (See; Bjørnland and Leitemo (2009), Brooks and Tsolacos (2001)).

This model can be at best used in the selection process as it highlights the assets that could potentially influence the entire portfolio, which was seen by *Growthpoints* influence in the Cholesky decomposition graphs. This model can be added to a DSAA model that allows institutional investors the opportunity to review allocation decisions (Reddy, et al., 2013).

Minimum Variance Portfolio and Maximum diversification portfolio are related to risk parity, and they are orientated towards controlling portfolio loss where a downside risk measure is used or a guiding threshold to limit loss (Roncalli, 2012). The risk parity strategy is one suited as a strategy to be applied for core asset holdings (Mueller, 1998), to reduce the risk of losses caused by an individual asset.

6.2.2 Data

The data from the different companies revealed some interesting results, sectoral or segment distribution, the information was sourced from the different company's annual returns reports, the IRESS data base and cross referenced with the Bloomberg terminal.

The companies still diversify in the traditional commercial investment segments, namely offices, retail and industrial. There are a few that have over the years rebalanced their portfolios in response to economic environments they operate in, to diversify into other segments and even other countries on the African continent and other continents such as Europe, the US and Australia.

The results have not highlighted stark differences between, diversified and focused, when it comes to the performance of the various property companies which is in line with the findings of (Ro & Ziobrowski, 2011).

6.2.3 Data analysis

The variables incorporated in the model were of the logged returns of company assets, and this was done to ensure that the data was not stationary, which meant that the data could be modelled using a vector autoregressive model. The results show that some

companies even though they operate in the same industry, they can be combined together in a portfolio of assets because they do not experience any contemporaneous effects on each other. The interesting findings were that the bigger REIT companies exhibited contemporaneous effects on other REIT companies which is attributed to the weightings they hold especially in relation to the South African property index and the all property index. Growthpoint and Redefine though diversified both geographically and sectorally are assets holdings that have to get reduced substantially in a Risk Parity portfolio strategy. The elegance of the VAR model can be understood under the lens of tactical asset allocation strategy where the Cholesky decompositions provides insights into the number of periods a company's share will be affected but unwanted shocks as a result of spill-over effects and provide an alternative guiding tool when making allocations into property assets, which was a similar finding to (Ro & Ziobrowski, 2011), who found strong short term effects and further added that over a longer period the explanatory power of the method loses its predictive ability.

6.2.4 *Research objectives*

The research problems were outlined in essence to guide the research objectives, the first part was to investigate how real estate assets can be included into mixed asset portfolio, and in this study the securitised real estate assets were found to be readily available and accessible. The second aspect was whether securitised real estate was more correlated with the stock market than direct ownership of property assets. Are there any companies currently operating in South Africa that are using alternative investment strategies when making investment decisions? The study unlike, Akinsomi, *et al.*, (2015), Reddy, *et al.*, (2013), who answered this question through the use of surveys to illicit the information.

Based on the problems found in the literature the research objectives changed slightly and have brought about a better understanding of the listed property market in South Africa. The deviation from investigating both direct and indirect real estate investments was due to the limited time for the completion of the masters and direct real estate returns data available, is aggregated please see Akinsomi *et al.* (2018), who used IPD data.

The choice in using listed real estate returns was due to the ease and availability of the company information, which was an important criteria, that companies had to be listed on the JSE, and they had to have been in operation for longer than ten years in order to capture

changes in the economic cycles. This research focused on analysing company diversification strategies and it was found that companies diversify sectorally and geographically. The analysis of the company data revealed the contemporaneous effects certain companies have on each other through the use of the VAR model specification. The lack of sophisticated investment strategies employed by the REIT companies, is highlighted by the property segments the assets held by companies can be considered traditional. The alternative investment strategy proposed in this study is more relevant to fund managers and pension fund investment analysts that use more sophisticated financial modelling techniques (Reddy, 2012).

6.3. Contribution of study

The contribution of the study is twofold, it has adapted an existing VAR model that has been used in previous studies to analyse the economic cycles and their convergence with property returns, in this research report the VAR model has been used as a tool in the construction of a purely securitised real estate portfolio. This can be viewed under the lens of a tactical asset allocation strategy (Reddy, 2012).

6.4. Limitations

The limitations of this study is that it focused on South African REITs and due to some difference in rules governing REITs, the findings might be applicable to the South African REIT industry.

6.5. Recommendations

The RP strategy can apply to a purely property portfolio, as can be seen above a truly risk parity diversified portfolio performs better in a highly volatile environment; it does speak to a strategy switches that occur during different economic cycles (Reddy, et al., 2013). The limited information regarding a RP strategy outside of traditional investment classes does not provide sufficient academic theory on which to base this strategy proposed (Roncalli, 2012), Further to this point, Roncalli and Weisang, (2016) explore a risk parity strategy that incorporates the three Fama factor models as an even better policy strategy that incorporates macroeconomic factors into the portfolio strategy.

6.6. Further Work

- A return dynamics and comparison of direct and indirect property assets over a ten year time horizon.
- Analysis of the alternative risk parity strategy that incorporates property assets, both direct and indirect property assets, and traditional investments such as bonds, stocks and commodities into truly mixed asset portfolio.
- The investigation of alternative investments such as infrastructure, forestry and farmland and their differences from other land and real estate-related real assets like housing, healthcare, student accommodation and other non-traditional real estate assets (See; Mansley & Lizieri 2015).

References

- Akinsomi, O., Mkhabela, N. and Taderera, M., 2018. The Role of Macro-economic Indicators in Explaining Direct Commercial Real Estate Returns: Evidence from South Africa. *Journal of Property Research*, 35(1), pp. 28-52.
- Akinsomi, O. and Ntuli, M., 2017. An Overview of the Initial Performance of South African REIT Market. *Journal of Real Estate Literature*, 25(2), pp. 365-388.
- Akinsomi, O., Pahad, R., Nape, L. and Margolis, J., 2015. Geographic Diversification Issues in Real Estate Markets in Africa. *Journal of Real Estate Literature*, 23(2), pp. 261-295.
- Andonov, A., Kok, N. and Eichholtz, P., 2013. A Global Perspective on Pension Fund Investment in Real Estate. *Journal of Portfolio Management*, Issue Special Real Estate Issue, pp. 32-41.
- Ang, A., Nabar, N. and Wald, S. J., 2013. Searching for a common factor in public and private real estate returns. *Special Real Estate Issue*, pp. 120-133.
- Beach, S. L. and Orlov, A. G., 2007. An Application of the Black-Litterman Model with EGARCH-M-Derived views for International Portfolio Management. *Financial Markets and Portfolio Management*, 21(2), pp. 147-166.
- Bhansali, V., 2011. Beyond risk parity. *The Journal of Investing*, 20(1), pp.137-147.
- Bjørnland, H.C. and Leitemo, K., 2009. Identifying the interdependence between US monetary policy and the stock market. *Journal of Monetary Economics*, 56(2), pp.275-282.
- Black, F. and Litterman, R., 1992. Global portfolio optimization. *Financial analysts journal*, 48(5), pp.28-43.
- Brooks, C., 2014. *Introductory Econometrics for Finance*. Third Edition ed. Cambridge: Cambridge University Press.
- Brooks, C. and Tsolacos, S., 2001. Forecasting real estate returns using financial spreads. *Journal of Property Research*, 18(3), pp.235-248.
- Brounen, D. and de Koning, S., 2013. 50 years of real estate investment trusts: An international examination of the rise and performance of REITs. *Journal of Real Estate Literature*, 20(2), pp.197-223.
- Bruder, B. & Roncalli, T., 2012. *Managing Risk Exposures using the Risk Budgeting Approach*, Paris : Lyxor Assetmanagement
- Chaves, D., Hsu, J., Li, E. and Shakernia, O., 2011. Risk Parity Portfolios vs Other Asset Allocation Heuristic Portfolios. *Journal of Investing*, Issue Spring 2011, pp. 108-118.
- Conover, M.C., Friday, H.S. and Howton, S.W., 2000. An analysis of the cross section of returns for EREITs using a varying-risk beta model. *Real estate economics*, 28(1), pp.141-163.

Cook, A., 2012. Internal liquidity, Capital Structure and Firm Profitability: A case for the South African listed real estate industry, Johannesburg: University of Witwatersrand Business School.

Corney, G., Lauder, C. and McElreath, B., 2016. Global Property Performance; Trends and Insights from the 2015 IPD® Global Annual Property Index, Cape Town: MSCI.

DiPasquale, D. and Wheaton, W. C., 1992. The Market for Real Estate Assets and Space; A Conceptual Framework. *Real Estate Finance*, 20(2), pp. 181-198.

Ducoulombier, F., 2007. EDHEC European Real Estate Investment and Risk Management Survey, Aberdeen: EDHEC Business School.

Edwards, F. R. and Caglayan, M. O., 2001. Hedge Fund and Commodity Fund Investment Styles in Bull and Bear Markets. *Journal of Portfolio Management*, 27(4), pp. 97-108.

Elton, E. J. and Gruber, M. J., 1997. Modern portfolio theory 1950 to date. *Journal of Banking and Finance*, 12(11-12), p. 1743 to 1759.

Falk, J., 2012. Direct and Indirect Real Estate in a Mixed-asset Portfolio - Is direct or indirect preferable? Stockholm: KTH Architecture and the Built Environment.

Fiorilla, P., Kapas, M. and Liang, Y., 2012. An Institutional View of Global Real Estate. *Journal of Real Estate Portfolio Management*, pp. 123-133.

Geltner, D. M., Miller, N. G., Calyton, J. and Eichholtz, P., 2007. Commercial Real Estate Analysis and Investments. International Student Edition ed. Mason: Cengage Learning.

Gujarati, D., 2012. *Econometrics by Example*. 1st ed. London: Palgrave Macmillan.

Hauss, H., 2004. The role of international property investments in the global asset allocation process. *Australian Property Journal*, 38(3), pp. 198-205.

Sieracki, K., Liow, K.H., Hoesli, M. and Lekander, J., 2008. Real estate portfolio strategy and product innovation in Europe. *Journal of Property Investment & Finance*.

Hoesli, M. and Moreno, C., 2006. Securitized real estate and its link with financial assets and real estate: an international analysis. *Journal of Real Estate Literature*, 15(1), pp.57-84.

Investopedia, LLC, 2018. Investopedia Bullmarket. [Online]
Available at: <https://www.investopedia.com/terms/b/bullmarket.asp>
[Accessed 04 November 2018].

Jiang, W., 2003. A nonparametric test of market timing. *Journal of Empirical Finance*, 10(4), pp.399-425.

Jones, C., Dunse, N., Livingstone, N. & Cutsforth, K., 2017. The Restructuring of Institutional Real Estate Portfolio in the UK. *Journal of Property Research*, 34(2), pp. 129-146

Joubert, H., 2015. The Allocation of Real Estate in an Investment Portfolio, Stellenbosch: Stellenbosch University.

Kaushik, A. and Pennathur, A., 2013. On the Timing of Real Estate Mutual Funds across Market Cycles. *Journal of Real Estate Practice and Education*, 16(2), pp. 93-106.

Lee, T., Spellar, A. and Bouchey, P., 2013. *Understanding Risk Parity*, Minneapolis: Clifton Group.

Leone, V. and Ravishnakar, G., 2017. Frontiers of Commercial Real Estate Portfolio Performance; Are Sector-Region-Efficient Diversification Strategies a Myth or Reality?. *Journal of Property Research*, 34(4), pp. 1-22.

Li, R. Y. M. and Chow, H. P., 2015. An Economic Analysis on REIT Cycles in Nine Places. *Real Estate Finance*, 32(1), pp. 23-28.

Ling, D. C. and Naranjo, A., 2015. Returns and Information Transmission Dynamics in Public and Private Real Estate Markets. *Real Estate Economics*, 43(1), pp. 163-208.

Liow, K.H. and Schindler, F., 2011. An assessment of the relationship between public real estate markets and stock markets at the local, regional, and global levels. ZEW-Centre for European Economic Research Discussion Paper, (11-056).

Maillard, S., Roncalli, T. and Teiletche, J., 2010. The Properties of Equally Weighted Risk Contribution Portfolios. *The Journal of Portfolio Management*, 36(4), pp. 60-70.

Mansley, N. & Lizieri, C., 2015. *What Constitutes Property for Investment Purposes? A Review of Alternative Real Estate Assets*, Cambridge: Investment Property Forum Research Programme.

Mantilla-Garcia, D., 2016. *Maximizing the Volatility Return: A Risk Based Strategy for Homogeneous Groups of Assets*. Edhec-Risk Institute.

Markowitz, H., 1952. Portfolio Selection. *The Journal of Finance*, 7(1), pp. 77-91.

McNees, S.K., 1986. Forecasting accuracy of alternative techniques: A comparison of US macroeconomic forecasts. *Journal of Business & Economic Statistics*, 4(1), pp.5-15.

Moss, A. and Farrelly, K., 2015. The performance of a blended real estate portfolio of UK DC investors. *The Journal of Property Investments and Finance*, 33(2), pp. 156-168.

Mueller, G. R., 1998. REIT Size and Earnings Growth: Is Bigger Better, or a New Challenge? *Journal of Real Estate Portfolio Management*, 42(2), pp. 149-157.

Mwanza K. (2013) REITs Growth To Help African Nations Deepen Real Estate Investments [Online] Available from: <http://afkinsider.com/35943/reits-growth-help-african-nations-deepen-real-estate-investments/> [Accessed 17th August 2018].

Newell, G., Worzala, E., McAllister, P. & Schulte, K.-W., 2004. An International Perspective on Real Estate Research Priorities. *Journal of Real Estate Portfolio Management*, 10(3), pp. 161-170.

Newell, G., Kim Hiang, L., Ooi, J. and Haihong, Z., 2005. The impact of information transparency and market capitalisation on out-performance in Asian property companies. *Pacific Rim Property Research Journal*, 11(4), pp.393-411.

- Ooi, J.T.L., G. Newell, and T.F. Sing. The Growth of REIT Markets in Asia. *Journal of Real Estate Literature*, 2006, 14:2, 203–22.
- Ori, J. J., 1995. A seven step portfolio diversification strategy, Chicago: Real Estate Review.
- Page, S. and Taborsky, M., 2011. The myth of diversification: Risk factors vs. asset classes. *Journal of Portfolio Management*, 37(4), pp.1-2.
- Pástor, Ľ. and Stambaugh, R.F., 2003. Liquidity risk and expected stock returns. *Journal of Political economy*, 111(3), pp.642-685.
- Pham, A. K., 2012. The Dynamics of returns and volatility in Emerging and Developed Asian markets. *Journal of Real Estate Literature*, 20(1), pp. 79-96.
- Reddy, W., 2012. Determining the current optimal allocation to Property; A Study of Australian Fund Managers. Adelaide, Annual Pacific-Rim Real Estate Society Conference.
- Reddy, W., Higgins, D., Wist, M. and Garimort, J., 2013. Australian industry superannuation funds: Investment strategies and property allocation. *Journal of Property Investment and Finance*, 31(5), pp. 462-480.
- Rodrigues, A., 2009. A Modern Portfolio Theory Approach to Asset Management in the Listed South African Property Market, Johannesburg: University of Witwatersrand.
- Roncalli, T., 2012. From Portfolio Optimization to Risk Parity, Paris: Lyxor Asset Management.
- Roncalli, T. and Weisang, G., 2016. Risk Parity Portfolios with Risk Factors. *Journal of Quantitative Finance*, 16(3), pp. 377-388.
- Ro, S. H. and Ziobrowski, A. J., 2011. Does Focus Really Matter? Specialised vs. Diversified REITs. *The Journal of Real Estate Finance and Economics*, 42(1), pp. 68-83.
- Saunders, M., Lewis, P. & Thornhill, 2007. *Research Methods for Business Students*. Fourth Edition ed. Essex : Pearson Education Limited .
- Sebehela, T., 2016. Portfolio Formation Memory. *Anal. of Financial Economics*, 11(2), p. 1650010 (16P).
- Śmietana, K., 2014. Diversification principles of real estate portfolios. *Real Estate Management and Valuation*, 22(1), pp.51-57.
- Su, H.-M., Huang, C.-M. and Pai, T.-Y., 2010. The Hybrid Characteristic of REIT Returns: Evidence from Japanese and U.S. Mark. *Journal of Real Estate Literature*, 18(1), pp. 77-98.
- Thiagarajan, S.R. and Schachter, B., 2011. Risk parity: Rewards, risks, and research opportunities. *The Journal of Investing*, 20(1), pp.79-89.