A Portfolio Analysis based on the Leverage effect of Exchange Rates on JSE stocks

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Abstract

Given the historical volatility of the South African Rand (ZAR), it is important for investors to consider the impact exchange rate movements have on stock valuations and portfolios' returns. This research paper sets out to determine whether domestic investors, constrained by capital controls, can minimise the adverse effects of a volatile ZAR by constructing stock portfolios based on three classifications. Stocks are defined as either hedge, leverage or play, according to the currency denomination of revenues earned and costs incurred by the company. Beta coefficients are estimated for the three groups and expected returns are calculated for the different investors, which are predetermined by their future exchange rate expectations vis-à-vis purchasing power parity (PPP). Portfolios differ by the weights assigned to the three stock groups within each portfolio and the weights of these constituents are obtained by Markowitz portfolio analysis. If the constructed portfolios' returns are greater than the benchmark's return once back-tested, a superior investment strategy is established. The portfolios' realised returns outperform the benchmark with varying degrees of success and imply the relative success with which an investor can protect his investment and outperform the market ultimately depends on the accuracy of the investor's exchange rate predictions.

Introduction

The South African Rand (ZAR) has been exceptionally volatile since the end of the 1970s, both in real and nominal terms. Political turmoil has undeniably affected the South African economy through exchange rate movements, which have had a resounding influence on the value of shares traded on the Johannesburg Stock Exchange (JSE). Given its dependency on resource production and its openness to international trade, South Africa is especially susceptible to exchange rate volatility. Political instability, as well as external shocks, have caused capital flight in the past and left the value of the ZAR weak, as shown by a capital account deficit. Although ZAR weakness adversely affects South African consumers by reducing their purchasing power, it is able to provide benefits for the economy and its asset market. Export producers earn additional profits when South Africa's international competitiveness increases due to a depreciated ZAR value; these events are subsequently reflected in the value of stocks traded on the JSE.

The JSE All Share index (ALSI), which is a market value weighted index of all stocks traded on the JSE, tends to react favourably to ZAR weakness whilst a strong ZAR causes it to deteriorate in value (Barr & Kantor, 2005). With more than half of its market capitalisation comprised of resource stocks and exports being predominantly resource based, South Africa plays an important role in global commodity markets along with other resource rich countries such as Argentina, Australia, Brazil, Canada, China, India and Russia. Consequently, the price of resources heavily influence company earnings, as well as the share market valuations on the JSE. The value of the ZAR and in particular the ZAR/USD exchange rate, therefore have a large impact on the performance of the JSE's different sectors (Kantor & Heese, 2002).

JSE investors are also affected by exchange rate movements, since these movements will ultimately affect the rate of return of their portfolios, through dividend and share price changes. The extent to which investors are affected will be largely determined by the constituents of the portfolio they hold, the sensitivity of individual shares to exchange rate changes and the approach taken when constructing their portfolio. Therefore, it is important to consider how ZAR value changes affect the rate of return of investors' portfolios, as well as ascertain ways in which the adverse effects of a volatile exchange rate can be minimised.

Most studies regarding JSE stock valuations have focused on the different sectors of the JSE (Resources, Industrials, Financials, Retail and Technology) and how macro economic changes, including exchange rate changes, impact the stocks in these sectors. This paper presents a relatively new method with which to classify JSE stocks, following the work of Barr & Kantor (2005). In their approach companies are defined as either rand hedge, rand leverage or rand play stocks, according to the currency denomination of revenue earned and costs incurred by the company. This stock classification allows one to better analyse the direct impact exchange rate movements may have on share prices.

Rand plays are defined as stocks listed on the JSE by companies with ZAR costs and ZAR revenues, whilst companies that incur ZAR denominated costs but earn foreign revenue (i.e. USD) are classified as rand leverage stocks. The third category of stocks considered are rand hedge stocks, which are companies with costs and revenues predominantly in foreign currency. Companies classified in the same group, which have similar currency denominated cost and earnings structures, should exhibit the same trend in share price when the value of the ZAR appreciates or depreciates. For example, when the value of the ZAR falls both rand leverage and rand hedge stocks tend to perform well since company revenue is earned in foreign currency, which is worth relatively more when converted into ZAR. Depreciation of the ZAR yields greater company profits and provides a higher rate of return to the investor, when investing in these two stock categories. In comparison, rand play companies with revenues and costs denominated in ZAR, realise inferior returns relative to the other two groups, given the same currency depreciation. Barr and Kantor's (2005) classification is therefore especially useful when examining the effect exchange rate fluctuations have on share prices.

The focus of this paper will be to extend the work done by Barr and Kantor in their 2005 paper by constructing stock portfolios based on their company classification. Portfolio construction will assume investors are risk-averse and obey a mean-variance criterion, a theory first introduced by Harry Markowitz in 1952. Expected returns are calculated for the hedge, leverage and play groups, which are dependent on the beta estimates of the three groups, as well as the investor's assumption of the future value of the ZAR. Once the three groups' expected returns are calculated, Markowitz portfolio analysis is used to obtain weights for the three constituent groups in the final portfolio. The results are back-tested to

ascertain whether using this type of classification provides the investor with a superior method with which to construct portfolios. If the constructed portfolios provide higher returns than those of a comparable benchmark when back-tested, this strategy could be used as a successful hedging tool that enables an investor to maximise portfolio returns by minimising the adverse effects of a volatile exchange rate.

Ultimately what this research paper sets out to do is determine whether a South African investor, who is constrained by capital controls, can actively seek to minimise the adverse effects of a depreciating ZAR (which decreases his wealth) by constructing portfolios according to Barr and Kantor's (2005) company classification, and which are dependent on the investor's future exchange rate expectations. If the returns of said portfolios can outperform the benchmark once back-tested, then the empirical evidence will support the hypothesis that a superior strategy with which to leverage against exchange rate fluctuations has been established.

Overview:
Section 1.1 provides the reader with a historical review of the South African ZAR and addresses the reasons behind its volatile nature. In section 1.2, the cause of exchange rate changes, as well as the effect of these changes is considered. Section 1.3 of the paper examines the relationship between the ZAR and the value of the JSE, and its importance for investors.

Section 2.1 looks at the methodology used by Barr and Kantor (2005) to classify the top 40 companies of the JSE All Share 40 index (ALSI40). Section 2.2 goes on to provide a summary of Barr and Kantor's results and replicates their sensitivity analysis of the 40 largest companies on the JSE to changes in the value of the ZAR. The results obtained are compared to those of Barr and Kantor (2005) to test for conformity and reasons for disparities are examined.

Section 3 extends the work of Barr and Kantor (2005) by estimating the exchange rate and market betas of the three stock classifications. The period under review is from July 1998 to the end of June 2004. To estimate the beta coefficients of the hedge, leverage and play groups, a 3-year rolling window is used to first calculate the rate of return of each stock.

Group returns are computed by assigning market capitalisation weights to each stock constituent within the three categories.

Section 4 estimates the expected returns of the hedge, leverage and play groups by applying the exchange rate and market beta estimates from the previous section. The three groups' expected returns are dependent on the exchange rate predictions of the different investors considered, as well as the market's return. PPP is explored as a means with which investors predict exchange rate movements for the year ahead.

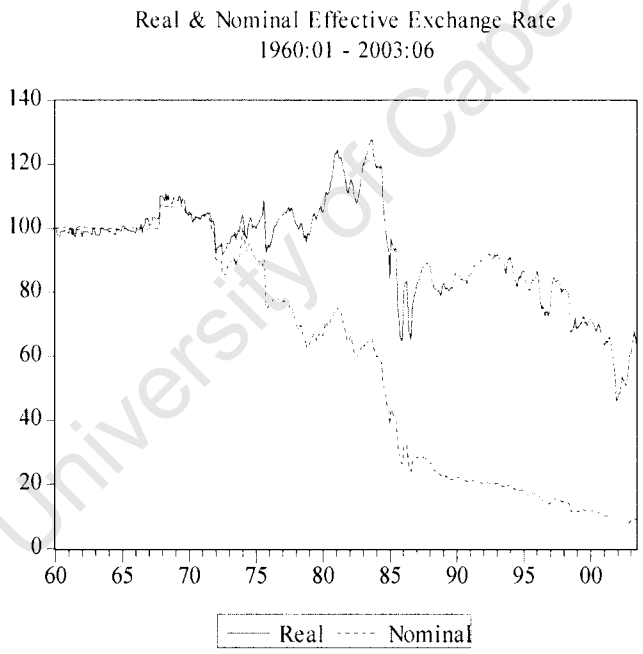
In section 5, Markowitz portfolio analysis uses the different investors' estimated returns of the three groups to determine each group's weight in the final portfolios constructed. These weights are subsequently back-tested and applied to the constituents' realised returns to ascertain how the investors' portfolios performed relative to the market. The results suggest an investor using Barr and Kantor's (2005) stock classification, as well as PPP to predict changes in the future value of the ZAR, is able to protect his investment against the undesirable effects of a volatile exchange rate. However, the relative success with which an investor can protect his investment and outperform the market ultimately depends on the accuracy of the investor's exchange rate predictions.

Section 1

1.1 A Historical review of the South African ZAR and grounds for its volatile nature

Exchange controls have heavily regulated the value of the ZAR and have been present in South Africa since the 1960's, when the South African ZAR was pegged to either the Great Britain Pound (GBP) or the American dollar (USD). Capital controls can reduce exchange rate volatility (Farrell, 2001), and have insulated the ZAR from the destabilising effects of political, as well as economic shocks. For the period 1961 to 1971, the ZAR exchange rate was pegged to the GBP which helped maintain a stable inflation rate in South Africa. The absence of shocks and a stable inflation rate during this period meant that the ZAR did not diverge significantly from its purchasing power parity (PPP) value. This is shown by low volatility in the real and nominal effective[1] exchange rate, represented in Figure 1 below.

Figure 1:



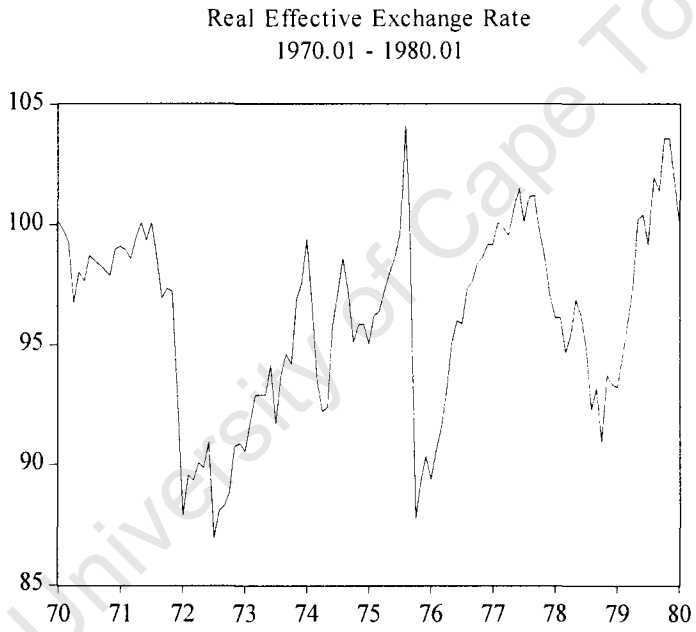
Source: Investec Asset Management[2] and IMF (1960=100), monthly data.

[1] South Africa's effective exchange rate is measured in terms of a weighted average exchange rate between South Africa and her 14 most important trading partners.

[2] There is no official data available prior to 1970. Andre Roux, from Investec, calculated an index going back to 1960 based on his estimates. Data for the period 1979:01 to 2003:06 is from the IMF monetary statistics, extracted from Time Series Explorer (TSE).

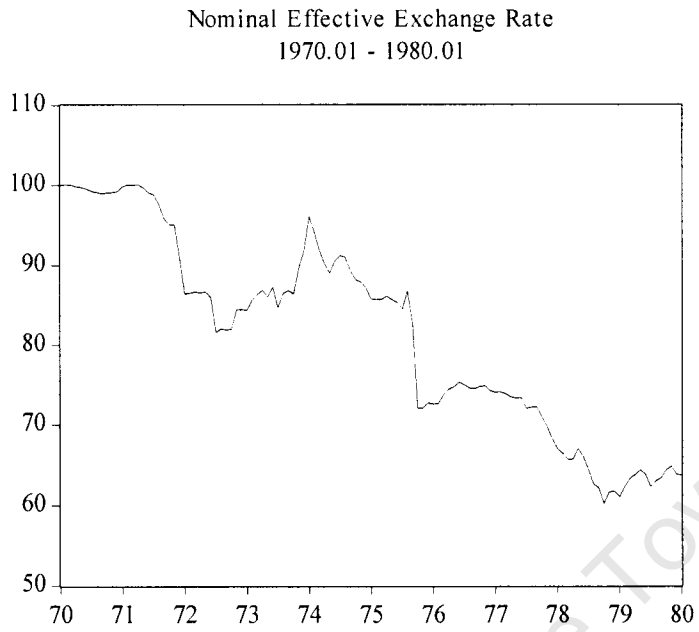
During the period 1971 and 1979, the ZAR was essentially fixed and pegged to the USD or the GBP. Notwithstanding, the real ZAR strengthen substantially when, led by the price of gold, commodity prices more than doubled in the early 1970s and again in the course of 1979-1980 (Kantor, 2003). Yet the exchange rate inevitably depreciated in 1976 when the Soweto uprising increased scrutiny of South African's apartheid policy and reluctance to implement democratic reform. Heightened political uncertainty in South Africa caused large capital outflows that severely impacted upon the value of the ZAR (Barr & Kantor, 2002). As figure 2 and 3 demonstrate, the presence of shocks during the period 1970 to 1979 caused a significant degree of exchange rate volatility in the nominal and real value of the ZAR.

Figure 2:



Source: Investec Asset Management (1970=100), monthly data.

Figure 3:



Source: Investec Asset Management (1970=100), monthly data.

In 1979, following the recommendation of the De Kock Commission, South Africa's exchange rate policy was aimed towards a more market orientated ZAR value and lead to the introduction of a dual currency exchange rate system. With two exchange rates in place, the financial ZAR and the commercial ZAR, South Africa had effectively implemented a floating peg to the USD. This allowed greater exchange rate flexibility in South Africa without fully liberalising the capital account and allowing the ZAR to float freely.

The South African Reserve Bank (SARB) set the financial ZAR exchange rate daily according to market forces and it was utilized solely for capital account transactions (Barr & Kahn, 1994). The financial ZAR represented the exchange rate for ZAR assets held by foreign investors, (Kantor & Heese, 2002). Its highly volatile nature was largely attributable to the perceived risk associated with the South African economy by foreigners, given the political circumstances at the time. Current account transactions were executed using the commercial ZAR, which was stronger than the financial ZAR. The fact that the financial ZAR traded at a discount afforded foreign JSE investors a higher return on their South African investments. The central purpose of the dual exchange rate system was to isolate the

damaging effects that volatile portfolio transactions (of non-residents) had on the capital account from other foreign transactions (Farrell, 2001). The use of the financial ZAR meant that capital flows from South African residents were under more austere controls than those of non-residents.

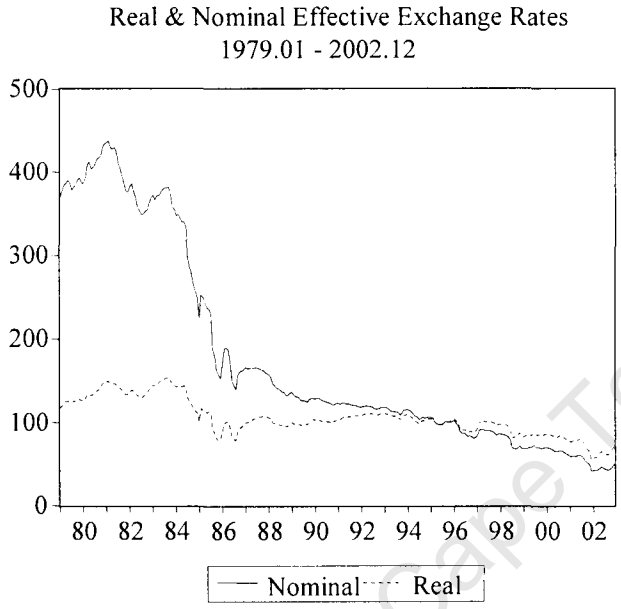
The dual exchange rate system was abolished in February 1983 in an attempt to further liberalise the capital account. This allowed non-residents to move their proceeds freely across South African borders and as a result, capital flows directly influenced the ZAR's value. Political and external shocks took their toll on the exchange rate in August 1985, when the South African government failed to meet the democratic reform expectations of foreign investors [P.W. Botha's "Rubicon" speech]. Despite high interest rates, the South African ZAR depreciated substantially as disappointed foreign investors withdrew their capital on a large scale. Consequently, the exchange rate did not maintain its PPP value and caused the ZAR to be 35% undervalued (Barr & Kantor, 1999). PPP contends that expected inflation rate differentials between countries are the cause for changes in a currency's expected value. Given a surprisingly stable inflation rate of 15% throughout the 1980s (Barr & Kahn, 1994), implies that the unexpected ZAR depreciation for this period was solely the effect of unpredictable shocks. Figure 4 illustrates the collapse of the real and nominal exchange rates during the course of the decade.

Capital flight, the falling gold price, and the debt standstill crisis of the mid 1980s, lead to the fall of the ZAR in the fist half of the decade and were catalysts to the reintroduction of the financial ZAR in August 1985 (Barr & Kahn, 1994). However, this did not prevent the ZAR from depreciating further in the last half of the 1980s, as the capital account had to be kept in surplus to enable South Africa to meet debt repayments.

Uncertainty over the shift in political power exacerbated the exchange rate's volatility during the first half of the 1990s and was the source of depreciation, both in real and nominal terms. Only in the year following South Africa's first democratic elections held in May 1994 did the nominal ZAR's value improve, as the future prospects of the economy strengthened. The financial ZAR was permanently removed in 1995 and was the first step towards the gradual relaxation of exchange controls that the government had sought to adopt in the last decade

(Nattrass, 2002). Consequently, large-sized portfolio movements have been allowed to flow between South Africa and abroad (Kantor, 2003).

Figure 4:



Source: South African Reserve Bank (1995=100), monthly data.

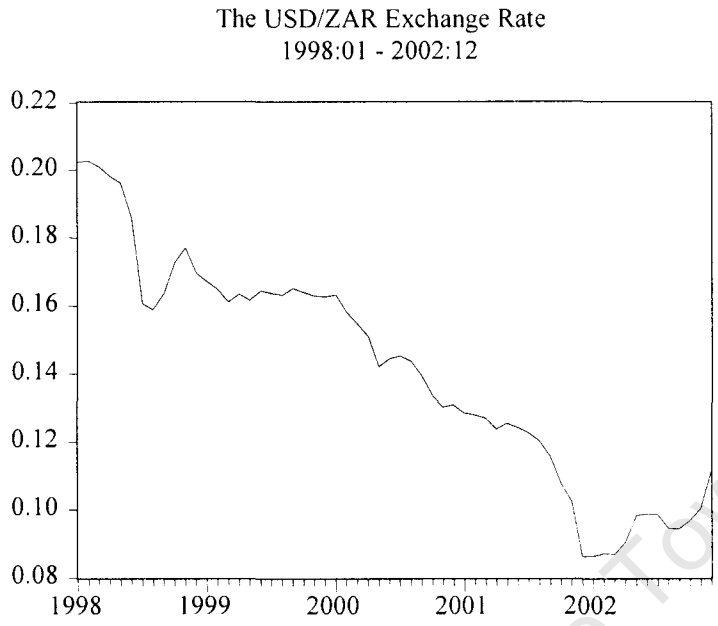
In 1998, monetary policy, which sought to defend the value of the ZAR and reduce inflation, was challenged by a volatile exchange rate. With the reserve bank informally targeting[3] an annual inflation rate of 1-5%, a relatively stable exchange rate was required in order to meet inflation targets. However, the emerging market liquidity crisis - an external shock - during this period caused a significant fall in the value of the ZAR in 1998 (Kantor, 2003). Although in 1999 the ZAR managed to regain some of the 20% real value it had lost in the previous year, it followed a consistent downward trend throughout 2000 and 2001. The ZAR weakness led to much speculation about its future value and caused panic amongst locals in 2001. The rush to obtain USD currency only served to depreciate the ZAR further and increase the rate of inflation. The ZAR depreciation continued over a 3-month period, losing 40% of its value despite attempts by the reserve bank to defend the currency with repeated interest rate hikes.

[3] Inflation targeting was formally introduced in South Africa on the 23 February 2000, when T.T. Mboweni (SARB Governor) announced an inflation target of 3-6% for 2002.

Since inflation differentials between South Africa and her trading partners have by and large been lower than 5% since 1996 (Barr & Kantor, 2005), it remains difficult to attribute the sizeable depreciation in 2000 and 2001 to economic fundamentals. General public concern at the time lead to the establishment of the Myburgh Commission of Inquiry, whose mandate was to investigate the cause of the 2001 depreciation of the ZAR. When the commission released their report in 2002, they concluded several key macroeconomic factors could have been at fault. Amongst the most notable were: global economic slowdown, contagion effects from Argentina, as well as deterioration of the current account. Even though people speculated that large currency bets had been taken against the ZAR, the Commission of Inquiry did not find such speculation to be true, nor that capital controls had been violated (Bhundia & Gottschalk, 2003).

However, given that most of these macroeconomic conditions had been present in 2001, the Commission was not able to explain the acceleration in depreciation during the last months of the year. An IMF working paper confirms that domestic, as well as global macroeconomic factors are "unlikely to be significant explanations for the sharp depreciation at year-end 2001" (Bhundia & Gottschalk, p.10, 2003). Therefore, the depreciation of the ZAR in 1998 and 2001 can only be attributed to shocks (i.e. nominal disturbances) the South African economy experienced during those years. The fall of the ZAR during these two periods is shown in figure 5. The real ZAR weakness during this period, however, gave exporters a competitive advantage that increased profits and helped South Africa escape a recession which was felt by most of the world (Kantor, 2003). The ZAR outperformed even the most optimistic of estimates towards the end of 2003 and 2004 when it regained lost value and settled at pre-1998 levels.

Figure 5:

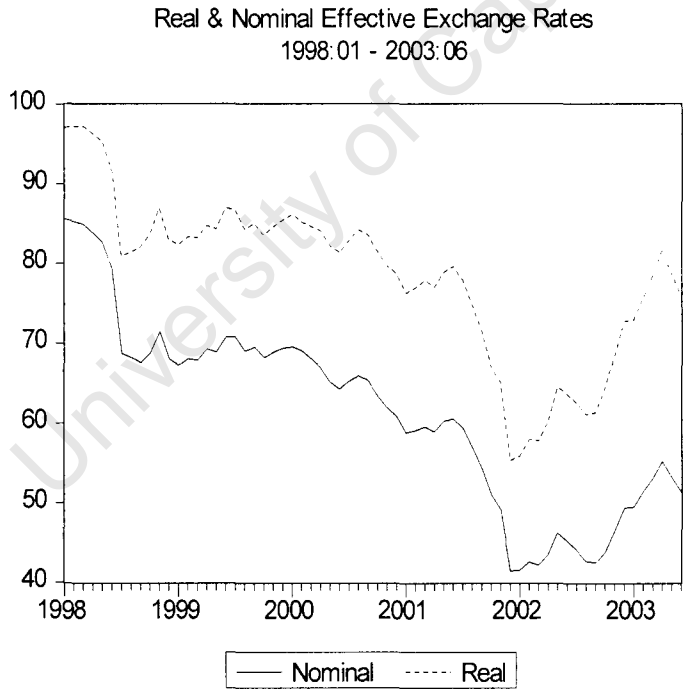


Source: IMF International monetary statistics, monthly data extracted from Time Series Explorer (TSE).

Section 1.2 The origin of exchange rate movements and their effects on the economy

As the previous section shows, the dominant force behind South Africa's variable exchange rate has been the existence of shocks, both political and macroeconomic, that the economy has endured. Whether or not these shocks have had a real effect on the state of the economy has been largely dependent on whether the nominal exchange rate, subsequent to the shock, deviated significantly from its PPP value. The real exchange rate would then diverge from its long run steady equilibrium path and render the currency under or over valued, depending on the direction of the change[4]. The economy's international competitiveness would be affected by a change in the real value of the ZAR and may have an effect on prices, which causes the exchange rate to revert back to its original PPP value. When shocks are the fundamental basis for changes in the exchange rate, nominal and real exchange rates display similar movement patterns (Barr & Kantor, 2005), as is shown by figure 6.

Figure 6:



Source: IMF International monetary statistics (1995=100), monthly data extracted from DataStream.

[4] The nominal exchange rate is undervalued if the currency depreciates above its PPP value (i.e. more than inflation differentials between countries would contend) and overvalued if it appreciates below its PPP value.

Nominal shocks are usually the reflection of monetary policy and tend to affect exchange rates less than real shocks, by causing prices to change in a more general manner rather than explicitly affecting the exchange rate. On the other hand, political instability or productivity changes (i.e. real shocks) are more likely to cause the real ZAR to deviate from PPP. When exchange rate movements can be attributed purely to monetary causes, the exchange rate will remain close to PPP, (Barr & Kantor, 2005). When exchange rates follow inflation differentials between countries and PPP holds, the real exchange rate remains constant (Barr & Kahn, 1994) and the economy does not sustain any real effects, since the competitiveness and profitability of the country is unaltered. Firms involved in international trade do not incur losses or gains, since what is lost from exchange rate swings is remunerated through price differentials and vice versa.

When PPP does not hold, however, the real profitability of foreign trade is affected and can have real repercussions for the economy (Kantor & Marchetti, 2003). If for example, the real exchange rate were to depreciate following a shock to the capital account, as occurred in 1998 and 2001, exports internationally become more competitive. The price of goods and services rises in response to increased foreign demand, which causes the price of domestic goods not traded internationally to also rise. The direct effect an exchange rate shock has on tradable goods and indirectly on non-tradable goods restores exchange rates back to their long run PPP value (Barr & Kantor, 2005).

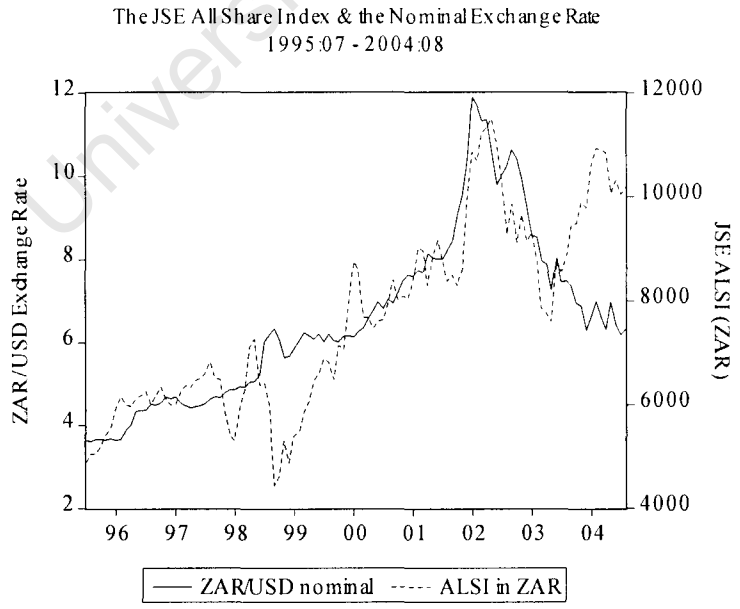
If the real exchange rate were to appreciate, the opposite would occur. Exports become relatively more expensive and less competitive abroad, which causes foreign demand to fall. The price of exported goods falls due to lower foreign demand and over time leads to a fall in the price of domestic goods not traded internationally. Competitive forces would put downward pressure on prices, which would eventually fall, thereby re-establishing PPP equilibrium. Therefore the further away the real exchange rate deviates from its long run PPP value, the stronger is the expectation that with time, through price changes, the real exchange rate will revert back to its PPP equilibrium value.

1.3 Investors, Exchange rates and the value of JSE stocks

Individuals purchase shares as a form of investment, which enables them to finance future consumption and accumulate wealth, (Kantor & Heese, 2002). Therefore, any variable that affects the price or earnings of stocks is particularly important to the investor, as it may adjust the expected return of shares, as well as the net worth of their assets. Given the past volatility of the ZAR, exchange rate movements are a major source of risk that affect stock valuations and which investors should account for when forming expectations about the future performance of stocks traded on the JSE.

A weaker nominal exchange rate places upward pressure on prices and produces, with a lag, a higher rate of inflation. For asset value to remain unchanged, share prices must rise in line with inflation so as to leave the real rate of return unchanged. However, ZAR weakness automatically reduces the value of current company earnings and dividends when denominated in a stronger currency and represents uncertainty for the foreign investor (Barr & Kantor, 1999). Even though the real rate of return will not be affected in the long term as inflationary forces drive up share prices, uncertainty may potentially cause investors to withdraw from the market.

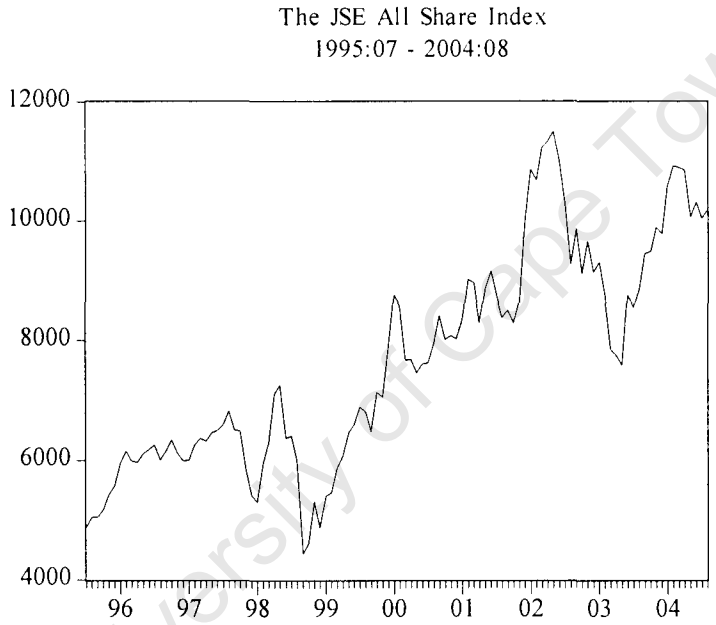
Figure 7:



Source: Monthly data extracted from DataStream and the McGregor Database.

Figure 7 illustrates the strong relationship between the value of the JSE All Share index expressed in ZAR and the nominal ZAR/USD exchange rate. The JSE performed remarkably well in 2002 and 2004 as shown in figure 8 below. During this period the index values of the JSE All Share index were close to what they had been in the late 1960's when the JSE realised all time highs around the 11500 mark that were led by the gold price. The good news for JSE investors is that these relatively high values represent high values for the JSE All Share index in real terms (Kantor & Heese, 2002).

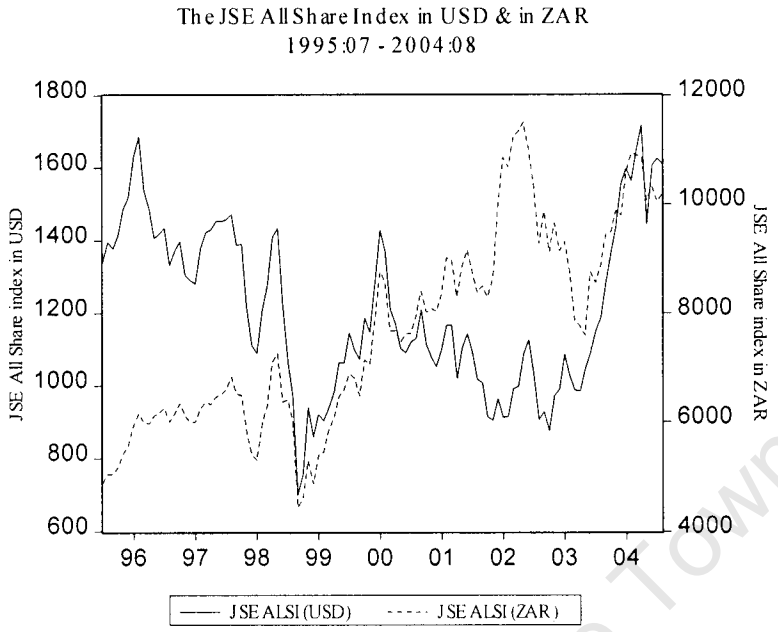
Figure 8:



Source: McGregor Database.

However, the historical performance of the JSE when expressed in USD terms has been poor. Although the JSE All Share index in USD has maintained a fairly constant value compared to its ZAR equivalent (figure 9), in 2003 its USD value was close to that in 1990 and substantially less (approximately half) than what it was worth in 1995 (Kantor, 2003). From 1980, the value of the JSE in USD has increased by approximately 20% which, given a 20% fall in the real exchange rate during this period, implies that the JSE has hardly experienced any real growth since growth rates have merely mirrored the rate of domestic inflation (Barr & Kantor, 2005).

Figure 9:



Source: McGregor Database.

Company earnings and dividend flows are the principal components that determine the value of the JSE All Share index in USD terms. For the period under review, the poor performance of the JSE in USD has to a large extent been the result of low real earnings growth, which can be attributed to the low price of commodities on world markets. Resource company earnings constitute approximately half of the JSE's earnings, and as such have a powerful influence on the value and growth rate of the JSE All Share index (Kantor, 2003).

Exchange rate changes have directly influenced the ZAR value of JSE stocks since South Africa's currency crisis caused the ZAR to depreciate significantly in 2001. ZAR weakness has had a positive effect on the value of the JSE All Share index, whereas a strong exchange rate has negatively affected its value (Barr & Kantor, 2002). The explicit relationship observed between the ZAR and the JSE All Share index (figure 7) is due to the large presence of resource companies listed on the JSE. Resource companies tend to perform exceptionally well in times of ZAR weakness, thereby leading the general direction of the JSE. However, other sectors, such as financial and retail, may not experience the same fortune as resource stocks and the way in which exchange rate movements affect the

profitability of their operations is a direct result of their cost and revenue structures (Barr & Kantor, 2005). The next section considers these relationships in more detail.

Section 2

2.1 The Leverage effect of Stocks on the JSE

The market value of shares listed on the JSE is a representative measure of companies' expected future dividends and earnings, discounted to their present value. The effect exchange rate movements have on company earnings, therefore, directly impacts their current market price. Following Barr and Kantor (2005), three categories can be used to classify companies listed on the JSE according to their revenue and cost structures; these are rand plays, rand leverage and rand hedge companies and are discussed in more detail below.

2.1.1 Rand plays

Rand plays are South African based companies that generate most of their revenue in ZAR and incur ZAR costs. As will be seen, this category is comprised mainly of retail and financial companies.

The ZAR proceeds or dividends of investing in rand plays are directly proportional to the profitability of the companies' operations at the time, which can be defined as:

$$Div(ZAR)_t \alpha \ Rev(ZAR)_t - Cost(ZAR)_t$$

Rand play companies provide no leverage to investors when the exchange rate fluctuates. Since most of their business depends on the purchasing power of domestic consumers, rand plays tend to perform poorly with exchange rate weakness and favourably when the ZAR is strong.

2.1.2 Rand leverage

Companies that are part of the rand leverage category have costs denominated in ZAR but most, if not all, revenue is earned in foreign currency. These are typically characteristics of resource companies that, for example, mine gold or platinum. The ZAR value of these stocks

are directly influenced by two factors; the ZAR/USD exchange rate and the USD price of resources. Dividends are proportional to profits once converted into ZAR[5]:

$$Div(ZAR)_t \alpha \ [Rev(USD)_t - Cost(ZAR)_t *(USD/ZAR)]* (ZAR/USD)^6$$

Rand leverage companies provide investors with protection against ZAR weakness, assuming USD commodity prices remain constant. A depreciated ZAR implicitly increases the ZAR value of these companies' USD revenues and simultaneously reduces costs incurred in ZAR, due to the USD's increased purchasing power. However, the beneficial leverage effect of ZAR weakness is only short lived since once prices rise, the real ZAR reverts back to its long run equilibrium value. The inflationary effect of ZAR weakness eliminates the leverage effect in the near future, implying investors are only able to take advantage of the leverage effect these companies provide for a short period of time whilst prices remain sticky. In other words, USD earnings are only effectively higher for as long as the real ZAR deviates from its PPP value.

2.1.3 Rand hedges

With predominantly all operations based abroad, rand hedge companies have both revenue and cost denominated in foreign currency. Once profits are converted into ZAR, dividends are directly proportional to the profits rand hedge companies generate overseas. It follows that:

$$Div(ZAR)_t \alpha \ [Rev(USD)_t - Cost(USD)_t]* (ZAR/USD)$$

These companies are also able to provide exchange rate leverage for investors when the ZAR is weak, as the ZAR/USD exchange rate affects the ZAR profits these companies earn directly, while their profits are not dependent on the welfare of the South African economy. As such, the weaker the ZAR is to the USD, the more ZAR profits are generated once foreign currency earnings are converted into ZAR and vice versa.

[5] Assume all foreign currency is earned in USD.

[6] ZAR costs must first be converted into USD (or to the relevant foreign currency), and then USD dividends are converted into ZAR using the appropriate exchange rate.

2.2 Are the results consistent with the theory?

Barr and Kantor (2005) used weekly data from I-Net Bridge to test the sensitivity of the JSE's 40 largest[7] listed companies to exchange rate fluctuations during the volatile period of 2001 to 2003. The model used was as follows:

$$\%ALSI_i = \alpha + \beta_1 \%(ZAR/USD) + \beta_2 \%ALSI_{40}$$

where[8]: $\%ALSI_i$ is the continuously compounded percentage change of the *i*-th component of the ALSI40;

%(ZAR/USD) is the continuously compounded percentage change of the ZAR/USD exchange rate;

$\%ALSI_{40}$ is the continuously compounded percentage change of the ALSI40.

The independent variables %(ZAR/USD) and $\%ALSI_{40}$ represent the exchange rate and market effects respectively and their beta values determine the degree of sensitivity each stock has with respect to exchange rate and market movements. Although changes in the value of the ZAR will indirectly affect the market's general movement, the authors contend that since the correlation between the independent variables (when presented in percentage change form) is low (0.23) the problem of multicollinearity can be ignored.

Two betas were calculated for each of the 40 listed shares from January 2001 to August 2003. The exchange rate beta, β_1, measures how responsive share prices are to exchange rate changes, whereas β_2 measures the sensitivity of individual companies to market wide movements[9]. The larger the value of β_1, the greater the change in share price given an exchange rate change. If β_1 is positive, the exchange rate and share price will move in the same direction. However, if β_1 is negative, the exchange rate and share price will move in opposite directions. Therefore, a positive β_1 implies a weak ZAR will cause the share price to increase and to decrease in value if β_1 is negative. A priori, one should expect rand plays to have negative betas, whereas positive betas should characterise rand leverage and rand hedge

[7] The 40 companies are the constituents of the ALSI40, which is a market value weighted index of the largest market capitalisation companies listed on the JSE.

[8] Definitions are those given by Barr & Kantor in their 2005 paper.

[9] For classification purposes β_1 is of greater importance that β_2, however both variables are important in terms of their explanatory power of the dependent variable $\%ALSI_i$.

stocks. Before estimating the β_1 value of the constituents of the ALSI40, Barr and Kantor (2005) grouped the shares into their respective categories, as shown in Table 1.

Table 1:

RAND PLAY	RAND LEVERAGE	RAND HEDGE
1 ABSA	1 Anglo American	1 Liberty International
2 Amalgmated Beverages	2 Anglo Gold	2 Old Mutual
3 Barloworld	3 Anglo Platinum	3 Richemont
4 Bidvest	4 Avgold	4 SABMiller
5 Firstrand	5 BHP Billiton	
6 Imperial	6 Gold Fields	
7 Investec Ltd	7 Harmony	
8 Investec Plc	8 Impala	
9 Liberty Group	9 Iscor	
10 MTN	10 Kumba	
11 Nampak	11 Remgro	
12 Naspers	12 Sappi	
13 Nedcor	13 Sasol	
14 Network Healthcare	14 Steinhoff	
15 Pick 'n Pay		
16 RMB		
17 Sanlam		
18 Standard Bank		
19 Telkom		
20 Tiger Brands		
21 Venfin		
22 Woolworths		

Description of Sectors and Classifications

The rand play category consists of 22 stocks predominantly from the financial and retail sectors. Although some of the companies in this group generate revenue abroad, their main business lies within South African borders and can be broadly defined as rand plays (PLAY). One should therefore expect these companies to have negative β_1 values, unless the fraction of earnings generated abroad have a larger than anticipated leverage effect on company profits.

Not surprisingly all of the 14 rand leverage (LEV) stocks (save for Steinhoff) are resource companies that, whilst incurring all of their costs locally, export their goods and earn foreign

revenues. These stocks should all have positive β_1 coefficients and provide the investor with short term leverage against currency depreciation.

Whilst only 4 stocks represent the rand hedge (HEDGE) classification, Richemont and Liberty International are the only pure HEDGE stocks with all of their operations conducted abroad. Even though the profitability of SAB Miller and Old Mutual still remain largely dependent on the South African economy, they have a significant portion of their operations conducted abroad, which is consistent with their HEDGE classification. A positive β_1 is also expected for the stocks in this group.

Barr and Kantor (2005) found their empirical estimates did reflect their a priori categories, even though the statistical significance of each share varied considerably across the 40 stocks. The authors argue that given the objective was to categorise the different shares into groups, their relative significance should not detract from the analysis. It is evident then that "the calculated beta coefficients for the exchange rate variable (β_1) serve as a strong empirical support for categorising the status of the ALSI 40 as either rand leverage stocks, rand hedges or rand plays", (Barr & Kantor, 2005: p.90). Their results are shown in table A in the appendix.

Barr and Kantor found that the LEV category, which comprised predominantly resource companies, had positive estimated exchange rate betas as expected, save for Gold Fields. All of the PLAY stocks had negative estimated exchange rate betas, which was noted by the authors as surprising given that some PLAY companies have a substantial share of their operations conducted abroad. Except for Old Mutual, which had a negative beta, positive exchange rate betas were estimated for the HEDGE group. Barr and Kantor suggest that the mixture of operating assets both locally and abroad is the primary rationale why Gold Fields and Old Mutual do not have positive beta estimates. Notwithstanding, Barr and Kantor's classification is most valuable when determining the effects exchange rate movements have on share prices and is firmly supported by their empirical results.

In order to replicate Barr and Kantor's classification model, 40 monthly data series were extracted from DataStream for the period January 2001 to August 2003. The most notable difference was that the stock Avgold was not captured as one of the 40 constituents of the

ALSI40. In its place was Discovery Holdings (the insurance company), which is omitted from the analysis for consistency purposes. While the period under review is the same, the source and frequency of the data differs from that used by Barr and Kantor. A low correlation between the two independent variables of 0.12 was observed for the given period and thus multicollinearlity can also be ignored for the purposes of this analysis. Data differences should cause the results to vary, although not significantly. The results obtained are summarised in table B of the appendix.

The findings are largely consistent with those presented by Barr and Kantor in their 2005 paper. All of the stocks in the HEDGE group had positive estimated β_1 coefficients, including Old Mutual. The 13 stocks in the LEV group, including Gold Fields, also had positive estimated β_1 coefficients. The reason for Old Mutual and Gold Fields stocks generating positive, as opposed to negative, estimated β_1 values may be attributable to the use of monthly data, thereby making the results more robust to market volatility during this period.

Most of the divergence between the results of this paper and those of Barr and Kantor (2005) were found within the PLAY group. In their study all 22 PLAY stocks had negative estimated β_1 values, which even Barr and Kantor found surprising given the mixture of local and foreign operations of some of the companies in the group. Table B (see appendix) shows only 12 of the 22 stocks in the PLAY group had negative estimated β_1 values. The 10 PLAY stocks[10] with positive β_1 values are not consistent with the PLAY group classification, but concur with the observation noted by Barr and Kantor above. Perhaps it is fair to say that the portion of earnings generated abroad do provide investors with greater than expected leverage against local currency depreciation. If operations abroad were to expand in the future, one could potentially consider revising the classification of these 10 stocks and reclassify them under the LEV group.

Although differences were found between the two studies and the statistical significance of both beta estimates vary widely across companies, it does not detract from the overall classification put forward by Barr and Kantor. The results of both papers provide strong empirical evidence that LEV and HEDGE stocks, with positive estimated exchange rate beta

[10] The stocks in the PLAY group with positive beta coefficients are Sanlam, Standard Bank, Liberty Group, Barloworld, Woolworths, Investec Plc, Nampak, Investec Ltd, Network Healthcare and Venfin.

coefficients (β_1), should provide investors leverage in times of currency depreciation given their cost and revenue structures. Whereas PLAY stocks, with predominantly local operations and negative (ZAR/USD) beta coefficients, do not perform as well given the same economic conditions.

Section 3

Methodology

The remainder of the paper focuses explicitly on verifying whether the segmentation of the ALSI40 constituents into three groups yields a superior portfolio contextualisation for the average investor. If the rate of return of the final portfolios constructed is found to be greater than that of a comparable index[11], the classification will prove to be extremely valuable to the investor, especially when faced with a depreciating ZAR. Effectively, this would imply that by actively constructing portfolios in accordance with the group classifications presented, investors are better able to protect their investment's asset value than by adopting a passive strategy and investing in the domestic market index.

The methodology section extends the work of Barr and Kantor (2005) by estimating the exchange rate and market beta coefficients for the three group classifications. In order to estimate the beta values, the rate of return of the three groups are first calculated by assigning market capitalisation weights to each stock constituent within a group. Once the return for each group has been computed, beta coefficients are estimated and the expected returns for the HEDGE, LEV and PLAY groups are calculated. The difference between the final portfolios' returns is the weights assigned to three constituent groups.

The expected returns of the portfolio constituents, at the HEDGE, LEV and PLAY level, are dependent on the investor's[12] a priori expectations of future exchange rate movements vis- à-vis PPP. Markowitz portfolio analysis allows one to compute constituent weights, which are back-tested to determine whether the performance of the final portfolios can consistently outperform the market, in our case the ALSI.

[11] The ALSI is used, as opposed to the ALSI40, as it is a better representation of the general state of the South African economy.
[12] Through out the study, all investors are assumed to be risk averse.

3.1 Calculating Realised Returns and Beta coefficients for the three groups

The period under review is from July 1998 to the end of June 2004 and the time series used were extracted from DataStream. To calculate the returns of the three groups in the study, one needs to first calculate the returns of the JSE ALSI40 constituents. The monthly Total Return Index[13] (TRI) is used for each stock to calculate its monthly growth rate, which is effectively the stock's rate of return. Each stock's monthly return is calculated for a three year period that is used to calculate the respective groups' rate of return over the period. Since the period considered is July 1998 to the end of June 2004, a total of four 3-year rolling windows are employed. The monthly returns for the three groups are calculated by assigning weights to each stock based on the market capitalisation value of the stock within the HEDGE, LEV and PLAY groups. Using the same methodology as in section 2, exchange rate and market beta coefficients are estimated for the three groups over the four 3-year window periods.

3.1.1 First 3-year window; period 1998:07 – 2001:06

During the first period the HEDGE group consists of only two stocks, Richemont and SAB Miller. Liberty International and Old Mutual are excluded from the calculation as they listed after July 1998 and there is not three full years worth of monthly TRI data. If one were to compute the rate of return of the HEDGE group using less than 3-years of monthly data for Old Mutual and Liberty International, the results would be biased.

Once the returns for Richemont and SAB Miller have been estimated, weights are assigned to the two stocks to calculate the rate of return for the HEDGE group over the period. Each stock's weight in a group is proportional to its market capitalisation (at the end of the 3-year window period) relative to the total market capitalisation of the stocks in that group during the period under consideration. For example, the weight of Richemont is calculated as the market capitalisation of Richemont (as at 2001:06) divided by the sum of the market capitalisation of Richemont and SAB Miller, as they are the only two stocks in the HEDGE group during the period. Following this method provides one with weights of 0.70 and 0.30

[13] A Total Return Index series assumes dividends paid out during the year are reinvested by the investor. Were dividends to be excluded, the estimated stock returns would be biased downwards.

for Richemont and SAB Miller respectively. Thus, the monthly returns for the HEDGE group are the sum of each stock's return multiplied by its respective weight.

Beta coefficients for each group are estimated using a similar model as in section 2. However, β_1 and β_2 now represent the degree of sensitivity of a group, and not of a stock, with respect to exchange rate and market wide movements. The model used is shown below:

$$\%GROUP_i^{14} = \alpha + \beta_1 \%(ZAR/USD) + \beta_2 \%ALSI_{40}$$

The problem of multicollinearity can be ignored since the correlation between the independent variables during the period is low (-0.02). An exchange rate beta (β_1) of -0.46 and a market beta (β_2) of 0.16 were estimated for the HEDGE group over the first 3-year window period. A negative beta coefficient is surprising given both Richemont and SAB Miller had positive exchange rate beta (β_1) estimates during the 3-year period, and could be attributable to the negative correlation between the independent variable.

The leverage group consists of 13 stocks[15], however, in the first window period only 10 stocks are included in the calculation. Kumba Resources, Remgro and Steinhoff are excluded as these companies only listed after 1998:06. To derive the rate of return for the LEV group the same methodology is used as with the HEDGE group. First, the returns of the 10 stocks are calculated, and then weights are assigned to the stocks according to the market capitalisation of each stock relative to the group's total market capitalisation. For the LEV group beta coefficients of 0.16 and 0.43 were estimated for β_1 and β_2 respectively.

Positive β_1 estimates for the LEV group are consistent with the theory covered in section 2. Given the depreciation of the ZAR during this period, the LEV group should theoretically yield the best protection against ZAR depreciation, achieve the largest return and outperform the other groups.

[14] Where $GROUP_i$ refers to either the HEDGE, LEV or PLAY constituent under consideration.

[15] It was noted in section 2 that at the time the study was conducted the stock Avgold was not a constituent of the ALSI40, and in its place was the stock Discovery. For the remainder of the paper, Discovery is omitted entirely from the analysis for consistency purposes. Consequently there are only 13, as opposed to 14, stocks in the LEV group.

A priori, one expects a negative β_1 coefficient for the PLAY group, which should yield the weakest performance of all three groups in times of ZAR weakness. The PLAY group, is the largest group and consists of 22 stocks. Three stocks (Investec, Sanlam and Telkom) are excluded in the first window period, given they are not listed as at 1998:07. Applying the same methodology as previously, the PLAY group's beta coefficients were calculated and β_1 and β_2 values were estimated of -1.60 and 0.41 respectively.

The estimated beta coefficients for the HEDGE, LEV and PLAY groups are used in section 4 to calculate the investor's expected returns for the year following the 3-year window period (2001:07 to 2002:06), and these returns are subsequently used to construct the final portfolios. Whilst the statistical significance of beta estimates for the three groups was notably varied across the different time periods, the results should not be disregarded on this basis given the aim is to estimate the relative sensitivity of each group to exchange rate and market movements.

3.1.2 Second 3-year window; period 1999:07 – 2002:06

In the second window period, the HEDGE group consists of all four stocks, as three full years of monthly data are now available for Liberty International and Old Mutual[16]. By using market capitalisation weights as at the end of the period (2002:06) and applying the same method as in the previous section, β_1 and β_2 coefficients of 0.30 and 0.44 respectively were estimated for the HEDGE group. Given the low correlation (0.19) of the independent variables during the second period, multicollinearity can be ignored.

Steinhoff is included in the calculation of the LEV group for this period, as the company listed on the JSE in October 1998. With 11 stocks, the group yields estimated beta values of 0.57 for β_1 and 0.29 for β_2. The PLAY group has a total of 20 stocks since Sanlam[17] is now included and beta coefficients of -0.21 and 0.39 were estimated for β_1 and β_2 respectively.

3.1.3 Third 3-year window; period 2000:07 – 2003:06

The HEDGE group yields beta estimates of 0.39 for β_1 and 0.52 for β_2 and the problem of multicollinearity can once again be ignored since the correlation between the independent

[16] Liberty International and Old Mutual both listed on the JSE in July 1999.
[17] Sanlam listed on the JSE in December 1998.

variables is low (0.16). Beta values for the LEV group are estimated as 0.71 for β_1 and 0.29 for β_2 and the PLAY group yields a β_1 value of -0.03 and a β_2 value of 0.27 over the period.

3.1.4 Fourth 3-year window; period 2001:07 – 2004:06

In the last window period, multicollinearity can also be ignored as the correlation of the independent variables is low at 0.05. The HEDGE group realised beta estimates of 0.06 and 0.03 for β_1 and β_2 respectively. For the LEV group (which for this period includes the stock Remgro[18]) a β_1 value of 0.58 and β_2 value of 0.38 are estimated, whereas the PLAY group yields beta estimates of -0.20 and 0.32 for β_1 and β_2 respectively.

Except for the HEDGE groups' negative estimated β_1 value in the first window period, the results concur with the a priori expectation of positive β_1 coefficient estimates for the HEDGE and LEV groups and negative β_1 estimates for the PLAY group.

The beta coefficients estimated in the four 3-year window periods for the HEDGE, LEV and PLAY groups are shown in table 2 below. The robustness of the results over the different periods considered, where the ZAR both depreciated and appreciated in value, provide further empirical evidence which support Barr and Kantor's (2005) stock classifications. These beta coefficients are applied in the following year to estimate the investor's expected returns for the three groups, whilst Markowitz portfolio analysis determines the weights assigned to each constituent group when constructing the final portfolios.

Table 2:

Time Period	HEDGE		LEV		PLAY	
	β_1	β_2	β_1	β_2	β_1	β_2
1998:07 to 2001:06	-0.46	0.16	0.16	0.43	-1.60	0.41
1999:07 to 2002:06	0.30	0.44	0.57	0.29	-0.21	0.39
2000:07 to 2003:06	0.39	0.52	0.71	0.29	-0.03	0.37
2001:07 to 2004:06	0.06	0.03	0.58	0.38	-0.20	0.32

[18] Remgro listed on the JSE in October 2000.

Section 4

Estimating expected returns

The aim of this section is to calculate the expected returns of the three company classifications by applying the estimated beta coefficients from the previous section. The four year investment period considered is from July 2001 to June 2005. The expected returns of the three groups are calculated over four 1-year periods and are dependent on the investor's future exchange rate expectations, as well as the market's return. The same model as in section 3 is used to estimate the expected returns of the HEDGE, LEV and PLAY groups in each 1-year period:

$$\%GROUP_i = \alpha + \beta_1 \%(ZAR/USD) + \beta_2 \%ALSI_{40}$$

Given one cannot predict what the broad market and the exchange rate will do in the future, one approach is to assume perfect foresight into the market's future movements (i.e. use actual realised market returns) and focus on the expected change of the ZAR's value in relation to its deviation from PPP. The beta coefficients estimated over the 3-year window period are applied in the subsequent year, with the market's realised rate of return and the investor's assumption of the exchange rate's movement for the year ahead. Looking forward 1-year, a set of expected returns for the three constituent groups of the final portfolios are estimated, which are dependent on the investor's exchange rate forecasts. Thus, if the investor's exchange rate predictions are well founded, constructing portfolios based on Barr and Kantor's (2005) stock classification should enable the investor to outperform the market.

4.1 The naïve investor

What if an investor does not have any definitive expectations of the future value of the ZAR? Or similarly, what would be the best approach if one thought the exchange rate was at its PPP value and not going to significantly change in value in the foreseeable future? In this event, the expected return of each group would only be dependent on the sensitivity of the group to the market's movement over the year (i.e. $\beta_2 * \%ALSI_{40}$).

Assuming the investor's profile did not change and he remained a naïve investor over the four year period, the expected returns of the HEDGE, LEV and PLAY groups would be directly proportional to the market's return. Table 3 illustrates the expected returns for the naïve investor.

Table 3:

Time Period	Expected returns (%)		
	HEDGE	LEV	PLAY
2001:07 to 2002:06	5.57	12.86	12.12
2002:07 to 2003:06	-2.72	-1.80	-2.45
2003:07 to 2004:06	9.43	5.13	4.82
2004:07 to 2005:06	1.33	15.67	13.34

4.2 The informed and the conservative investors

An investor with a better understanding of the macro economy could adopt a more astute approach when estimating the expected returns of the different groups of stocks. At the end of each 3-year window period, when forming exchange rate predictions for the following year, the informed investor could take a position on the ZAR dependent on the ZAR's current valuation vis-à-vis its PPP value. The ratio of the PPP exchange rate and the nominal ZAR/USD exchange rate is the real value of the ZAR (Kantor and Marchetti, 2003). Thus, using 1990 as the base[19] year, if the investor was able to recognise the rand was undervalued i.e. the current ZAR/USD exchange rate is larger than PPP would content, the expectation would be for the value of the ZAR to appreciate in the long term and restore the nominal exchange rate back to its PPP value. Similarly, if the ZAR was overvalued, the expectation would be for the ZAR to depreciate to its PPP value over time. Hence, PPP could be used to form superior exchange rate predictions, which would allow the investor to make a more informed prediction as to the future value of the ZAR, as well as the exchange rate's movement.

[19] The base year is ideally a year when the ZAR is fairly close to its PPP value, which implies a real ZAR value of one and therefore serves as a good base from which to infer PPP deviations. For the remainder of the analysis, deviations from PPP are measured relative to the base year (1990).

4.2.1 Period 1; 2001:07 – 2002:06

At the end of June 2001, with the current exchange rate trading at ZAR 8.05 to the USD and a PPP value of ZAR 5.08, the ZAR had become undervalued (5.08/8.05=0.63) relative to the base year. The informed investor therefore expects the ZAR to appreciate and forecasts a 20% appreciation in the ZAR's value during the year. The investor does not expect the nominal exchange rate to be fully restored to its PPP value in the 1-year period ahead; however, the extent by which the ZAR is over or undervalued enables the investor to better forecast the relative magnitude of the expected change of the exchange rate in the following year. The further away the exchange rate is from its PPP value, the stronger the expectation PPP will be restored through exchange rate movements.

A more conservative investor may recognise the ZAR is undervalued and expect the exchange rate to appreciate over the long term. However, given the ZAR's recent depreciation, the conservative investor may not expect the exchange rate to appreciate in the short term and start to move towards its PPP value during the course of the following year. Instead, the conservative investor anticipates the ZAR will continue its downward trend and forecasts a further depreciation of 20%.

During the period 2001:07 to 2002:06, the ZAR did in fact depreciate significantly. However, one could have not predicted the external shock the South African economy endured in the last three months of 2001.

4.2.2 Period 2; 2002:07 – 2003:06

Due to the sizable depreciation of the ZAR over the last year, the exchange rate would have deviated further from its PPP value. With a nominal ZAR value of 10.30 to the USD and a PPP exchange rate of 5.95 (5.95/10.30=0.58), the ZAR had become relatively more undervalued. Hence, given the significant undervaluation of the ZAR, at the beginning of the second period the informed investor could expect PPP to be restored through a strong appreciation in the ZAR and therefore forecasts a 30% appreciation for the year. Alternatively, despite the long term expectation for the ZAR to appreciate, the conservative

investor could assume the exchange rate to depreciate further in the short term, albeit by a small amount[20], and forecasts a 10% ZAR depreciation over the course of the year.

4.2.3 Period 3; 2003:07 – 2004:06

Even with the improvement in the ZAR's value during the period 2002:07 to 2003:06, at the start of the third period the ZAR remains undervalued on a PPP basis since the nominal exchange rate of ZAR 7.48 to the USD is larger that the PPP ZAR/USD exchange rate of 5.92 (5.92/7.48=0.79). Therefore, the informed investor expects the exchange rate to continue to regain lost value and PPP equilibrium to be restored through ZAR appreciation. Looking 1-year ahead, the investor forecasts an optimistic[21] exchange rate appreciation of 20%. The more conservative investor also believes the ZAR will continue to appreciate but anticipates the exchange rate's movement towards PPP to be slower and forecasts a modest ZAR appreciation during the year of 10%.

4.2.4 Period 4; 2004:07 – 2005:06

Despite the ZAR's appreciation during the last two years, the informed investor infers the ZAR still to be undervalued relative to the base year, given a nominal and PPP value of ZAR 6.15 and ZAR 5.77 to the USD respectively (5.77/6.15=0.94), and consequently expects an appreciation in the value of the ZAR. However, since the exchange rate is currently closer to its PPP value than in the previous periods, the investor anticipates a smaller ZAR appreciation and forecasts a 5% appreciation for the period. If more conservative, the investor could assume the exchange rate may once again deviate further from its PPP value and forecast a small depreciation in the exchange rate of 5% over the coming year.

Appling the estimated beta coefficients from section 3 provides a set of expected returns for the three constituent groups that are a function of the investor's exchange rate assumptions vis-à-vis PPP, as well as the market's realised returns. The informed and the more conservative investors' expected returns for the four years are illustrated in tables 4 and 5 respectively.

[20] Given the significant depreciation in the ZAR's exchange rate during the past two years, the investor assumes a smaller relative fall in the ZAR's value when looking 1-year ahead.

[21] The investor forecasts an appreciation of equal magnitude as in the first period, despite the ZAR not being as relatively undervalued, due to the improvement of the exchange rate during the past year.

Table 4: Informed investor

Time Period	Expected returns (%)		
	HEDGE	LEV	PLAY
2001:07 to 2002:06	14.76	9.72	44.09
2002:07 to 2003:06	-11.70	-18.91	3.95
2003:07 to 2004:06	1.71	-9.14	5.36
2004:07 to 2005:06	1.03	12.76	14.35

Table 5: Conservative investor

Time Period	Expected returns (%)		
	HEDGE	LEV	PLAY
2001:07 to 2002:06	-3.62	16.01	-19.85
2002:07 to 2003:06	0.27	3.90	-4.58
2003:07 to 2004:06	5.57	-2.00	5.09
2004:07 to 2005:06	1.63	18.59	12.32

Section 5

Markowitz portfolio analysis and back-testing

In this section, Markowitz portfolio analysis is used to obtain weights for the three constituent groups of the final portfolios for the naïve, informed and conservative investor. These weights are back-tested and applied to the constituents' realised returns to ascertain how the investors' portfolios performed relative to the market over the four 1-year periods.

Using the theory and methodology presented to construct portfolios should afford the investor with two key advantages. Firstly, it should enable an investor to minimise their exposure to the adverse effects of a depreciating ZAR by using the three stock classification presented by Barr and Kantor (2005). Secondly, if exchange rate assumptions are well founded, it should allow the investor to consistently outperform the market. Back-testing the results will verify whether these observations are true.

5.1 Markowitz portfolio analysis

Markowitz frontiers are calculated for the naïve, informed and conservative investor using the solver tool in excel. With solver one is able to estimate a mean-variance efficient frontier over a range of risk, using as inputs the expected returns of the three groups and the historical return volatility as a proxy for volatility (i.e. standard deviation), both of which were estimated and derived in previous sections. The Markowitz efficient frontier graphically represents the portfolios that maximise returns at each level of risk, by varying the weights of the portfolio's constituents. However, only one of the portfolios along the efficient frontier represents the best optimal portfolio for the investor.

Once Markowitz frontiers are estimated for the four time periods, the risk free rate[22] is introduced to the optimisation problem to obtain a tangency point with the efficient frontier, which depicts the optimal portfolio that maximises the reward-to-variability ratio for the

[22] The yield of the South African Reserve Bank's 3-month Treasury bill is used as a proxy for the risk free rate.

investor. A direct measure of reward-to-risk is the Sharpe ratio, which is defined as a portfolio's excess returns to standard deviation. Therefore, the portfolio with the largest Sharpe ratio along the Markovitz efficient frontier also represents the optimal portfolio[23]. From the return-standard deviation co-ordinates at the tangency point, constituent weights can be derived for the optimal portfolio.

The estimated efficient frontier is dependent on the objective function of the optimisation problem and may be subject to constraints. The objective function can be to either minimise the variance or maximise the mean return. More specifically, one is able to set the variance or mean to equal a required value and solver will calculate the largest possible mean for a given variance or lowest variance for a given mean return. Constraints may also be placed on the optimisation problem. For example, if short sales (i.e. negative weights) are not desired, one can place a constraint on the constituents' weights to be greater than or equal to 0.

Two restrictions were placed on the optimisation problem; weights must be larger than or equal to zero i.e. no short-sales and the investor must be fully invested, therefore the sum of the constituents' weights is set equal to one. It is important to note a restricted efficient frontier is not able to achieve a mean return for the portfolio that is larger or smaller than the estimated returns (inputs) of the portfolio's constituents. To estimate the efficient (restricted) Markowitz frontier, the global minimum-variance portfolio[24] i.e. the portfolio with the smallest attainable variance, was first calculated. Once the return for this portfolio had been estimated, the entire efficient frontier was generated by setting the mean equal to incrementally larger amounts and solving for the variance.

The weights derived from the Markowitz portfolio analysis for the naive, informed and conservative investors are illustrated in tables 6, 7 and 8 respectively.

[23] The slope of the line from risk free rate that is tangent to the efficient frontier, also know as the Capital Allocation Line, is maximised and equal to the Sharpe ratio of the optimal portfolio, which denotes the portfolio with the highest reward-to-variability ratio on the efficient frontier.
[24] The global minimum-variance portfolio was calculated with the same two constraints of no short selling and a fully invested portfolio.

Table 6:

	Weights		
Naïve	**HEDGE**	**LEV**	**PLAY**
2001:07 - 2002:06	0.32	0.68	0.00
2002:07 - 2003:06	0.00	1.00	0.00
2003:07 - 2004:06	1.00	0.00	0.00
2004:07 - 2005:06	0.01	0.53	0.46

Table 7:

	Weights		
Informed	**HEDGE**	**LEV**	**PLAY**
2001:07 - 2002:06	0.00	0.63	0.37
2002:07 - 2003:06	0.00	0.00	1.00
2003:07 - 2004:06	0.00	0.00	1.00
2004:07 - 2005:06	0.00	0.22	0.78

Table 8:

	Weights		
Conservative	**HEDGE**	**LEV**	**PLAY**
2001:07 - 2002:06	0.13	0.87	0.00
2002:07 - 2003:06	0.00	1.00	0.00
2003:07 - 2004:06	1.00	0.00	0.00
2004:07 - 2005:06	0.11	0.85	0.04

During the second and third time periods, the risk free rate was greater than the largest estimated return for the portfolios of the naïve, informed and conservative investors. In this case, the optimal portfolio on the efficient frontier would be that which is able to achieve the largest return[25]. Thus, a weight of one is assigned to the constituent with the largest estimated return and zero to the remaining constituents.

[25] Given the goal is to calculate a set of constituent weights for the three groups, the option of investing in the risk free asset is ignored.

5.2 Back-testing

To verify whether using the methodology presented affords the investor with a strategy with which to construct final portfolios that minimise the adverse effects of exchange rate movements, it is necessary to back-test the results. Given ex-post returns, beta estimates and PPP forecasted exchange rates can only be used to estimate, but not predict future returns, it is imperative to back-test the estimated constituents' weights to learn the true performance of the portfolios had these weights been applied.

The realised returns of the HEDGE, LEV and PLAY constituents during the four 1-year periods (from 2001:07 to 2005:06) in conjunction with the estimated constituents' weights are used to derive the returns of the investors' portfolios. If the realised portfolio returns consistently outperform the market (i.e. the JSE ALSI benchmark), then a successful hedging strategy is established that can be used to protect the investor from the adverse effects of a fluctuating ZAR. The results are shown in table 9.

Table 9:

	Realised returns (%)			
Period	**Naïve**	**Informed**	**Conservative**	**ALSI**
2001:07 - 2002:06	59.55	46.23	69.16	29.90
2002:07 - 2003:06	-16.35	1.40	-16.35	-6.25
2003:07 - 2004:06	34.19	26.19	34.19	18.15
2004:07 - 2005:06	42.20	46.64	36.56	41.25
Cumulative Return	119.59	120.46	123.56	83.05

Only the informed investor is able to consistently outperform the market over the four years. Surprisingly, with the exception of the second period, the naïve investor outperforms the market and is perhaps attributable to the fact that perfect market foresight is assumed in the study. However, the naïve investor inevitably achieves the lowest return on a cumulative basis. Over the four year investment period, the conservative investor realises the second largest cumulative return despite underperforming the market during the second and third time periods.

The relative performance of the informed and conservative investors' portfolios is linked to the congruency of their exchange rate assumptions during each time period. In the first period, the conservative investor's portfolio realises a higher return given the investor correctly anticipated a depreciation in the ZAR for the year ahead. However during the second period, the informed investor's portfolio outperforms as the exchange rate did in fact appreciate during the year. Both informed and conservative investors anticipated the ZAR would appreciate in the third period, but since the conservative investor's forecast was closer to the ZAR's realised appreciation during the period, his portfolio realises a larger return. Interestingly, the informed investor's portfolio yields a larger return relative to the conservative investor during the fourth period, despite having incorrectly predicted an appreciation in the ZAR. This is due to the PLAY group realising the largest returns for the period even though the ZAR depreciated and could be attributable (as stated in section 2) to some PLAY stocks having a larger than expected leverage effect. Thus, given the informed investor forecasted an exchange rate appreciation, Markowitz portfolio analysis assigned a larger weight to the PLAY group in comparison to the conservative investor's optimal portfolio. The results illustrate that the relative success of the investment strategy presented is ultimately dependent on the accuracy of the investor's exchange rate predictions.

Conclusion

The depreciation of the ZAR has had an undeniable effect on the wealth of JSE investors through share price fluctuations. This research paper set out to determine whether Barr and Kantor's (2005) company classification could provide investors with a method to minimise the adverse effects of a volatile exchange rate when constructing portfolios.

Barr and Kantor's (2005) sensitivity analysis of the 40 constituents of the ALSI40 to exchange rate movements was replicated and disparities were noted in the PLAY group. The results imply future studies may need to reclassify certain PLAY stocks to LEV stocks, as these South African companies expand their operations abroad. Notwithstanding, the sensitivity analysis provides further empirical research that supports the relationship between the ZAR exchange rate and the three stock classifications reported by Barr and Kantor (2005).

The paper extends the work of Barr and Kantor (2005) by estimating the exchange rate and market beta coefficients of the HEDGE, LEV and PLAY groups for the period 2001:07 to 2005:06. The robustness of the beta coefficients estimated over the period, where the ZAR both depreciates and appreciates, further supports and provides empirical evidence of Barr and Kantor's (2005) stock classification. These beta estimates are used to calculate the expected returns of the three groups for the different investors considered that are dependent on the investor's assumptions regarding future exchange rate movements vis-à-vis PPP, as well as the market's realised return. Markowitz portfolio analysis is subsequently applied to obtain weights for the three groups of stocks, which are the constituents of the final portfolios constructed. The results are back-tested to determine whether the portfolios' realised returns can outperform the market, and thereby establish a successful investment strategy.

Given the study assumes perfect foresight as to the market's future movements, further studies could determine whether the use of a market proxy, such as an appropriate risk free rate plus a market premium, would afford similar results. Notwithstanding, the results provide empirical evidence which imply a South African investor constructing portfolios based on PPP forecasted exchange rates and Barr and Kantor's (2005) stock classification may actively reduce the adverse effects of a volatile exchange rate. In the study, only the

informed investor is able to achieve consistently higher returns than the market, which suggests the relative success with which the investor can protect his investment and outperform the market ultimately depends on the accuracy of his exchange rate predictions.

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Appendix

Table A:

	β_1 (ZAR/USD Beta)	$t(\beta_1)$	β_2 (ALSI 40 Beta)	$t(\beta_2)$	R_2
RAND HEDGE					
Liberty International	0.64	6.46	0.34	4.85	0.42
SABMiller	0.45	3.80	0.53	6.49	0.38
Richemont	0.27	1.78	1.07	9.89	0.49
Old Mutual	-0.22	-1.61	1.00	10.47	0.46
RAND LEVERAGE					
Iscor	0.64	2.30	0.94	4.79	0.23
Impala	0.49	2.56	1.16	8.59	0.45
Sasol	0.43	2.48	0.61	4.98	0.25
BHP Billiton	0.32	2.69	1.19	14.12	0.66
Harmony	0.24	0.75	0.77	3.42	0.11
Steinhoff	0.22	1.41	0.57	5.23	0.23
Anglo Platinum	0.17	0.88	1.12	9.01	0.43
Anglo American	0.12	1.07	1.54	19.80	0.78
Sappi	0.06	0.35	1.16	10.19	0.47
Anglo Gold	0.05	0.20	0.68	4.14	0.13
Kumba	0.03	0.12	1.30	5.30	0.31
Avgold	0.02	0.09	0.57	3.83	0.11
Remgro	0.00	0.04	0.40	5.14	0.18
Gold Fields	-0.04	-0.14	0.77	3.85	0.11
RAND PLAY					
Telkom	-0.78	0.64	-1.74	1.73	0.15
Firstrand	-0.67	-5.19	0.72	7.87	0.34
Naspers	-0.65	-2.58	1.13	6.38	0.24
RMB	-0.63	-4.63	0.70	7.26	0.30
Imperial	-0.60	-4.50	0.57	6.09	0.25
Sanlam	-0.55	-3.71	0.76	7.30	0.29
MTN	-0.55	-2.66	0.82	5.65	0.20
Standard Bank	-0.53	-4.01	0.65	6.99	0.28
Nedcor	-0.50	-3.38	0.54	5.22	0.18
Pick 'n Pay	-0.50	-3.34	0.40	3.83	0.13
Liberty Group	-0.45	-3.30	0.67	7.09	0.28
ABSA	-0.44	-2.48	0.65	5.26	0.18
Bidvest	-0.42	-3.38	0.49	5.58	0.20
Barloworld	-0.40	-2.98	0.83	8.88	0.37
Woolworths	-0.40	-2.42	0.51	4.43	0.13
Investec Plc	-0.35	-0.15	0.86	0.46	0.01
Nampak	-0.32	-2.30	0.54	5.50	0.19
Investec Ltd	-0.26	-1.39	0.80	6.21	0.23
Amalgmated Beverages	-0.25	-1.97	0.31	3.51	0.09
Network Healthcare	-0.21	-1.37	0.46	4.28	0.12
Tiger Brands	-0.20	0.31	-1.71	3.75	0.10
Venfin	-0.14	-1.25	0.61	7.90	0.33

Table B:

	β_1 (ZAR/USD Beta)	$t(\beta_1)$	β_2 (ALSI 40 Beta)	$t(\beta_2)$	R_2
RAND HEDGE					
Liberty International	0.56	3.78	0.17	1.34	0.39
SABMiller	0.44	1.86	0.39	1.98	0.23
Richemont	0.52	1.94	0.80	3.55	0.40
Old Mutual	0.28	1.07	0.53	2.39	0.21
RAND LEVERAGE					
Iscor	1.78	2.44	0.84	1.35	0.24
Impala	0.79	2.18	0.65	2.09	0.27
Sasol	0.58	2.24	0.22	1.01	0.19
BHP Billiton	1.00	6.04	0.21	1.51	0.60
Harmony	0.99	2.10	0.06	0.16	0.14
Steinhoff	0.39	1.51	0.15	0.71	0.10
Anglo Platinum	0.64	1.68	0.41	1.26	0.15
Anglo American	0.84	2.92	0.22	0.91	0.27
Sappi	0.80	2.77	0.21	0.87	0.25
Anglo Gold	0.19	0.59	0.35	1.31	0.08
Kumba	0.61	1.34	0.49	1.02	0.13
Avgold					
Remgro	0.26	1.27	-0.02	-0.09	0.05
Gold Fields	0.90	2.02	0.33	0.88	0.16
RAND PLAY					
Telkom	-1.63	-1.55	-1.74	-1.41	0.71
Firstrand	-0.11	-0.36	0.25	1.02	0.04
Naspers	-0.27	-0.54	0.33	0.78	0.03
RMB	-0.07	-0.25	0.19	0.78	0.02
Imperial	-0.20	-1.05	0.14	0.84	0.05
Sanlam	0.29	1.10	0.09	0.39	0.05
MTN	-0.50	-1.42	1.00	3.32	0.30
Standard Bank	0.03	0.11	0.27	1.31	0.06
Nedcor	-0.18	-0.78	0.39	1.99	0.13
Pick 'n Pay	-0.25	-0.98	0.06	0.25	0.03
Liberty Group	0.19	0.94	0.20	1.20	0.09
ABSA	-0.03	-0.08	0.16	0.56	0.01
Bidvest	-0.16	-0.76	0.16	0.88	0.04
Barloworld	0.18	0.83	0.08	0.43	0.03
Woolworths	0.00	0.00	0.29	1.52	0.08
Investec Plc	0.44	0.96	0.67	1.47	0.24
Nampak	0.02	0.06	0.03	0.15	0.00
Investec Ltd	0.01	0.04	0.55	2.10	0.14
Amalgmated Beverages	-0.18	-0.77	-0.05	-0.27	0.03
Network Healthcare	0.17	0.68	0.34	1.60	0.11
Tiger Brands	-0.05	-0.25	0.12	0.67	0.02
Venfin	0.11	0.69	0.20	1.43	0.09