An Analysis of the South African Equity Market and Sector Return-Risk Relationship
(January 1990 – December 2002)

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As the candidate's supervisor, I have approved this thesis for submission

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DECLARATION

I the undersigned, hereby acknowledge that this thesis, except where otherwise specified in the text, is my own work and has not been submitted at any other university.

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Brent Mallari Malahay (January 2004)

ABSTRACT

The research paper is an analysis of the South African equity market and sector return-risk relationship. The following two basic questions, addressed in the research paper, pertain to the South African equity market for the period January 1990 to December 2002: (1) how did equity prices behave; and (2) what were the fundamental factors that caused these price movements? Two contrasting sub-periods are identified, namely, Period 1 (January 1990 to June 1997) and Period 2 (July 1997 to December 2002). Period 1 is the pre-Asian financial crisis period and Period 2 is the post-Asian financial crisis period. During the thirteen-year period (1990 to 2002) a market index explained most of the effect on market and sector returns. However, the composition of this market index varied between Period 1 and Period 2. During Period 1, when equity prices and the rand exchange were relatively stable, the market index was composed of *domestic* systematic risk. This signified that investors were looking 'inwards' or were more concerned about domestic fundamentals i.e. domestic financial stability. Contrastingly, during Period 2, when equity prices and the rand exchange were relatively volatile, the market index was composed of *foreign* systematic risk. This signified that investors were looking 'outwards' or were more concerned about global fundamentals i.e. global financial stability. It was further found that over the course of January 1990 to December 2002, South African equity sector returns from the resource, financial and non-resource/financial sectors had experienced abnormal returns. The abnormal returns indicate sector inefficiency or/and cognitive biases in investor behaviour.

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List of Acronyms and Symbols

AIE – Adjustment to inflation expectations

ALSI – All Share Index

APT – Arbitrage Pricing Theory

BA – Bankers acceptance rate

CAPM – Capital Asset Pricing Model/Theory

CPI – Consumer Price Index

DF – Degrees of freedom

DJIA – Dow Jones Industrial Average

EMH – Efficient Markets Hypothesis

FIN – Financial Sector

FTSE – Financial Times Stock Exchange

GDP – Gross Domestic Product

ITNLSUR – Iterated Non-Linear Seemingly Unrelated Regression

MVM – Mean-variance model

JSE – Johannesburg Stock Exchange

PCA – Principal Components Analysis

S&P 500 – Standard and Poor 500 Index

NRF – Non-Resource/Financial sector

OLS – Ordinary Least Squares

PC – Principal Component

RES – Resource Sector

UDG – Unanticipated changes in the dollar price of gold

UDJ – Unanticipated changes in the returns of the Dow Jones Industrial Average

UDO – Unanticipated changes in the dollar price of oil

UFT – Unanticipated changes in the returns of the Financial Times Stock Exchange

UINT – Unanticipated changes in the yield curve

UINTD – Unanticipated changes in the interest differential

UINF – Unanticipated changes in inflation

UK – United Kingdom (Britain)

UMP – Unanticipated changes in the market *premia*

UNI – Unanticipated changes in the returns of the Nikkei

URD – Unanticipated changes in the rand/dollar exchange

URG – Unanticipated changes in the rand price of gold

USP – Unanticipated changes in the returns of the S&P 500

US – United States

List of Statistical Symbols

$COV(.)$	The covariance between the variables specified in the brackets
$COR(.)$	The correlation between the variables specified in the brackets
$x \sim ND(.)$	Variable x is normally distributed. The variables specified in the bracket indicate the first two moments (i.e. mean and variance) of the probability distribution.
$VAR(.)$	The variance of the variable specified in the brackets
R^2	Correlation coefficient
$z(.)$	The variable specified in the brackets is standardized with a mean of zero
$\pi()$	The probability that the variable specified in the brackets is observed.
$\pi(x \mid y)$	The conditional probability that x occurs conditional to y occurring

List of Important Equations

Equation number	Equation	Description
2.1	$E(R_{jt}) = R_f + \alpha_{jt} + \beta_{jt}[E(R_M) - R_f] + \kappa_{jt}$	The complete CAPM
2.2	$\sigma_j^2 = \beta_j \sigma_M^2 + \sigma_{\kappa_j}^2$	Risk in an un-diversified portfolio (CAPM)
2.3	$E(R_j) = R_f + \alpha_j + \beta[E(R_M) - R_f] + u_j$	The CAPM for a diversified portfolio
2.4	$\sigma_j^2 = \beta_j^2 \sigma_M^2 + \sigma_{u_j}^2$	Risk in a diversified portfolio (CAPM)
2.5	$E(R_{jt}) = R_f + \sum_{k=1}^{K} \beta_{jk} X_{kt} + u_{jt}$	The APT model
2.6	$\sigma_j^2 = \sum_{k=1}^{K} \beta_{jk}^2 \sigma_K^2 + \sigma_{u_j}^2$	Risk in a diversified portfolio (APT)
3.1	$P_s = \beta_s X + u_s$	Regression model to identify structural breaks volatility differentials
3.2	$E(R_{jt}) - R_f = \alpha_{jt} + \beta_{jt}[E(R_M - R_f)] + u_{jt}$	The regression form of the CAPM
4.1	$Y = \sum_{k=1}^{K} \beta_{jk} X_{kt} + u_{jt}$	Functional form of a multiple regression
4.2	$z(Y) = \sum_{k=1}^{K} \beta_{jk} PC_{kt} + u_{jt}$	The multiple regression model used in the identification of priced macroeconomic factors
4.3	$PC_i = a_{i1}X_1 + a_{i2}X_2 + \ldots + a_{in}X_n$	Composition of a principal component

CHAPTER 1: OVERVIEW

1. Introduction

The research paper is an analysis of the South African equity market and sector *return-risk relationship* i.e. the relationship between return and risk in market and sector returns. Two basic questions pertaining to the South African equity market for the period January 1990 to December 2002 are addressed in the research paper, namely: (1) how did equity prices behave; and (2) what were the fundamental factors that caused these price movements? It must be noted that the research paper is concerned with the analysis of *general* equity price movements. The research paper is therefore concerned with well-diversified portfolios. Consistent with the above concern, the research paper analyses the price movements *and* the fundamental factors causing *the* price movements in: (i) the South African equity market, proxied by the Johannesburg Stock Exchange (JSE) All Share Index (ALSI); and (ii) three broad South African equity sector indexes, namely, the resource, financial and non-resource/financial sector indexes.

Over the course of January 1990 to December 2002, the responsiveness of the South African equity market to fundamental factors resulted in substantial price fluctuations in the JSE. Conventional wisdom suggests that equity prices are a function of certain macroeconomic factors, and equity price *movements*, which are a result of the *unanticipated changes* in macroeconomic factors, may vary across sectors and over time. Although equity prices change continuously over time, they are always assumed to be consistent with underlying macroeconomic factors. These macroeconomic factors could be factors of production, consumer preferences, governmental policies or any other systematic event that will affect a particular economy. The uncertainty in equity markets i.e. macroeconomic factors change *unexpectedly*, hence, equity prices are stochastic and unpredictable, would suggest that equity markets are in a state of 'dynamic' equilibrium. This is to say that there is a continuous and instantaneous impounding of new information into equity prices. This equilibrium state follows from the *efficient market hypothesis* (EMH). The EMH is the proposition that the efficiency of the market ensures that all available information pertaining to underlying macroeconomic factors is instantaneously impounded into prices. A crucial assertion of the EMH is that, because *all available* information is impounded into prices, investors *en masse* share the same information set. Moreover, all pertinent information is exhausted such that no one investor can gain an advantage over the market, hence, investors cannot make an abnormal return. An abnormal return is a risk-free return in excess of the market risk-free rate – the EMH assures that no arbitrage opportunities occur in the market, or at least, any arbitrage opportunities are instantaneously eliminated.

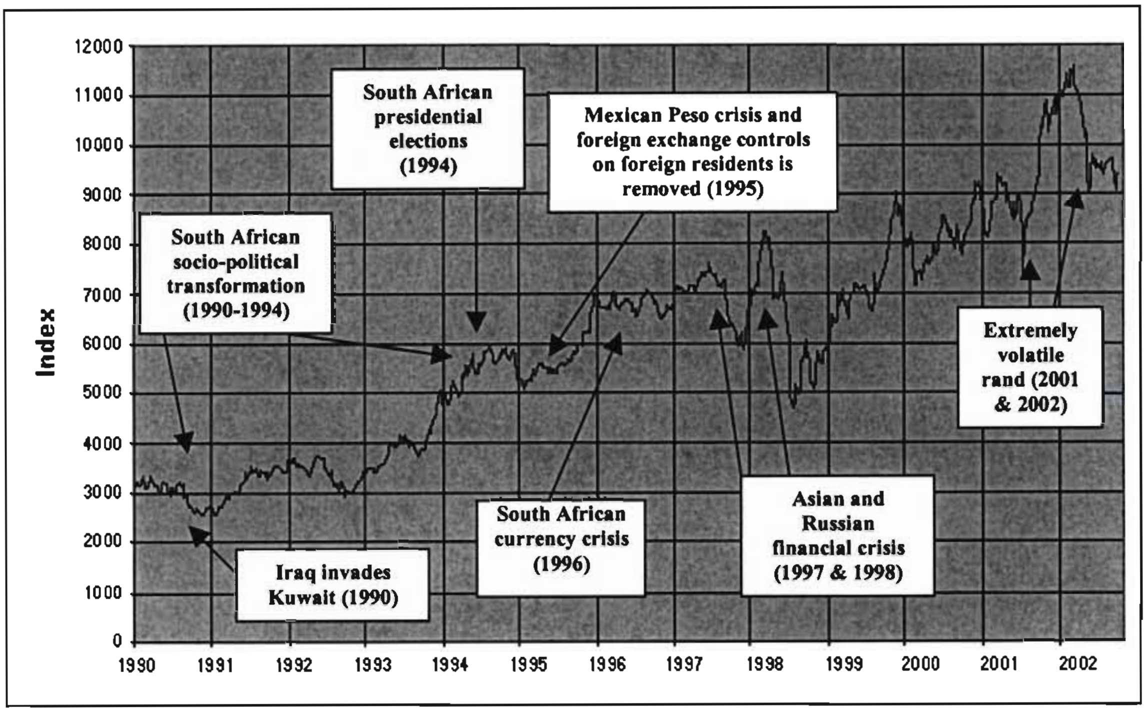
Consistent with the EMH, equity price changes are consistent with *new* information; similarly, equity price movements are exclusively the result of the unanticipated changes in macroeconomic factors. The research paper analyses equity price movements and the factors causing these movements in the South African equity market during January 1990 to December 2002.

1.1. South African Equity Price Movements: An Overview

The responsiveness of the South African equity market to macroeconomic factors during January 1990 to December 2002 is illustrated in Figure 1.1 – Figure 1.1 shows the price movements in the ALSI. During January 1990 to December 2002, domestic socio-political transformations, uncertainty in global oil supplies, a volatile exchange rate, various global financial crises and subsequent government policy changes had a pervasive effect on the South African equity market.[1] Decomposing the South African equity market into three broad sectors, namely, the resource, financial, and non-resource/financial sectors, Figure 1.2 illustrates the differing responsiveness of the three sectors during the same period. A closer inspection of Figure 1.1 and Figure 1.2 indicates an apparent structural change – change in long-term price movements/trend.

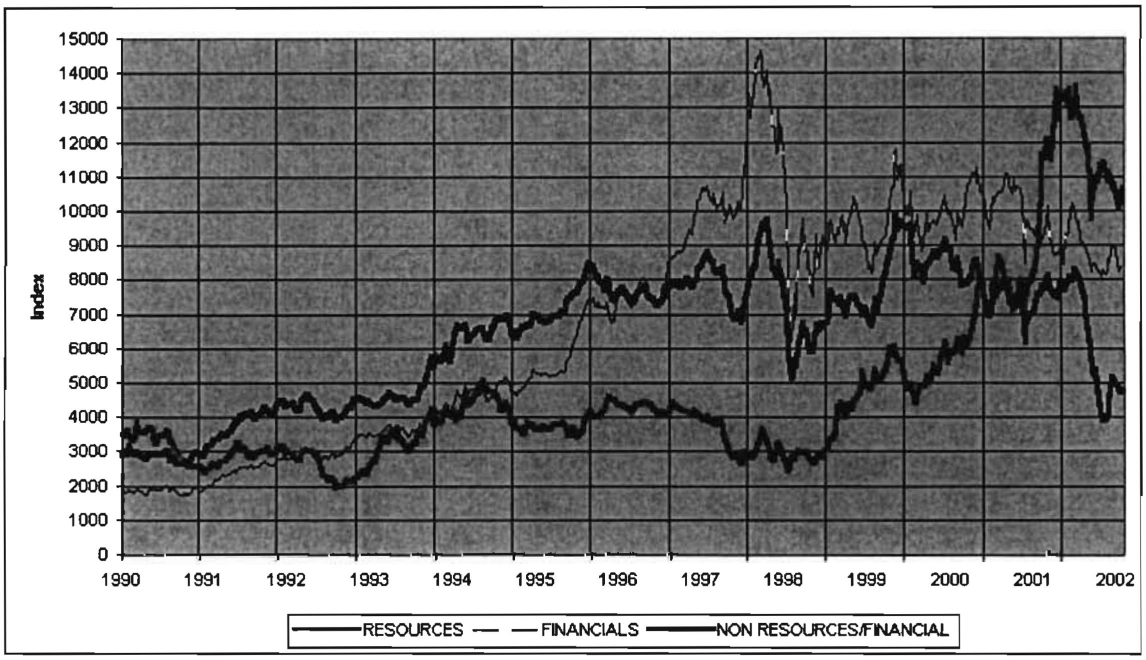
[1] In 1990, the Apartheid government lifted its 30-year ban on all anti-apartheid organizations and Nelson Mandela was released from prison. During 1990 Iraq invaded Kuwait during disputes over oil rights causing the volatile oil market to peak at a historical volatility figure of 96.17% after Brent crude reached $41 a barrel in October 1990 from $15 in June of the same year. In 1994 South Africa had its first democratic presidential elections and in 1995, foreign exchanges controls on foreign residents were removed. Subsequent to the last two quarters of 1997, various global financial crisis developed, resulting in volatile foreign exchanges and equity markets

Figure 1.1: **Price behaviour of the South African equity market (1990-2002)**



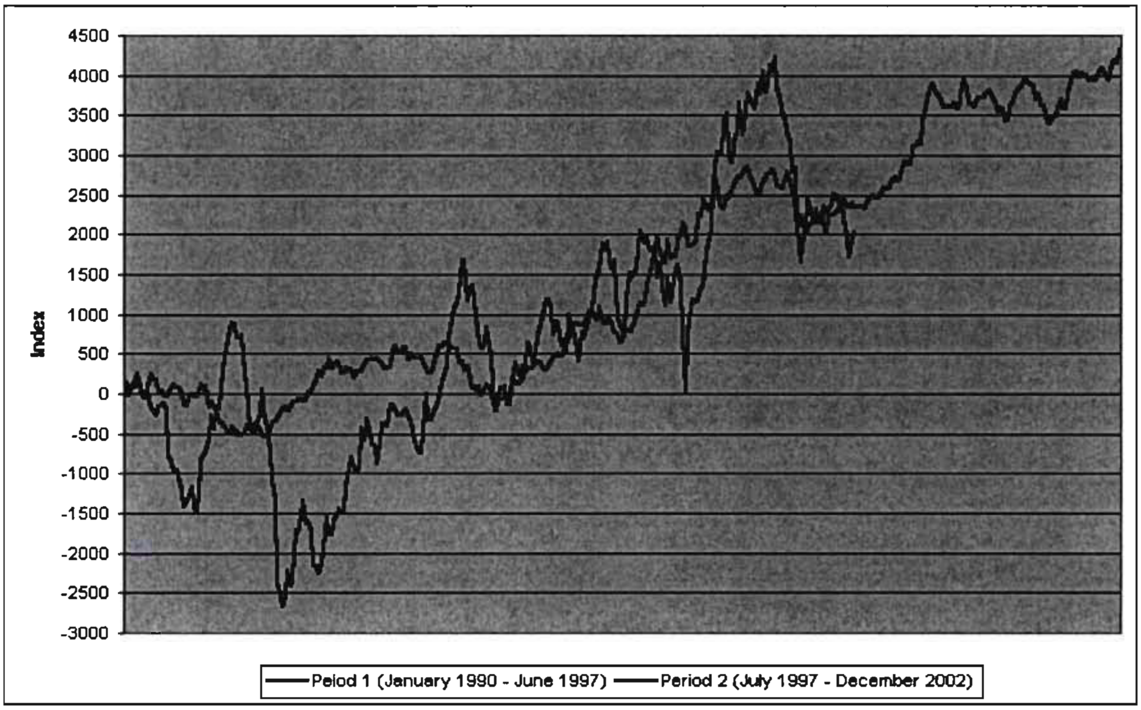
Data Source: **JSE (1990-2002)**

Figure 1.2: **Price behaviour of the resource, financial and non-resource/financial sectors (1990-2002)**



Data Source: **JSE (1990-2002)**

Figure 1.3: **Price behaviour of the ALSI during Period 1 (January 1990 – June 1997) and Period 2 (July 1997 – December 2002)[2]**



Data Source: **JSE (1990-2002)**

It is further evident from Figure 1.1 and Figure 1.2 that short-term price fluctuations (volatility) subsequent to the last-half of 1997 were more pronounced. The apparent structural change and progressive[3] volatility subsequent to Period 1 (i.e. Period 2 – July 1997 to December 2002) is clearly evident in Figure 1.3. In Figure 1.3, the price movements of the ALSI are divided into Period 1 and Period 2. Overlapping the two periods clearly indicates the contrasting price movements between the two periods.

In retrospect to: (i) the differing market and sector price responsiveness of the South African equity market during January 1990 to December 2002; (ii) the apparent structural change between Period 1 and Period 2; (iii) the apparent progressiveness of price volatility subsequent to Period 1; and (iv) market efficiency, which entails that abnormal returns cannot be experienced, one would need to: (1) *qualify* such price behaviour and

[2] Index values are not the correct values as the intercept has been set to zero
[3] It is progressive in the sense that volatility seemed to be more pronounced in Period 2 relative to Period 1

any discrepancies in equilibrium prices; and (2) identify the macroeconomic factors causing such price behaviour.

1.2. Equilibrium Factor Models

The attempt to unravel the dynamics and complexities of equity markets is recorded in capital market theory. The latter theory is concerned with equilibrium conditions in speculative markets such that speculative prices are consistent with underlying fundamentals. In concerning itself with equilibrium conditions, capital market theory seeks to predict the relationships between variables that affect equilibrium conditions. On the one side of the equilibrium scale is the 'reactive' stochastic price of the asset, and on the other, are the macroeconomic factors that generate the stochastic price movements in speculative assets. Two equilibrium factor models that portray the return-risk relationship of equities, namely, the Capital Asset Pricing Model (CAPM) and the Arbitrage Pricing Theory (APT) model, postulate that equity returns[4] are a function of a real risk-free rate, an inflation premium, and the systematic risk affecting returns. Both models assert the existence of a *measurable* relationship between the return and systematic risk of equities. The CAPM and APT are applied to address the basic questions of the research paper.

2. Objectives of the Research Paper

The objective of the research paper is to analyse general equity price movements in the South African equity market in terms of return and risk i.e. analyse market and sector price movements and the macroeconomic factors causing the market and sector price movements. The South African equity market, proxied by the ALSI, and three broad sectors, namely the resource, financial, and non-resource/financial sectors are analysed for the period January 1990 to December 2002.

The market and sector analysis includes:

1. Return side analysis: Analysis of price movements

   The following are analysed:

   (i) Structural change – fundamental changes in long-term price movements/trends;

   (ii) Price volatility – changes in short-term price fluctuations; and

   (iii) Abnormal returns

2. Risk side analysis: Macroeconomic identification of the pricing factors on the South African equity market

   A set of pre-specified macroeconomic factors are arranged into different risk indexes. The different risk indexes are tested for statistical significance.

3. Research Questions

The following research questions provide a structured approach to complete the research objectives. The research questions pertain to the South African equity market and its three broad-based sectors of the resource, financial, and non-resource/financial sectors for the period January 1990 to December 2002:

Return side analysis

1. Was there a structural change subsequent to the outbreak of the Asian financial crisis, that is, was there a change in long-term price movements/trends; and if so, what are the implications?
2. Were equity price movements relatively more volatile subsequent to the outbreak of the Asian financial crisis, that is, were short-term price movements more pronounced around their long-term price trend; and if so, what are the implications and the justifications?
3. Were abnormal sector returns experienced; and if so, what are the implications and the justifications?

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[4] Essentially, returns are the change in price at time $t + 1$ (plus a dividend) relative to the price at date t

Risk side analysis:

4. What were the macroeconomic factors that caused the general price movements?

4. Methodology and Scope of the Research

The foundation of the research paper is provided by: (1) *The literature review* on certain areas of financial theory; and (2) *The econometric analysis* on market and sector return/price movements and the factors causing these price movements in the South African equity market during January 1990 to December 2002.

With respect to:

(1) The literature review

The review focuses on equilibrium factor models and the EMH. A review of previous studies on the identification of macroeconomic factors causing price movements (domestically and internationally) is also provided. The theories, views, arguments, and related topics in the research paper are referenced from various published journals, published and unpublished working papers and other periodicals, and books.

(2) The econometric analysis

Various econometric methods are applied to observed economic data and then interpreted by testing a set of research hypothesis for validity. Addressing the four research questions, the following statistical methods are applied and interpreted by testing a set of research hypothesis for validity:

Methodology to answer question one:

To test for a structural change in South African equity price movements, a Chow test is applied to test for a structural change between Period 1 (January 1990 – June 1997) and Period 2 (July 1997 – December 2002). The null hypothesis for the Chow test is that there *is* parameter stability (i.e. no structural change) in market price movements, as proxied by the ALSI. Mathematically:

$$H_0: \hat{\beta}_1 = \hat{\beta}_2$$

If the null hypothesis is rejected, it is concluded there is a structural change between Period 1 and Period 2.

Methodology to answer question two:

To test whether the South African equity market was relatively *more* volatile during Period 2 than during Period 1, an *F*-test of the ratio of variances in equity prices for Period 1 and Period 2 is applied. The null hypothesis for this test is that the estimated variance (volatility) in Period 1, $\hat{\sigma}_1^2$, is statistically the same for Period 2, $\hat{\sigma}_2^2$. Mathematically:

$$H_0 : \hat{\sigma}_1^2 = \hat{\sigma}_2^2$$

If the null hypothesis is rejected, it is concluded that Period 2 was more volatile than Period 1.

Methodology to answer question three:

To test whether abnormal returns were experienced in the different sectors, a factor model synonymous with the CAPM is applied. Given:

$$E(R_{jt}) - R_f = \alpha_{jt} + \beta\left[E(R_M - R_f)\right] + u_{jt}$$

The null hypothesis is that the estimated intercept coefficient $\hat{\alpha}_{jt}$ is statistically equal to zero i.e. a *t*-test is applied. Mathematically:

$$H_0 : \hat{\alpha}_{jt} = 0$$

If the null hypothesis is rejected it is concluded that abnormal returns in the respective sectors, did occur for the specified period.

Methodology to answer question four:

To identify the macroeconomic factors that caused market and sector price movements, principal components analysis (PCA) is applied to a macroeconomic factors data set to form risk indexes. Standardized market and sector returns are subsequently regressed on the retained risk indexes using ordinary least squares (OLS). The econometric model used in the analysis has the same functional form as the APT model. A *t*-test is then applied to the structural estimates $\hat{\beta}_{jk}$. The null hypothesis is that structural estimates are statistically equal to zero. Mathematically:

$$H_0 : \hat{\beta}_{jk} = 0$$

If the null hypothesis is rejected, it is concluded that risk index k is a priced factor for the corresponding dependent variable for the specified period. The term 'priced' indicates that factor k has a pervasive effect on the regressed dependent variable.

5. The Data

The input data used in the research paper, namely: (1) the various JSE stock indexes (e.g. ALSI); (2) the various international indexes (e.g. S&P 500); (3) the rand-dollar exchange; (4) oil prices; (5) the rand and dollar price of gold; and (6) the various interest rates (e.g. prime rates), are the weekly closing prices. In the case of inflation figures (i.e. consumer price index (CPI)), these figures were only available on a monthly basis. It is therefore assumed that the closing weekly figure would be the same as the month end figure. All the data was downloaded from the JSE using the EasySoft Market Master Software.

6. Organization of the Research Paper

The research paper consists of five chapters. This introductory chapter is followed by chapter two. Chapter two reviews the factors models required for the econometric analysis of the research paper. Two models, the CAPM and the APT, are reviewed in this chapter. Included in chapter two is a review of the EMH. Chapters three and four cover the methodologies and findings of the econometric analysis on, respectively: (1) structural change, progressive volatility and abnormal returns in the South African equity market during January 1990 to December 2002, hence, chapter three addresses questions one, two and three; and (2) the macroeconomic identification of the pricing factors on the South African equity market during January 1990 to December 2002, hence, chapter four addresses question four. Chapter five summarizes and concludes the findings of the research paper. Included in chapter five is an assessment of the utility of the research paper to interested groups, research limitations and topics for future research.

CHAPTER 2: EQUILIBRIUM FACTOR MODELS

1. Introduction

The objective of this chapter is to provide a theoretical review on the statistical models used in the econometric analysis. A review of two equilibrium factors models, namely, the CAPM and the APT follows. A review of the EMH is included in this chapter as both models assume equilibrium conditions in capital markets.

2. The Capital Asset Pricing Model

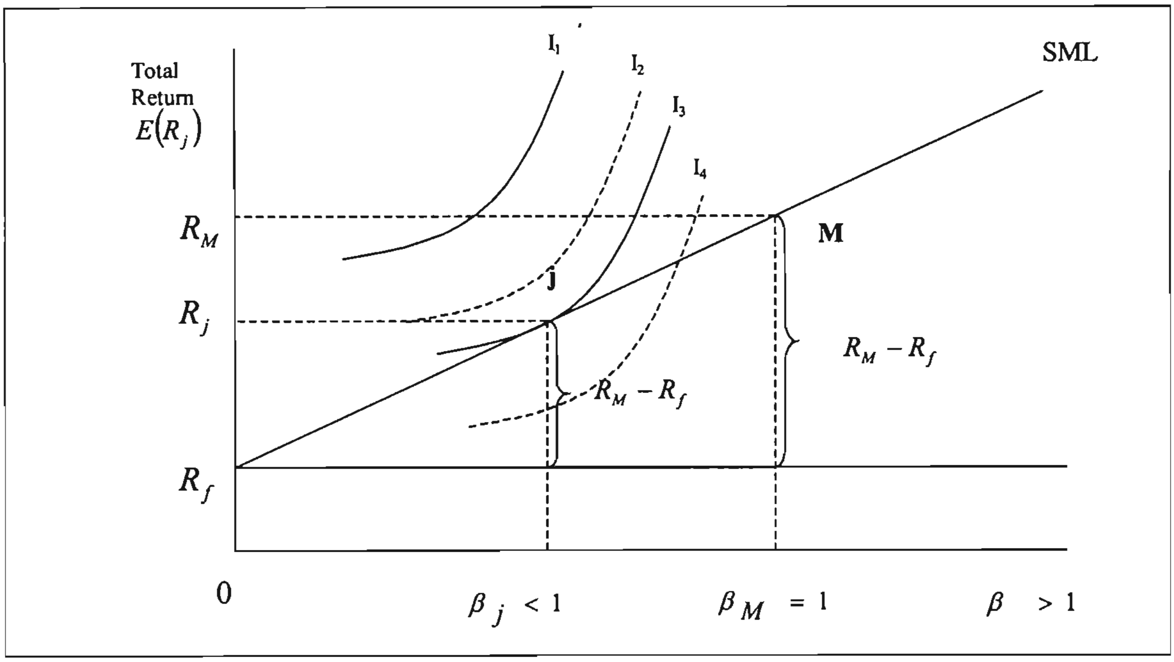
It is common knowledge that equity prices are a function of macroeconomic factors and that equity price *movements* are the result of the *unanticipated changes* in macroeconomic factors. The unanticipated changes, hence, the uncertainty in most financial assets (i.e. risky assets), requires that risky assets, in addition to the real time value of money, require a risk premium. This is to say that a risky asset requires a return in excess of the real risk-free rate to compensate for the risks inherent in the asset. These are the risks of unforeseen changes in the yields of risky assets.

When investing in risky assets, Sharpe (1964) postulated that if individuals act in accordance with the mean-variance model i.e. maximize return while minimizing risk, the expected return on any investment j at date t (i.e. $E(R_{jt})$), can be expressed as a linear function of the market's real risk-free rate plus a risk premium.[5] Consistent with the introductory chapter of the research paper, the expected return of a well-diversified portfolio is a linear function of its underlying fundamentals. In the CAPM, it is assumed that an investment's underlying fundamentals are captured by the market *premia*.[6] The market *premia* is the return from a market portfolio in excess of the real risk-free rate. Sharpe (1964) postulated that risk factors that do not contribute to the portfolio's covariance with the market portfolio would not influence the returns on a well-diversified portfolio.

[5] See Appendix 1.b on the mean-variance model

[6] The CAPM is a single-factor model in the sense that the only exogenous factor is the market *premia*.

Figure 2.1: **The security market line**



The intuition of the CAPM is that unsystematic risk can be eliminated through diversification leaving only systematic risk (Roll, 1988: 542).[7] In order for the CAPM to hold, Sharpe (1964), stipulated the following assumptions:

1. Individuals are risk-averse and are subject to the same information set – individuals have homogenous rational expectations.
2. Capital markets are complete (there is always a buyer and a seller) and efficient (consistent with the EMH, all available information is instantaneously impounded into prices.
3. There is a common or market risk-free rate in which there is no limit to how much an individual/s can borrow or lend.

In Figure 2.1, risky portfolios, indicated by a β greater than zero, require a return greater than the risk-free portfolio R_f. The set of efficient portfolios diversified in risky assets i.e. portfolios that maximize return while minimizing risk, is indicated as a straight line passing through R_f. This line is commonly referred to as the security market line (SML). The SML indicates the optimal ratio between risk and return. The slope of the SML is determined by the riskiness of obtainable portfolios relative to the market portfolio *M*. In this instance a risk-averse individual will select portfolio *j*, which is tangent to his indifference curve I_3. The indifference curve indicates the individual's preference towards return and risk in which he is indifferent. Crucial to the CAPM is that individuals are assumed to be risk-averse. This is implicitly implied by the positive sloping indifference curves. Consistent with the market portfolio having a beta equal to one, Portfolio *j* is relatively less risky than the market portfolio *M*, this is indicated by a beta coefficient less than one. According to Sharpe (1964), mathematically, the CAPM is similar to the SML. A complete model of the CAPM can be expressed as:[8]

$$E(R_{jt}) = R_f + \alpha_{jt} + \beta_{jt}\left[E(R_M) - R_f\right] + \kappa_{jt} \tag{2.1}$$

Where,

$E(R_{jt})$:	Dependent variable – stochastic return on portfolio *j* at date *t*;
R_f:	Intercept coefficient – the real rate of return on a risk-free asset;
α_{jt}:	Sporadic intercept coefficient – sporadic abnormal return (risk-free return in excess of R_f) on portfolio *j* due to market inefficiency or other market discrepancies;
β_{jt}:	Slope coefficient – responsiveness of the return on portfolio *j* to unanticipated changes in the market portfolio *M*;
$E(R_M) - R_f$:	Independent variable – market *premia*. Consistent with the EMH, the expectations of the independent variable is zero i.e. $E(X_{kt}) = 0$. The significance of this is that it is the unanticipated changes in these factors that are priced[9]; and
κ_{jt}:	Unsystematic risk specific to portfolio *j* at date *t*.

[7] Unsystematic risk is the risk that is unique to a particular investment. In a well-diversified portfolio of assets, unsystematic risk, in the respective assets, is eliminated. The remaining un-diversifiable risk is systematic risk. Systematic risk is synonymous with the mentioned macroeconomic factors.

[8] Subscript *t* is the date counter

[9] This applies to the APT. See following section

Equation 2.1 illustrates that there are two sources of risk, namely systematic risk (due to $E(R_M) - R_f$) and unsystematic risk (due to κ_{jt}). The importance of the distinction between systematic and unsystematic risk is illustrated next. Equation 2.1 explicitly assumes an un-diversified portfolio; this portfolio, *j*, is composed of one risk-free asset and one risky asset. The risk of each asset in portfolio *j* can be expressed as follows:[10]

$$\sigma_j^2 = VAR(R_j)$$
$$= VAR\lfloor R_f + \alpha_j + \beta_j \lfloor E(R_m) - R_f \rfloor + \kappa_j \rfloor$$

$VAR(.)$ denotes variance of the variables in the brackets. By definition R_f is a risk-free return from the risk-free asset and α_j is a risk-free return in excess of R_f generated by portfolio *j*. Although R_f and α_j both have positive returns (μ_{R_f} *and* $\mu_{\alpha_j} > 0$), their variances are zero ($\sigma_{Rf}^2 = \sigma_{\alpha_j}^2 = 0$). Therefore, total risk in portfolio *j* can be mathematically expressed as:

$$\sigma_j^2 = VAR\lfloor \beta_j E(R_M) + \kappa_j \rfloor$$
$$= VAR\beta_j E(R_M) + VAR(\kappa_j)$$

Similarly, the total risk of portfolio *j* can be expressed as:

$$\sigma_j^2 = \beta_j \sigma_M^2 + \sigma_{\kappa_j}^2 \qquad (2.2)$$

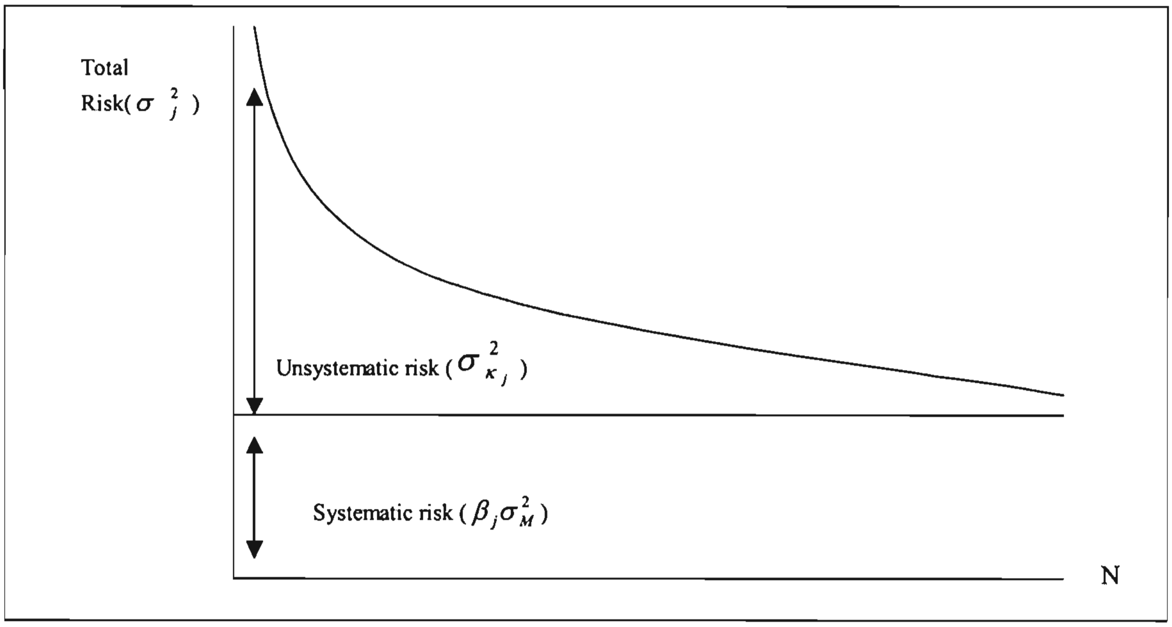
$\beta_j \sigma_M^2$ measures the systematic risk component and $\sigma_{\kappa_j}^2$ measures the unsystematic risk component of portfolio *j*. Essentially, Equation 2.2 is the total risk of an un-diversified portfolio. We now assume portfolio *j* consists of *N* amount of uncorrelated risky assets and a risk-free asset that are equally weighted. The implication of diversification on unsystematic risk, $\sigma_{\kappa_j}^2$, can be mathematically expressed as:

$$\sigma_{\kappa_j}^2 = \sum_{n=1}^{N} \frac{1}{N^2} \sigma_{\kappa_j}^2$$

$$\sigma_{\kappa_j}^2 = \frac{1}{N^2} \sigma_{\kappa_j}^2 \xrightarrow{N \longrightarrow \infty} 0$$

[10] Subscript *t* is dropped for ease of understanding

Figure 2.2: **The implications of diversification**



As an individual increases the portfolios' investments in *N* assets, unsystematic risk tends towards zero. The concept of diversification is illustrated in Figure 2.2. Consistent with diversification, the CAPM is expressed as:

$$E(R_j) = R_f + \alpha_j + \beta\lfloor E(R_M) - R_f \rfloor + u_j \tag{2.3}$$

Total risk for a well-diversified portfolio is therefore:

$$\sigma_j^2 = \beta_j^2 \sigma_M^2 + \sigma_{u_j}^2 \tag{2.4}$$

In Equation 2.3, u_j is a residual risk term, therefore, in Equation 2.4, $\sigma_{u_j}^2$ is a residual variance. Due to the complex dynamics of speculative assets, the specified variables (i.e. $R_f + \alpha_j + \beta\lfloor E(R_M) - R_f \rfloor$) do not capture the *complete* set of causal variables. The residual term captures the unspecified causal variables. Lastly, the argument that all available information is instantaneously impounded into current prices is the proposition asserted by the EMH.[11] It follows that if equity markets are efficient, investors cannot expect to achieve an abnormal return. Consistent with the EMH, abnormal returns α_t is zero.[12]

[11] See Fama (1970)

It therefore follows that the equilibrium benchmark for portfolio *j* at date *t* is:

$$E_t(\alpha_{jt} \mid \Omega) = E(R_{jt}) - R_f - \beta_{jt}[E(R_M - R_f)] - u_{jt} = 0$$

$E_t(\alpha_{jt} \mid \Omega)$ denotes the mathematical expected abnormal return conditional on information set Ω at date *t*, on portfolio *j*. Similarly:

$$E(R_{jt}) = R_f + \beta_{jt}[E(R_M) - R_f] + u_{jt}$$

Passing note: Although the standard CAPM does not explicitly contain prices but returns, the CAPM *is* a pricing model. To illustrate this, the definition of return is considered. Suppose that equities are purchased at price P_t and later sold at price P_{t+1}. By definition the rate of return for a portfolio is then $R = (P_{t+1} - P_t)/P_t$.[13] It should be noted that although P_t is known, P_{t+1} is unknown and stochastic. Hence, R represents the expected return, that is, $R = E(R)$. Hence, the CAPM can be formulated in its price form as:

$$E\left(\frac{P_{t+1} - P_t}{P_t}\right) = R_f + \beta_t[E(R_M) - R_f] + u_t$$

3. The Arbitrage Pricing Theory

Similar in many respects to the CAPM, Ross (1976) applies the factor model and employs its approach to develop an equilibrium asset pricing theory. The APT developed by Ross (1976) assumes that the expected returns from equities are a linear function of *K*-fundamental factors, where *K* is a number greater than one. This is in contrast to the CAPM, where essentially, *K* is equal to one and is the market *premia*. According to Wei (1988: 881) the assumptions that are generally employed in the derivation of the APT are:

1. A *K*-factor model can represent the process that generates asset price movements, where *K* is conventionally the number of priced macroeconomic factors.

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[12] In the econometric analysis (see Chapter Three), α_t is the estimated intercept

[13] Due to the unavailability of dividends, dividends are ignored, see van Rensburg (1999)

2. In the capital markets there are no arbitrage opportunities or capital markets are in competitive equilibrium. Consistent with the EMH, capital markets are in 'dynamic' equilibrium and, hence, abnormal returns are zero.
3. The number of assets in the economy is either infinite or so large that the residual term is sufficiently diverse to allow the law of large numbers to hold – individuals are able to diversify away unsystematic risk.

A requirement of the APT is that the number and the nature of macroeconomic factors, *K*, is known in advance i.e. the factors are pre-specified. The APT model for a well-diversified portfolio is given as:[14]

$$E(R_{jt}) = R_f + \sum_{k=1}^{K} \beta_{jk} X_{kt} + u_{jt} \tag{2.5}$$

Where,

$E(R_{jt})$:	Dependent variable – stochastic return on portfolio *j* at date *t*;
R_f:	Intercept coefficient – the real rate of return on a risk-free asset;
K:	The number of priced macroeconomic factors;
β_{jt}:	Slope coefficient – responsiveness of the return on portfolio *j* to unanticipated changes in macroeconomic factor *k*;
X_{kt}:	Independent variable – the value of macroeconomic factor *k* at date *t*; and
u_{jt}:	Residual term at date t.

According to the APT the return on an asset is a linear function of the nominal risk-free rate and more than one priced factor. The variance or movements in asset returns that are not linearly captured by the predetermined factors is captured by the residual term α_j. Using the APT, the risk of a well-diversified portfolio would be:[15]

$$\sigma_j^2 = \sum_{k=1}^{K} \beta_{jk}^2 \sigma_K^2 + \sigma_{u_j}^2 \tag{2.6}$$

[14] α_j is assumed to be zero

$\sum_{k=1}^{K}\beta_{k_j}^2\sigma_{k_j}^2$ are the pre-specified macroeconomic systematic risk variance and $\sigma_{u_j}^2$ is the residual variance. A specification of the APT is that the pre-specified macroeconomic factors (independent or explanatory variables) should be uncorrelated i.e. multicollinearity should not be present in the model. Referring back to Equation 2.5, the sum of the pre-specified factors should be statistically different from zero i.e.

$$\sum_{k=1}^{K}\beta_{jk}X_{kt}\neq 0$$

If multicollinearity is present among explanatory variables, structural estimates $\hat{\beta}_{jk}$ are biased and inconsistent, and hence, imprecise structural estimates are produced i.e.

$$\hat{\beta}_{jk}\neq\beta_{jk}$$

Essentially, if multicollinearity is inherent in the model, structural estimates $\hat{\beta}_{jk}$ will not equate the true structural coefficients β_{jk}. A further requirement of the APT is that the residual term, u_j, at date t is stochastic i.e. independent to κ_j at date $t-1$:

$$E(u_t, u_{t-1}) = 0$$

This is to say that autocorrelation is not present. If however autocorrelation is present, structural estimates, $\hat{\beta}_{jk}$, although unbiased and consistent are no longer efficient i.e. variances are high. Similar to the CAPM, the APT can be expressed as:

$$\frac{P_{t+1}-P_t}{P_t}=P_t\left(R_f+\sum_{k=1}^{K}\beta_k X_{kt}+u_t\right)$$

In the following two chapters, the CAPM and APT are applied to test for:

1. In chapter three, the functional form of the CAPM is used to analyse market sector return movements in the South African equity market during January 1990 to December 2002.
2. In chapter four, the functional form of the APT is used to identify the macroeconomic factors causing market and sector price movements in the South African equity market during January 1990 to December 2002.

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[15] The date subscript t is dropped for simplicity

CHAPTER 3: PRICE MOVEMENTS IN THE SOUTH AFRICAN EQUITY MARKET

(JANUARY 1990 – DECEMBER 2002)

1. Introduction

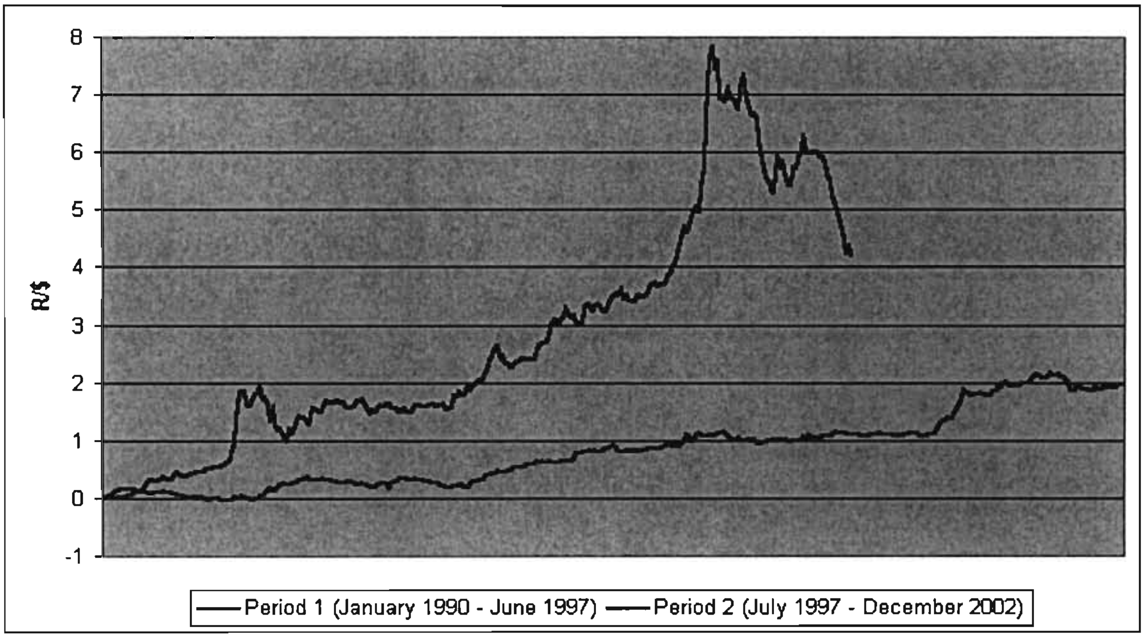
The objective of this chapter is to analyse market and sector price movements in the South African equity market during January 1990 to December 2002. This is accomplished by applying the CAPM framework and the EMH discussed in the previous chapter. More specifically the following will be analysed and tested for: (1) structural change; (2) progressive volatility; and (3) abnormal returns. This chapter essentially focuses on the return side of the return-risk relationship of South African equity market and sector returns.

2. Structural Change in South African Equity Prices

The contagion effect of the Asian financial crisis on global foreign exchanges and equity markets during the late 1990's, resulted in substantial price fluctuations in speculative assets, particularly the foreign exchanges and equity markets in developing countries, such as South Africa[16]. The significance of a volatile rand exchange (particularly against the US dollar) on the JSE, is that, the JSE is largely weighted by rand exchange-sensitive companies. The significance of a volatile rand is clearly evident from the highly capitalised resource and industrial sectors fluctuating substantially *since* the rapid depreciation of the rand in the last two quarters of 1997. A common negative factor amongst such companies is that a volatile exchange causes a volatile profit base in domestic companies that operate internationally – profits that are denominated in foreign currency need to be repatriated back to the home country, hence, are largely exposed to exchange rate risk. Furthermore, profit volatility disrupts project planning (including foreign direct investments into the country) as the viability of planned projects become increasingly uncertain.

[16] See Goldstein 1998

Figure 3.1: **Rand-dollar exchange during Period 1 and Period 2**[17]

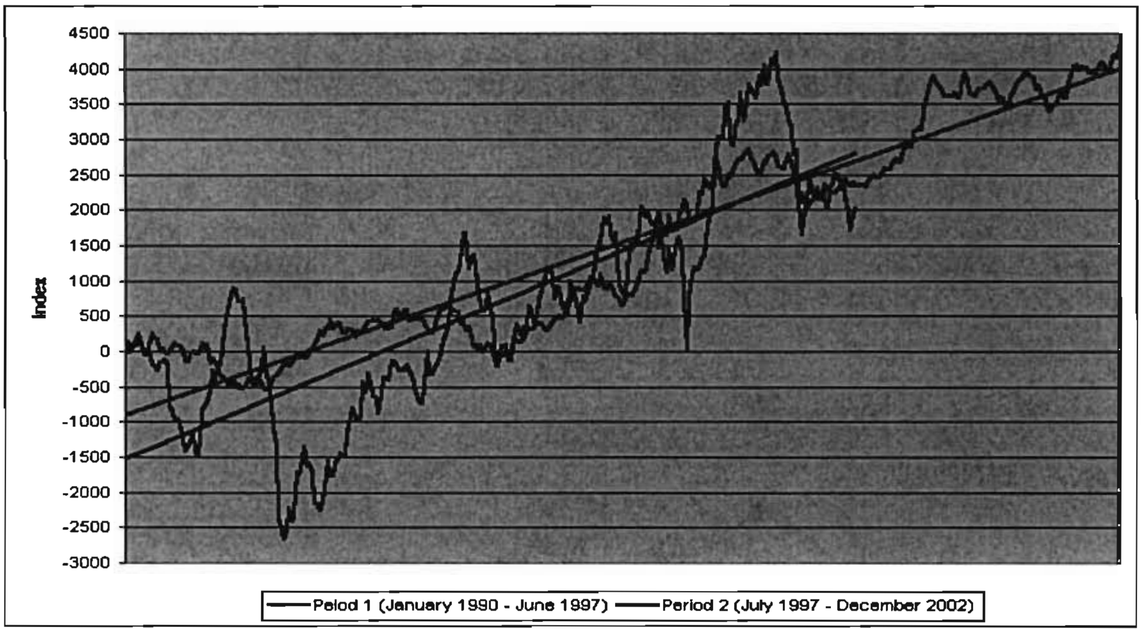


***Data Source*: JSE (1990-2002)**

Figure 3.1 and Figure 1.3 (Figure 1.3 is reproduced in the following page for convenience) show the marked increase in *volatility* of, respectively, the rand against the dollar and the South African equity market, between Period 1 and Period 2. Subsequent to the outbreak of the Asian financial crisis i.e. Period 2, two main features/effects of the Asian financial crisis have seemingly remained intact in the South African economy: (1) the volatility of the rand against major currencies, particularly against the US dollar. This is clearly indicated by Figure 3.1, and (2) the South African equity market has *remained* substantially volatile. This is clearly indicated by Figure 1.3. It is well documented that the initial heightened volatility in equity markets and foreign exchanges in a select few Asian countries, such as Thailand and Malaysia, subsequently led to investors reassessing their exposure to risk[18]. The reassessment of risk amongst investors, particularly the heightened risk in developing countries, had an adverse effect on *global* markets, as investors became more risk-averse, particularly towards developing countries. Essentially, the increased risk-averse attitude of investors spread globally.

[17] The rand values are 'undervalued' as the intercept is set to zero
[18] See Goldstein 1998

Figure 1.3: **Price behaviour of the ALSI during Period 1 (January 1990 – June 1997) and Period 2 (July 1997 – December 2002)**



Data Source: **JSE (1990-2002)**

A closer inspection of Figure 1.3 shows that during Period 1 and Period 2 the ALSI trended positively. However, the positive trend lines are distinctly different between Period 1 and Period 2 – the trend line for Period 2 is steeper than the trend line for Period 1. It is plausible that a 'bull' period, indicated by a positively sloping trend line, is the result of underlying fundamentals causing, on average, positive price changes. It therefore follows that the difference in the slopes of the two trend lines, are the result of differences in the relationship between relative price increases (decreases) and relative positive (negative) unanticipated changes in underlying fundamentals, during Period 1 and Period 2.

To identify a structural *break* in the South African equity market, one would need to identify a distinct change or break in long-term price trends. Although identifying distinct breaks in the equity price data is more of a statistical problem (which will have a significant effect on the identification of fundamental factors causing equity price movements), the research paper is more concerned with identifying a particular event, as to provide an economic reason for the structural break.

According to Goldstein (1998), two plausible channels of Asian financial crisis contagion have been identified, namely, the *"wake-up call" hypothesis* and the *competitive dynamics of devaluation*. With respect to the former, subsequent to the devaluation of the Thai Baht in July 1997, international investors began reassessing the financial risks inherent in developing countries, which subsequently led to investors becoming 'edgy' or more risk-averse towards developing countries. With respect to the latter, the subsequent devaluation of the Thai Baht in July 1997 resulted in many developing countries devaluing their currency in an attempt to remain internationally competitive, for those countries that did not subsequently devalue (and experienced a deterioration in competitiveness), these countries were more susceptible to speculative attacks on their currency's. Regardless of the channel in which the Asian financial crisis spread, it is apparent that subsequent to the devaluation of the Thai Baht in July 1997, a structural break was identified in the South African equity market – this is the point in time that a structural change began. The methodology to test for structural change is discussed next, followed by the findings.

2.1. Methodology

To test whether a structural change did occur in the South African equity market between Period 1 (where s = 1) and Period 2 (where s = 2), a Chow test is applied to the following regression model:

$$P_s = \beta_s X + u_s \qquad s = 1 \text{ or } 2 \qquad (3.1)$$

P_s are the index prices of the ALSI during Period s, X is a trend variable where X can take the values 1, 2…x, and x is the number of observations in Period s. u_s is a residual term. The null hypothesis for the Chow test is that there is parameter stability i.e. $\hat{\beta}_1 = \hat{\beta}_2$ (i.e., no structural change) if the estimated $\hat{F}$ value does not exceed the critical F value.[19] Therefore, if

$$\hat{F} < F,$$

the null hypothesis

$$H_0: \hat{\beta}_1 = \hat{\beta}_2$$

is accepted. This implicitly implies that $P_1 = P_2$, that is, the structural trend for both periods is best fitted with a single trend line. However, if

$$\hat{F} > F,$$

the null hypothesis is rejected. This implies that

$$\hat{\beta}_1 \neq \hat{\beta}_2.$$

Implicitly, this implies that $P_1 \neq P_2$, that is, the structural trend for both periods is best fitted with two separate trend lines – one for Period 1 and another for Period 2. Essentially, if there is no structural change, we do not have to differentiate between Period 1 and Period 2. Hence, when identifying the fundamental factors causing market and sector price movements in the South African equity market during 1990 to 2002 (See chapter four) the econometric model is applied for one period only, namely Period 0, which includes the data set for Period 1 and Period 2. However, if there is a structural change, Period 0 has to be differentiated into two periods (i.e. Period 1 and Period 2). Subsequently, the macroeconomic identification of priced factors is separately applied to Period 1 and Period 2.

2.2. Findings

Estimating Equation 3.1, using OLS, the estimated F value is calculated at 70.5. From the F tables, it is found that for 2 and 674 degrees of freedom (DF) the 1 percent critical F value is 4.61, hence:

$$70.5 > 4.61$$

Therefore, the null hypothesis, $H_0: \hat{\beta}_1 = \hat{\beta}_2$, is rejected at the 1 percent level of probability. The Chow test supports the observations made previously that the South African equity market had undergone a structural change subsequent to the devaluation of the Thai Baht on July 1997.

[19] See Appendix 2.a for the F 'model' used

2.3. Implications

As mentioned, an implication is that the macroeconomic identification of priced factors is separately applied to Period 1 and Period 2. Therefore, given the following multiple regression model:[20]

$$z(Y) = \sum_{k=1}^{K} \beta_{jk} PC_{kt} + u_{jt} ,$$

which is used for the macroeconomic identification of priced factors for market and sector returns in the South African equity market, structural estimates $\hat{\beta}_{jk}$ will be statistically different between Period 1 and Period 2. The above econometric model is therefore applied separately to the data set for Period 1 and Period 2 (see chapter four). Apart from the statistical implications, the structural change indicates that long-term price movements i.e. average price movements during Period 1 and Period 2 (indicated by a trend line), behaved differently during Period 1 and Period 2. Moreover, it is a clear indication that the market return-risk relationship was different between Period 1 and Period 2. It is common knowledge that the slope of the trend lines are determined by the responsiveness of prices to underlying fundamentals. In the above model, the responsiveness is measured by β_{jk}. Consistent with Bayes' theory, the differing price responsiveness between the two periods would indicate:[21]

1. The *quantity* of new information/events being absorbed by the market, over the duration of Period 2, was substantially different (i.e. less or more) than in Period 1; or/and
2. The *quality* i.e. the level of surprise, of new information/events being absorbed by the market, over the duration of Period 2, was substantially different (i.e. neutral or substantial) than in Period 1.

Consistent with macroeconomic factors having a pervasive effect on equity prices, a steeper trend line for Period 2 (see Figure 1.3) would indicate that long-term equity prices were more responsive to unanticipated changes in macroeconomic factors. This would

[20] See Chapter Four

make sense because a flat trend line would indicate that prices remained the same regardless of any available information. Hence, during Period 2 it is plausible that prices were more responsive to:

1. The relatively 'more' new information/events that occurred during Period 2; or/and
2. The level of surprise from new information/events during Period 2.

Noticeable events during Period 2 were the competitive currency devaluations between developing countries, the default on government loans by the Russian government, rand volatility and 'September 11'. Period 2 can be seen as a period when international events had a major impact on financial markets, including South Africa's. Contrastingly, Period 1 can be seen as a period when socio-political transformation (domestic events) had a major impact on the South African equity market.

3. Volatility in the South African Equity Market

Prior to the outbreak of the Asian financial crisis, but beginning from January 1990, historical volatility[22] for Period 1 averaged 10 percent and peaked above the 25 percent level occasionally during 1990 and 1994. However, Subsequent to the outbreak of the Asian financial crisis in July 1997, it is apparent from Figure 1.3 that the South African equity market had not only undergone a structural change but, weekly prices had become relatively more volatile – price fluctuations around the structural trend for Period 2 were more pronounced and remained volatile up to December 2002. Historical volatility for Period 2 was more than double the historical volatility for Period 1. During Period 2 historical volatility averaged about 20 percent and peaked above the 25 percent level regularly, whereby towards the end of 1998 and the beginning of 1999, historical volatility peaked above the 50 percent level.

[21] See Appendix 2.c for a short review on Bayes' theory

[22] Historical volatility measures price fluctuations from a historical time series set, in this instance, the price fluctuations of the ALSI. Historical volatility figures are sourced from the JSE

The apparent volatility differential between Period 1 and Period 2 is tested to determine whether short-term price fluctuations between Period 1 and Period 2 were statistically different. The methodology to test for the volatility differential is discussed next, followed by its findings.

3.1. Methodology

To test whether a volatility differential did occur, or put differently, whether the South African equity market had become substantially more volatile subsequent to the outbreak of the Asian financial crisis in July 1997, an F-test similar to that used in the Chow Test (Refer to the previous section) is applied. However, in this instance, the F-test is the ratio of variances (volatility) in equity prices during Period 1 and Period 2.[23] The following regression model is again estimated:

$$P_s = \beta_s X + u_s \qquad s = 1 \text{ or } 2 \qquad (3.1)$$

The null hypothesis for this test is that the estimated variance (volatility) in Period 1, $\hat{\sigma}_1^2$, is the same for Period 2, $\hat{\sigma}_2^2$, that is, if

$$\hat{F} < F,$$

the null hypothesis

$$H_0: \hat{\sigma}_1^2 = \hat{\sigma}_2^2$$

is accepted. However, if

$$\hat{F} > F,$$

the null hypothesis is rejected. Hence,

$$\hat{\sigma}_1^2 \neq \hat{\sigma}_2^2$$

Note: Weekly data is used in the analysis, hence, the test determines whether average weekly volatility between Period 1 and Period 2 were statistically different.

3.2. Findings

The estimated F value was calculated to be 34.36. From the F tables, it was found that for 2 and 674 DF the 1 percent critical F value is 4.61, hence, $34.36 > 4.61$.

[23] See Appendix 2.b for the F 'model' used

Therefore, the null hypothesis, $H_0 : \hat{\sigma}_1^2 = \hat{\sigma}_2^2$, is rejected at the 1 percent level of probability. Hence, average weekly price movements in the South African equity market between Period 1 and Period 2 were different. Moreover, it indicates that the average weekly price movements during Period 2 were relatively more volatile. This can be graphically observed in Figure 1.3.

3.3. Implications

Consistent with Bayes' theory, the relatively more volatile Period 2 indicates:

1. The *quantity* of new information being absorbed by the market, on a weekly basis, was substantially more than in Period 1; or/and
2. The *quality* i.e. the level of surprise, of new information being absorbed by the market, on a weekly basis, was substantially greater than in Period 1.

Consistent with macroeconomic factors having a pervasive effect on equity prices, the greater the unanticipated change (whether in quantity or/and quality) the more volatile prices will be.

4. Abnormal South African Sector Returns

In this section a test is applied to determine whether weekly abnormal returns were experienced in the South African resource, financial and non-resource/financial sectors during 1990 to 2002. Moreover, the test determines whether weekly sector returns were consistent with underlying fundamentals. If sector returns deviated from underlying fundamentals, this indicates an 'extra' return that is in excess of what ought to have been achieved given the available set of information.

4.1. Methodology

To test whether weekly abnormal returns were experienced in South African equity sector returns, the CAPM is applied. Given:

$$E(R_{jt}) - R_f = \alpha_{jt} + \beta_{jt}\lfloor E(R_M - R_f)\rfloor + u_{jt} \tag{3.2}$$

Equation 3.2 contains the same variables as Equation 2.3 (see chapter two). However, for regression purposes Equation 2.3 is rearranged so that the dependent variable is the sector *premia* and α_{jt} is the intercept coefficient. The null hypothesis is that the estimated intercept coefficient $\hat{\alpha}_{jt}$ is statistically equal to zero i.e. a *t*-test is applied. Mathematically:

$$H_0 : \hat{\alpha}_{jt} = 0$$

If the null hypothesis is rejected it is concluded that a weekly abnormal return did occur for the specified period. The specified periods analysed are the annual periods beginning from 1990 to 2002. Annual periods are analysed to overcome the biases that may arise due to thin trading.

4.2. Findings

Over the thirteen-year period (1990 to 2002), weekly abnormal sector returns were identified during 1992, 1995, 1997 and 2001. The findings are tabled in Table 3.1. It should be noted that the findings do not imply that weekly abnormal returns were experienced throughout the latter periods but that weekly abnormal returns did occur *sporadically* during the respective periods.

4.3. Implications

Apart from the ability of investors making risk-free profits in excess of the risk-free rate the abnormal returns indicate that equity prices deviated from underlying economic fundamentals during the identified periods. Two possible reasons for the abnormal returns are provided, namely, sector inefficiency or/and cognitive biases.

4.3.1 Sector Inefficiency

A plausible reason for the weekly abnormal sector returns or for equity returns deviating from underlying fundamentals during the stated periods is that the sectors were inefficient. This is to say that not all the available information during these periods were impounded into equity prices.

Table 3.1: Abnormal returns during January 1990 to December 2002

YEAR	MAJOR EVENT	SECTOR					
		Resource		Financial		Non-resource/financial	
		α	*t*-value	α	*t*-value	α	*t*-value
1990	- Iraq invades Kuwait - Un-banning of the ANC and socio-political transformation in South Africa	-0.207	-0.996	0.255	1.070	0.195	0.928
1991	- Gulf war - Volatile oil prices	-0.227	-1.036	0.212	1.081	0.198	1.351
1992	- Favourable conditions for financial sector i.e. low inflation, reduced money market rates and progress towards a more stable financial environment	-0.360	-1.730	0.412	**2.343** **	0.132	1.354
1993		0.223	0.749	-0.078	-0.459	-0.096	-0.556
1994	- South African presidential elections	-0.184	-0.686	0.159	0.753	0.113	0.672
1995	- Removal of exchange controls on non-residents to South Africa - Mexican Peso crisis	-0.469	**-2.008** *	0.415	**2.874** ***	0.094	1.031
1996	- South African currency crisis	0.177	1.088	0.075	0.398	-0.193	-1.670
1997	- Asian financial crisis - Rand volatility	-0.460	**-2.885** ***	0.714	**4.403** ***	-0.015	-0.139
1998	- Russian financial crisis	-0.038	-0.062	0.242	0.546	0.001	0.005
1999		0.659	1.426	-0.483	-1.578	-0.039	-0.167
2000	- Rand volatility	0.204	0.591	0.132	0.455	-0.220	-1.062
2001	- Rand volatility - September 11	0.709	**3.109** ***	-0.637	**-2.155** **	-0.446	**-2.513** **
2002	- Rand volatility	0.247	1.059	-0.215	-0.569	-0.681	-1.349

According to the EMH there are three forms of efficiency or information availability, namely:

1. Weak-form efficiency: Prices reflect historical information
2. Semi-strong efficiency: Prices reflect historical and public information
3. Strong-form efficiency: Prices reflect historical, public information, and private information

Therefore, sector returns were either weak-form efficient or semi-strong efficient.

* n < 60. Significant at the 0.10 level
** n < 60. Significant at the 0.05 level
*** n < 60. Significant at the 0.01 level

4.3.2 Cognitive Biases

Another plausible reason for weekly abnormal returns or for equity returns deviating from underlying fundamentals during the stated periods is that psychological factors could have played a role in equity return determination.

Is it justified to say that equity prices *always* reflect underlying 'economic' fundamental factors only; or are equity prices sometimes a mixture of 'economic' fundamentals and 'noneconomic' fundamentals? Over the past three decades, numerous studies have documented equity price movements that sometimes (i.e. sporadically) fluctuate in a manner that cannot be explained by traditional financial economic theories (e.g. Shiller (1981, 1999), Bhana (1985) and Malkiel (1990)). The latter authors have respectively documented, excess volatility, seasonal returns and speculative bubbles.[24] Essentially, these studies document the existence of abnormal return movements. Bernstein (1996) states that such return movements:

> "...reveals repeated patterns of [irrationality]...in the ways human beings arrive at decisions and choices when faced with uncertainty" (p. 281).

There is a vast literature in behavioural finance on decision-making under conditions of uncertainty. Perhaps the most distinguished contributions to the latter field are those by Kahneman and Tversky (1974, 1979). The latter authors suggest that decision-making in conditions of uncertainty is subject to cognitive biases. These cognitive biases are traditionally discussed under two classifications, namely (1) those that stem from the reliance on "judgemental heuristics" and (2) those that stem from "framing effects".

Judgemental Heuristics[25]

Judgmental heuristics are rules of thumb which individuals apply to complex decisions under conditions of uncertainty. This decision-making process is not a strictly rational one where all pertinent information is processed and objectively interpreted; rather the

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[24] See Appendix 2.d for a brief description of excess volatility, seasonal returns and speculative bubbles

decision-maker takes mental "short cuts" in the process. There may be good practical reasons for adopting a heuristic decision process, particularly when time available for decision-making is limited. Well-documented examples of cognitive biases resulting from the reliance on judgemental heuristics include:

(1) Representativeness: The tendency of individuals to make decisions based on stereotypes. In contrast to Bayes' theorem in which prior probabilities have a major effect in decision-making, prior probabilities have no effect on representativeness. Biases may also arise in the guise of the "misperception of chance" whereby investors tend to assume that recent events will continue into the future.
(2) Availability of instances or scenarios: The tendency of individuals to assess the probability of an event by the ease in which instances or occurrences can be brought to mind i.e. the ease in which an event can be retrieved from memory. Biases may arise as a result of the undue weight on easily accessible information in making a decision.
(3) Adjustment and Anchoring: The tendency of individuals to make final estimates that are biased towards their initial estimates. This behaviour could provide an explanation for investor under-reaction or over-reaction.

Framing Effects[26]

Framing effects is the state of mind that can be expected to influence an individual's decision-making processes in conditions of uncertainty. Well-documented examples of cognitive biases resulting from the reliance on framing effects are grouped in prospect theory.[27] According to prospect theory, outcomes that are probable tend to be under-weighted in comparison with outcomes that are certain. Moreover, the "mental penalty" associated with a given loss is greater than the "mental reward" from a gain of the same size. If investors are risk-averse, they tend to limit any possible losses while making a gain i.e. individuals tend to play safe when incurring gains. In contrast to traditional

[25] The review on judgmental heuristics is a summarized adaptation from Kahneman, Slovic and Tversky (1982: 4-18)
[26] The review on framing effects is adapted from Kahneman and Tversky (1979)
[27] See Kahneman and Tversky's (1979) seminal paper on prospect theory

economic theory where individuals' risk preferences are independent of the state of the world, individuals tend to be *risk-inclined* when incurring losses i.e. individuals are willing to take on more risk in an attempt to escape from a losing position.

5. Concluding Remarks

It is evident from the preceding analysis that market and return/price movements in the South African equity market varied over time. It was found that a structural break had occurred in South African equity price movements subsequent to the outbreak of the Asian financial crisis. During this post-Asian financial crisis period, the South African equity market was relatively more volatile than the pre-Asian financial crisis period. 'Anomalous' price movements, in the form of abnormal returns, were also identified in various sectors. Given the latter price/return behaviour, chapter four identifies the macroeconomic factors causing the identified price/return behaviour.

CHAPTER 4: MACROECONOMIC IDENTIFICATION OF THE PRICING FACTORS ON THE SOUTH AFRICAN EQUITY MARKET[28]

(JANUARY 1990 – DECEMBER 2002)

1. Introduction

In the previous chapter, an analysis of price behaviour in South African equity market and sector returns, during January 1990 to December 2002, is provided. The objective of this chapter is to identify the macroeconomic factors that caused the latter price behaviour. A brief review of previous studies on the identification of macroeconomic factors for the South African equity market is followed by the research papers own analysis and findings. This chapter essentially focuses on the risk side of the return-risk relationship of South African equity market and sector returns.

2. Previous Studies

Chen, Roll, and Ross (1986) state that:

> "Asset prices are commonly believed to react sensitively to [economic news]. Daily experience seems to support the view that...asset prices are influenced by a wide variety of unanticipated events and that some have a more pervasive effect" (p. 383).

The *economic news* that the latter authors are referring to are the unanticipated changes in macroeconomic factors that drive the economy of a country. It has been mentioned that such factors could be factors of production, consumer preferences, or government policies; it should be noted that the macroeconomic factors of a particular country are not exclusive to that country, but that it may contribute to the price movements of another country's equity market. The complex dynamics, multi-directional relationships of economic variables, and other facets of financial markets have made the identification of the *complete* number of macroeconomic factors extremely difficult if not impossible. Although there may be numerous factors that contribute to equity price movements, academic and commercial research has identified several primary sources of systematic risk that *consistently* impact global equity returns. Burmeister, Roll & Ross (2003: 3) mention that the primary sources of systematic risk that consistently impact equity returns are the unanticipated changes in:

(1) Investor confidence
(2) Interest rates[29]
(3) Inflation[30]
(4) Real business activity
(5) A market index

In addition to the above list of priced macroeconomic factors, various studies have also found the following macroeconomic factors to be priced:

(6) Exchange rates[31]; and
(7) Oil prices[32]

A review on the latter list of economic fundamentals follows.

Investor confidence

Confidence risk is the unanticipated changes in investors' willingness to undertake relatively risky investments. It is measured as the difference between the return on relatively risky corporate bonds and risk-free government bonds, both with long-term maturities (e.g. twenty years). If the difference is positive, confidence risk is inherent.

[28] The chapter heading is similar to Barr's (1990) research paper title
[29] See Fisher (1930), Flannery and James (1984), and Cox, Ingersoll and Ross (1985)
[30] See Bodie (1976)
[31] See Adler and Dumas (1983), and Dumas and Solnik (1995)

The reason for this is that a positive return difference reflects an increased willingness to undertake relatively risky investments – the required rate of return on risky corporate bonds would have fallen relative to the required rate of return on risk-free government bonds. Portfolios that are positively correlated with confidence risk (i.e. $\beta > 0$) will increase in price (Burmeister *et al*, 2003: 7-9).

Interest rates

Interest rate risk is the risk of a decline in earnings due to unanticipated changes in interest rates. It is measured as the difference between the returns on long-term maturity bonds and short-term maturity bonds, hence, unanticipated changes in the yield curve. An individual who lends or borrows is subject to interest rate risk. In the former, the lender earning a variable rate of return is exposed to the risk of revenues being reduced through a decline in interest rates. In the latter, borrowers paying a variable rate are exposed to the risk of higher costs if interest rates increase. Both positions are exposed to unanticipated changes in interest rates since they accrue revenue or costs indexed to market rates (Bessis, 1995: 8).

Inflation

Inflation risk is the risk of a decline in the purchasing power of earnings due to unanticipated changes in inflation. This is simply measured as the difference between actual inflation and expected inflation. According to Nichols (1976: 483 - 485): (1) when inflation increases, real tax payments increase therefore reducing earnings; (2) a variable inflation rate may result in variable interest rates; and (3) inflation reduces the buying power of consumers (income) and companies (profits).

Real business activity

Real business activity risk is the risk of *the* level of real productivity decreasing. This can be measured as the unanticipated changes in real gross domestic product (GDP) (Burmeister *et al*, 2003: 7-9).

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[32] See Jones and Kaul (1996)

Market index

Traditional market *index* risk is the residual risk not detected by the other four risk factors (Investor confidence, interest rates, inflation, and real business activity) or other pre-specified factors (Burmeister *et al*, 2003: 7-9). Market index risk can be measured as the portion of a market index (e.g. ALSI) that is not explained by the pre-specified factors. However, in this research paper, domestic and international market indexes are included in the proceeding econometric analysis to determine whether a country prices its *own* systematic risk along with the systematic risk of other countries. It is plausible that systematic risk is the risk affecting the whole market, however, this is systematic risk of a specific country. For example, developed countries such as the United States and Japan, who do not rely heavily on their resource sectors, would not 'price' the dollar-price of gold. However, resource-reliant countries such as South Africa do. It therefore follows that there are differing priced factors for different countries, along with the differing responsiveness to common priced factors. Furthermore, a country's market index would be affected largely by its own domestic macroeconomic factors i.e. its own exchange rate, domestic interest rates etc.

It is maintained in this research paper that the ALSI is a proxy for the South African equity market's domestic systematic risk, whereas, foreign indexes, such as the Dow Jones, would indicate foreign systematic risk. It therefore follows that, if a foreign index were priced for the South African equity market, this would indicate that equities listed on the JSE are responsive to other countries systematic risk. Domestic and foreign country systematic risk is calculated as the unanticipated changes in the different market indexes.

Foreign Exchange

Foreign exchange rate risk is the risk of a decline in earnings due to unanticipated changes in foreign exchange (Rugman and Hodgetts, 1995: 202). It is measured as the difference between the spot exchange rate and the expected exchange rate at date *t*.

Oil Prices

Many companies are reliant on oil as a source of power generation. Oil risk is therefore the risk of a decline in earnings due to unanticipated changes in the cost of oil. It is measured as the difference between the spot dollar price of oil and the expected dollar price at date *t*.

In addition and specific to gold-reliant countries is the dollar price of gold.

Dollar-Gold Price

Dollar-gold risk is the risk of a decline in earnings due to unanticipated changes in the price of gold. The dollar-gold price is often not priced in international studies as most of the research on priced factors, is conducted by developed countries such as the United States, Great Britain and Japan. In these countries, the resource industry (i.e. the primary industry) no longer plays a major role in their economies – the tertiary industry (e.g. services and research) play a major role. However, in the case of South Africa, the resource sector (particularly the gold industry) currently plays a major role in the South African economy. South African studies by Barr (1990), Reese (1993), and van Rensburg (1996), have examined the effect of the gold price on the South African equity market. Barr (1990: 21) concluded that to a large degree, economic activity in South Africa is driven by the levels of gold/metal prices through their effect on the mining sector and the various filter-through effects on the rest of the country.

South African Studies

Amongst the more notable research on the identification of priced factors for the South African equity market are Barr (1990) and van Rensburg (1996). Barr (1990) applied factor analysis to a macroeconomic data set for the period 1979 to 1987. This technique allowed the researcher to compress a large set of correlated variables (pre-selected macroeconomic factors) into a smaller set of risk indexes or principal components (PC's) which are mutually orthogonal[33]. Barr found two main economic factors that are significantly priced and are primarily of an industrial and financial type index. In the case

[33] Uncorrelated i.e. eliminates the problem of multicollinearity

of the former index, it was found that gold and interest rates were the main driving forces in this index whereas in the latter, foreign share markets and local property effects (representing a proxy for local confidence) were the main driving forces. Contrastingly, van Rensburg (1996) applied *iterated non-linear seemingly unrelated regression* (ITNLSUR) estimation techniques[34] to a data set for the period 1980 to 1989. The latter author found that the unexpected movements in rand-gold returns, the Dow-Jones Industrial Index (DJIA), the term structure of interest rates, and inflation expectations together with the residual market factor[35] were priced.

This research paper applies the same econometric technique applied by Barr (1990). The econometric model, the rationale for selecting the macroeconomic factors, the testing methodology and the findings follow.

3. The Econometric Model

The econometric model applied in the analysis is an adaptation of the functional form of the APT model discussed in Chapter Two. The APT model is given as:

$$E(R_{jt}) = R_f + \sum_{k=1}^{K} \beta_{jk} X_{kt} + u_{jt} \qquad (2.5)$$

Where,

$E(R_{jt})$:	Dependent variable – stochastic return on portfolio *j* at date *t*;
R_f:	Intercept coefficient – the real rate of return on a risk-free asset;
K:	The number of priced macroeconomic factors;
β_{jt}:	Slope coefficient – responsiveness of the return on portfolio *j* to unanticipated changes in macroeconomic factor *k*;
X_{kt}:	Independent variable – the value of macroeconomic factor *k* at date *t*; and
u_{jt}:	Residual term at date t.

[34] See Pindyck and Rubinfeld (1991)
[35] See Burmeister & Wall (1986)

The functional form is simply that of a multiple regression model i.e.

$$Y = \sum_{k=1}^{K} \beta_{jk} X_{kt} + u_{jt} \tag{4.1}$$

Where,

$$Y = E(R_{jt}) - R_f$$

Y:	Dependent variable – market and sector returns in excess of the risk-free rate i.e. market or sector *premia's*;
K:	Number of pre-selected independent variables/factors;
β_{jt}:	Slope coefficient – responsiveness of the return on portfolio *j* to unanticipated changes in macroeconomic factor *k*;
X_{kt}:	Independent variable – the value of the k^{th} pre-selected factor at date *t*; and
u_{jt}:	Residual term at date t.

The proxies for the market and sector returns, and the *K* pre-selected macroeconomic factors used in the analysis are presented in Table 4.1 and Table 4.2 respectively. Due to the econometric technique applied it is only the functional form of the APT model depicted in Equation 4.1 that is used. The final model applied in the analysis is:

$$z(Y) = \sum_{k=1}^{K} \beta_{jk} PC_{kt} + u_{jt} \tag{4.2}$$

Where,

$z(.)$:	Standardized dependent variable – standardized market and sector returns in excess of the risk-free rate i.e. standardized market or sector *premia's*;
K:	Number of PC's retained as independent variables;
β_{jk}:	Slope coefficient – responsiveness of the respective standardized dependent variables to unanticipated changes in the independent variables PC_{kt};
PC_{kt}:	Independent variable – value of the *k*th PC at date *t* retained; and
u_{jt}:	Residual term at date t.

Table 4.1 Market and sector returns used in the econometric analysis

Dependent variables[36]: $E(R_{it})$	**Description**
MARKET	The South African market portfolio proxied by the ALSI
RES	The resource sector including basic industries
FIN	The financial sector
NRF	All sectors except for the resource, financial and basic industries

Table 4.2 The pre-selected macroeconomic factors used in the econometric analysis

	Candidate Factors[37]	**Description**
1	**Market *premia*** UMP_t	Movements in the market in excess of the risk-free rate. The return from the market is proxied by the ALSI, while the risk-free rate is proxied by BA rate.
2	**Dollar gold price (UDG_t)**	Unanticipated changes in the dollar gold price.
3	**Rand gold price (URG_t)**	Unanticipated changes in the rand gold price.
4	**Exchange rate between SA* and the USA** (URD_t)**	Unanticipated changes in the exchange rate between SA and the USA.
5	**Dollar oil price (UDO_t)**	Unanticipated changes in the dollar oil price proxied by the price of Brent crude oil.
6	**The term structure of interest rates ($UINT_t$)**	Unanticipated changes in the term structure of interest rates. The term structure of interest rates at date *t* are proxied by the differences in the yields between long-term bonds (R150) and short-term bonds (BA)
7	**Interest differential between the USA and SA ($UINTD_t$)**	Unanticipated changes in the interest differential between SA and the USA are proxied by their respective prime rates.
8	**Inflation expectations (AIE_t)**	Adjustments to inflation expectations at date *t* are proxied by changes in the BA rate $BA_t - BA_{t-1}$
9	**Inflation ($UINF_t$)**	Unanticipated changes in the inflation rate – proxied by the consumer price index (CPI)
10	**Dow Jones Industrial Average (UDJ_t)**	Unanticipated changes in the DJIA
11	**Nikkei (UNI_t)**	Unanticipated changes in the Japanese stock exchange is proxied by the Nikkei Average
12	**Financial Times 100 (UFT_t)**	Unanticipated changes in the British stock exchange is proxied by the Financial Times 100 (FTSE100)
13	**Standard & Poor 500 (USP_t)**	Unanticipated changes in the Standard & Poor 500 (S&P500)

Rationale in pre-selecting the K factors

As discussed in Chapter Two, the APT does not provide specific guidelines to the economic nature or specify the number of macroeconomic factors to be pre-specified. However, the data used for the respective pre-selected factors should be the deviations

[36] See Appendix 3.a for the calculation method for the dependent variables

[37] See Appendix 3.b for the calculation methods for the pre-selected macroeconomic factors

* South Africa

** United States of America

from the respective pre-selected factors' mean values. This is simply because it is the unanticipated changes in the pre-selected macroeconomic factors that cause return movements. The selection of candidate factors requires the researcher to apply economic rationale with the aid of previous studies as a *guideline* in selecting potential priced factors. The onus is on econometric testing to determine whether the pre-selected factors *are* priced. The pre-selected factors stated in Table 4.2 are selected from previous studies done by Chen, *et al* (1986), Barr (1990), and van Rensburg (1996).

4. Methodology

The econometric techniques applied for the identification of macroeconomic factors causing market and sector price movements in the South African equity market are principal components analysis (PCA) and ordinary least squares (OLS). The software used for the analysis is SPSS version 11. According to Kendall (1957) and Nieuwoudt (1972) the objective of PCA is to *economise* the number of variates. In the analysis the variates are the original pre-selected macroeconomic factors. In addition, PCA aids in the remedying of multicollinearity, allows the researcher to analyse inter-relationships between variates and creates risk indexes of the original pre-selected macroeconomic factors.

In the analysis, PCA converts the original values of the pre-selected macroeconomic factors into orthogonal variates that are linear combinations of the original values. These orthogonal variates make up the respective PC's. Mathematically:

$$PC_i = a_{i1}X_1 + a_{i2}X_2 + \ldots + a_{in}X_n \qquad 4.3$$

Where,

PC_i: ith estimated PC;

a_{in}: Component loadings of the original pre-selected macroeconomic factors; and

X_n: Original values of the pre-selected macroeconomic factors.

In order to avoid a variate (i.e. $a_{in}X_n$) having an undue influence on the PC's, due to different measurements, the original values of the pre-selected macroeconomic factors,

X_n, are standardized to have means of zero and variances of one. The PC's are therefore extracted from the correlation matrix. The correlation matrix standardizes the respective original values of the pre-selected factors; this is done, as opposed to extracting the PC's from the variance-covariance matrix, which does not account for the different measurements in the original values (Manly, 1988: 63). SPSS version 11 applies the correlation matrix as a default option. The number of estimated PC's would be $K - 1$. In PCA, the first PC (PC1) accounts for the majority proportion of the variation in the original values of the pre-selected macroeconomic factors with successive PC's accounting for the remaining variation, hence, the PC's are ranked in a cardinal manner. As mentioned the PC's (also known as risk indexes), which will be used as the explanatory variables in the analysis, are standardized. The dependent variables i.e. market and sector return *premia's*, therefore, need to be standardized. Standardized dependent variables are estimated by running a simple OLS regression i.e. the original dependent variables are regressed on the original pre-selected macroeconomic factors. The estimated OLS market and sector return *premia's* are retained and used as the standardized dependent variables. Therefore, given Equation 4.2:

$$z(Y) = \sum_{k=1}^{K} \beta_{jk} PC_{kt} + \kappa_{jt} ,$$

the standardized dependent variables, $z(Y)$, are regressed on the retained PC's, PC_{kt}, using OLS.[38] Structural coefficient estimates, $\hat{\beta}_{jk}$, are then tested for significance using a t-test. The null hypothesis is that the respective $\hat{\beta}_{jk}$ are statistically equal to zero. Mathematically:

$$H_0 : \hat{\beta}_{jk} = 0$$

If the null hypothesis is rejected, it is concluded that that risk index PC_{kt} is a priced factor for the corresponding South African equity market/sector for the specified period. The term 'priced' indicates that a certain factor had a pervasive effect on the respective market/sector.

[38] The Kaiser criterion (retain components with an eigen value equal to or greater than one) is not applied in the analysis, but instead, all the initial estimated PC's (12) were used, but are successively dropped until the

Lastly, in chapter three, a structural change subsequent to the outbreak of the Asian financial crisis in July 1997 meant that the data set used in the analysis, Period 0: January 1990 to December 2002, is required to be divided into two sub-periods, namely, Period 1 (January 1990 to June 1997) and Period 2 (July 1997 to December 2002). The methodology discussed above is applied twice – for Period 1 and Period 2.

5. Findings[39]

The data set used in the analysis were analysed using the discussed methodology for Period 1 and Period 2. The findings for Period 1 are presented first, followed by the findings of Period 2.

Period 1

The estimated components matrix for Period 1 is presented in Table 4.3 (refer to the end of this section). The components matrix is a decomposition of the individual PC's into the respective component loadings. The highlighted figures are the component loadings that have the larger portion/weighting of the PC. Suitable names were given to the PC's on the criteria that that the component loadings with the larger absolute value are taken into consideration. In the case where two or more macroeconomic factors have similar values, an 'approximate' name is given. An interpretation of the first *seven* PC's follows, as they are the only PC's retained for the analysis of Period 1.

PC1 (Rand 1): Weighted largely with factors that are directly or indirectly related to the rand. These heavily weighted factors are the rand-dollar exchange (URD), inflation (UINF), rand-gold price (URG), interest differential between SA and the US (UINTD) and domestic interest rates (UINT).

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regression coefficients estimated for the original variables stabilized. This method is applied as to limit the loss of information on the economic factors

[39] Using the Durbin-Watson test, no autocorrelation was detected

PC2: (US/UK):	Weighted largely by US and UK equity market indexes, namely, the S&P 500 (USP), DJIA (UDJ) and the FTSE (UFT).
PC3 (Rand 2):	Weighted largely with factors that are directly or indirectly related to the rand. However, PC3 captures less of the variation than PC1 – subsequent PC's carry less of the total variation. Furthermore, inflation (UINF) features more prominently than oil prices (UDO) in PC1 compared to PC3, for PC3 it is the direct opposite.
PC4 (Dollar-Gold):	The dollar price of gold (UDG) is prominent in this PC.
PC5 (Market *Premia*):	Weighted largely by the domestic market *premia* (UMP).
PC6 (Inflation Expectations):	Weighted largely by adjustments in inflation expectations (AIE).
PC7 (Asian):	Weighted largely by the Nikkei index (UNI).

For the resource and non-resource/financial sectors and the market the first seven PC's are retained and used as independent variables in Equation 4.2. For the financial sector only the first six PC's are retained and used as independent variables in Equation 4.2. In the analysis, it is found that the retained PC's were all statistically significant at the 1 percent level of probability for all the respective sectors and the market. The OLS regression results for the three sectors and the ALSI are produced in the Table 4.4 (refer to the end of this section).

Using Table 4.3 and Table 4.4 it is clear that PC5 (Market *Premia*) had the greatest impact on market and sector returns. This is evident from the standardized coefficients and the corresponding *t* statistics in Table 4.4. The implication is that market and sector returns are largely influenced by *domestic* systematic risk factors. Put differently, domestic macroeconomic factors had the most significant effect on market and sector returns as opposed to foreign systematic risk. This would seem plausible as South Africa was in a period of socio-political transition for most of Period 1, and therefore investors 'looked inward' and monitored domestic indicators. Also significantly pervasive on market and sector returns, *except* for the resource sector, is PC2 (US/UK) followed by PC4 (Dollar-Gold). With regards to PC2, this would indicate that the larger international exchanges also had a significant effect on market returns as well as on financial and non-resource/financial sector returns. In the case of the resource sector PC6 (Inflation Expectations) followed by PC4 (Dollar-Gold) had a more significant effect than the international exchanges. This would seem plausible as many of the resource companies have a majority of their earnings denominated in foreign currency, particularly in dollars. It should be noted that, although priced, PC1 (Rand 1) and PC3 (Rand 2) did not have much of a significant effect during Period 1 – during Period 1, the rand was relatively stable (refer to Chapter Three).

Table 4.3: Components matrix: Period 1

PC's\ K FACTORS	PC1: RAND1	PC2: US/UK	PC3: RAND 2	PC4: DOLLAR-GOLD	PC5: MARKET *PREMIA*	PC6: INFLATION EXPECTATION	PC7: ASIAN	PC8	PC9	PC10	PC11	PC12
UMP	0.088	0.387	-0.161	0.359	**0.628**	0.345	-0.217	-0.226	0.276	0.001	0.011	0.004
UDG	0.485	-0.262	0.150	**0.452**	0.567	-0.265	0.006	-0.103	-0.172	0.011	0.182	-0.064
URD	**0.806**	0.012	**0.436**	-0.306	-0.204	0.064	-0.024	0.016	0.037	-0.008	0.050	0.125
UNI	0.116	0.549	-0.096	-0.103	0.097	0.017	**0.803**	-0.093	-0.022	0.017	0.025	0.011
UFT	0.076	**0.692**	-0.003	-0.064	0.223	0.144	-0.126	0.560	-0.330	0.062	-0.003	0.003
UDO	-0.421	-0.096	**0.600**	0.207	0.195	-0.066	0.146	0.374	0.453	0.003	-0.020	-0.006
AIE	0.278	-0.137	0.086	0.584*	-0.137	**0.728**	0.069	-0.043	-0.020	0.016	-0.003	-0.012
UINF	**-0.919**	0.056	-0.124	0.157	0.019	0.037	-0.032	-0.030	-0.035	-0.007	0.209	0.251
UDJ	0.135	**0.784**	0.083	0.317	-0.205	-0.196	-0.166	-0.191	0.136	0.310	-0.014	0.006
USP	0.123	**0.846**	0.074	0.285	-0.150	-0.111	-0.130	-0.070	0.069	-0.347	0.020	-0.025
URG	**0.876**	-0.055	**0.428**	-0.162	-0.046	-0.007	-0.019	-0.010	-0.012	-0.003	0.105	0.078
UINTD	**-0.700**	0.153	**0.468**	-0.309	0.208	0.162	-0.027	-0.103	-0.088	0.031	0.220	-0.182
UINT	**0.509**	-0.074	**0.689**	-0.014	-0.228	-0.004	0.003	0.270	0.282	0.020	0.225	-0.066
Eigen value	3.561	2.392	1.521	1.154	1.036	0.827	0.781	0.652	0.533	0.222	0.191	0.127
% Variance	27.393	18.400	11.700	8.876	7.970	6.364	6.011	5.013	4.104	1.711	1.473	0.979
Cum. %	27.393	45.793	57.493	66.370	74.340	80.704	86.714	91.727	95.831	97.542	99.015	99.994

* This *K* factor is not considered in the naming of this PC as it is considered in PC6

Table 4.4 OLS regression results: Period 1[40]

Coefficients [a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	.000	.018		.000	1.000
	PC1	.101	.018	.101	5.529	.000
	PC2	.385	.018	.385	21.107	.000
	PC3	-.175	.018	-.175	-9.577	.000
	PC4	-.361	.018	-.361	-19.786	.000
	PC5	.623	.018	.623	34.124	.000
	PC6	.344	.018	.344	18.847	.000
	PC7	-.216	.018	-.216	-11.857	.000

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: MARKET

RESOURCE: PERIOD 1 [a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t
1	(Constant)	.000	.021		.000
	PC1	.121	.022	.121	5.641
	PC2	.246	.022	.246	11.436
	PC3	-.184	.022	-.184	-8.566
	PC4	-.364	.022	-.364	-16.947
	PC5	.619	.022	.619	28.790
	PC6	.388	.022	.388	18.032
	PC7	-.218	.022	-.218	-10.145

a. R Square = 0.823 d stat = 2.049 F stat = 254

FINANCIALS: PERIOD 1 [a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t
1	(Constant)	.000	.017		.000
	PC1	.063	.017	.063	3.580
	PC2	.554	.017	.554	31.700
	PC3	-.118	.017	-.118	-6.745
	PC4	-.431	.017	-.431	-24.655
	PC5	.564	.017	.564	32.273
	PC6	.237	.017	.237	13.576

a. R Square = -0.883 d stat = 1.925 F stat = 482

NON-RESO/FIN: PERIOD 1. [a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t
1	(Constant)	.000	.016		.000
	PC1	.044	.016	.044	2.791
	PC2	.533	.016	.533	33.621
	PC3	-.183	.016	-.183	-11.517
	PC4	-.315	.016	-.315	-19.845
	PC5	.609	.016	.609	38.398
	PC6	.274	.016	.274	17.275
	PC7	-.200	.016	-.200	-12.636

a. R Square = 0.904 d stat = 1.884 F stat = 513

[40] All retained PC components are significant at the 0.01 level

Period 2

The estimated components matrix for Period 2 is presented in Table 4.5 (refer to the end of this section). Suitable names are given to the PC's on the same criteria as in Period 1. An interpretation of the first *eight* PC's follows, as they are the only PC's retained for the analysis of Period 2.

In Table 4.5, PC1, PC2, PC3, PC4, PC5, and PC 8 have names that applied in Period 1. However, it should be noted that the component loadings are different. This simply indicates that the unanticipated changes in the original macroeconomic factors during Period 2 were different to those in Period 1. An interpretation of the retained PC's follows.

PC1: (US/UK):	Weighted largely by US and UK equity market indexes, namely, the S&P 500 (USP), DJIA (UDJ) and the FTSE (UFT).
PC2 (Rand 1):	Weighted largely with factors that are directly or indirectly related to the rand. These heavily weighted factors are the rand-dollar exchange (URD), inflation (UINF), rand-gold price (URG), interest differential between SA and the US (UINTD) and domestic interest rates (UINT).
PC3 (Rand 2):	Weighted largely with factors that are directly or indirectly related to the rand. However, PC3 captures less of the variation than PC2 – subsequent PC's carry less of the total variation. Furthermore, inflation (UINF) features more prominently than oil prices (UDO) in PC1 compared to PC3, for PC3 it is the direct opposite.
PC4 (Inflation Expectations):	Weighted largely by adjustments in inflation expectations (AIE).
PC5 (Asia):	Weighted largely by the Nikkei index (UNI).
PC 6 (Dollar):	Weighted largely with factors that are dependent on the US dollar. These heavily weighted factors are the rand-dollar

	exchange (URD), dollar price of gold (UDG) and the dollar price of oil.
PC 7 (Inflation):	Weighted largely by the unanticipated changes in inflation (UINF).
PC8 (Market *Premia*):	Weighted largely by the domestic market *premia* (UMP).

For the market and resource sector the first six PC's are retained and used as independent variables in Equation 4.2. For the financial sector only the first three PC's are retained and used as independent variables in Equation 4.2. For the non-resource/financial sector the first eight PC's are retained and used as independent variables in Equation 4.2. In the analysis, it is found that the retained PC's were all statistically significant at the 1 percent level of probability for all the respective sectors. However, for the market, PC5 and PC6 are only statistically insignificant at the 5 percent level of probability. The OLS regression results for the three sectors and the ALSI are produced in Table 4.6 (refer to the end of this section).

Using Table 4.5 and Table 4.6 it is clear that PC1 (US/UK) had the greatest impact on market and sector returns. This is evident from the standardized coefficients and the corresponding *t* statistics in Table 4.6. In contrast to Period 1 where domestic systematic risk factors had the greatest impact, during Period 2 i.e. subsequent to the outbreak of the Asian financial crisis, market and sector returns were largely influenced by *international* systematic risk factors. Also significantly pervasive on market and sector returns is PC2 (Rand 1). This would be plausible as the rand was substantially volatile during this period as indicated in Figure 3.1 (see Chapter Three). In contrast to Period 1, when the rand was relatively stable, a relatively volatile rand had a major impact on market and sector returns, particularly on the resource sector during Period 2.

Table 4.5: Components matrix: Period 2

PC's\ K FACTORS	PC1: US/UK	PC2: RAND 1	PC3: RAND 2	PC4: INFLATION EXPECTATION	PC5: ASIA	PC6: DOLLAR	PC7: INFLATION	PC8: MARKET PREMIA	PC9	PC10	PC11	PC12
UMP	0.603	0.403	0.231	-0.286	0.053	0.016	-0.325	**0.459**	0.138	0.024	0.020	0.012
UDG	0.166	-0.550	0.396	-0.014	-0.073	**0.625**	-0.297	-0.159	0.012	0.035	-0.029	-0.024
URD	-0.370	0.135	**0.853**	0.035	0.088	**-0.308**	-0.092	-0.053	-0.037	-0.003	-0.005	-0.020
UNI	0.448	0.216	0.127	0.032	**0.813**	0.150	0.203	-0.076	0.068	-0.007	-0.010	0.002
UFT	**0.748**	0.350	0.156	0.169	-0.056	0.064	0.034	0.067	-0.503	-0.013	-0.011	0.004
UDO	-0.508	**0.566**	0.397	-0.104	-0150	**0.322**	0.255	0.068	0.028	-0.203	0.055	0.111
AIE	-0.222	-0.116	0.085	**0.925**	0.009	0.087	0.015	0.236	0.090	0.043	0.007	0.012
UINF	0.154	**-0.593**	0.479	-0.222	-0.150	0.059	**0.502**	0.192	0.017	0.168	-0.012	-0.045
UDJ	**0.789**	0.379	0.205	0.125	-0.248	-0.096	0.077	-0.155	0.185	0.008	-0.187	0.080
USP	**0.810**	0.365	0.181	0.156	-0.214	-0.029	0.070	-0.190	0.150	-0.016	0.191	-0.085
URG	-0.319	-0.010	**0.917**	0.024	0.068	-0.147	-0.142	-0.086	-0.032	0.015	0.000	-0.007
UINTD	0.433	**-0.852**	0.063	-0.001	0.058	-0.157	-0.056	-0.049	-0.022	0.032	0.106	0.191
UINT	-0.405	**0.829**	-0.101	-0.041	-0.012	0.120	-0.029	-0.102	-0.027	0.321	0.045	0.069
Eigen value	3.351	3.028	2.303	1.071	0.840	0.698	0.596	0.427	0.346	0.178	0.089	0.071
% Variance	25.776	23.293	17.718	8.240	6.463	5.371	4.585	3.281	2.659	1.3783	0.686	0.543
Cum. %	25.776	49.069	66.788	75.028	81.491	86.862	91.447	94.728	97.387	98.760	99.446	99.989

Table 4.6: OLS regression results: Period 2[41]

ALSI: PERIOD 2 ᵃ

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t
1	(Constant)	.000	.035		.000
	PC1	.593	.035	.593	17.141*
	PC2	.416	.035	.416	12.015*
	PC3	.235	.035	.235	6.800*
	PC4	-.286	.035	-.286	-8.273*
	PC5	.052	.035	.052	1.513
	PC6	.018	.035	.018	.521

a. R Square = 0.666 d stat = 1.805 F stat = 92

RESOURCE: PERIOD 2 ᵃ

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t
1	(Constant)	.000	.043		.000
	PC1	.473	.043	.473	10.999*
	PC2	.386	.043	.386	8.972*
	PC3	.247	.043	.247	5.751*
	PC4	-.130	.043	-.130	-3.026*
	PC5	.155	.043	.155	3.611*
	PC6	-.094	.043	-.094	-2.182**

a. R Square = 0.484 d stat = 1.829 F stat = 43

FINANCIALS: PERIOD 2 ᵃ

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t
1	(Constant)	.000	.038		.000
	PC1	.637	.038	.637	16.686*
	PC2	.377	.038	.377	9.885*
	PC3	.205	.038	.205	5.379*

a. R Square = 0.590 d stat = 1.727 F stat = 135

NON-RESO/FIN: PERIOD 2 ᵃ

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t
1	(Constant)	.000	.007		.000
	PC1	.690	.007	.690	93.151*
	PC2	.435	.007	.435	58.737*
	PC3	.166	.007	.166	22.453*
	PC4	-.284	.007	-.284	-38.290*
	PC5	.030	.007	.030	4.075*
	PC6	.069	.007	.069	9.338*
	PC7	-.293	.007	-.293	-39.502*
	PC8	.345	.007	.345	46.603*

a. R Square = 0.985 d stat = 2.004 F stat = 2241

[41]* denotes significance at the 0.01 level
** denotes s significance at the 0.05 level

CHAPTER 5: CONCLUSION

1. Introduction

The research paper has analysed the South African equity market and sector return-risk relationship during the period January 1990 to December 2002. The following basic questions pertaining to the South African equity market for the period January 1990 to December 2002 have been addressed: (1) how did equity prices behave; and (2) what were the fundamental factors that caused these price movements? The main findings of this paper are synthesized in this chapter. Furthermore, the utility of the research paper to interested groups; the research limitations and future research topics covered in this paper are provided in this concluding chapter.

2. The South African Equity Market and Sector Return-Risk Relationship (January 1990 – December 2002)

The research paper has provided an analysis of the South African equity market and sector return-risk relationship in terms of a literature review of past studies and an econometric analysis for the period January 1990 to December 2002. The literature review and the econometric analysis have addressed the following basic questions pertaining to the South African equity market for the period January 1990 to December 2002:

(1) How did equity prices behave?
(2) What were the fundamental factors that caused these price movements?

Addressing the two questions will provide an analysis of the South African equity market and sector return-risk relationship.

How did equity prices behave?

Over the thirteen-year period, January 1990 to December 2002, two contrasting sub-periods are identified, namely, Period 1 (January 1990 to June 1997) and Period 2 (July 1997 to December 2002). This structural break in South African equity price movements was subsequent to the outbreak of the Asian financial crisis on July 1997. During July 1997, the devaluation of the Thai Baht resulted in competitive currency devaluations amongst developing countries. Subsequently, investors became more risk-averse towards investments in developing countries. Period 1 is the pre-Asian financial crisis period and Period 2 is the post-Asian financial crisis period. During the post-Asian financial crisis period, the South African equity market was relatively more volatile than the pre-Asian financial crisis period. Consistent with new information (i.e. unanticipated changes) on macroeconomic factors having a pervasive effect on equity prices, equity prices reacted substantially to the following during Period 2:

1. The relatively 'more' new information/events that occurred during Period 2; or/and
2. The level of investors' 'surprise' from new information/events.

The noticeable events during Period 2 were the competitive currency devaluations between developing countries, the default on government loans by the Russian government, rand volatility and the events of September 11. It was further found that, in contrast to Period 1, weekly market price movements were relatively more volatile during Period 2. Consistent with Bayes' theory this indicated that during Period 2:

1. The *quantity* of new information being absorbed by the market, on a weekly basis, was substantially more than in Period 1; or/and
2. The *quality* i.e. the level of surprise, of new information being absorbed by the market, on a weekly basis, was substantially greater than in Period 1.

Furthermore, past studies, both South African and international, have documented abnormal price movements in equity markets. Over the thirteen-year period analysed, sporadic weekly abnormal returns were identified during 1992, 1995, 1997 and 2001 in certain sectors. This indicated:

1. Sector inefficiency: Sectors were either weak-form efficient or semi-strong efficient i.e. not all the available information was impounded into prices; or/and
2. Cognitive biases: Kahneman and Tversky (1974, 1979) suggest that decision-making in conditions of uncertainty is subject to cognitive biases. Behavioural finance theories suggest that individuals tend to take mental short cuts in processing and interpreting information. These "short cuts" result in cognitive biases in the way individuals process and interpret information, hence, a deviation from underlying economic fundamentals.

What were the fundamental factors that caused these price movements?

A literature review of past studies documenting the macroeconomic factors causing equity price movements is provided. In the literature, the following macroeconomic factors were consistently found to have a significant effect on global equity prices:

(1) A market index;
(2) Investor confidence;
(3) Interest rates;
(4) Inflation;
(5) Real business activity;
(6) Exchange rates; and
(7) Oil prices.

In addition to the above list of priced macroeconomic factors, and unique to gold/resource-reliant countries, such as South Africa, is the dollar price of gold. During the thirteen-year period, January 1990 to December 2002, a market index had the most significant effect on market and sector returns. However, the composition of this market index varied between Period 1 and Period 2. During Period 1 the market index was composed of *domestic* systematic risk, proxied by the ALSI. This signified that investors were looking 'inwards' or were more concerned about domestic fundamentals i.e. domestic financial stability. During this period, South Africa was in a period of socio-political transition for most of the latter period, and therefore investors 'looked inward' and monitored domestic indicators. Incidentally, price movements during Period 1 were relatively less volatile than during Period 2. During Period 2, the market index was composed of *foreign* systematic risk, as this index was significantly weighted by foreign stock indexes. This signified that investors were looking 'outwards' or were more concerned about global fundamentals i.e. global financial stability. During this period, global financial crisis and relatively volatile exchanges plagued international financial markets. It was further found that over the thirteen-year period a rand-dollar exchange index was pervasive on market and sector returns. However, the responsiveness of market and sector returns, to this rand-dollar exchange index, varied between Period 1 and Period 2. In contrast to Period 1 when the rand was relatively stable and had little impact on market sector returns, a volatile rand had a major impact on market and sector returns, particularly on the resource sector, during Period 2.

3. The Utility of the Research Paper

The utility of the research paper, to various interested groups is:

1. The research paper provides an analysis of the return-risk relationship of the South African equity market. Most research papers focus only on the risk side i.e. the macroeconomic identification of priced factors. In addition to the macroeconomic identification of priced factors for the South African equity market, the effect that these factors have on equity price movements is also analysed.
2. The estimated PC's provide risk indexes that identify the underlying fundamentals driving equity prices prior and subsequent to the Asian financial crisis. These risk indexes can be used in commercial practices.

4. Research Limitations

Due to the unavailability of information on other potential priced factors, the pre-selected macroeconomic factors are substantially less than previous studies.

5. Future Research

Possible future research topics/ideas:

1. Additional pre-selected macroeconomic factors can be introduced into the econometric analysis.
2. The psychological aspects of the South African equity market can be further analysed.
3. Excess volatility can be tested for the South African equity market.
4. A more precise identification of abnormal returns can be researched.

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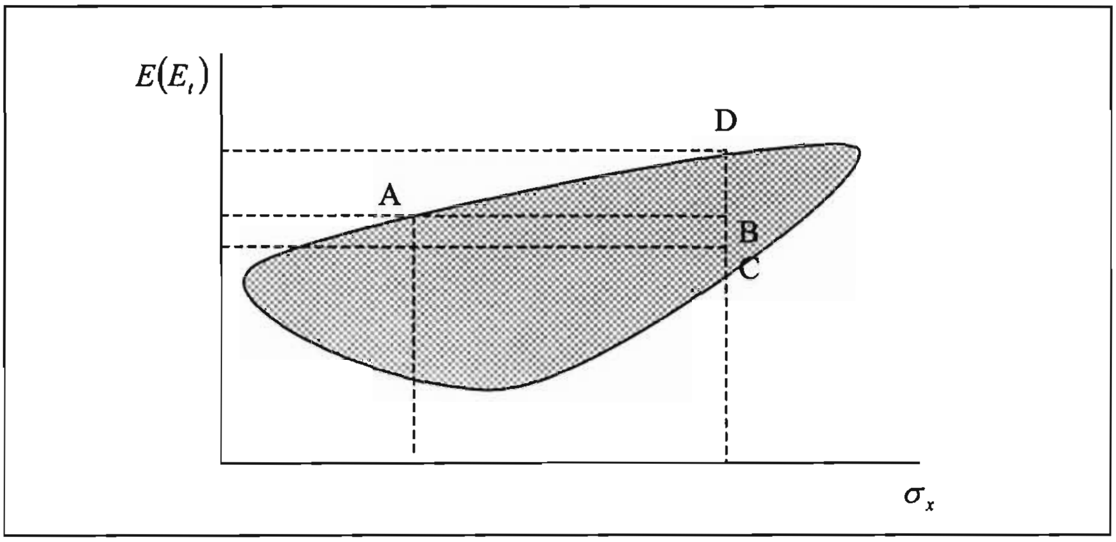
Appendix

Appendix 1: The Mean-variance model

The uncertainty in equity markets force individuals to form expectations of probable future returns based on the available information set. Essentially, the formation of expectations is a problem of probability inferences. The mean-variance model (MVM) describes an individual's preferences, illustrated by indifference curves, by only considering the first two moments of a probability distribution, namely: (1) it's mean or expected return; and (2) it's variance – the expected value of the squared deviation from the mean (Varian, 1990: 231-232). When determining the portfolio j that maximizes expected return with fixed probability beliefs, the individual has a choice of various portfolios j_n. Note that $j_n \sim ND(\mu, \sigma^2)$. Crucial to the MVM is that it assumes that the individual is risk-averse. This is indicated by a negatively sloping indifference curve. Given a set of all obtainable portfolios, the MVM asserts that the individual should select a portfolio that is efficient i.e. minimum variance for a given expected return (Markowitz, 1952: 77-79).

The potential optimal portfolios may be shown by an investment opportunity set. An investment opportunity set depicts all attainable combinations of risk and return offered by portfolios in the market (see Sharpe (1970)). A hypothetical investment opportunity set is provided in Figure 1. In Figure 1, the shaded area depicts the attainable portfolios in the market. Portfolios outside the shaded area are unattainable. Portfolios inside the shaded area, as depicted by portfolios B and C, are not optimal. This can be clearly seen, since an optimal portfolio is whereby the standard deviation, σ, is minimized for a given expected return $E(R_t)$. Portfolio B's standard deviation is clearly not minimized – portfolio A has a smaller standard deviation (note that portfolio A lies on the boundary of the shaded area). Similarly, an optimal portfolio is whereby $E(R_t)$ is maximized for a given σ. Portfolio B and C's expected return is clearly not maximized – portfolio D has a higher expected return (note that portfolio D lies on the boundary of the shaded area).

Figure 1: **Hypothetical investment opportunity set**



It therefore follows that optimal portfolios lie on the northwest border of the investment opportunity set i.e. maximum expected return towards the north of the diagram, and minimum standard deviation to the west of the diagram (see Sharpe (1970)). The MVM is a theorem for optimal portfolio selection under uncertainty.

According to Sharpe (1970: 55-56), the optimisation problem includes:

1. *One or more decision variables*: These are the proportions invested in various assets.
2. *One or more constraints*: Most of the constraints inherent in investing are placed by the individual or by the market in which the individual operates such as the capital available for investing.
3. *An objective to be maximized or minimized*: This is the objective of portfolio theory, which is to find the optimal portfolio. The MVM does so by minimizing variance (i.e. systematic risk) for a given expected return.

Appendix 2.a: Chow test – test for structural change

The Chow test, which is essentially an F-test, is formulated by the following ratio (see Gujarati, 2003: 276):

$$\hat{F} = \frac{(RSS_R - RSS_{UR})/k}{RSS_{UR}/(n_1 + n_2 - 2k)} \sim F_{[k,(n_1+n_2-2k)]}$$

The estimated F value for the research is estimated as follows:

1. Equation 3.1 is estimated using the data set for Period 0 (January 1990 – December 2002) and applying OLS. The restricted residual sum of squares (RSS_R) is estimated with $DF = (n_1 + n_2 - k)$, where k is the number of parameters estimated, n_1 and n_2 are the number of observations in Period 1 and Period 2, respectively. The estimated variables are:

   $RSS_R = 377\ 528\ 954$

   $k = 2$

   $n_1 = 389$

   $n_2 = 285$

2. Equation 3.1 is estimated again but using the data set for Period 1 only. The residual sum of squares (RSS_1) is estimated with $DF = (n_1 - k)$. The estimated variables are:

   $RSS_1 = 82\ 847\ 017$

   DF = 389

3. Equation 3.1 is now estimated using the data set for Period 2. The residual sum of squares (RSS_2) is estimated with, $DF = (n_2 - k)$. The estimated variables are

   $RSS_2 = 229\ 349\ 330$

   DF = 287

4. The unrestricted residual sum of squares (RSS_{UR}) is estimated as:

   $RSS_{UR} = RSS_1 + RSS_2 = 312\ 196\ 347$

5. Substituting the appropriate values into the F ratio, the estimated F value is $\hat{F} = 70.5$

Appendix 2.b: Test for volatility differential

A similar procedure to the Chow test is used and is formulated by the following ratio

$$\hat{F} = \frac{(VAR_R - VAR_{UR})/k}{VAR_{UR}/(n_1 + n_2 - 2k)} \sim F_{[k,(n_1+n_2-2k)]}$$

The estimated F value for this test is estimated as follows:

1. Equation 3.1 is estimated using the data set for Period 0 and applying OLS. The restricted variance (VAR_R) is estimated with $DF = (n_1 + n_2 - k)$. (VAR_R) is estimated as:

   VAR_R= 5 060 295.2

2. Equation 3.1 is again estimated but using only the data set for Period 1. The variance (VAR_1) is estimated with $DF = (n_1 - k)$. The estimated variables are:

   VAR_1= 2 216 524.4

   DF = 389

3. Equation 3.1 is now estimated using the data set for Period 2. The variance (VAR_2) is estimated with $DF = (n_2 - k)$. The estimated variables are

   VAR_2= 2 375 544

   DF = 287

4. The unrestricted variance (VAR_{UR}) is estimated as:

   $VAR_{UR} = VAR_1 + VAR_2$

5. Substituting the appropriate values in to the F ratio, the estimated F value is $\hat{F} = 34.36$

Appendix 2.c: Bayes' theory

The assumption that individuals *correctly* process and interpret information is the assumption that individuals are consistent with Bayes' theorem. It is well established that Bayes' theory is "the formally optimal rule about how opinions (that is, probabilities) should be revised on the basis of new information" (Kahneman *et al*, 1982: 356). It is often neglected that when forming expectations it is essentially a problem of probability inferences. For instance, if an individual wants to form expectations of tomorrows share price, the individual is essentially determining the probability of whether:

H_A : Prices will increase by x; or

H_B : Prices will decrease by y

H_A and H_B are both mutually exclusive and random events. To anticipate whether H_A or H_B will occur, individuals have pertinent information on which to produce probabilities of H_A and H_B occurring. The process in which individuals estimate the probability of either H_A or H_B occurring assumed to be consistent with Bayes' theory. Bayes' theory is given as:[42]

$$\pi(H_A \mid D) = \frac{\pi(D \mid H_A) * \pi(H_A)}{\pi(D)} \quad (1)$$

Equation 1 is the conditional probability that H_A occurs conditional to event D occurring. Similarly, the conditional probability that H_B occurs conditional to event D occurring is:

$$\pi(H_B \mid D) = \frac{\pi(D \mid H_B) * \pi(H_B)}{\pi(D)} \quad (2)$$

$\pi(H_A \mid D)$ and $\pi(H_B \mid D)$ are formally known as the posterior probability of, respectively, H_A and H_B occurring. $\pi(D \mid H_A)$ and $\pi(D \mid H_B)$ is formally known as the likelihood probability of, respectively, H_A and H_B occurring, and $\pi(H_A)$ and $\pi(H_B)$ is the prior probability of, respectively, H_A and H_B occurring (Kahneman *et al*, 1982: 360). For ease of understanding, posterior probabilities can be seen as the revised probabilities, whereby 'past' information and 'new' information have been impounded. Likelihood probabilities can be seen as the 'new' information whereas prior probabilities can be seen as the 'past' information. To determine the most likely event of either H_A or H_B occurring, the individual estimates the odds-likelihood ratio.

[42] See Kahneman et al (1982: 359-360)

Dividing Equation 1 by Equation 2 the following odds-likelihood ratio in favour of H_A is estimated:

$$\frac{\pi(H_A \mid D)}{\pi(H_B \mid D)} = \frac{\pi(D \mid H_A) * \pi(H_A)}{\pi(D \mid H_B) * \pi(H_B)}$$

or

$$\Omega_1 = L * \Omega_0 \qquad (3)$$

Ω_1 is the posterior odds in favour of H_A over H_B, Ω_0 is the prior odds ratio and L is likelihood function (Kahneman *et al*, 1982: 360). Two crucial assertions are implicit in Bayes' theorem:

1 Prior probabilities and likelihood probabilities both have an equal weighting on an individual's posterior probabilities.

2 The *greater* the quantity or quality/level of surprise of new information, the more the posterior probability distribution will resemble the likelihood probability distribution. The lesser the quantity or quality/level of surprise of new information, the more the posterior probability distribution will resemble the prior probability distribution. Hence, sample size has a major effect on the posterior probability distribution.

(Hirshleifer and Riley, 1992: 177)

Appendix 2.d: Excess volatility, seasonal returns and speculative bubbles

Excess Volatility

Excess volatility is the price movements in speculative assets, which are in excess to what is predicted by underlying fundamentals. The excess volatility in equity markets was first documented by Shiller (1981) and independently supported by Leroy & Porter (1981) and later by West (1988). In their study of equity price movements, the latter authors compared actual equity prices with *ex post* prices. *Ex post* prices are prices determined for some date in the *past*, hence, the actual values of the factors affecting prices are known. In comparing actual prices with *ex post* prices, the latter authors determined whether underlying fundamentals *always* provided complete causation to equity price movements.[43] The authors found that the variability in speculative prices, particularly in equity markets were "too large to be justified...given the relatively low variability in economic fundamentals and given the correlation of price with fundamentals" (Shiller, 1999: 2). According to DeBondt (1996), Shiller's (1981) findings (and that of Leroy and Porter (1981) and West (1988)) imply two important facts: (1) it indicates that equity prices are too volatile; and (2) factors other than new information play a major role in equity price determination.

Seasonal Anomalies

Below is a partial-list of the seasonal anomalies that have been documented:

1. The size effect: The tendency of average returns on small capitalization firms to outperform the market portfolio (e.g. Musto (1997) and Sias and Starks (1997)).
2. The weekend effect: The tendency of average equity returns to be higher on Fridays and negative on Mondays (e.g. Cross (1973) and Wong, Li and Erickson (1997).
3. The January effect: The tendency of average equity returns to be higher on January in comparison to other months of the year (e.g. Debondt and Thaler (1985) and Thaler 1987)).

Speculative Bubbles

A speculative bubble

> "...is a way of characterizing periods at various times and in various countries when the combination of...economic fundamentals [and] investor confidence pushes the prices of stocks...far beyond traditionally prevailing standards of value." (Dreman, 1977: 47)

[43] Forecast errors were taken into consideration

It is well documented that during the Dutch tulip craze, the South Sea Bubble, the biotechnology bubble, and more recently, the information technology bubble, prices exaggerated their true economic worth[44].

It is apparent that excess volatility, seasonal returns and speculative bubbles are synonymous with abnormal returns.

[44] See Malkiel (1990) and Dreman (1977) for a concise account of these speculative bubbles

Appendix 3.a: Method to calculate the dependent variables

The original data set for the dependent variables were in index price-form. For the econometric analysis the data set is required to be in market and sector returns in excess of the risk free rate, hence, market and sector *premia's*. Firstly, market and sector index prices need to be converted into returns. To convert market and sector price indexes into return-form, $E(R_{jt})$, the following method is employed:

$$E(R_{jt}) = \frac{P_t - P_{t-1}}{P_{t-1}}$$

P_t is the index price at date t and P_{t-1} is the index price one period before. It should be noted that P_t and P_{t-1} are weekly prices, hence, the above returns are weekly returns. Secondly, the real risk-free rate has to be converted into weekly figures, as they are expressed as an annual rate. The following method is employed:

$$R_f = BA_t^{1/52}$$

R_f is the weekly real risk free-rate, BA_t is the annualised three-month banker's acceptance rate and is the proxy for the real risk-free rate. Lastly, to obtain the market and sector *premia's* the following method is employed:

$$Y_t = E(R_{jt}) - R_f$$

Appendix 3.b: Methods to calculate the pre-selected macroeconomic factors

It should be noted that with the exception of AIE_t the pre-selected K factors are deviations from their means.

1. UMP_t: Unanticipated changes in the market *premia*

Given:

$$Y_t = E(R_{jt}) - R_f$$

Y_t is the market *premia* at date t. The average or mean of Y_t is estimated as:

$$Y_{average} = \sum_{t=0}^{T} Y_t / T \qquad (1)$$

T is the number of periods/observations. Hence, UMP_t is estimated as:

$$UMP_t = Y_t - Y_{average}$$

2. UDG_t : Unanticipated changes in the dollar price of gold

Given Equation 1, Y_t in this instance, is the dollar price of gold at date t, hence, UDG_t is estimated as:

$$UDG_t = Y_t - Y_{average}$$

3. URG_t : Unanticipated changes in the rand gold price

Given Equation 1, Y_t in this instance, is the rand gold price at date t, hence, URG_t is estimated as:

$$URG_t = Y_t - Y_{average}$$

4. URD_t : Unanticipated changes in the rand/dollar exchange

Given Equation 1, Y_t in this instance, is the rand/dollar exchange of gold at date t, hence URD_t is estimated as:

$$URG_t = Y_t - Y_{average}$$

5. UDO_t : Unanticipated changes in the dollar oil price

Given Equation 1, Y_t in this instance, is the dollar price of oil at date t, hence, UDO_t is estimated as:

$$UDO_t = Y_t - Y_{average}$$

6. $UINT_t$: Unanticipated changes in the yield curve

The yield curve is, essentially, the difference between the yields on long-term and short-term bonds. The proxy for the yields on long-term bonds is the R150 and for short-term yields it is the BA rate. Hence, the yield curve is given as:

$$INT_t = R150_t - BA_t$$

INT_t is the yield at date *t*, $R150_t$ is the yield on the R150 at date *t*. Given Equation 1, Y_t in this instance, is the yield curve at date *t*, hence, $UINT_t$ is estimated as:

$$UINT_t = Y_t - Y_{average}$$

7. $UINTD_t$: Unanticipated changes in the interest differential between South Africa and the US

Interest differentials are essentially the difference between the yields of bonds with the same maturity date. The yields used are the Prime rates of the two respective countries. The interest differential is given as:

$$INTD_t = SA_t - US_t$$

$UINTD_t$ is the interest differential at date *t*, SA_t is the South African prime rate and US_t is the US prime rate at date *t*. Given Equation 1, Y_t in this instance, is the interest differential at date *t*, hence, $UINTD_t$ is estimated as:

$$UINTD_t = Y_t - Y_{average}$$

8. AIE_t: Adjustments to inflation expectations

This is calculated as:

$$AIE_t = BA_t - BA_{t-1}$$

9. $UINF_t$: Unanticipated changes in inflation

Given Equation 1, Y_t in this instance, is the CPI at date *t*, hence, $UINF_t$ is estimated as:

$$UINF_t = Y_t - Y_{average}$$

10. UDJ_t: Unanticipated changes in the returns on the Dow Jones Industrial Average

Given Equation 1, Y_t in this instance, is the return on the DJIA at date *t*, hence, UDJ_t is estimated as:

$$UDJ_t = Y_t - Y_{average}$$

11. UNI_t: Unanticipated changes in the returns on the Nikkei Average

Given Equation 1, Y_t in this instance, is the return on the Nikkei at date *t*, hence, UNI_t is estimated as:

$$UDJ_t = Y_t - Y_{average}$$

12. UFT_t: Unanticipated changes in the returns on the FTSE

Given Equation 1, Y_t in this instance, is the return on the FTSE at date *t*, hence, UFT_t is estimated as:

$$UFT_t = Y_t - Y_{average}$$

13. USP_t: Unanticipated changes in the returns on the S&P 500

Given Equation 1, Y_t in this instance, is the return on the S&P 500 at date *t*, hence, USP_t is estimated as:

$$USP_t = Y_t - Y_{average}$$

Appendix 4.a: PCA Results (Period 1)

Correlation Matrix

		UMP	UDG	URD	UNI	UFT	UDO	AIE	UINF	UDJ	USP	URG	UINTD	UINT
Correlation	UMP	1.000	-.004	.022	.183	.297	-.137	-.097	-.064	.109	.154	.019	-.035	.006
	UDG	-.004	1.000	.174	-.076	-.088	.014	.185	-.376	-.053	-.082	.423	-.533	-.002
	URD	.022	.174	1.000	.052	.051	-.169	.151	-.803	.090	.083	.965	-.227	.177
	UNI	.183	-.076	.052	1.000	.275	-.091	-.052	-.092	.268	.321	.031	-.033	.040
	UFT	.297	-.088	.051	.275	1.000	-.038	-.062	-.033	.347	.459	.026	.024	-.003
	UDO	-.137	.014	-.169	-.091	-.038	1.000	-.021	.304	-.076	-.067	-.163	.360	-.443
	AIE	-.097	.185	.151	-.052	-.062	-.021	1.000	-.162	.007	.019	.192	-.203	.096
	UINF	-.064	-.376	-.803	-.092	-.033	.304	-.162	1.000	-.049	-.033	-.845	.555	-.382
	UDJ	.109	-.053	.090	.268	.347	-.076	.007	-.049	1.000	.765	.071	-.004	-.015
	USP	.154	-.082	.083	.321	.459	-.067	.019	-.033	.765	1.000	.057	.006	-.021
	URG	.019	.423	.965	.031	.026	-.163	.192	-.845	.071	.057	1.000	-.351	.180
	UINTD	-.035	-.533	-.227	-.033	.024	.360	-.203	.555	-.004	.006	-.351	1.000	-.630
	UINT	.006	-.002	.177	.040	-.003	-.443	.096	-.382	-.015	-.021	.180	-.630	1.000

Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings		
PC	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.561	27.393	27.393	3.561	27.393	27.393
2	2.392	18.400	45.793	2.392	18.400	45.793
3	1.521	11.700	57.493	1.521	11.700	57.493
4	1.154	8.876	66.370	1.154	8.876	66.370
5	1.036	7.970	74.340	1.036	7.970	74.340
6	.827	6.364	80.704	.827	6.364	80.704
7	.781	6.011	86.714	.781	6.011	86.714
8	.652	5.013	91.727	.652	5.013	91.727
9	.533	4.104	95.831	.533	4.104	95.831
10	.222	1.711	97.542	.222	1.711	97.542
11	.191	1.473	99.015	.191	1.473	99.015
12	.127	.979	99.994	.127	.979	99.994
13	.001	.006	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix [a]

	Component											
	PC1: Rand	PC2: US/Europe	PC3: Monetary	PC4: Gold	PC5: Market Premia	PC6: Inflation Expectations	PC7: Asian	PC8: Europe	PC9: Oil	PC10: US	PC11: Interest Rates	PC12: Inflation
UMP	.088	.387	-.161	-.359	.628	.345	-.217	-.226	.276	.001	.011	.004
UDG	.485	-.262	.150	.452	.567	-.265	.006	-.103	-.172	.011	.182	-.064
URD	.806	.012	.436	-.306	-.204	.064	-.024	.016	.037	-.008	.050	.125
UNI	.116	.549	-.096	-.103	.097	.017	.803	-.093	-.022	.017	.025	.011
UFT	.076	.692	-.003	-.064	.223	.144	-.126	.560	-.330	.062	-.003	.003
UDO	-.421	-.096	.600	.207	.195	-.066	.146	.374	.453	.003	-.020	-.006
AIE	.278	-.137	.086	.584	-.137	.728	.069	-.043	-.020	.016	-.003	-.012
UINF	-.919	.056	-.124	.157	.019	.037	-.032	-.030	-.035	-.007	.209	.251
UDJ	.135	.784	.083	.317	-.205	-.196	-.166	-.191	.136	.310	-.014	.006
USP	.123	.846	.074	.285	-.150	-.111	-.130	-.070	.069	-.347	.020	-.025
URG	.876	-.055	.428	-.162	-.046	-.007	-.019	-.010	-.012	-.003	.105	.078
UINTD	-.700	.153	.468	-.309	-.208	.162	-.027	-.103	-.088	.031	.220	-.182
UINT	.509	-.074	-.689	-.014	-.228	-.004	.003	.270	.282	.020	.225	-.066

Extraction Method: Principal Component Analysis.

a. 12 components extracted.

Appendix 4.b: PCA Results (Period 2)

Correlation Matrix

		UMP	UDG	URD	UNI	UFT	UDO	AIE	UINF	UDJ	USP	URG	UINTD	UINT
Correlation	UMP	1.000	.005	.018	.331	.528	-.009	-.306	-.049	.552	.534	.012	-.069	.048
	UDG	.005	1.000	.039	-.007	.008	-.122	.062	.421	-.032	.008	.274	.481	-.455
	URD	.018	.039	1.000	-.019	-.104	.457	.128	.176	-.060	-.101	.970	-.164	.143
	UNI	.331	-.007	-.019	1.000	.367	-.082	-.073	-.031	.291	.329	-.020	.031	-.011
	UFT	.528	.008	-.104	.367	1.000	-.107	-.062	-.024	.685	.710	-.103	.027	-.026
	UDO	-.009	-.122	.457	-.082	-.107	1.000	.026	-.058	-.100	-.113	.414	-.734	.609
	AIE	-.306	.062	.128	-.073	-.062	.026	1.000	-.065	-.115	-.097	.136	-.016	-.054
	UINF	-.049	.421	.176	-.031	-.024	-.058	-.065	1.000	.010	-.010	.286	.542	-.569
	UDJ	.552	-.032	-.060	.291	.685	-.100	-.115	.010	1.000	.910	-.071	.027	-.031
	USP	.534	.008	-.101	.329	.710	-.113	-.097	-.010	.910	1.000	-.100	.049	-.041
	URG	.012	.274	.970	-.020	-.103	.414	.136	.286	-.071	-.100	1.000	-.033	.028
	UINTD	-.069	.481	-.164	.031	.027	-.734	-.016	.542	.027	.049	-.033	1.000	-.872
	UINT	.048	-.455	.143	-.011	-.026	.609	-.054	-.569	-.031	-.041	.028	-.872	1.000

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.351	25.776	25.776	3.351	25.776	25.776
2	3.028	23.293	49.069	3.028	23.293	49.069
3	2.303	17.718	66.788	2.303	17.718	66.788
4	1.071	8.240	75.028	1.071	8.240	75.028
5	.840	6.463	81.491	.840	6.463	81.491
6	.698	5.371	86.862	.698	5.371	86.862
7	.596	4.585	91.447	.596	4.585	91.447
8	.427	3.281	94.728	.427	3.281	94.728
9	.346	2.659	97.387	.346	2.659	97.387
10	.178	1.373	98.760	.178	1.373	98.760
11	.089	.686	99.446	.089	.686	99.446
12	.071	.543	99.989	.071	.543	99.989
13	.001	.011	100.000			

Extraction Method: Principal Component Analysis.

Component Matrix [a]

	Component											
	PC1: International	PC2: Interest Rates	PC3: Resource	PC4: Inflation Expectations	PC5: Asian	PC6: Dollar Gold	PC7: Inflation	PC8: Market Premia	PC9: Europe	PC10: Interest Rates	PC11: US	PC12: Interest Differential
UMP	.603	.403	.231	-.286	.053	.016	-.325	.459	.138	.024	.020	.012
UDG	.166	-.550	.396	-.014	-.073	.625	-.297	-.159	.012	.035	-.029	-.024
URD	-.370	.135	.853	.035	.088	-.308	-.092	-.053	-.037	-.003	-.005	-.020
UNI	.448	.216	.127	.032	.813	.150	.203	-.076	.068	-.007	-.010	.002
UFT	.748	.350	.156	.169	-.056	.064	.034	.067	-.503	-.013	-.011	.004
UDO	-.508	.566	.397	-.104	-.150	.322	.255	.068	.028	-.203	.055	.111
AIE	-.222	-.116	.085	.925	.009	.087	.015	.236	.090	.043	.007	.012
UINF	.154	-.593	.479	-.222	-.150	.059	.502	.192	.017	.168	-.012	-.045
UDJ	.789	.379	.205	.125	-.248	-.096	.077	-.155	.185	.008	-.187	.080
USP	.810	.365	.181	.156	-.214	-.029	.070	-.190	.150	-.016	.191	-.085
URG	-.319	-.010	.917	.024	.068	-.147	-.142	-.086	-.032	.015	.000	-.007
UINTD	.433	-.852	.063	-.001	.058	-.157	-.056	-.049	-.022	.032	.106	.191
UINT	-.405	.829	-.101	-.041	-.012	.120	-.029	-.102	-.027	.321	.045	.069

Extraction Method: Principal Component Analysis.

a. 12 components extracted.

Appendix 5.a: Complete OLS Regression Results (Period 1)

1. Regression: Market

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.934[a]	.873	.870	.360	2.027

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6, PC7

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: MARKET

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	339.493	7	48.499	374.226	.000[a]
	Residual	49.507	382	.130		
	Total	389.000	389			

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6, PC7

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: MARKET

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.000	.018		.000	1.000
	PC1	.101	.018	.101	5.529	.000
	PC2	.385	.018	.385	21.107	.000
	PC3	-.175	.018	-.175	-9.577	.000
	PC4	-.361	.018	-.361	-19.786	.000
	PC5	.623	.018	.623	34.124	.000
	PC6	.344	.018	.344	18.847	.000
	PC7	-.216	.018	-.216	-11.857	.000

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: MARKET

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-4.058	2.772	.000	.934	390
Residual	-1.805	1.125	.000	.357	390
Std. Predicted Value	-4.344	2.967	.000	1.000	390
Std. Residual	-5.014	3.126	.000	.991	390

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: MARKET

2. Regression: Resource Sector

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.907[a]	.823	.820	.424	2.049

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6, PC7

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: RESOURCE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	320.271	7	45.753	254.300	.000[a]
	Residual	68.729	382	.180		
	Total	389.000	389			

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6, PC7

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: RESOURCE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.000	.021		.000	1.000
	PC1	.121	.022	.121	5.641	.000
	PC2	.246	.022	.246	11.436	.000
	PC3	-.184	.022	-.184	-8.566	.000
	PC4	-.364	.022	-.364	-16.947	.000
	PC5	.619	.022	.619	28.790	.000
	PC6	.388	.022	.388	18.032	.000
	PC7	-.218	.022	-.218	-10.145	.000

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: RESOURCE

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-3.491	2.750	0	.907	390
Residual	-2.031	1.321	0	.420	390
Std. Predicted Value	-3.848	3.031	0	1.000	390
Std. Residual	-4.788	3.114	0	.991	390

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: RESOURCE

3. Regression: Financial Sector

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.940[a]	.883	.881	.344	1.925

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: FINANCIALS

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	343.577	6	57.263	482.829	.000[a]
	Residual	45.423	383	.119		
	Total	389.000	389			

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: FINANCIALS

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.000	.017		.000	1.000
	PC1	.063	.017	.063	3.580	.000
	PC2	.554	.017	.554	31.700	.000
	PC3	-.118	.017	-.118	-6.745	.000
	PC4	-.431	.017	-.431	-24.655	.000
	PC5	.564	.017	.564	32.273	.000
	PC6	.237	.017	.237	13.576	.000

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: FINANCIALS

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-4.837	2.867	.000	.940	390
Residual	-1.272	1.236	.000	.342	390
Std. Predicted Value	-5.147	3.051	.000	1.000	390
Std. Residual	-3.694	3.588	.000	.992	390

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: FINANCIALS

4. Regression: Non-Resource/Financial Sector

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.951[a]	.904	.902	.313	1.884

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6, PC7

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: NON-RESOURCE/FINANCIALS

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	351.656	7	50.237	513.880	.000[a]
	Residual	37.344	382	.098		
	Total	389.000	389			

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6, PC7

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: NON-RESOURCE/FINANCIALS

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.000	.016		.000	1.000
	PC1	.044	.016	.044	2.791	.006
	PC2	.533	.016	.533	33.621	.000
	PC3	-.183	.016	-.183	-11.517	.000
	PC4	-.315	.016	-.315	-19.845	.000
	PC5	.609	.016	.609	38.398	.000
	PC6	.274	.016	.274	17.275	.000
	PC7	-.200	.016	-.200	-12.636	.000

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: NON-RESOURCE/FINANCIALS

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-4.500	2.682	.000	.951	390
Residual	-1.556	.925	.000	.310	390
Std. Predicted Value	-4.733	2.820	.000	1.000	390
Std. Residual	-4.975	2.957	.000	.991	390

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: NON-RESOURCE/FINANCIALS

Appendix 5.b: Complete OLS Regression Results (Period 2)

1. Regression: Market

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.816[a]	.666	.658	.584	1.805

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: MARKET

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	189.712	6	31.619	92.579	.000[a]
	Residual	95.288	279	.342		
	Total	285.000	285			

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: MARKET

Coefficients[a]

		Unstandardized Coefficients		Standardized Coefficients		
Model		B	Std. Error	Beta	t	Sig.
1	(Constant)	.000	.035		.000	1.000
	PC1	.593	.035	.593	17.141	.000
	PC2	.416	.035	.416	12.015	.000
	PC3	.235	.035	.235	6.801	.000
	PC4	-.286	.035	-.286	-8.274	.000
	PC5	.052	.035	.052	1.514	.131
	PC6	.018	.035	.018	.521	.603

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: MARKET

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-4.913	2.659	-4.913	2.659	.000
Residual	-2.393	1.609	-2.393	1.609	.000
Std. Predicted Value	-6.021	3.259	-6.021	3.259	.000
Std. Residual	-4.095	2.752	-4.095	2.752	.000

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: MARKET

2. Regression: Resource Sector

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.696[a]	.484	.473	.726	1.829

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: RESOURCE

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	137.899	6	22.983	43.591	.000[a]
	Residual	147.101	279	.527		
	Total	285.000	285			

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: RESOURCE

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.000	.043		.000	1.000
	PC1	.473	.043	.473	11.000	.000
	PC2	.386	.043	.386	8.972	.000
	PC3	.247	.043	.247	5.751	.000
	PC4	-.130	.043	-.130	-3.026	.003
	PC5	.155	.043	.155	3.612	.000
	PC6	-.094	.043	-.094	-2.183	.030

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: RESOURCE

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-3.523	2.196	0	.696	286
Residual	-3.128	2.524	0	.718	286
Std. Predicted Value	-5.065	3.158	0	1.000	286
Std. Residual	-4.307	3.476	0	.989	286

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: RESOURCE

3. Regression: Financial Sector

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.768[a]	.590	.585	.644	1.727

a. Predictors: (Constant), PC1, PC2, PC3

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: FINANCIALS

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	168.032	3	56.011	135.036	.000[a]
	Residual	116.968	282	.415		
	Total	285.000	285			

a. Predictors: (Constant), PC1, PC2, PC3

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: FINANCIALS

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.000	.038		.000	1.000
	PC1	.637	.038	.637	16.687	.000
	PC2	.377	.038	.377	9.885	.000
	PC3	.205	.038	.205	5.379	.000

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: FINANCIALS

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-3.072	2.712	.000	.768	286
Residual	-3.469	1.625	.000	.641	286
Std. Predicted Value	-4.001	3.531	.000	1.000	286
Std. Residual	-5.386	2.523	.000	.995	286

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: FINANCIALS

4. Regression: Non-Resource/Financial Sector

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.992[a]	.985	.984	.125	2.004

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: NON-RESOURCE/FINANCIALS

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	280.665	8	35.083	2241.725	.000[a]
	Residual	4.335	277	.016		
	Total	285.000	285			

a. Predictors: (Constant), PC1, PC2, PC3, PC4, PC5, PC6, PC7, PC8

b. Dependent Variable: STANDARDIZED PREDICTED VALUE: NON-RESOURCE/FINANCIALS

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.000	.007		.000	1.000
	PC1	.690	.007	.690	93.152	.000
	PC2	.435	.007	.435	58.737	.000
	PC3	.166	.007	.166	22.453	.000
	PC4	-.284	.007	-.284	-38.290	.000
	PC5	.030	.007	.030	4.075	.000
	PC6	.069	.007	.069	9.338	.000
	PC7	-.293	.007	-.293	-39.503	.000
	PC8	.345	.007	.345	46.604	.000

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: NON-RESOURCE/FINANCIALS

Residuals Statistics[a]

	Minimum	Maximum	Mean	Std. Deviation	N
Predicted Value	-5.622	3.663	.000	.992	286
Residual	-.373	.372	.000	.123	286
Std. Predicted Value	-5.665	3.692	.000	1.000	286
Std. Residual	-2.982	2.977	.000	.986	286

a. Dependent Variable: STANDARDIZED PREDICTED VALUE: NON-RESOURCE/FINANCIALS