Macroeconomic Risk Variables on the Johannesburg StockExchange

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Abstract

A large body of knowledge attempts to identify the types of risks investors require a premium for when investing in financial assets. The Arbitrage Pricing Theory ("APT") of Ross (1976) relates excess returns of financial assets to several macroeconomic risk factors either through a factor analysis- or observable macroeconomic variable-approach. Research in developed markets has shown that systematic risk factors do influence returns however there is a gap in studies which relate the macroeconomy to financial assets in South Africa. This study aims to identify observable macro-variables which offer a risk premium on the Johannesburg Stock Exchange ("JSE") to gain insight on the systematic variables pertinent to the pricing of risk on the JSE. Some of the prespecified macro-variables in this study are selected based on the influential studies of Chan,Chen and Hsieh (1985) and Chen, Roll and Ross (1986) while further variables are adopted from studies which have explored the relation between the macroeconomy and stock market. A variant of Fama and Macbeth's (1973) two-step procedure was employed to estimate risk premia. Subsequently, pooled Ordinary Least Squares ("OLS") as well as fixed-effects regressions were employed for analysis of results. Pooled OLS analyses showed South Africa's equity risk premium as well as Term Structure of Interest Rates to be significantly priced risk factors while Gross Domestic Product, Manufacturing Production, Retail Sales, Money Supply, Gold and the USD/ZAR exchange rate were negatively and significantly priced over the period 2000 to 2019. Fixed-effects regressions showed the equity market risk premium to be positive and significantly priced. Oil, Gross Domestic Product and the USD/ZAR exchange rate were significantly and negatively priced. Results indicate that the presence of multinational companies on the JSE may cause a discord in the relation between South African economic data and the JSE return as the JSE is not representative of the South African economy.

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Introduction

Background

Asset Pricing is one of widely studied tenets in Financial Economics as it characterizes the risk of financial assets. The model central to the pricing of financial asset risk is the Capital Asset Pricing Model ("CAPM" hereafter) of Sharpe (1964), Treynor (1962), Lintner (1965a, b) and Mossin (1966). The CAPM asserts that, since investors hold diversified portfolios with no idiosyncratic risk, market risk is the main systematic risk that investors require compensation for. In the CAPM framework, beta is a measure of a financial asset's risk with respect to a market portfolio. This portfolio is optimally diversified and is mean- variance-efficient, wherein a value-weighted share index serves as a proxy for the portfolio. Roll (1977) argues that a "true" test of the CAPM is one where the market portfolio consists of all marketable securities in the entire financial economy. According to Roll (1977)since such a portfolio is unobservable CAPM is untestable. Alternative asset pricing models such as the intertemporal models, originally introduced by Merton (1973) and Cox, Ingersoll and Ross (1985), explore alternative frameworks to describe how the risk and expected returns of securities relate. One such theoretical framework that is to be explored in this study is the Arbitrage Pricing Theory ("APT" hereafter) proposed by Ross (1976). This model is a testable alternative to the CAPM because of its relaxed assumptions. Moreover, APT holds that if a market has no pure arbitrage opportunities and the returns of assets are described by a linear factor model then there is a linear relation between the expected returns for assets and their various exposures to risk factors. Contrary to CAPM, there can be several systematic risks affecting expected returns. It is this multivariate framework of the APT and intertemporal models that forms the basis of relating stock returns to different risk factors. The APT framework is considered to perform better than CAPM because firstly, it is a multifactor model and therefore allows for more than one systematic variable. Secondly, APT can be tested using different approaches such as measuring systematic factors as observable macroeconomic variables or identifying systematic factors as latent variables through factor analysis. The former approach is investigated in this study. Additionally, portfolios are not required to be mean-variance efficient, and betas can be estimated in various ways (Connor and Korajczyk,1995).

Research Objective

The version of APT that is adopted in this study is pioneered by Chen, Roll and Ross (1983, 1986) ("CRR" hereafter) and relies on economic intuition to link the macroeconomy to the stock market. Observable economic variables are used to determine potential risk factors which investors require a risk premium for. This version is called the Macrovariable Model ("MVM" hereafter) and holds that there is a linear relationship between the expected returns of securities and the macroeconomic variables which affect their systematic risk. CRR premise the MVM approach on two assumptions. Firstly, a firm's share price is the sum of expected cash flows discounted at a risk-adjusted discount rate. Secondly, stock prices are sensitive to economic events. Using U.S. financial data, the authors found five out of the nine observed macroeconomic variables namely, twists in the yield curve, monthly growth rates in industrial production, unexpected changes in the bond risk premium, measures of unanticipated inflation and changes in anticipated inflation during volatile periods to be significant in explaining expected returns. The objective of this study is to explore whether the observable macroeconomic variables employed by CRR as well as other potential macro-variables are priced on the JSE.

Research Question

Are the macroeconomic variables namely, Term Structure of Interest Rates, Exchange Rates, Manufacturing Production, Retail Sales, Gross Domestic Product (GDP), Money Supply, Oil prices, and gold prices associated with statistically significant risk premia?

Importance and Benefits of Proposed Study

The MVM is compelling for several reasons. Firstly, unlike the factor analysis approach of testing APT, factor loadings of the model can be interpreted using observable and hence quantifiable economic variables (Burmeister, Roll and Ross, 1988). Secondly, using non-equity returns to describe equity returns broadens the amount of potential systematic risk factors that investors must consider in making informed investment decisions in an emerging market. This insight into systematic risk factors pertinent on the JSE may facilitate international diversification as investors will be informed on risks affecting the JSE (Hosseini, Ahmad and Lai, 2011). Lastly, early tests which utilized similar macroeconomic variables showed encouraging results in developed markets (Chan, Chen and Hsieh 1985; Dickinson 2000 and Chen, Hsieh, Vines and Chiou, 1998). Peiró (2016) tested the MVM in European economies

(Germany, Finland and the United Kingdom) and found movements in industrial production and interest rates to determine stock returns in all three countries for the whole sample period of 1969-2012. However, the results in developing markets have not been as encouraging. For example, in Nigeria, none of the CRR prespecified variables explain returns. Some examples are Izedonmi and Abdullahi (2011), Okoro (2017) and Iqbal and Haider (2005). A possible reason for this could be that the characteristics between developed and developing markets are vastly different thereby necessitating the identification of systematic risks that pertain to different markets (Van Rensburg ,1997). By the same token, this study takes into consideration liquidity effects (by applying a liquidity filter to equity data) which plague the JSE.

The structure of the thesis is as follows: section two provides a review of literature which firstly details the APT. Subsequently, intertemporal model and factor analysis are briefly discussed. This is followed by literature of MVM in developed markets, South Africa and in emerging markets. Section three discusses methodology as well as motivations for the selected variables and regressions employed. Section four explains results and section five concludes.

Literature Review

Firstly, literature on the two main linear factor models that provide frameworks for this study are discussed. Subsequently there is a discussion of the two approaches used empirically to link the macroeconomy to the stock market.

Arbitrage Pricing Theory

The APT is a linear factor model that was introduced by Roll (1976). Some studies such as Shanken and Weinstein (2006) consider the model as an alternative to CAPM. Roll (1976) demonstrated proofs which showed that in an equilibrium market for which there was no arbitrage opportunities, there exists k + 1 observations, such that the expected return on the*ith* asset is equal to the intercept plus the sum of beta coefficients times the risk factor and is given by:

$$E(r_i) = F_0 + B_{i1}F_1 + \cdots B_{i2}F_k. \quad (1)$$

The APT model is governed by assumptions that markets are perfectly competitive, frictionless and well- diversified. Also, the model is based on two underpinnings that Roll (1976) proved. The first proof or postulate shows that the difference between realized and expected return of an asset is a sum of the betas of risk factors multiplied by actual values of risk factors plus an asset-specific errorterm and is the postulate expressed by the equation:

$R_i(t) - E[r_i(t)] = B_{i1} f_1(t) + \dots b_{ik} f_k(t) + e_i(t)$ (2)

Where

$R_i(t)$ = the end-of-period realized return for asset *i*.

$E[r_i(t)]$ = the expected return at the start of the period.

B_{ij} = the risk exposure of asset *i* to risk factor j for the period j=1 to k.

$f_1(t)$= actual value for the *jth* risk factor at end of period t when j=1 to k.

$e_i(t)$ = value of "asset-specific" shock at the end of period t.

The first postulate holds under the assumption that mean values and hence expectations of therisk factors are zero. For each asset, there should be no covariance between the assets' risk factors and idiosyncratic shocks for all time periods. However, values of the distinct risk factors may be correlated. The second postulate is that financial markets are competitive and thereforehave no pure arbitrage opportunities. Consequently, investors must incur risk to earn risk premia. The 'no arbitrage' condition implies that APT is an equilibrium model which means itapplies fewer restrictions and assumptions of probability distributions (Burmeister, Roll and Ross,1998).

When Equation 1 and the second postulate are combined, it results in what Burmeister, Roll and Ross (1998) term as the "full APT".

Intertemporal Models

The intertemporal CAPM of Merton (1973) is another linear factor model that showed the expected returns on a consumer's portfolio to be influenced by systematic factors which could influence the wealth of a consumer and in turn the consumer's portfolio profits. Cox, Ingersoll and Ross (1985) also developed an equilibrium model of asset prices and concluded that, in equilibrium, asset prices were a combination of underlying economic forces. These intertemporal models allowed multiple variables to be included in the pricing relation. According to CRR this was evidence that latent economic variables described the stock market. Both models assumed that more than one systematic factor existed and that state variables could be correlated.

Factor Analysis

There are two prominent approaches of testing the APT. The first uses multivariate analysis such as factor analysis, principal component analysis or maximum likelihood analysis. This approach is conducted on a large set of observable variables and aims to reduce the number of explanatory factors necessary to describe share returns. The unobservable variables are called principal components and represent underlying latent variables when a set of variables are systematically interdependent (Bartholomew, Knott and Moustaki,2011). APT tests that apply factor analysis have produced encouraging results particularly when it comes to identifying the number of risk factors affecting stock returns (Burmeister, Roll and Ross, 1998). Roll and Ross (1980) carried out one of the earlier tests of APT using the maximum likelihood method and concluded that at least three factors were significant for pricing. Brown and Weinstein (1983) found that there are at most five factors produced by factor analysis which explain stock returns. Connor and Korajczyk (1986) introduced the use of PCA which, unlike previous APT factor-analytic-methods such as common factor analysis, required approximate factor structures (a less restrictive assumption) as opposed to exact factor structures. A similar method was adopted by Page (1986) on the JSE where the author constructed a correlation matrix from a time series ofJSE-listed returns, and by employing PCA found two factors to be priced on the JSE.

The Macroeconomic Variable Model

This section takes an in-depth look into the MVM method from the different ways in which portfolios are formed to how macroeconomic variables are derived to represent risk. Early studies of MVMs in developed markets are explored. Finally, the last section contrasts factor analysis and MVM.

Origin of the Macroeconomic Variable Model

Motivated by the multivariate frameworks of the APT of Ross (1976) and the intertemporal CAPM models of Merton (1973) Cox, Ingersoll and Ross (1985) posited that share returns were described by several pervasive risks. CRR conducted a study which explored observable macroeconomic variables that influence share returns in a multivariate model framework. Specifically, the objective was to identify macroeconomic indicators which would hold as pervasive state variables, and to investigate whether there were statistically significant risk premia associated with shares' exposures to macroeconomic risk since prior studies focused on factor analysis to test the APT model. The authors selected a set of macroeconomic variables based on the a priori assumption that share prices could be defined as the sum of expected discounted dividends. Moreover, chosen variables were those which directly or indirectly influenced expected dividends and the discount rate of the Gordon Growth Model.

To represent the prespecified macroeconomic variables as observable risk factors, CRR obtained a time series of unexpected movements in the economic variables. Thereafter, innovations were generated by computation of first differences or rates of growth for each variable. Before Fama-Macbeth regressions were estimated, CRR investigated whether proposed variables did indeed react to macroeconomic news. Factor analysis was employed to extract common stock factors and the factors were regressed on the proposed economic state variables for analysis on the significance of the variables. If an economic variable was related to one of the common stock factors then it would be significantly related to the stock market.

The derived macroeconomic risk factors were then employed as independent variables in a linear factor model to take the form:

$$R = a + b_{MP}MP + b_{DEI}DEI + b_{UI}UI + b_{UPR}UPR + b_{UTS}UTS + e \qquad (3)$$

Where R represented the return on an asset, a denoted the constant term, and b the betas or the exposure of the asset to macroeconomic variables. MP represented the monthly growthrate in industrial production and affected expected cash flows. DEI represented shifts in expected inflation and UI was unexpected inflation, where both variables were expected to impact cash flows and interest rates. UPR was the bond risk premium and UTS represented theterm structure of interest rates. Other macroeconomic factors such as market indices, oil and consumption were included as explanatory variables. Descriptive statistics showed evidence of autocorrelation between the variables which CRR ascribed to errors-in-variable problem. The authors did not reconcile or remove the autocorrelation in the macro-variables.

A multivariate variant of the Fama and Macbeth (1973) two-pass technique was employed to determine whether the prespecified economic risk variables were priced risk factors on the share market. In the first pass, time series returns of portfolios were regressed on the given risk factors (unexpected changes in macroeconomic variables). The authors noted that individual assets had to be grouped into portfolios to reduce variability attributed in individual returns as well as to control the errors-in-variable problem that arose from the use of proxies as independent variables in linear regressions. Portfolios were grouped according to market capitalization (size) of shares since it had been shown empirically that returns sorted by size showed variation. Furthermore, CRR attempted to form portfolios based on alternative conventions such as betas of a market index, standard deviation and level of stock prices with no success. In the second pass, resultant betas were used as independent variables in monthly cross-sectional regressions and average portfolio returns for those respective months were dependent variables. The yearly repetition of the two-pass technique resulted in a time series of risk premia estimates which were associated with each of the macroeconomic variables (each macrovariable had a time series of risk premia attached), subsequently the means were tested for significance using t-tests.

The macroeconomic variables which produced statistically significant t-statistics over the sample period were namely, changes in risk premium, twists in the yield curve, industrial production and to a weaker degree measures of unexpected inflation and changes in expected inflation for period when these variables are high.

Early applications of the Macroeconomic Variable Model

Early applications of MVM which replicated or closely replicated CRR produced t-statistics which pointed to priced macroeconomic risk factors. Chan, Chen and Hsieh (1985) employed similar variables and methodology to CCR to examine the size effect and found statistically significant risk premia in twists in the yield curve, changes in unanticipated and monthly growth rate in industrial production. Drawing upon APT, Chan, Chen and Hsieh (1985) employed observable macroeconomic factors to investigate the tendency of large firms to have lower average returns than small firms (this phenomenon is typically referred to as the"size effect"). Relevant macro-variables which were selected were those which would have an impact on changes in expected cash flows as well as those which influenced the denominator of share price valuation. The authors employed similar macroeconomic variables to CRR however, their study was more comprehensive to CRR. Chan, Chen and Hsieh (1985) elaborated more on the intuition behind the selection and computation of the macroeconomic indicators which would serve as macro-variables. The authors included component contribution analysis to be able to interpret economic significance for variables associated with statistically significant risk premia. Equally weighted stock market indices were included to proxy for long-run expected growth rates in economic activity as these growth rates influence expected cash flows. Moreover, stock indices would consider the role of expectations in pricing financial assets. According to the authors, since efficient market theory asserts that all information regarding past data and future expectations is already encompassed in market prices, these stock indices were appropriate measures of expectations. To depict the role of changes in current economic conditions on financial asset pricing, Chan, Chen and Hsieh (1985) computed the log monthly growth rates of industrial production to their multi-pricing equation. Unexpected inflation was computed as the difference between actual inflation and expected inflation via the equation: UI=CPI-EI for month t. The change in expected inflation was added for robustness in case the former inflationmeasure did not capture necessary information. Because the price of financial asset is a sum of cash flows projected in the future; a measure capturing the yield curve was included. The measure namely, changes in the term structure of interest rates was computed as the excess return of a long-term government bond portfolio over treasury-bill rates. Lastly, bond returns, specifically excess returns of "under Baa" bond portfolios over long-term government bonds, were included to represent the changes in risk premium.

The methodology (a variant of Fama-Macbeth) employed was like that of CRR. Initially,time series regressions were run on size portfolios for five-year intervals. Following that general least squares cross-sectional regressions were run on a monthly basis in the sixth year. Results were, therefore, time series of risk premia linked to the macro-variables. Subsequently, null hypotheses tested whether the resultant-risk premia were significantly different from zero. Means of residuals measured the presence of size effect using paired t-tests and Hotelling t- squared tests. Paired t -tests were used to test whether the returns on the largest size portfolios were statistically different from the smallest size portfolios and results showed marginal and insignificant portfolio returns between the smallest and largest size portfolios. Hotelling t- squared tests determined whether mean residuals were jointly equal to zero and the tests returned insignificant estimates. Overall, there was no size effect on the stock market. The macro-variables namely, bond risk premium, industrial production and unexpected inflation had significant and positive risk premia. Chan, Chen and Hsieh (1985) included component contribution analysis to examine the magnitude of the size effect that statistically significant macro-variables had on the size effect. Bond risk premium which measured changes in risk premium had the largest contribution to the size effect. Since Chan, Chen and Hsieh (1985) asserted that changes in risk premia were influenced by business conditions they estimated the initial equation with business condition indicators which showed evidence of being priced risk factors. Hamao (1988) applied a similar methodology and constructed economic variables on the Japanese stock market and found expected inflation, unanticipated changes in risk premium and unanticipated changes in the slope of the yield curve to be associated with statistically significant risk premia.

Macroeconomic Variable Models in developed markets

One study which provided an in-depth analysis of CRR was conducted by Poon and Taylor (1991). The authors extended CRR to the U.K. stock market to see if the newly introduced approach was applicable to the U.K, and in doing so took note of significant critiques of CRR.The sample consisted of Monthly series of U.K.-listed share returns for the period January 1965 to December 1984. Before factor analysis regressions were run, share returns were grouped into portfolios according to the market capitalization of the firms. The first critique was that this step was based on empirical observations and had no theoretical foundations to it. Similar macrovariables, as employed by CRR, were used as measures of macroeconomic risk factors.However, instead of solely applying first differences to account for unexpected movements econometric modelling was utilized to filter unexpected components in the macrovariables. Moreover, Poon and Taylor

(1991) pre-whitened (imposed a process on a series to make it behave like white noise) the macroeconomic variables, portfolio returns and market indices so that correlations were filtered out to avoid the errors-in-variables problem. The pre-whitening process was accomplished by fitting Autoregressive Integrated Moving Average (ARIMA) univariate models to the time series of each of the variables included in the sample of data thereby producing autocorrelation coefficients with lags up to order twelve at five percent level of significance. Results for the autocorrelation coefficients of portfolio returns showed significance at the five percent level of significance. This autocorrelation was attributed to thintrading. Furthermore, Poon and Taylor (1991) criticized CRR for failure to address thin trading in their MVM model. The autocorrelation coefficients for macrovariables constructed in a fashion similar to CRR showed the variables namely, first difference in term structure of interest rates,inflation rates and changes in expected inflation to not be correlated. Monthly and annual changes in industrial production displayed seasonality and risk premia seemed to show significant autocorrelation coefficients. When autocorrelation was detected, MA (1) would befit to remove correlations.

Clare and Thomas (1994) explored the applicability of CRR on the U.K share market but employed alternative portfolio-formation strategies and extended CRR by adding previously unstudied macrovariables used within a multivariate framework. The authors used GARCH models up to order twelve to test for autocorrelation in the economic variables and if autocorrelation was detected, lags were used to make the variables be serially uncorrelated. The authors replicated the Fama and Macbeth (1973) procedure following CRR. However, the exception was that portfolios were ranked according to market capitalization as in CRR and alternatively according to market beta coefficients. The CAPM linear relation below was estimated for individual stocks per yearover the sample period 1983 to 1990.

$$R_{it} - R_f = \lambda_i + \delta_i(R_{mt} - R_{ft}) + c_i \quad (4)$$

This allowed for portfolio composition to change since the beta coefficients were updated in line with monthly changes in share prices. Stocks were then classified and ranked into portfolios based on the values of the market beta coefficients. Forecast Vector Autoregression models were estimated and the error terms of these models would be proxies of unexpected movements in the risk factors.

When tests were conducted on the portfolios formed according to market capitalization (size) as per CRR, the measure of market risk and the retail price index were reported to be associatedwith statistically significant risk premia. However, results for the portfolios ranked according to the market beta were as follows; oil price, two measures of corporate default, the retail price index, UK private sector bank lending, the current account balance, and the redemption yield on an index of UK corporate debentures and loans were priced on the U.K. stock market.

Another study with investigated MVM in developed markets was done by Priestly (1996). Priestly (1996) introduced an alternative method of generating unexpected movements, whichwould, according to the author, provide relatively more reliable statistical inferences on the MVM of APT. Priestly (1996) argued that the notion of stock prices being reactive to macroeconomic news implied that investors had formed expectations and that the gap in literature which applied the MVM approach of APT was that the methods used to generate innovations did not take into consideration the expectations forming process of the investor. Error terms of the forecast variables should have a mean value of zero, be serially uncorrelated and orthogonal to information set. The authors concluded that the Kalman Filter or any innovation-generating- process which met the criteria of the Kalman Filter was suited to generate innovations.

Critiques of Fama and Macbeth (1973)

Several studies conducted by Shanken critiqued the use of Fama and Macbeth (1973) techniques. Use of Fama and Macbeth (1973) has been widespread even though the statistical properties were not known (Shanken 1992, 2007). Shanken (1992) noted that some of the problems with Fama and Macbeth (1973) technique was that measurement errors were not considered in the computation of standard errors, and this led to overestimation of betas. Additionally, Fama-Macbeth cross-sectional regressions introduced error-in-variable problems which could remain a problem even if largesamples were used. Therefore, Shanken (1992) introduced a newer version of the Fama and Macbeth (1973) techniqueintended to reduce measurement error. Shanken and Weinstein (2006) noted that the method required improvement. Shanken and Zhou (2007) provided a comprehensive review on the traditional asset pricing techniques empirically namely, Fama-Macbeth procedures, OLS, weighted least squares (WLS) and Generalized Least Squares (GLS). The authors conducted simulations to compare the sample properties of the different estimation techniques. Asset pricing models varying in the number of factors and in sample sizes were simulated using eachof the abovementioned procedures. Generally, results were inconclusive when with regards to an overall well-rounded estimation technique.

Shanken and Weinstein (2006) reinvestigated CRR and concluded that results were sensitive to changes made in portfolio formation process. By generating portfolios differently to the approach taken by CRR, Shanken and Weinstein (2006) reported dramatically different t-statistics which they attributed to the lack of robustness in CRR. Following the Fama-Macbeth (1973) two-pass procedure, CRR and Chan, Chen and Hsieh (1985) divided the full sample period (1953 to 1983) intosix-year intervals where beta coefficients of size portfolios were estimated over previous five-year periods and subsequently, cross-sectional regressions were run on a monthly basis over the following year. A critique was that this stage assumed that compositions of portfolios remained constant for the entire five-year period. The authors referred to "winner reversal" phenomenon documented by Ball and Kothari (1989) as evidence of the selection biases that were associated with betas computed based on five-year data. To avoid the selection bias fromestimating betas based on the returns of portfolios formed on past data, an alternative approachstudied by Black and Scholes (1974) and Fama and French (1992) was adopted where portfolioreturns are calculated a year ahead to ensure that compositions of the portfolio changed. Before Fama-Macbeth regressions were run, shares were ranked according to market capitalization and assigned to one of 20 size portfolios. Errors-in-variables-adjusted standard errors showed that none of the variables suggested by CRR were linked to statistically significant risk premia.When portfolios were formed identically to CRR only MP was a priced risk factor however seasonality in industrial production levels was not removed therefore the significance could have been a result of lack of pre-whitening. Shanken et al (2006) also tested for the linearity ofthe pricing relation and found the combination with factors and expected returns to be linear. The authors added long-term government bond portfolios as well as low grade corporate bondsto improve estimates of risk premia. Results found neither of the state variables had a significant risk premium. The most recent study on the analysis of Fama and Macbeth (!973) was conducted by Bai and Zhou (2017) where adjusted OLS and GLS estimators suited for Fama and Macbeth (1973) regressions were introduced, these estimators were deemed to produce reliable inferences.

Arguments for the Macrovariable method

Literature also compares which approach between MVM and factor analysis is better suited to explain equity returns. For example, parametric as well as non-parametric tests called R-squared and Davidson Mackinnon (1981) respectively, were employed to test which approach was better at explaining variability of Equity Real Estate Returns ("EREIT") returns. To comparatively analyze the goodness of fit to EREIT returns between the two approaches average R-squared estimates were analyzed. R-squared estimates of the MVMwas marginally higher than R-squared of factor analysis method. Z-statistics showed the significance of R-squared MVM approach was superior to that of factor analysis. Proving thatthe MVM approach was a better model to fit EREIT returns. Further, Chen, Hsieh and Jordan(1997) employed the Davidson and Mackinnon (1981) parametric test to directly compare theforecast ability of the distinct models. The process was as follows: a time series of expected returns was estimated for both MVM and Factor analysis models, followed by forecast model where coefficients explained significance of the models. Results for the overall sample period showed that MVM approach was better at predicting EREIT returns. Both parametric and non- parametric test results showed evidence that MVM approach was relatively appropriate at describing variation and predicting EREIT returns. Furthermore, the actual regression used to investigate whether macro-variables were priced risk factors showed inflation and interest ratesto be significantly priced risk factors.

Also, the MVM approach can be regarded as a dynamic method because its use can and has been extended to the investigation of other asset classes such as Real Estate. An example of this is the study conducted by Chen, Hsieh and Jordan (1997) who extended the prespecified macroeconomic variables used in CRR to real estate returns. According to Chen, Hsieh and Jordan (1997) an earlier comparison study Chen and Jordan (1993) showed that empirically MVM-APT was “preferable” to factor analysis on the stock market and the study was extended to the real estate market. Following CRR, Chen and Jordan (1997) selected macroeconomic indicators based on the discounted expected cash flows,derived a series of macroeconomic variables and computed innovations in those macrovariables. Box- Q statistics were then estimated to test for serial correlation. Instead of stock returns being the dependent variable, Real Estate Investment Trust returns were dependent. OLS regressions were then estimated to give the time series of risk premia. Another study which compared the relative performance of different approaches of testing multivariate frameworks was by Connor (1995). According to Connor (1995), asset pricing canbe tested using statistical factor models, which rely on Principle Component Analysis and maximum likelihood analysis to identify pervasive factors. Fundamental factor models employ company-specific data in order to relate asset returns to companies and macroeconomicfactor models rely on observable data. Connor (1995) identified the different ways each approach defines risk factors. This identification of the distinct methods of defining risk factors provides evidence of one of the advantages of the APT model. Being that it is a general modelby which the determination of risk factors need not be realized using a single technique as in CAPM (Burmeister, Roll and Ross, 1988). By comparing the explanatory powers of independent variables employed in each model, Connor (1995) was able to compare how wellthese explanatory factors explained

asset returns. Explanatory power was tested by examiningasset-specific variances when a different number of factors were added to a particular model. Specifically, given a model with *n* number of independent variables, the authors compared how explanatory power would change when the model had *n+1* independent variables. If asset specific variance was zero or close to zero it would mean that addition of the variable did not better explain the model. If asset-specific variances became positive, then it meant that the addition of the independent variable improved description of variables. This logic was appliedto the three distinct models. For example, if a statistical model were added to a fundamental model and as a result the explanatory power of the latter model increased then the former modelwould be the superior model.

The study found statistical factor analysis to outperform both fundamental and macroeconomic model while fundamental models outperformed macroeconomic model. MVM had the lowest explanatory power.

Some useful conclusions from the study that are in support of the MVM were that the three distinct approaches are not necessarily unrelated and inconsistent with one another because the respective strengths and weaknesses of these model lie in how error terms are treated and on how readily available data is to accurately measure explanatory factors, reducing measurement errors. Therefore, if availability of data were not an empirical issue, interpretations of these versions would be synonymous with one another or would be "rotations" of one another statistically speaking. Additionally, MVM is superior when it comes to intuitive interpretation as measuring explanatory power was one of many measures to consider.

Macroeconomic Variable Models in South Africa

The earliest published study of the MVM on the Johannesburg Stock Exchange was done by van Rensburg (1996). In contrast to the Fama-Macbeth technique utilized by CRR, van Rensburg employed iterated non-linear seemingly unrelated regression (ITNLSUR) estimation techniques as in McElroy and Burmeister (1988) to identify the observable macroeconomic variables, if any, which were priced risk factors; this technique was chosen because it was reported by McElroy et.al (1988) to have had less statistical and economic difficulties that accompanied the Fama-Macbeth technique, also the ITNLSUR system encapsulated APT restrictions. Van Rensburg (1996) also added a residual market factor to the MVM following research done by Burmeister and Wall (1986) which concluded that a residual market factor could be a catchall proxy that represented the variation in share returns not explained by the macrovariables specified in the model

The ITNSLUR system was set up to simultaneously measure beta coefficients and risk premia associated with each share.

Macroeconomic variables were selected based on the influence of the variables to the share valuation. Innovations of macrovariables were generated such that the mean values of the factor measurements were zero. If the mean values were not zero, a constant would be added to ensure that the values would be so. Additionally, Box-Pierce and L-Jung tests were run to test the null hypothesis of values of autocorrelation coefficients being zero. Before ITNLSUR system was estimated, the JSE-All Share Index was regressed on unexpected changes in rand gold price, unexpected returns on the Dow Jones Industrial index, unexpected changes in expected inflation and the term structure of interest rates to analyze whether the variables explained the market proxy and all the above-mentioned variables explained ALSI.

The macroeconomic variables selected by Van Rensburg (1996) led to an ITNLSUR system as follows:

$$\rho_{it} = b_{i1}\lambda_1 + b_{i2}\lambda_2 + b_{i3}\lambda_3 + b_{i4}\lambda_4 + b_{i5}\lambda_5 + b_{i1}UGOLD_i + b_{i2}UDJ_i + b_{i3}UINF_i + b_{i4}UTSD_i + b_{i5}UM_i + c_{it} \quad (5)$$

Where $UGOLD_i$ represented unexpected change in gold prices (Rands), UDJ_i unexpected changes in the returns of the Dow Jones Industrial Index, $UINFi$ denoted unexpected inflation rates, and $UTSD_i$ unanticipated changes in the term structure of interest rates.

Van Rensburg (1996) showed that equation five could be expressed in matrix notation in notation form to give the following equation which was then used to find the beta coefficients and risk premia for each share.

$$\rho = [I_n Ø ɣ\ (\lambda)]\ b + c \quad (6)$$

Equation six was estimated for each share in the sample by Ordinary Least Squares (OLS hereafter) regressions wherein error terms of each share resulted in a vector of residual values. The residual vector was then used to estimate a variance-covariance matrix which in turn, was computed into a quadratic expression. The values of b and λ that were chosen were those that minimized the quadratic expression. Results showed that, for the period 1980-1989, the macroeconomic variables associated with statistically significant risk premia were namely, innovations in the Dow Jones Industrials, the yield curve, expected inflation, and a residual market factor proposed by Burmeister and Wall (1986).

Van Rensburg (2000) conducted a study similar but more comprehensive to van Rensburg (1998). The author utilized generalized Box-Jenkins's transfer function techniques to generate innovations in the macroeconomic variables that is, vector autoregression models (VAR) were estimated to forecast the values of the macrovariables and then, residual terms of models were employed as estimates to proxy unexpected movements in the variables. The residuals had a mean value of zero and L-Jung tests showed no autocorrelation over 12 lags. An addition to the previous study was that two residual market factors, All-Gold index to proxy for the mining market sector, and Industrial Index to represent the industrial market sector were added to the factor model to account for contrasting nature of return-estimation models when based on industrial and mining shares on the JSE at the time. Van Rensburg (2000) stated that the time of publication (1990s) empirical results were showing that majority of market capitalization comprised of gold mining shares on the JSE, and gold shares were more actively traded leading to overrepresentation of mining shares and underrepresentation of industrial shares in ALSI. This made use of the All-Share Index as a market proxy misleading since it was not representative of themining-saturated market thus, the idea was that market residuals had to be separated. Two- factor analysis was applied, and the All-Gold index and Industrial index were imposed as proxies and the error terms of Ordinary Least Squares (OLS). Subsequently INTLSUR techniques were used similarly to van Rensburg (1996) to investigate whether macrovariable factors were priced factors. The variables: Dow Jones Industrial Index, rate on long bonds, goldprice (rand) and gold and foreign reserves were the explanatory variables. The study found that, All-Gold and industrial index residual market factors were associated with significant riskpremia on the JSE over 1985-1995.

The literature which relates the stock market and macroeconomy using Fama-Macbeth regressions and INTLSUR techniques is scarce in South Africa. Interest has been directed towards cointegration and error correction techniques.

Jefferis and Okeahalam (2000) used cointegration and error correction techniques to explore whether domestic and international economic fundamentals influenced share returns, represented by share indices, of the Southern African countries namely, South Africa, Botswana and Zimbabwe over the period 1985-1995. The use of this technique in a South African market was introduced by the authors and had the advantage of being able to explain short-term co-movements and the long run behaviour in stock market returns. The authors did not explicitly use an APT framework however the intuition behind the selection of macrovariables was consistent with to selection intuition of CRR. Jefferis and Okeahalam (2000) estimated a linear multifactor model composed of the log-formed independent variables: local and foreign real GDP, real exchange rate and domestic and foreign interest rates. Real stock market indices were regressed on the changes in variables. Firstly, the authors ran Augmented Dickey Fuller (ADF) tests to ascertain whether the macrovariables were stationary because stationarity was a necessary requirement that the variables had to meet before accurate OLS regressions could be estimated. Thereafter, cointergration tests would be run to establish whether the variables found to be non-stationary would be stationary when combined with other variables. If cointergration tests produced cointergration equations, then it meant that error correction equations would be estimated to explain short-term dynamics after the long run behaviour of the variables had been modelled. In South Africa, the long run cointergration vector showed that, real changes in the long-term interest rate, U.S interest rates, the real exchange rate and domestic GDP were significant in describing returns of the JSE ALSI. There was a positive relation between the ALSI and real exchange rate and real GDP while a negative relation was reported between ALSI and long-term interest rates.

A similar study was done by Moolman and Du Toit (2005) who created a structural model of JSE-listed shares using cointergration and error correction methods which would facilitate insight into the relation between listed shares and the macroeconomy in South Africa in the short-run and long-run. A cointergration equation was used to model the long-run behaviour of stock returns. A cointergration vector which detailed the magnitude of macrovariables on the long run stock market provided was a product of the cointergration equation. In this equation, the dependent variable, the JSE-All share index was modelled as a function of GDPand the discount rate. The explanatory variables were found to be cointergrated at the five percent level of significance which meant there existed a relation between the stock returns andmacrovariables and the data was stationary. Results showed that the long-term stock market level in South Africa was determined by the constant dividend growth model. There was a significant and positive relationship between GDP and stock returns and a negative relationship between discount rate and the returns. Additionally, error correction models were modelled and showed that in the short-run, fluctuations in the ALSI were explained by gold prices, interest rates and the U.S stock market index and changes in risk premium.

Szczygielski and Chipeta (2015) published a study which focused on the return generating process of the South African Stock Market in a manner that would identify the macroeconomic variables influencing the share market. The authors constructed macroeconomic variables which would be used as proxies of the underlying and unidentified pervasive risk factors in the South African stock market in the same manner as CRR. The methodology was organized such that a multifactor return generating process was estimated to explore the influence of macrovariables on the JSE where OLS methodology was used to analyze data. Another generating process was estimated based on a ARCH/GARCH framework.

Like van Rensburg (2000) the authors estimated a multifactor return generating process wherein monthly expected equity returns on the JSE ALSI were modelled as functions of innovations or unexpected movements in a list of macroeconomic variables. Innovations were generated by VAR models whereby changes in the macroeconomic indicators were regressed to forecast the indicators, but the residual terms of the VARs were treated as innovationsin the variable. These innovations were also represented as systematic factors in ARCH/GARCH. Subsequently, an ARCH/GARCH framework was used to estimate the multifactor model that represented macroeconomic risk factors on the JSE. Results showed thatall the macroeconomic variables proposed in the unrestricted model namely innovations in:FTSE All World Index, expected inflation, real activity, broad money supply, oil prices, Rand-Dollar exchange rate were statistically significantly and positively related to JSE-listed firms over the period 1995-2007. Additionally, ARCH and GARCH estimates revealed that the conditional variance of shares in the JSE-ALSI changed over time.

Macroeconomic Variable Models in emerging markets

In recent years, the literature in emerging markets has also employed vector cointergration and error correction techniques to examine the relationship between stock market returns and macroeconomic variables.

Empirical literature relating macroeconomic indicators to stock returns in Nigeria have exclusively used VECM models. Uwubanmweni and Obayagbona (2012) used factor analysis as well as VECM to identify the number of priced risk factors in the Nigerian stock market and found that money supply and oil prices statistically significantly impacted share returns.

Johansen Cointergration, VECM and OLS regressions were employed by Nkechukwu, Onyeagba, and Okoh (2013) to investigate the impact macroeconomic variables have on the Nigerian stock market over the period. Results showed that there was significant long run relationship between broad money supply and real GDP.

Ouma and Muriu (2014) employed OLS methods to analyze regressions which related changes in macroeconomic variables to Nairobian Stock Market in Kenya. OLS regressions were estimated and produced OLS-coefficient-estimates wherein the significance of the beta coefficients would be inferred by the t-statistic and the sign would have economic significance. However, before OLS regressions were estimated, ADF test were run to test for stationarity in the data. Non-stationarity could be corrected, and the authors found money supply (M2), exchange rate and inflation to statistically significantly explain the variation on NSE 20-Share Index. Multiple regression analyses, OLS estimations included, were utilized by Mohi-u-Din and Mubasher (2013) to investigate the impact macroeconomic variables have on returns listed on the Indian Stock Exchange. Mohi-u-Din et al found inflation and exchange rates to statistically significantly describe variation in share returns on the Indian share market. Jecheche (2012) used VAR framework that produced estimates in the form of impulse response and variance decomposition to explore the relationship between macroeconomic factors and share returns listed in Zimbabwe. Granger causality tests showed that over the period 1980 to 2005, Consumer Price Index caused movements in share returns listed on Zimbabwean stock exchanges. Samadi, Bayani and Ghalandari (2012) used GARCH models and found that oil prices, inflation and exchange rate explain Tehran Exchange-listed returns.

Summary of review

CRR examined the influence of several macroeconomic variables on the stock market and the study by CRR was arguably a breakthrough in Asset Pricing because for the first time, observable systematic risk factors other than market risk as per CAPM could be related to stock returns. The authors' approach was novel and important because the results were economically interpretable. Using intuitive financial theory, CRR selected state variable and derived a series of innovations in the variables in line with the efficient market hypothesis which posits that stock returns react to economic news. Fama and Macbeth (1973) two-step procedure was used to investigate the macrovariable pricing relationship and the systematic variables namely, industrial production, unanticipated changes in the bond risk premium and unexpected changes in the term structure of interest rates had a strong influence on stock returns with reported t-statistics of 2.761, 2.869 and, -2.194 respectively. Measures of inflation were found to be significant for periods of high volatility in the inflation measures. These results showed that stock prices are indeed sensitive to the macroeconomy. The study by CRR inspired a plethora of studies which pointed to relationship between the stock market and the macroeconomy. Early tests of the MVM approach in U-S market showed encouraging results as Chan, Chen, and Hsieh (1985) employed the MVM approach to explore firm size effect and found industrial production, unexpected inflation and bond market risk premium to explain the cross-sectional variation in stock returns with t-statistics of 2.72, -2.56 and 2.87 respectively. Hamao (1988) replicated CRR on the stock market in Japan and found unexpected changes in term structure of interest rates, risk premium, and expected inflation to significantly influence stock returns.

Tests of the MVM evolved to the use of advanced econometric modelling and to considerations of market characteristics to ensure accurate data. An example of this is the study done byPoon and Taylor (1991) who pre-whitened stock return series to more accurately stand for innovations or unexpected changes in macro-variables. Subsequently the Fama and Macbeth (1973) procedure was adapted as in CRR. Unfortunately, after this enhancement, none of the macrovariables were reported to influence the variation in expected returns. In addition to exploring alternative econometric methods, alternative portfolio formations were explored. Clare and Thomas (1994) extended CRR to the UK stock market using Fama and Macbeth (1973) procedure and instead of forming portfolios according to market capitalization as CRR, they formed portfolios according to market betas. The study found oil price, the retail price index, measures of corporate default, the retail price index, loans, UK private sector bank lending, the current account balance and the redemption yield on an index of UK corporate debentures to significantly explain the variation of returns. Priestly (1996) concluded that the Kalman Filter was the most appropriate tool for generating unexpected movements in the chosen variables to ensure more appropriate results. Essentially the study of MVM produced positive results. Furthermore, the study conducted by Chen, Hsieh and Jordan (1997) which aimed to compare the performance of MVM and factor analysis showed evidence that MVM was superior. Connor (1995) also concluded that MVM was a more appropriate model when it came to economic intuition and interpretation.

Van Rensburg (1996) utilized iterated non-linear seemingly unrelated regression (ITNLSUR) estimation techniques to identify potential macrovariables which may influence stock returns on the Johannesburg Stock Exchange. The author took cognizance of the generation of unexpected changes in macroeconomic variables and employed vector autoregressive to generate those innovations. Unexpected changes in the Dow Jones Industrials, term structure of interest rates, expected inflation, and the residual market factor were associated with statistically significant risk premia. Van Rensburg (2000) tested the MVM approach considering the unique characteristics of the Johannesburg Stock Exchange at the time. Mining shares were overrepresented on the JSE. The study found All-Gold and industrial index residual market factors to explain JSE-listed share returns.

Usage of cointegration and error correction techniques to explore MVM approach has been popular in many emerging markets in Africa as well as in South Afirca. Jefferis and Okeahalam (2000) conducted stationarity tests using Augmented Dickey Fuller (ADF) tests and if non-stationarity was detected, cointegration tests would correct for that. Subsequently, error correction techniques were run to model the long-run behavior of macrovariables. The study found real changes in long-term interest rates, U-S interest rates, real exchange rate and domestic GDP to statistically influence JSE ALSI. The relation between the ALSI and real exchange rate and real GDP was while the relation between ALSI and long-term interest rates was negative. Moolman and Du Toit (2000) also employed cointegration and error correction techniques and found that movements in the ALSI were explained by gold prices, interest rates and the U.S stock market index and changes in risk premium.

Szczygielski and Chipeta (2015) explored the relation between macrovariables and the stock market with focus being on the return generating process and concluded that unexpected movements in FTSE All World Index, expected inflation, real activity, broad money supply, oil prices, Rand-Dollar exchange rate were statistically significantly and positively related to the JSE market index. Furthermore, there is extensive literature which employs variables adapted in this study. Table 1 lists the different studies concerned with deriving prespecified macroeconomic variables.

Table 1

Previous studies employing selected macroeconomic variables

Macroeconomic Variables	Previous studies using selected Macroeconomic Variables
USD/ZAR Exchange Rate	Antonious, Garret and Priestley (1998), Azeez and Yonezawa (2006)
Real Gross Domestic Product	Tursoy, Gunsel and Rjoub (2008)
Manufacturing Production	Van Rensburg (1996)
Retail Sales	Van Rensburg (1996), AntoniouS, Garret and Priestley (1998)
Term Structure	French (2017), Chen, Roll and Ross (1983,1986), Chan, Chen and Hsieh (1985), Antoniou, Garret and Priestley (1998), Azeez and Yonezawa (2006)
Gold Prices	Van Rensburg (2000), Tursoy, Gunsel and Rjoub (2008), Samadi, Bayani and Ghalandri (2012)
Money Supply	Azeez and Yonezawa (2006), Antoniou, Garret and Priestley (1998), Clare and Thomas (1994)
Oil Prices	Chen and Jordan (1993), Clare and Thomas (1994), Samadi, Bayani and Ghalandri (2012)
Equity Market Risk Premium	Chen, Roll and Ross (1983,1986), Chan, Chen and Hsieh (1985), Sharpe (1964), Antoniou, Garret and Priestley(1998), Chen and Jordan (1993)

Note: Several studies such as CRR, Chan,Chen and Hsieh (1985) tabulate the various risk factors adopted by prior literature investigating MVM. Although the table format may be like past studies, the information stated is based on the variables adopted in this study and thus no reference was replicated directly from those similar studies.

Motivation of Macroeconomic Variables

MVM literature shows evidence that there is indeed a relation between the stock market and the macroeconomy. Following CRR, the state variables to be applied in this study are those which directly and indirectly influence the basic share valuation and since the MVM provides economically interpretable state variables, the signs of coefficients can also be interpreted to have a positive or negative relation to expected returns.

The basic share valuation is given as:

$$p = \sum_{t=1}^{\infty} \frac{E(c)}{(1+m)^t} \tag{7}$$

Where p (the present value of a financial asset) is the sum of m (discount rate) discountedexpected cashflows represented by $E(c)$. As such, macroeconomic variables which are selected are those which will impact all values of the basic share valuation as well as the overall state of the economy. Table 1 summarizes the macroeconomic variables selected for this study and sources of data.

Equity Market Risk Premium

In line with the argument posed by CRR and CCH – which states that efficient market theory holds that aggregate market returns reflect all information, new and old, regarding real activities - the J203 ALSI is a proxy for aggregate market returns. As such, the ALSI represents the market portfolio which gauges market movements. The rate thereof represents the market risk rate. To derive the equity market risk premium, the RSA 91-Day Treasury-Bill rate which represents a riskless rate is subtracted from the market rate.

USD/ZAR Exchange Rate

USD/ZAR is the Dollar price of the Rand and movements in USD/ZAR represent exchange rate fluctuations which is a variable that is relevant on the JSE, since there is a concentration of listed multinationals.

The potential impact of exchange rates and stock prices is based on the 'flow-orientated' model of Dornbusch and Fischer (1980). The model states that fluctuations in the exchange rate affect the competitiveness of multinationals, their earnings and hence expected cashflows. In theory, a depreciation in domestic currencies should make exports (imports) cheaper (more expensive), increase (decrease) profits which in turn increases cashflows and increase (decrease)hence stock prices (Imna and Amin, 2016). Further, expectations or news on exchange rates impacts expected cashflows that is the numerator of Gordon's valuation model. Exchange rates represent international economic conditions(Jefferis and Okeahalam, 2000). There is a plethora of studies done which investigate the relation between exchange rate movement and volatility on the JSE. Empirical evidence showsthat a statistically significant relationship exists between exposure to foreign exchange rates and expected returns however results on the direction of the relationship vary.

Barr, Kantor and Boldsworth (2007) conducted a study which aimed to rank JSE Top40-listed firms according to the sensitivity of the firms to changes in the Rand-Dollar exchange rate which were presented as continuously compounded percentage changes. Firms were assigned into categories according to the degrees by which rand-dollar currency affected firm profit, costs and investment activities. A GARCH (1,1) regression was estimated for each share and the t-statistics of the beta coefficients were ranked. Results showed that movements in exchange rates were associated with statistically significantly negative betas for “Rand-Play” firms which are firms whose revenue and costs are denominated in U.S dollars even though firms are operational in South Africa. Muzindutsi and Niyimbanira (2012) employed a two-factor APT model to ascertain whether constituents of the JSE Top40 as well as the JSE Top40 index (market proxy) were sensitive to movements in the Rand price of the U.S. dollar over the period 1995-2007. The authors found that the JSE Top40 Index maintained a significantly negative relationship with movements in exchange rates.

Real Gross Domestic Product (GDP)

Gross Domestic Product is the total value of all goods and service produced within a country over a period (Jordaan, 2013). A state variable representative of the state of the economy is necessary because the equity market relies on the long run behavior of production (Chen, Roll and Ross, 1986). CRR andChan, Chen and Hsieh (1985) employed growth rates of industrial production to proxy for theeconomic condition however, empirically other indicators of economic condition such as GrossDomestic Product and Gross National Product have been used.

Quarterly GDP levels which are seasonally adjusted are indicative of the state of the economy. GDP measures the value of aggregate output, goods and services combined, in a country and is an indicator of a country’s economic performance. This variable will show how changes in economic state affects expected cash flows. Most MVM studies make use of industrial production as a proxy for economic conditions (per CRR), an indicator which is not readily available in South Africa, and Industrial output focuses on goods only. Moreover, since GDP includes output from production and income, it gives broader and robust information on the total output of the economy. The use of GDP differs from other studies which use Gross National Product, an indicator which measures total income of citizens of a country exclusive of a country’s production.

Manufacturing Production

Similarly, to Van Rensburg (1996) manufacturing production is chosen as a macroeconomic risk factor. Manufacturing production refers to output produced efficiently from raw materials in plants as well as in factories and is often synonymous with industrialization in an economy

(Kenton, 2020). The level of growth stemming from output produced in the manufacturing sector is regarded as a precondition to the growth of several macroeconomic indicators such as industrialization as well as employment in the economies of developing anddeveloped countries (Kwode (2015) and Otech (2010) as cited by Michael, Emeka and Ogbonna, 2019). As such, manufacturing output is a vital driver of the economy (Michael, Emeka and Ogbonna, 2019).Further, since manufacturing production is related to output in the economy, it affects the expected cash flow variable of the basic share valuation. Several studies have explored the role of manufacturing in the economy. For example, Szirmai and Verspagen (2015) tested the engine of growth hypothesis in developingcountries for the period 1950-2005. The Engine of growth theorem was first introduced by Kaldor (1967) as most studies suggest (Chakravarty and Mitra, 2008) and hypothesizes that manufacturing is the main driver of economic development and growth. To test the hypothesis that there was a positive and significant relationship between manufacturing and growth rate of GDP per capita, Szirmai and Verspagen (2015) estimated panel regression models for a sample of 88 countries and found a moderate positive relationship between manufacturing production and economic growth. Chakravarty and Mitra (2008) examined the importance of the manufacturing sector as a main driver of growth in India and found that, in line with the engine of growth hypothesis, manufacturing was one of the important drivers of the economy in India. The inclusion of manufacturing as a risk variable differs from most MVM studies as Manufacturing Production is seldom included in similar research and has been an important indicator of development in economies.

Retail Sales

Retail sales are a measure the volume of durable and non-durable goods which are purchased by consumers varying from individuals to businesses to indicate demand for final products (Amadeo, 2020). The inclusion of retail sales relates asset pricing to consumption. This is because consumer spending is indicative of the possible future expansion and contraction of the economy and is hence a good indicator of some aspects and even the overall economy. For example, higher retail sales may mean there is higher consumer spending and thus expected economic growth (McConkey, 2015). Moreover, higher consumption should increase earnings, expected cashflows and hence stock prices. CRR computed real consumption per capita series by dividing real consumption by population to be included in themultifactor equation. Use of direct data from the South African Reserve Bank limits computation errors.

Money Supply

Money supply is the total value of currency and all liquid instruments circulating in the economy at a point in time (Westfall, 2021). It is used to serve as a proxy for monetary policy. Printing money leads to a decrease in interest rates, increasing stock prices, therefore an expansion in money supply leads to increases in stock prices. Unexpected changes in money supply should therefore be priced in stock returns.Money supply will be included as an explanatory variable as it is representative of the risk thatmonetary policy poses to investors. There is empirical evidence of a relation between monetarypolicy and the share market. For example, to determine whether JSE shares reacted to public information in the form of monetary policy, Glass and Smit (1995) found that changes in the anticipated growth rate of aggregate money supply (M3) explained variation in stock returns while changes in unexpected money supply were insignificant in explaining expected returns.Noumbissie and Mongale (2014) investigated the effect of monetary policy on stock market turnover by employing impulse response function analysis (IRF). IRF worked such that an innovation in the macrovariable was generated and the null hypothesis of no impact was rejected or not. Amongst other variables, stock market turnovers were described to be affectedby shocks in aggregate monetary supply. Clare and Thomas (1994) also found money supply to be associated with a risk premium at the ten percent level of significance in the U.K. Ahmadand Husain (2006) found a long run causal relationship from Money supply to share returns onthe Karachi Stock Exchange.

Credit Default Swap ("CDS") Spread

CDS spreads are premiums that buyers of CDS contracts are required to pay. These spreads measure credit risk and can be employed as measures of systematic risk (Breitenfeliner and Wagner, 2012). The use of CDS spreads differs from CRR and CCH as they measure bond risk premium by computing excess portfolio returns of long-term government bonds over the returns of portfolios consisting of bonds rated "Baa" and under by Moody's. In recent years, the use of CDS spreads to measure credit risk has gained popularity.

One example which argues for employing CDS spreads was conducted by Blanco, Brennan and Marsh (2005) who investigated a comprehensive test of an arbitrage parity, proposed by Duffie (1999), which equated CDS prices to credit spreads. Credit spreads were defined as the difference between bond yields of *T*-year par bonds and the risk-free reference rates. To test the validity of the arbitrage theory, Blanco, Brennan and Marsh (2005) computed basis points defined as differences between CDS prices and credit spreads of the same maturity (5 years) for 33 American as well as European firms and descriptive results were in line with the arbitrage condition. More formally, Blanco et al (2005) estimated cointergration vectors to investigate whether the two measures of credit risk (CDS prices and credit spreads) priced riskefficiently (according to random walk theory) and equally in the long-run so that they could observe whether prices reverted to their means in the long-run. Results showed that CDS pricesas well as credit spreads were cointergrated for most of the companies in the sample, implyingthat both measures equally priced credit risk. Given that both measures priced credit risk equally, the authors explored which of the two maintained the most significant contribution tothe discovery of the price of credit risk, and in turn, which was more important for "price discovery" of credit risk. The study found that on average, the CDS market contributed eightypercent of price discovery. This study has important implications; the equilibrium arbitrage parity that CDS prices are equivalent to credit spreads holds however, CDS prices lead cash bond markets in price discovery. This implies that CDS spreads contain information more timeously. The use of CDS spreads is therefore an appropriate indicator of credit risk for this study.

Another reason for including CDS spreads is that credit default spreads give a global view and in turn give a global perspective on country-specific risk. Heinz and Sun (2014) found that sovereign CDS spreads were driven by liquidity, global investor sentiment and macroeconomics. High spreads during the global financial crisis were attributed partly to increases in risk aversion in Central, Eastern and South-Eastern European countries. If countries are globalized, then this is an important proxy for risk.

Term Structure of Interest Rates

By virtue that the discount rate of the share valuation is an average of short-term as well as long-term rates of return, changes in the slope of the yield curve influences the discount rate (Chen, Roll and Ross, 1986). The term structure of interest rates is a yield curve measuring the relationship between bonds that have same risk but have different maturities. There are several theories which explain the implications and importance of the shape of the yield curve to market-participants. According to the expectation's hypothesis of the yield curve, in equilibrium the expected return on a single long-term bond has to equal a series of short-term bonds (Brealey, Myers and Aleen, 2014). Cox, Ingersoll and Ross (1985) state that this hypothesis implies that bonds are priced such that “implied forward rates are equal to expected spot rates”. This provides evidence that the bond risk premium may give insight into the effect that expectations on interest rates (hence discount rates) may have on shares’ premia. The liquidity preference hypothesis asserts that interest rates are determined by investors’ preference for liquidity, and hence, for short-term credit exposure and market segmentation hypothesis, based on demand and supply for debt, attributes changes in interest rates to changes in monetary policies, the economy, future interest rate expectations and liquidity (Mishkin and Eakins, 2009 cited by Johnson, Zuber and Ganda, 2010). Following CRR, term structure is computed as the difference between returns on a long-term government bonds and treasury-bill rates. In essence, including the term structure facilitates insight into whether investor expectations on long-term and short-term interest rates are priced on the JSE.

Treasury-Bill Rate

Treasury- Bill rates are included, as short-term riskless rates represented by T-bill rates impact the “time value of expected cash flows” (Chen, Roll and Ross ,1986). Treasury-Bill rates are used to compute market risk premium as well as term structure of interest rates. Furthermore, Chan, Chen and Hsieh (1985) state that T-bills contain inflation expectations. T-bills are also affected by factors such as monetary policy as well as risk aversion (Corporate Finance Institute, 2020).

Oil Price

Studies show that systematic influence of oil prices on the macroeconomy is ubiquitous depending on whether a country primarily exports or imports oil and as such impacts stock returns. Moreover, CRR state that any macroeconomic data set in asset pricing is incomplete without oil. Clare and Thomas (1994) noted that movements in oil prices affected the production costs of industry which had a systematic impact on policy, revenues etc. However,results showed that oil prices were not priced risk factors. Earlier studies relating oil shocks to stock markets have been studied on developed markets. For example, Sadorsky (2001) reportedon positive relationship between oil prices and stock returns. Jones and Kaul (1996) found changes in oil price to lead changes in real stock returns, while studies such as Papapetrou (2001) concluded on a negative relationship.

More studies showed that the relationship between oil innovations and the stock market is nested. For example, a study conducted by Gupta and Modise (2013) which explored the relationship between shocks in oil prices and the South African stock market showed that there was a positive relation between the stock market and unanticipated increases in oil prices only when the shocks were a result of unexpected increases in the aggregate demand for oil. Wang, Wu and Yang (2014) noted that the effect of shocks in oil prices depended more on whether the country concerned was a net importer or exporter of oil and less on whether shocks were related to demand or supply shocks. Reboredo and Castro (2014) found that over the sample period 2000 to 2011, there was no relationship between oil price shocks and aggregate U.K. as well as U.S. stock markets prior to the 2007-2008 financial crisis.

Gold Price

Gold is considered as an indicator of inflationary expectations. The demand for gold increases when the prospect of inflation ensues. This is because investors typically invest in Gold as a hedge against inflation therefore when price levels increase, so do gold prices (Moore, 1990).

Studies find that changes in gold prices influence share prices in South Africa. For example, Mongale and Eita (2014) investigated the impact of commodity prices and macrovariables on the JSE share returns using Engel-Granger technique. Results, showing increases in gold prices to be related to increases in the All-Share index, suggested that there was a positive relation betweenthe two variables. Gilmore, Mcmanus and Sharma (2009) estimated vector error correction (VEC) which showed that the stock market index caused movements in the gold index and notvice versa. Mishra, Das and Mishra (2010) found a long run relation on the Indian Stock Market. In line with empirical evidence of factor analysis by Page (1986) which concluded thattwo to three factors explained returns on the JSE, a study by Van Rensburg and Slaney (1997)was consistent with that finding of Page (1986) as the provided evidence that the Industrial Index as well as the JSE All-Gold Index could have been the two priced factors (Van Rensburg,1998). In a later study, Van Rensburg (2000) employed iterated non-linear seemingly unrelatedregression technique of McElroy & Burmeister (1988) and included two residual market factorsto account for saturation of mining and industrial shares on the JSE and in addition to other variables, found rand gold prices, the level of gold and foreign exchange reserves as well as the Industrial and All-Gold residual market factors to be associated.

Table 2

Glossary and definitions of macroeconomic variables

Symbol	Macroeconomic variable	Definition or Measurement
	Basic Series	
J201 ALSI	JSE All Share Index	Daily Prices of All share Index. *(Bloomberg)* .
TB	RSA 91-Day Treasury-Bill rate	91-day tender rates. (*South African Reserve Bank website*)
GDP	Gross Domestic Product	Quarterly Gross Domestic Product at market prices. Seasonally adjusted. (R millions). (*South African Reserve Bank and Statistics South Africa websites*).
MP	Manufacturing Production	Monthly manufacturing production and sales. (Physical volume production. Seasonally Adjusted. (*Statistics South Africa).*
RS	Retail Sales	Monthly Retail Sales Index. Code: KBP7086T.(*South African Reserve Bank website).*
MS	Money Supply	M3 Monthly Monetary Aggregate money supply. (R millions). Code: KBP1374N. (*South African Reserve Bank website)*
GB	RSA 10-Year Government Bond	Monthly GTZAR10Y Govt. (*Bloomberg*).
GLD	Gold	Monthly gold price per ounce. (*Bloomberg*).
Brent	Oil	Monthly Generic Brent Crude oil (Futures). CO1. (*Bloomberg)*
Usd/Zar	Exchange Rate	Daily exchange rates. *(Bloomberg*).

Following CRR, a series of changes in the macrovariables is derived as shown in table 2.

Table 3

Derivation of macroeconomic variables

Derived Series		
Symbol	**Macroeconomic variable**	**Definition or Measurement**
Y1	Equity Market Risk Premium	J201 ALSIt − TBt
Y2	Gross Domestic Product	GDPt − GDPt−1
Y3	Manufacturing Production	MPt − MPt−1
Y4	Retail Sales	RSt − RSt−1
Y5	Money Supply	MSt − MSt−1
Y6	Term Structure	$(GBt - TBt) - (GBt{-}1 - TBt{-}1)$
Y7	Gold	GLDt − GLDt−1
Y8	Oil	Brent$t$ − Brent$t$−1
Y9	Exchange Rate	Usd/Zar$t$ − Usd/Zar$t$−1

Note:The method of derivation of risk factors is adopted from Chen, Roll & Ross.

Methodology

Data and Sampling Collection

The data used in this study is sourced from Bloomberg, South African Reserve Bank and Statistics South Africa and covers every JSE-listed shares over the period January 2000 – December 2019. The dataset comprises of daily raw prices, volumes, market capitalizations and accounting ratios where shares can enter and exit the dataset over the sample period to account for survivorship bias. All data are adjusted for corporate actions such as, the consolidations of subsidiaries, unbundlings, dividend pay-outs and share-splits while accounting data are lagged for a single month to account for look-ahead bias. In order to ascertain that all selected shares are both liquid and investable, a liquidity filter is applied. The liquidity filter is conditioned such that at each date when portfolios are sorted, shares are required to be within the largest 120 shares according to market capitalization (portfolio sorts are described in detail in the section that follows).

One reason for selecting the largest 120 shares according to market capitalization is because companies which fall out of that range are too small and illiquid to investors (Ward and Muller,2012). These shares make up a majority of market capitalization and are an accurate reflectionof the stock exchange in South Africa. Macroeconomic data is sourced from Bloomberg and the South African Reserve Banks website and includes the JSE equity market risk premium based on the J203 ALSI and RSA 91-day Treasury-bill rate, Gross Domestic Product (GDP), exchange rate, manufacturing production, retail sales, money supply, South Africa's credit default swap rate (CDS), gold prices, Brent oil as well as term structure of interest rates. Most South African macro-economic data are available on a quarterly basis; therefore, all daily data points are converted to quarterly data points.

Description and Overall Research Design

This section explains how portfolios were sorted and how Fama-Macbeth regressions were run. More information is discussed on Pooled and fixed effect regressions.

Since an integral part of methodology is sorting portfolios, descriptive statistics of the cumulative returns on size sorted portfolios are calculated. A correlation matrix of macroeconomic variables is included to summarize the data for analysis of any patterns between variables and to test the reliability of regression estimates.

Portfolio Sorts

Following CRR, size portfolios of shares are constructed and sorted a monthly basis. These shares are classified into one of six size portfolios which are grouped according to each share's most recent pre-sort market capitalization. Since the equity data is restricted to 120 of the largest shares according to market capitalization, each portfolio is expected to contain 20 shares at rebalance. Two weighting mechanisms are applied, the first being equal weighting where each share (of the top 120 shares) is allotted an initial weight of 1/20 and the second being the market capitalization weighting where each shares' weight is based on its latest market capitalization relative to other constituent shares within the portfolio. Returns of the portfolios are subsequently calculated on a buy-and-hold basis where returns are based on the sum of portfolio weights where each respective in-portfolio share weight is compounded using the respective shares return at time t. In order to match the frequency of portfolio returns to the macro-economic explanatory variables, portfolio returns are converted from daily to quarterly frequency.

Fama-Macbeth Regressions

A variant of Fama-Macbeth regression is applied to estimate the respective factor premia associated with the time-series macro-economic variables. First-pass time-series regressions are estimated quarterly contingent on the historical 5 years of data (20 quarters) applying the time-series regression equation that is described below:

$$r_{i,t} - rf_t = \alpha_i + \sum_{z=1}^{n} \beta_z X_z + \varepsilon_{i,t} \qquad (8)$$

In equation 9, $r_{i,t}$ is the return on portfolio i at time t, rf_t is the quarterly 91-day t-bill return, $\square_i$ is the time-series alpha of portfolio i, $\square_z$ is a nx1 vector describing the time-series of factor loadings and X_z is a n x t matrix of independent macro-economic variables. Once time-series factor loadings are estimated, the results are reconfigured in a panel, where the betas estimated from time series regression for every one of the portfolios across the various time-periods, are treated as independent variables and annualized rolling 5 year quarterly excess returns for each portfolio are applied as the dependent variable, as represented in the regression below.

$$ar_i = \alpha + \sum_{i=1}^{n} \gamma_i \beta + \varepsilon_i \qquad (9)$$

Where ar_i represents the annualized excess returns for portfolio i, □ is n x n matrix of time-series factor loadings estimated via the first-pass regression and □$_i$ is the cross-sectionally defined factor premium associated with each macro-economic variable. Two-models are applied in estimating the n × 1 vector □, namely a pooled OLS which is a stacked panel that assumes no variation in alpha across individual portfolios as well as fixed-effects panel data regression assuming time-series effects. The latter model is applied as it allows for variation in the portfolio alphas across time given that portfolios are constructed using a consistent size - based methodology. The two models are discussed in more detail below.

Panel Data Regression Models

Panel data is pooling or the combination of time series and cross-sectional observations where the same cross-sectional units are observed over a period. One advantage of this data that benefits this study is that the data is suited to analyze "dynamics of change" since cross-sectional observations are studied repeatedly. Also, combining cross-sectional and time series data results in a more informative data set. However, due to problems of heteroscedasticity present in cross-sectional data and autocorrelation apparent in time-series, a fixed effects model needs to be estimated to address these problems (Gujarati and Porter, 2009).

Panel data analysis was employed using the two approaches namely, pooled OLS as well as fixed time-effects to estimate the risk premia. Because panel data deals with large samples over a period, it is highly likely that explanatory observations are somewhat dependent. A description of the respective approaches as well as differences between the two models follows.

Pooled OLS Model

A pooled OLS model is an estimation technique that neglects the fact that two different types of data, namely, cross-sectional as well as time-series data, are employed and combines these into a single regression. The pooling of distinct data sets allows for improved detection and measurement of unobservable effects which would otherwise not be accounted for in the versions of time-series and cross-sectional data wherein the respective data sets are not combined. The major issue of this model is that the uniqueness of independent variables can be subsumed in the error term. This could potentially result in correlation between idiosyncratic term and independent variables which would lead to inconsistent and biased coefficients. Therefore, a fixed-effects model considers and settles the correlation between regressors and error term (Gujarati and Porter, 2009).

Fixed effects Model

A fixed effects model is a regression model where the parameters assume non-random quantities. Fixed effects are included to assist in controlling for omitted-variable bias which potentially cause biased and inconsistent OLS estimators. This biasedness is omitted by cancelling constant heterogeneity. Removal of constant heterogeneity is necessary as it leads to biased estimators if it is not removed.

In summary, the differences between pooled OLS and fixed effects are:

- Pooled estimators are consistent only if regressors are uncorrelated to error term while fixed-effects estimators are always consistent.

If disturbance terms are uncorrelated regressors, pooled estimates are consistent but serial correlation still possible resulting in inefficient estimates whereas fixed effect is constant thus estimates are consistent and efficient (Gujarati and Porter, 2009).

Empirical evidence from this will determine whether there is evidence of statistically significant risk premia associated with the unexpected changes in the abovementioned macro-variables. By doing so, we will be able to ascertain whether other systematic factors, other than market risk as per the CAPM, are relevant risk factors for investors to consider when pricing financial assets on the JSE. Additionally, as far as the author's knows, this study will be the first in South Africa that considers a MVM approach using a combination of Fama-Macbeth and panel data regressions. Even though there are negative aspects describes in the literatures related to CRR and Fama-Macbeth regressions, empirical results will provide key insight into which variables influence share returns on the JSE.

Empirical Results

Descriptive Statistics

Figures 1 and 2 is a graphical description of the cumulative performance of size-sorted portfolios whose constituents are based on equal weighting of market capitalization.

Figure 1

Equally weighting Size Portfolio Cumulative Performance

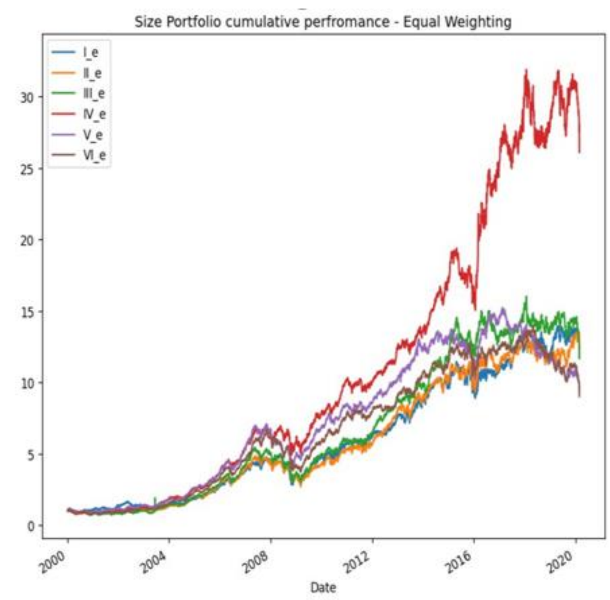

Figure 2

Market capitalization Size Portfolio Cumulative Performance

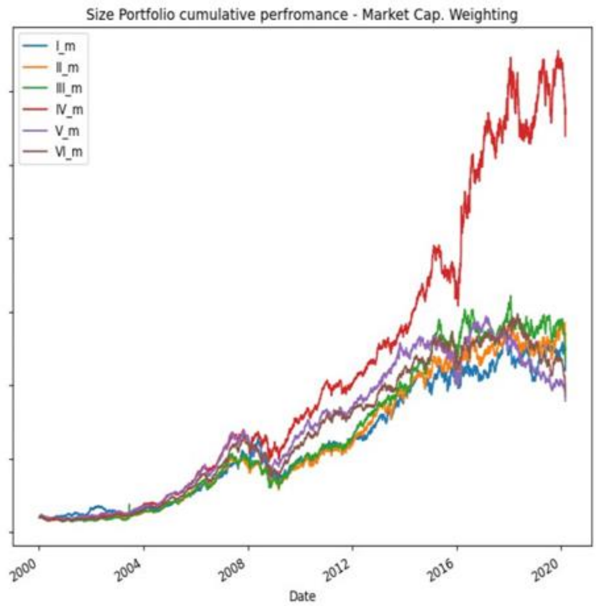

Table 4

Equally weighted portfolio returns sorted on size

	Portfolio I_e	Portfolio II_e	Portfolio III_e	Portfolio IV_e	Portfolio V_e	Portfolio VI_e
Annual Return	12.999%	12.915%	13.144%	17.569%	10.995%	11.160%
Standard Deviation	16.18%	16.669%	17.072%	15.537%	14.953%	15.672%

Table 5

Market capitalization weighted portfolio returns sorted on size

	Portfolio I_m	Portfolio II_m	Portfolio III_m	Portfolio IV_m	Portfolio V_m	Portfolio VI_m
Annual Return	12.744%	13.240%	13.100%	17.768%	10.805%	11.411%
Standard Deviation	18.674%	16.741%	17.065%	15.644%	14.892%	15.645%

Following CRR, 120 shares were allocated into portfolios based on their market capitalizations. This resulted in six size portfolios to be formed in descending order, each consisting of 20shares with each share bearing an equal weighting of 1/20. Figures 1 and 2 show a gradual upward trend in all six portfolio returns from 2000 to 2007 followed by a gradual decline in all portfolios returns from 2008/2009. The fall in portfolio returns coincides with the occurrence of the Global Financial Crisis which caused share prices to plummet on the JSE. In 2016 there is another sharp decline in average returns for all portfolios. Possible reasons for this could be China's economic crisis which could have impacted Africa as it is an influential and important trading partner in Africa. Since a vast amount of stock traders were international traders, market participants could have withdrawn funds given the close alliance between China and Africa. Average annual returns of the different size portfolios have marginal annual return differences except for portfolio four which is slightly higher than other portfolios. Portfolio I_e which consists of 20 firms with the highest market capitalization has an average return of 13% while portfolio six (with 20 smallest market capitalization firms) has an average annual return of 11.16%. The difference between the returns of the smallest and biggest portfolios is 1.4%. This difference is marginal which leads to the conclusion there appears to be no evidence of the "size effect" on the JSE over period 2000 to 2019. Additionally, size portfolios were formed wherein portfolio constituents were based on the latest market capitalization values. These market capitalization weighted portfolios follow similar trends to equally weighted portfolios whereeconomic crises caused declines in average portfolio returns around the same years. The largecap portfolio has an annual mean return of 12.74% and the small cap portfolio has an averagereturn of 11.41%. The difference between the two is marginal and does not show evidence of a significant size effect.

Portfolio I_e has an average standard deviation of returns of 16.2% which means portfolio returns deviate in a positive direction by 3% from the portfolio's annual mean returns. This displays historical volatility in the portfolio wherein returns have been more dispersed around the portfolio mean, and hence, fluctuated over the period. Portfolios II_e, V_e and VI_ealso have standard deviations above their respective portfolio annual average returns. Returns are dispersed around the mean, implying that they are not predictable as they can swing in either direction. Portfolio IV_e, the best performing portfolio in terms of annual returns has a standard deviation which is lower than the portfolio's annual returns. This implies that portfolio returns are more predictable even amidst turbulent economic conditions.

Portfolio VI_e, the smallest portfolio has a standard deviation of 15.7%; volatility of this portfolio is relatively low when compared to portfolio I_e. This implies that portfolio VI_e is less risky to the largest portfolio since returns do not fluctuate as much as portfolio I's returns. This further reinforcesevidence that there is no evidence of the size effect since the largest portfolio is associated withhigher volatility and the smallest portfolio has lower volatility.

Similar results to those reported from equally weighted portfolios are evident when portfolios are weighed according to market-capitalization. Portfolio I_m has a standard deviation of 18.62%, a deviation higher than that of portfolio I_e, meaning that the largest market-cap firm's returns are more spread out and are riskier. Portfolio VI_m consisting of small cap firms has a lower standard deviation to the largest size portfolio therefore it is less risky. Portfolios namely, II_m, III_m and V_m also have unstable portfolio returns, while portfolio IV_m has a standard deviation lower than the portfolio's annual returns, meaning values in the portfolio are closer to mean returns and are stable.

Essentially, there appears to be no evidence of size effect on the JSE for the period 2000 to 2019. There are also no notable differences in average portfolio returns given the two weighting conventions used.

Correlation matrix

One of the assumptions in multiple linear regressions is that explanatory variables should not be highly correlated with other independent variables because that poses a challenge in interpreting results. The phenomenon if having highly correlated independent variables is called multicollinearity and it is a problem because it makes it difficult to isolate the impact that an individual predictor will have on a dependent variable. A correlation matrix is one way of whether independent variables are unrelated and hence will produce reliable results. Table 5 is a correlation matrix of the correlation coefficients of macroeconomic variables selected as risk factors in this study.

Table 6

Correlation Matrix of Macroeconomic Variables

	EMRP	GDP	MP	Ret. Sale	MS	TS	Gold	Brent	Usd/Zar
EMRP	100.00%	6.20%	-0.80%	10.50%	18.30%	-6.20%	10.10%	32.80%	-1.20%
GDP	6.20%	100.00%	16.30%	26.20%	34.70%	-11.50%	17.40%	11.50%	9.90%
MP	-0.80%	16.30%	100.00%	1.30%	-7.90%	-7.10%	-5.50%	2.10%	1.30%
Ret. Sales	10.50%	26.20%	1.30%	100.00%	34.60%	-5.30%	10.20%	4.10%	6.70%
MS	18.30%	34.70%	-7.90%	34.60%	100.00%	-3.40%	8.90%	23.50%	-0.50%
TS	-6.20%	-11.50%	-7.10%	-5.30%	-3.40%	100.00%	-14.30%	1.60%	-9.50%
Gold	10.10%	17.40%	-5.50%	10.20%	8.90%	-14.30%	100.00%	20.40%	69.10%
Brent	32.80%	11.50%	2.10%	4.10%	23.50%	1.60%	20.40%	100.00%	16.60%
Usd/Zar	-1.20%	9.90%	1.30%	6.70%	-0.50%	-9.50%	69.10%	16.60%	100.00%

The correlation coefficients are all low which shows that there is no multicollinearity between macroeconomic variables. The largest correlation is a positive relationship between Gold and the USD/ZAR exchange rate. Gold is priced in Dollars therefore it is reasonable to assume that the correlation is due to that. This is followed by Brent oil and the market risk premium. Money supply and GDP are also positively correlated. Correlation could be explained by Macroeconomic theory, as increases in money supply lead to lower interest rates.Lower interest rates lead to expansions in investment spending, demand for goods, output and income (Blanchard and Johnson, 2014). The two commodities, Brent Oil and Gold, are weakly correlated in contrast to empirical results such as Simakova (2011) which record a strong co- movement between oil and gold.

OLS Regression Results

Pooled OLS

Table 7

Pooled OLS Regression Results

Dependent variable:	Average Returns	**R-squared:**	0.458
Model:	OLS	**Adjusted R squared:**	0.444
Method:	Least Squares	**F-statisitc:**	32.85
Date:	06-Apr-20	**Prob (F-Statistic)**	1.91C-41
Time:	10:52:01	**Log-Likelihood**	979.29
Number of Observations	354	**AIC:**	-1939
DF Residuals:	344	**BIC:**	-1900
DF Model:	9		
Covariance Type:	HCI		

Parameter Estimates

	Coefficient	**Standard Error**	**z**	**P>|z|**	**[0.025**	**0.975]**
Constant	-0.0069	0.004	-1.656	0.098	-0.015	0.001
EMRP	0.029	0.004	7.15	0	0.021	0.037
GDP	-0.0025	0.001	-2.898	0.004	-0.004	-0.001
MP	-0.0375	0.004	-9.597	0	-0.045	-0.03
RS	-0.0009	0.001	-0.992	0.321	-0.003	0.001
MS	-0.0032	0.001	-3.238	0.001	-0.005	-0.001
TS	0.0721	0.016	4.449	0	0.04	0.104
Gold	-0.0335	0.005	-6.415	0	-0.044	-0.023
Brent	-0.0212	0.009	-2.338	0.019	-0.039	-0.003
Usd/Zar	-0.0321	0.004	-7.459	0	-0.04	-0.024

Omnibus:	4.298	Durbin-Watson:	0.983
Prob(Omnibus):	0.117	Jarque-Bera (JB):	3.208
Skew:	0.094	Prob(JB):	0.201
Kurtosis:	2.573	Cond.No.	30.3

Warnings: [1] Standard Errors are heteroscedasticity robust (HCI)

Table 7 reports on the pooled OLS regression results pertaining risk premia associated with macrovariables. The R-squared estimate shows a good fit of the model as the included factorsexplain 46 percent of variation in size-sorted portfolio returns on the JSE. Firstly, the constantis negative and barely significant at the ten percent level with a p-value of 0,098. This impliesthat the independent variables included in this model are adequate in explaining returns. The negative alpha implies that after adjusting for risk, excess risk-adjusted returns are on aggregatenegative. South Africa's equity market risk premium is positively and statistically significant with a p-value of less than one percent. This indicates that investors require a premium for taking on market risk. The results differ to CRR who did not find market premium to be statistically significant and thus reinforce CAPM theory that market risk is an important systematic consideration for investors. GDP is a statistically significant priced risk at the five and ten percent level of significance. The negative GDP coefficient means that an increase in GDP has a negative impact on returns. A reason for this could be that the JSE is dominated bymulti-national shares, especially in the Top 40 index which makes up more than 85 percent ofthe total JSE therefore, the JSE is not representative of the South African economy. Consequently, a low-level relationship between domestic data and stock market is expected. Manufacturing production is highly significant at one, five and ten percent level of significance indicating that it is priced risk factor on the JSE. The indicator is an alternative measure of current economic activity as it influences total output in the economy and shows that changes in real activity are priced in financial asset prices because investors form expectations based on current production and thus should theoretically require a premium for investing on the JSEgiven the economic climate in South Africa. Because South Africa is a developing country, manufacturing levels are not always stable compared to developed countries, and as such investors may require premiums for exposure to relative instability. However, the negative coefficient associated with manufacturing production may be a result of multinational companies dominating the composition of the JSE and that, portfolio returns are not sensitive to changes in domestic manufacturing production as the JSE does not reflect a local economicclimate. Retail sales measuring the role of consumption in financial assets is insignificant,

consistent with the findings of CRR. This indicates that consumption risk is not a determinantof returns on the JSE. The negative and insignificant result reinforces the notion of low-level relation potentially caused by rand-hedge concentration. Another potential reason for this is that because the vast majority of JSE participants (38 percent in 2016 as reported on the research report for South Africa's National Treasury) are international institutional investors who focus on index-performance rather than on the maximization of wealth and consumption as retail investors. The risk premium associated with Money supply is significant at the one, five and ten percent level of significance on the South African stock market. This should be a result of the multiplier effect as increases (decreases) in money supply reduce (increase) interest rates and hence discount rates, increasing (decreasing) output (Begg et al ,2014). But, the negative coefficient of money supply provides evidence that returns are less sensitive to changes in monetary policy. Significance of the term structure of interest rates is expected as Chan, Chen and Hsieh (1985) state that interest rates represent the "opportunity cost" of spending money, since investors forego spending money in exchange of investing it for a return, as such investors require a premium for the trade-off. Gold is statistically significant with a negative coefficient. The negative coefficient provides evidence of the lack of representation of South African economy on the stock exchange. The JSE has a vast amount of mining companies with foreign operations. When gold increases returns are negatively impacted. Oil prices are significant as oil is largely substantial cost in production and manufacturing (Clare and Thomas, 1994). Also, as a net importer of oil, increased oil prices lead to higher balance of payments in current accounts of net oil importers which spark inflationand since inflation is one component of discount rate, stock prices decline (Huang, Masulis andStoll, 1996). The risk premia of commodities are negative implying that returns of commodities are low on the JSE. At first glance it is logical to relate the reason for the result is with studiesthat concluding that commodities are regarded as safe investments during turbulent economic times. However, Coudert and Raymond (2013) conclude that this phenomenon applies for certain countries (most likely developed countries) and is applicable only in the short run. Lastly, USD/ZAR exchange rate serving as an indicator of inflation is statistically significant because inflation affects expected cash flows and interest rates therefore a premium is required.The negative coefficient indicates that an increase in inflation has a negative effect on returns.If the determining factor of holding a stock is that it must be positively correlated with inflationthen it is plausible for the coefficient to be negative (Chan, Chen and Hsieh, 1985). Moreover,when inflation rises, interest rates rise causing share prices to decline.

Panel OLS with Fixed time effects

Panel OLS Estimation Summary

Table 8

Pooled OLS with Fixed Effects

Dependent Variable:	Average Return	**R-squared:**	0.3754
Estimator:	Panel OLS	**R-squared (Between):**	0.1173
Number of Observations	354	**R-squared(Within)**	0.3754
Date:	06-Apr-20	**R-squared (Overall)**	0.1549
Time:	10:54:38	**Log-likelihood:**	1295
Covariance Estimator:	Robust	**F-statistic:**	19.099
Entities:	59	**P-value:**	0
Average Observations:	6	**Distribution:**	F(9.286)
Minimum Observation:	6	**F-statistic(robust):**	16.162
Maximum Observation:	6	**P-value:**	0
Time periods:	6	**Distribution:**	F(9.286)
Average Observations:	59		

Parameter Estimates

	Parameter	Standard Error	T-statisitc	P-value	Lower CI	Upper CI
Constant	0.0076	0.0029	2.6209	0.0092	0.0019	0.0132
EMRP	0.0138	0.0138	4.9424	0	0.0083	0.0192
GDP	-0.0009	-0.0004	-2.1204	0.0348	-0.0016	-6.10E-05
MP	-0.0092	-0.0023	-4.0507	0.0001	-0.0136	-0.0047
RS	-0.0001	0.0006	-0.1699	0.8652	-0.0014	0.0012
MS	-0.001	0.0006	-1.5681	0.118	-0.0022	0.0002
TS	-0.0015	0.0106	-1.4208	0.1565	-0.0358	0.0058
Gold	-0.0022	0.0036	-0.6206	0.5353	-0.0093	0.0049
Brent	-0.0188	0.0041	-4.6323	0	-0.0267	-0.0108
Usd/Zar	-0.0182	0.0029	-6.3384	0	-0.0239	-0.0126

F-test for Pool-ability: 24.425
P-value: 0.0000
Distribution: F (58.286)
Included effects: Time-period

Table 8 reports on risk premia associated with macro-variables using fixed-effect OLS regressions. The regression constant is positive and significant indicating that there are more factors explaining returns on the JSE not included in this model therefore, the model does not fully capture or represent variation in stock returns. South Africa's equity risk premium is highly significant at the one, five and ten percent level of significance. GDP is statistically significant at the five and ten percent significance level. The coefficient is negative implying an inverse premium. This is explained by the fact that majority of companies on the JSE Top 40, which makes up most of total JSE, are Rand Hedge companies. Because these companies derive most of profits overseas, they are less sensitive to changes in local data. Manufacturing

Production also serving as a measure of industrial activity is statistically significant at the one, five and ten percent level. The reason for this should be that declines in manufacturing production and thus downturns in industrial activity in South Africa pose a risk that investors require a premium for. Because the JSE consists of multinationals, it is not sensitive to changes in domestic data. The risk premium of the bond market is significant at ten percent level of significance. This premium which is a proxy for risk aversion which is dependent on business cycles is priced by investors. The result is plausible as during recessions, businesses may achieve low earnings and as a result one would expect investors to be hesitant on taking on risk and thus to require a premium for taking on the risk during downturns or troughs of business cycles. Brent oil is significant with a negative coefficient which means increases in oil prices correlate with declines in return. Increased oil prices may increase production costs and reduce the earnings of corporations thus lowering returns (Clare and Thomas, 1994). This result is different to CRR as they found no significance of oil in stock returns. Retail sales are insignificant and negative as market participants are not concerned about consumption risk because the composition of the JSE does not represent South Africa's economy hence stock returns are not sensitive to local economic data. Surprisingly, the term structure of interest rates as well as money supply, two variables showing the impact of monetary policy as well asgold prices are insignificant in this model with negative coefficients. The USD/ZAR exchangerate representing inflation is highly significant at the one, five and ten percent level and as to be expected because inflation influences the value of expected cash flows. The results are similar to CRR and are consistent with literature that stock prices react to economic variables.

Limitations of Study

The study has some limitations. The study employed Fama and Macbeth regressions and as discussed in the literature Shanken (1992, 2006) state that Fama and Macbeth regressions have errors-in-variables problems and thus may overstate betas.

Summary of results

In summary, pooled OLS regressions show that South Africa's equity market risk premium and adjustments in the term structure of interest rates are positively and significantly priced risk macroeconomic factors on the JSE whereas the variables GDP, Manufacturing production, retail sales, money supply, gold and inflation are negatively and significantly priced. The dominance of rand hedge companies is a potential reason for this. This contrasts with Fixed -effects regressions. The only positive and significant macro-variables at fixed effects regressions is the equity market risk premium. GDP, oil and the USD/ZAR exchange rate are significantly and negatively priced. This provides evidence of the lack of representation of South African economy on the JSE. This potential reason is further proved by evidence that retail sales, money supply, and the term structure are insignificant with negative coefficients on the JSE.

Conclusion

The main objective of this research report was to obtain insight into which macroeconomic risk factors offered premia for JSE-listed shares and, in turn, to test whether the MVM approach of APT, pioneered by Chen, Roll and Ross (1986), is applicable in a market that is emerging. Several empirical tests of the MVM approach have been studied in developed markets with encouraging results however, such tests are sparse on the JSE. Also, several studies in South Africa employ cointegration and error correction techniques to examine the relationship between the macroeconomic variables which are considered to influence the

economy and share returns in the long run however, research investigating whether macroeconomic variables are priced risk factors is limited. The most prominent contribution to knowledge on the study of macroeconomic variables and JSE-listed shares is credited to Van Rensburg (1996, 1998, and 2000) who used an alternative method to the Fama and Macbeth (1973) regressions. This study therefore contributes to literature by using an MVM approach to test which macroeconomic factors should be priced systematic risk factor in an emerging market, a topic which has previously been neglected compared to traditional asset pricing models. Based on Fama and Macbeth (1973) panel regressions with pooled OLS aswell as fixed effects, it can be concluded that South Africa's equity market risk as well as the term structure of interest rates are priced risk factors on the JSE. The finding of positive and significant term structure is in line with Van Rensburg (2000) and Chen, Roll and Ross (1986).Several indicators namely, manufacturing production, gold, oil inflation are significantly yet negatively priced. This result may have to do with the fact that the JSE does not reflect South African economy therefore local macrovariables affect share returns at a low-level. While theFama- Macbeth regressions have been reported to have some downfalls, the approach provides insight into relevant macroeconomic risk factors. From the results it is evident that share returnsare impacted by changes in the macroeconomy in line with efficient market hypothesis and Chen, Roll and Ross (1986). The list of variables selected is not exhausted in this study. Further research can test more macrovariables using panel regressions with fixed effects for better accuracy.

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