Portfolio Strategies for hedging against Rand weakness

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November 2006

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1. Introduction and Summary

The volatility of the Rand over the last twenty-five years has made most South Africans aware of the risk of holding Rand denominated assets. In this paper we show how optimised strategic equity positions on the Johannesburg Stock Exchange (JSE) may give protection against Rand weakness. We first consider how portfolio strategies may be used to hedge against South African exchange rate volatility in general (with a particular focus on the dollar Rand exchange rate) as well as how strategies may be used to optimise portfolios under expectations of either future strengthening or weakening of the Rand. However, since the primary focus has been on protection against Rand weakness we then formulate, test and compare the Rand hedge characteristics of JSE portfolios (using Top40 components) which are optimised to maintain foreign currency value in the face of Rand depreciation against well known Rand hedge portfolios such as the ITRIX exchange funds which track the FTSE100 in rand terms. The portfolios were re-estimated annually each July from 2003 to 2005 using the previous four and a half years of monthly data and were evaluated over the next 12 months, both for the entire 12 months and for subsections of the 12 months. The results showed that it is possible to form domestic portfolios that give consistent protection against a R/$ depreciation.

2. The History of SA exchange rate movements 1980-2006

South Africa over the last twenty-five years has been characterised by periods of exchange rate volatility and, apart from a recent period from early 2002 to late 2005, long periods of nominal and real Rand weakness. In Figure 1, we demonstrate and compare the behaviour of the real R/$ exchange rate and the nominal R/$ exchange rate over the period 1980-2006 when the rand has traded as a managed float and over some sub-periods with an associated freely traded *Financial Rand*. In August 1985, it is seen that the rand was subject to a severe real and nominal shock when the former Nationalist government resisted any change to democratic rule in South Africa and severely disappointed financial markets. As a result foreign capital was withdrawn on a very large scale, and the exchange rate weakened sharply. An exchange rate shock of equivalent magnitude to that experienced in 1985 occurred in

November and December of 2001 when the rand fell sharply but in this case the explanation for the shock was much less obvious and has largely defeated official attempts to explain it.[1]

The volatility of the nominal and the real rand over the more recent period; 1998-2006 is of particular interest. Over this period the nominal (and real) Rand first collapsed and then systematically recovered. Note that since the difference in the rates of inflation between South Africa and its trading partners has generally been of the order of 5% (or lower) over this period, the actual difference (in percentage changes) between the real and nominal exchange rate has been small. This leads to the important realisation that most of the exchange rate movement (again nominal or real) represents movements which one could classify as real shock, rather than stemming from inflation rate differences. By definition, such real shocks constitute unexpected movements in the exchange rate and this is exactly the type of movement that portfolio strategists would want to hedge against.

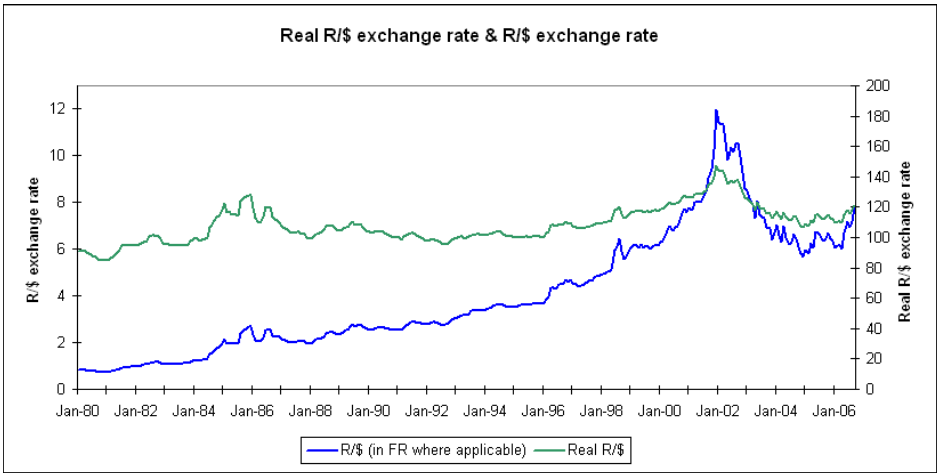

Figure 1: Real and nominal rand exchange Rates 1980.01 - 2003.04

Source: South African Reserve Bank

[1]See the Myburgh Commission of Enquiry into the collapse of the rand in 2001. (The commission's report is available at http://www.polity.org.za/html/govdocs/reports/). We have ascribed the rand's collapse to a panic demand for foreign exchange from wealthy individuals with newly found access to hard-currency assets made available through the asset swap mechanism. Effectively the only limits imposed on these demands for US dollars were the Rands individuals could muster for the purpose. We describe this panic demand for US dollars as one of the unintended effects of partial exchange control reform (see Kantor and Marchetti (2003).

2.1 The link between the Rand exchange rate and the JSE

The level of the JSE in current prices and the Rand exchange rate are obviously linked because both are simultaneously affected by South African inflation. If one considers the relationship since 1980 it is seen that the JSE has tracked the R/US$ exchange rate quite closely over the period until recently, implying a fairly long-run equilibrium value of the JSE measured in US dollars over the 26 year period examined. It is worth noting that at year-end 2002 the JSE was only about 20% higher in dollars than in the early eighties and since the real exchange rate in dollars has declined about 20% over the same period, the JSE had barely kept up with inflation up to 2002. In comparison, the US market has shown spectacular real growth over the same period. However, since 2002 the JSE has more than tripled in Rand value and has increased five fold in dollar terms, closing the gap on the US market.

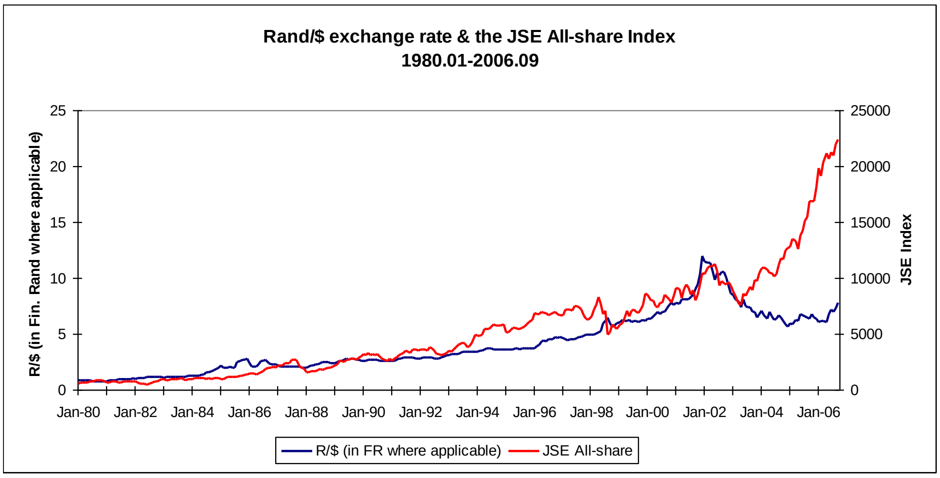

Figure 2: Rand/$ exchange rate and the JSE All-share Index 1980.01 - 2003.04

Source: South African Reserve Bank

Not all sectors of the JSE respond to exchange rate innovations in the same way and individual companies are clearly affected in line with the market's perceptions on how real exchange rate changes would impact on company operating profits and dividend flows. We first examine how the individual operating characteristics of listed companies would determine the way in which their profitability, and hence their share price, would be affected by exchange rate changes. We may in fact segment shares on the JSE into four broad categories following Barr and Kantor(2005);

Rand leverage companies, that is those companies with SA based operations who sell into foreign markets;

Rand hedge companies, that is those companies with foreign based operations who sell into foreign markets;

Rand play companies, that is those companies with SA based operations who sell primarily into the SA market;

Mixed companies, that is those companies which have a mix of the above and are not clearly classified into either of the three categorisations above.

The economic details relating to this categorisation is not central to this paper but is given in the appendix to this paper.

3. Literature Review

Barr and Kantor (2005) provided the framework for classifying shares according to their theoretical exposure. They grouped shares into three categories; Rand Play, Rand Hedge and Rand Leverage. Rand Plays had their revenue stream and costs based domestically (in Rands), Rand Hedges had their revenues and costs primarily based offshore (in foreign currency), Rand Leverage shares' revenues were in foreign currency with their costs in Rands. Barr and Kantor then tested the following regression model for each share *i* in the Top40 index:

$$R_{it} = \alpha_i + \beta_{i1} I_{1t} + \beta_{i2} I_{2t}$$

where

I_{1t} denotes the log percentage change on the R/$ exchange rate for time t

I_{2t} denotes the log percentage change on the Top40 index for time t

They found that, in general, the sign of the R/$ β corresponded to the direction given by the *a priori* classification of share *i*. This is an important result as it enables the *a priori* selection of shares with potentially positive R/$ Betas, implying benefit from a Rand depreciation.

Benson and Faff (2003) examined the exchange rate exposure of unlisted, Australian international equity funds from 1989 to 1999, a period characterised by large volatility in the Australian Dollar (AUD). These funds typically had more than 90% of their assets invested in international shares. Benson and Faff found weak evidence of exposure to the trade-weighted exchange rate. When bilateral exchange rates were used instead, the exposure to individual currencies was revealed and it was found that exposure was more prevalent for each of the currencies than had previously been estimated. The reason the trade-weighted exposure had been negligible was that the exposure to the U.S. Dollar was in general the opposite sign to the exposure to the other currencies. Benson and Faff also found exchange rate exposure to be inconsistent between time periods and reasoned that the decreasing exposure could be due to increased hedging by firms as the AUD became more volatile. This research is useful in the South African context as it suggests that one is more likely to find foreign exchange exposure in South African shares by using an important bilateral rate than by using a trade weighted exchange rate.

This idea was also tested by Dominguez and Tesar (2001), who using multiple bilateral exchange rates instead of a trade-weighted exchange rate to avoid the possibility of averaging out exposure, found considerable exchange rate exposure when examining companies based in Chile, France, Germany, Italy, Japan, The Netherlands, Thailand and the United Kingdom. They used.

Loudon (1993) investigated the exchange rate exposure of 141 Australian companies, using monthly data from 1984 to 1989. He found cross-sectional differences in exposure, with Resource companies benefiting from exchange rate depreciation and Industrials gaining from an appreciation. This confirms the notion of being able to categorise shares with respect to their exposure to the exchange rate.

Jorion (1990) was arguably the first to empirically examine the exchange rate as an explanatory variable when modelling share returns. He examined the exposure of U.S.

multinationals to a trade-weighted exchange rate from 1971 to 1987. Although he was unable to find widespread significance, Jorion (1990) was able to reject the hypothesis that exposure, measured by the exchange rate Beta, was zero for all multinationals.

3.1 Model Formulation and Nomenclature

The focus of this paper is the implementation of a methodology to hedge against a depreciation in the exchange rate against the dollar by investing locally, specifically in the JSE, and hence the problem is one of portfolio selection. Given the focus on the exchange rate, aside from the market, it was necessary to include a term for the R/$ exchange rate when modelling share returns.

Following Barr and Kantor (2005), this paper relies on regressing the log returns of each of the Top40 shares against the log returns of the Top40 Index and R/$ exchange rate. In order to avoid the problems associated with multicollinearity, the Top40 returns are orthogonalised relative to the R/$ exchange rate. Although the absence of multicollinearity is not a strict assumption of Ordinary Least Squares regression, multicollinearity can lead to instability in coefficients, with higher associated variances. Instability of the R/$ β would be a particular problem in this instance as different periods are used to form estimates of the betas and instability due to multicollinearity could make it very difficult to examine the consistency of exchange rate exposure. The relationship between Top40 returns and innovations in the exchange rate can be represented as equation (1).

$$R_{Tt} = \gamma_0 + \gamma_1 R_{\$t} + c_t \qquad (1)$$

Where

$R_{\$t}$ is the log return of the R/$ exchange rate at time t

R_{Tt} is the log return of the orthogonalised top40 index at time t

Regressing the top40 onto the exchange rate gives equation (2)

$$\hat{R}_{Tt} = \hat{\gamma}_0 + \hat{\gamma}_1 R_{\$t} \tag{2}$$

$R_{Tt} - \hat{R}_{Tt}$, denoted as R'_{Tt} is orthogonal to the exchange rate and represents the fluctuations in the top40 not explained by the exchange rate.

This allows the log return on each share *i* to be related to the movements of the exchange rate and the Top40 Index in the following manner:

$$R_{it} = \alpha_i + \beta_{i1} R_{\$t} + \beta_{i2} R'_{Tt} + e_{it} \tag{3}$$

Where

R_{it} is the log return of share *i* at time t

This is a two-index model, where index means "term" and is not indicative of an actual index being used, and is subject to the conditions, as shown in Elton, Gruber, Brown and Goetzmann (2000) and Sharpe (1970)

$$
\begin{aligned}
&1)\ \mathrm{corr}(e_{it}, e_{jt}) = 0 \quad \forall\, i \neq j \\
&2)\ \mathrm{corr}(R_{\$t}, e_{it}) = 0 \quad \forall \mathrm{i} \\
&3)\ \mathrm{corr}(\mathrm{R'}_{\mathrm{Tt}}, \mathrm{e}_{\mathrm{it}}) = 0 \quad \forall \mathrm{i} \\
&4)\ \mathrm{corr}(R_{\$t}, \mathrm{R'}_{\mathrm{Tt}}) = 0 \quad \forall\, i \neq j
\end{aligned}
$$

This is very close to a prespecified, two-index APT model. However, the methods used in this paper do not require the pricing of exchange rate exposure or the pricing of the Top40. All that is required is the ability to, *a priori*, select hedge shares, which Barr and Kantor (2005) have shown to be possible and thus the pricing factors remain in the alpha term.

For any given portfolio where share *i* constitutes (100*w_i)% of the portfolio, equation (4) relates the log return of the portfolio to the log returns of the exchange rate and the orthogonalised Top40 index.

$$R_{pt} = \alpha_p + \beta_{p1} R_{\$t} + \beta_{p2} R'_{Tt} + e_{pt} \qquad (4)$$

Where

R_{pt} is the log return of portfolio *p* at time t

$\alpha_p = \sum_i w_i \alpha_i$

$\beta_{p1} = \sum_i w_i \beta_{i1}$

$\beta_{p2} = \sum_i w_i \beta_{i2}$

$\sum_i w_i = 1$

The variance of portfolio p is given by :

$$w' \sum w$$

Where

w is the vector of weights associated with portfolio p

$\sum$ is the covariance matrix of the log returns of the shares.

Equation (1) is estimated via Ordinary Least Squares regression for each share *i*. This gives:

$$\hat{R}_{it} = \hat{\alpha}_i + \hat{\beta}_{i1} R_{\$t} + \hat{\beta}_{i2} R'_{Tt}$$

The estimated return on portfolio p can then be expressed as equation (5).

$$\hat{R}_{pt} = \widehat{\alpha}_p + \hat{\beta}_{p1} R_{\$t} + \widehat{\beta}_{p2} R'_{Tt} \tag{5}$$

Where

$\widehat{\alpha}_p = \sum_i w_i \widehat{\alpha}_i$

$\widehat{\beta}_{p1} = \sum_i w_i \widehat{\beta}_{i1}$

$\widehat{\beta}_{p2} = \sum_i w_i \widehat{\beta}_{i2}$

$\sum_i w_i = 1$

The expected return of portfolio p is:

$$\overline{R}_{pt} = \widehat{\alpha}_p + \widehat{\beta}_{p1} \overline{R}_{\$t} + \widehat{\beta}_{p2} \overline{R}'_{Tt} \tag{6}$$

Where

$\overline{R}_{it}$ is the expected log return of share *i* at time t

$\overline{R}_{\$t}$ is the expected log return of the R/$ exchange rate at time t

$\overline{R}'_{Tt}$ is the expected log return of the orthogonalised top40 index at time t

Elton, Gruber, Brown and Goetzmann (2000) have provided a summary of the research conducted both in using Indices formed from shares and using Fundamental factors in multi index models. One of the more important papers they reviewed was by Chen, Roll and Ross (1986) who introduced a set of non-equity factors to explain share price movement. Their model was successful in that they found certain factors to be significant, showing that factors affecting the future income of the firm have an effect on the returns in the share price. Others have looked at forming indices of companies to act as factors but the results in this field have been mixed with no clear dominance of multi-factor models over single-index models, this was clearly shown by Elton Gruber (1973) who found the single index model to be better at predictions as the multi-index model introduced too much noise. Elton et al. (2000)

concluded that while multi-index models have nice simplification properties, more research needs to be completed before multi-index models will be able to dominate simpler models.

4. Data and Methodology

The data used in this investigation were sourced from DataStream and McGregor and for all of the analysis, monthly data was used.

Following the literature, it was decided to use the bilateral R/$ exchange rate instead of the trade-weighted exchange rate. This is as a result of the possibility that a trade-weighted exchange rate might bias down the exchange rate exposure as it could include exchange rates that individual companies are not be exposed to. The R/$ exchange rate was used as the bilateral exchange as resource prices are typically priced in U.S. Dollars and most of the traditional Rand-hedges that are not resource companies are listed in England and the British Pound is highly correlated with the American Dollar. Returns for the exchange rate were defined such that a depreciation of the Rand against the dollar resulted in a positive return and an appreciation resulted in a negative return.

In the interests of liquidity and allowing the portfolios to be applicable to the investment community the universe of shares available for the portfolios was restricted to the consistent constituents of the Top40 index over the past few years**.** It was decided to set a minimum number of available entries for the estimation of the portfolios at 30 to prevent short-term movements dictating the constituents of the portfolio. This constraint eliminated the possibility of certain shares being placed in the portfolios, due to their date of listing disallowing 30 points in the time period. This meant that Telkom was excluded from the study.

The Itrix 100 was chosen to provide a benchmark to compare the effectiveness of the Rand hedges. The Itrix 100, owned by the JSE, Deutsche Securities and Sanlam, is effectively an index of the 100 largest stocks listed on the LSE. It was listed in South Africa very recently, October 2005, and in order to have sufficient data points to analyse it, its performance was simulated. This was achieved by taking the prices for the FTSE 100 and multiplying them by the Rand/Pound exchange rate. This allowed sufficient points for the test period.

4.1 Methodology

Given the literature on Multi-index models it was decided to use a two-index model to estimate the return generating process of the portfolios. The two indicess were the return of the R/$ exchange rate and the return of the Top40 index. The reason for this specification was that it allowed for an expectation of the movement of the exchange rate to have an impact on the expected return of a portfolio. This specification was also consistent with the literature regarding exchange rate exposure. As mentioned above a required assumption for index models is that the indices have to be independent. The correlation between the returns in the R/$ exchange rate and the top40 for the first, second and third periods was 0.25, 0.28 and 0.38 respectively. The significance of these values was investigated using the Fisher z-transformation and the p-values against a two-sided alternative were 16%, 12% and 2% respectively. Given the fact that the correlation was relatively consistent and sometimes significant it was decided to orthogonalise the two independent variables. This is also common in the literature for example, Benson & Faff (2003), Youguo & Mbodja (1996), Choi & Prasad (1995) and Jorion (1991) who orthogonalised the exchange rate relative to the market. Usually in the literature the market effect is removed from the exchange rate, but since the purpose of the paper is to protect against a predicted exchange rate movement it was decided to rather remove the exchange rate effect from the market through equation (2). As shown in Gilibetro (1985) the Top40 Beta is equal in value to the orthogonalised Top40 Beta. This allows the possibility of still examining the market risk of a portfolio, while obtaining independent explanatory variables.

The orthogonalised Betas were estimated for each of the shares in the Top40 using this two-step approach. First the Top40 Index was orthogonalised relative to the exchange rate using equation (2) and then equation (3) was run, giving the required estimated Betas. Once this had been completed it was possible to investigate the two portfolio estimation techniques.

4.1.1 The Naïve method

The first technique was to estimate the exchange rate and orthogonalised Top40 Betas using equation (4). Excel’s solver was then used to construct a portfolio from the available shares that maximised the portfolio’s exchange rate Beta. To disallow portfolios that were overly weighted in one share or invested tiny amounts in shares a constraint was added that forced an investment in a share to either be 0 or constitute between 5 and 25 percent of the portfolio. The constraints allowed for only one portfolio to be optimal and it had to include at least 4 shares. This effectively meant that the 4 shares with the highest R/$ beta were selected. This method would correspond with an investor anticipating a R/$ depreciation, or trying to hedge against one, with the assumption that if a share had a relatively high R/$ beta over the estimation period then it would still have a positive R/$ beta over the test period. The portfolio's Top40 beta was used to gauge the market risk of the portfolio.

4.1.2 The Efficient frontier method

The concept behind the second method was to calculate an efficient frontier allowing for not only movements in the market but also the exchange rate. This is the reason behind the multi-index approach. Equation (6) reduces the problem of estimating the return for each portfolio to a matter of estimating expected returns for the orthogonalised Top40 index and the exchange rate. The expected return on the Top40 index was taken as the average annual return over the estimation period. Since the Top40 has performed remarkably well over the past few years, the average is unlikely to be a good indicator for future performance. An expected return of the Top40 of the long term bond yield, measured by the R153, plus 4% was examined as well. This left only an expected return for the exchange rate to be estimated. Since the purpose of this paper is to provide a method of hedging against a possible R/$ depreciation, various expected returns for the exchange rate were used. The expected returns examined were a 5%, 10%, 15% and 20% depreciation in the R/$ exchange rate. These expectations need not be accurate as effectively the investor is requiring a list of shares to invest in for a given anticipated depreciation. The effect of changing the expected return of the exchange rate is examined later. Once the expected return for the Top40 Index and the R/$ exchange rate are fixed it is possible to calculate the expected return of the orthogonalised Top40 through equation (2).

The problem then becomes one of finding the minimum variance portfolio, assuming a return in the market with an expected depreciation of the Rand relative to the Dollar for each possible return on a portfolio. Thus one is estimating the return on the market and examining how the efficient frontier changes for each estimated return on the exchange rate.

Graphically one is looking at the following picture:

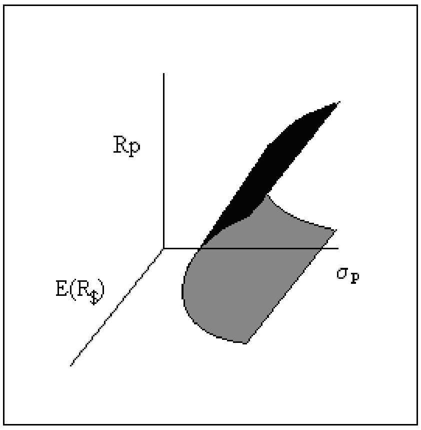

Figure 1: Efficient frontier for different expected depreciations

Where

Rp is the return on a portfolio

σ_p is the standard deviation of a portfolio

$E(R_\$)$ is the expected change in the exchange rate

The shaded region is an efficient frontier for differing values of $E(R_\$)$. The idea is to see how the constituents of the portfolios on the efficient frontier change as the expected return on the R/$ rate changes. In this case only positive values of $E(R_\$)$ are examined, these correspond to depreciations in the Rand relative to the dollar.

Instead of the usual efficient frontier, where one examines which portfolio of shares would have been optimal over the estimation period, this specification implies one is examining which portfolio of shares will be optimal if the market performed according to an expectation *and* the exchange rate does something specified, such as depreciate by 5%. Though this may seem to be imposing a specific relationship between the Top40 and the exchange rate, this assumption can be dropped later.

In order to examine the effects of differing expectations of the R/$ on the efficient frontier four cross sections along the $E(R_\$)$ axis in Figure 1 were examined, these were for 5%, 10%, 15% and 20% expected annual depreciations in the R/$ exchange rate. This gave four efficient frontiers for each window period.

Once the efficient frontier was determined the portfolio that maximised the Sharpe ratio was selected for testing. The average yield of the R153 was taken as the risk-free rate. Similarly to the previous method constraints were placed on the minimum and maximum possible allocations to each possible share with 5% being the minimum and 25% being the maximum. A constraint was added that ensured that the Top40 Beta was within 0.15 of 1 to ensure that the portfolio was able to maintain exposure to the market while hedging against a depreciation. Only shares with consistently positive R/$ Betas were looked at, this gave 16 shares to pick from, namely Anglo American PLC (AGL), Anglo Platinum (AMS), Anglogold Ashanti Ltd (ANG), BHP Billiton PLC (BIL), Gold Fields Ltd (GFI), Harmony Gold Mining Ltd (HAR), Impala Platinum Holdings Ltd (IMP), Kumba Ltd (KMB), Liberty International PLC (LBT), Richemont Securities AG (RCH), Remgro Ltd (REM), SAB Miller PLC (SAB), Sappi Ltd (SAP), Steinhoff International Holdings Ltd (SHF) and SASOL Ltd (SOL)

The performance of the selected portfolio was examined for the 12 months after the estimation period, with the assumption that the portfolio was rebalanced monthly to the allocation set out in the estimation period.

Both methods used 54 months of data to estimate their portfolios for the next 12 month period, at the end of 12 months the portfolios were re-estimated. This gave three portfolio test periods for each method, July 2003-June 2004, July 2004-June 2005 and July 2005-June 2006. These corresponded to the three estimation windows January 1999-June 2003, January 2000-June 2004 and January 2001-June 2005.

5 . Estimation

There were three test periods to evaluate for each of the methods. Each method was evaluated on two aspects, the orthogonalised R/$ beta and the risk-adjusted return during the test period. Since the objective is to hedge against a R/$ depreciation, the return during the months that the R/$ depreciated is also looked at separately from the periods when the Rand appreciated against the dollar.

The method using the maximisation of the R/$ beta produced the following portfolios during the three construction periods, only shares that were selected in a portfolio are displayed. N1, N2 and N3 represent the portfolio for the first, second and third test period respectively.

Portfolio allocations			
	N1	**N2**	**N3**
IMP	25%	25%	0%
AMS	25%	25%	25%
SOL	25%	25%	25%
LBT	25%	25%	0%
HAR	0%	0%	25%
AGL	0%	0%	25%
R/$ beta	0.8625	0.7706	0.9208
Top 40 Beta	1.1362	1.2221	1.1995
Start	1999/01/31	2000/01/31	2001/01/31
End	2003/06/30	2004/06/30	2005/06/30

Table1: Portfolio allocations for maximising R/$ Beta

Even though all of the top40 shares were available to pick from only six were selected over the three periods, and thus the portfolios are similar. This shows the stability of the ranking of the R/$ Betas, the four highest R/$ betas in the second period belong to the same set of shares with the four highest R/$ betas in the first period. Two of those four have are in the top four in the last period. This shows that by selecting the set of share with the highest R/$ betas allows for relatively consistent portfolios with respect to their constituents.

The following table represents the activity of the portfolios during the test period.

	N1	**N2**	**N3**
R/$ beta	0.4964	0.8346	1.3769
Top 40 Beta	1.0051	0.5523	1.9850
Start	2003/07/31	2004/07/31	2006/07/31
End	2004/06/30	2005/06/30	2006/06/30

Table 2: Orthogonalised Betas of portfolios during test period.

This table shows that while the R/$ beta is not consistent with respect to the value during the portfolio construction period and the test period, at least the sign remains consistent. In addition to this table, it is important to see how the portfolios performed with respect to returns during periods when the R/$ depreciated and when it appreciated. Ideally one would like the portfolio to perform better when the R/$ depreciated. These values are displayed in the tables on the following page (Tables 3-5).

It is evident from the tables that over the periods of investigation R/$ depreciation has not been as pronounced as in previous years. This can be seen by looking at the values for the annual R/$ return and the fact that in each of the years examined there were more months where the Rand appreciated relative to the Dollar than there were where the Rand depreciated against the dollar. The important statistics in the tables are that of the performance of the portfolio when the R/$ depreciated and when it appreciated. As can be seen in the table for the first two periods the portfolio selection method was successful in that the portfolio performed better when the R/$ depreciated than it did when the R/$ appreciated and the difference is quite large. The last period is different in that the portfolio performed better when the R/$ appreciated than when it depreciated. This is examined later.

N1					
	Portfolio	**R/$**	**Top40**	**Portfolio when R/$ Appreciated**	**Portfolio when R/$ depreciated**
Average return	13.40%	-19.70%	21.20%	2.55%	45.95%
Std. Deviation	19.76%	19.99%	15.45%	19.50%	21.21%
Return/Std. Deviation	0.678	-0.986	1.372	0.131	2.166
count	12	12	12	9	3

Table 3: Performance of P1 from 2003/07/31 to 2004/06/30

N2					
	Portfolio	**R/$**	**Top40**	**Portfolio when R/$ Appreciated**	**Portfolio when R/$ depreciated**
Average return	39.52%	8.10%	36.04%	1.53%	92.72%
Std. Deviation	21.16%	18.80%	16.28%	14.49%	20.26%
Return/Std. Deviation	1.868	0.431	2.214	0.105	4.576
count	12	12	12	7	5

Table 4: Performance of P2 from 2004/07/31 to 2005/06/30

N3					
	Portfolio	**R/$**	**Top40**	**Portfolio when R/$ Appreciated**	**Portfolio when R/$ depreciated**
Average return	70.73%	6.21%	43.91%	76.87%	62.13%
Std. Deviation	31.94%	16.37%	16.16%	17.00%	48.57%
Return/Std. Deviation	2.214	0.380	2.718	4.521	1.279
count	12	12	12	7	5

Table 5: Performance of P3 from 2005/07/31 to 2006/06/30

Where “count” refers to the number of months in the test period that is applicable to the column label.

The second portfolio construction method produced more portfolios as for each construction period a portfolio was constructed for a 5%, 10%, 15% and 20% expected annual depreciation in the R/$ rate.

The following table shows the allocations for each estimated depreciation in the exchange rate for the each of the first estimation period. Only shares that were selected in at least one portfolio are shown

	Expected depreciation of Rand relative to Dollar			
	5.00%	**10.00%**	**15.00%**	**20.00%**
IMP	0.2500	0.2500	0.2500	0.2406
SOL	0.1655	0.1729	0.2445	0.2129
LBT	0.0845	0.1865	0.2438	0.2500
BIL	0.2500	0.1658	0.0791	0.1109
GFI	0.2500	0.2248	0.1826	0.1856

Table 6: Portfolio allocations for the first period for each expected depreciation in the exchange rate.

The portfolios are remarkably similar, both in terms of constituents and in terms of allocations. This shows that the level of expected depreciation is not as important as expecting a depreciation of any value. This is an important result which suggests that there is a “best” set of shares to invest in irrespective of the level of expected depreciation as long as a depreciation is anticipated or needed to be hedged against.

Given the similarity between the portfolios, only the results corresponding to the portfolios formed with a 20% expected depreciation in the R/$ exchange rate are displayed. This makes the portfolio selection method comparable to the first method where the R/$ Beta was maximised and would benefit most from a large depreciation in the R/$ exchange rate. The next table displays the portfolio allocations for the multi index efficient frontier method for each estimation window. Portfolios are labelled M1, M2 and M3 corresponding to the first, second and third test periods respectively.

	Portfolio allocations		
	M1	**M2**	**M3**
IMP	0.2406	0.0915	0.0000
SOL	0.2129	0.2227	0.2500
LBT	0.2500	0.2500	0.1786
BIL	0.1109	0.0500	0.2500
KMB	0.0000	0.1446	0.1422
GFI	0.1856	0.0000	0.1791
REM	0.000	0.241	0.000
R/$ beta	0.7367	0.6087	0.7581
Top40 beta	0.9885	0.8500	0.8500
Start	1999/01/31	2000/01/31	2001/01/31
End	2003/06/30	2004/06/30	2005/06/30

Table 7: Portfolio allocations for Multi index optimisation

Whereas the method that maximised the R/$ Beta used four shares at a time, this method never uses less than five, with seven shares used over the entire test period. The portfolios are relatively consistent with regard to their constituents, with each portfolio sharing 4 shares with the next period's optimal portfolio. LBT, SOL and BIL appear in each of the portfolios, with SOL and LBT consistently receiving high allocations. This shows that resource stocks are not necessarily the best hedges, but rather duel listed shares and SASOL.

The tables on the following page (tables 8-10) show the performance of the portfolio using the same measures as before.

M1					
	Portfolio	**R/$**	**Top40**	**Portfolio when R/$ Appreciated**	**Portfolio when R/$ depreciated**
Average return	10.12%	-19.70%	21.20%	2.60%	32.67%
Std. Deviation	18.65%	19.99%	15.45%	18.34%	21.97%
Return/Std. Deviation	0.54	-0.99	1.37	0.14	1.49
count	12	12	12	9	3

Table 8: Performance of M1 from 2003/07/31 to 2004/06/30

M2					
	Portfolio	**R/$**	**Top40**	**Portfolio when R/$ Appreciated**	**Portfolio when R/$ depreciated**
Average return	47.30%	8.10%	36.04%	22.61%	81.86%
Std. Deviation	14.94%	18.80%	16.28%	12.64%	12.67%
Return/Std. Deviation	3.17	0.43	2.21	1.79	6.46
count	12	12	12	7	5

Table 9: Performance of M2 from 2004/07/31 to 2005/06/30

M3					
	Portfolio	**R/$**	**Top40**	**Portfolio when R/$ Appreciated**	**Portfolio when R/$ depreciated**
Average return	54.72%	6.21%	43.91%	77.24%	23.19%
Std. Deviation	22.34%	16.37%	16.16%	10.76%	31.96%
Return/Std. Deviation	2.45	0.38	2.72	7.18	0.73
count	12	12	12	7	5

Table 10: Performance of M3 from 2005/07/31 to 2006/06/30

Where “count” refers to the number of months in the test period that is applicable to the column label.

Even though this method differs from the naïve method the results are similar in that the constructed portfolio performs better when the R/$ depreciates for the first two periods but this is not so for the last period.

The explanation for the lower performance in the third period is not necessarily obvious. This is a strange result as it shows that two different sets of traditional Rand hedges performed better when the Rand appreciated than when the Rand depreciated. A possible explanation is that this was due to shares rising due to positive sentiment that happened to occur while the Rand appreciated in value and this is plausible since the test period was a period of rapid share price growth that was not associated with higher R/$ volatility.

The last investment option examined was the Itrix Exchange traded Fund. Since this is based on the FTSE 100 it should give a natural hedge to the R/$ exchange rate as the correlation between the British Pound and the American Dollar is traditionally very high. The following table gives the beta values of the Itrix fund for the three test periods:

	Itrix fund		
	I1	**I2**	**I3**
R/$ Beta	0.960	0.614	0.537
Top40 Beta	0.425	0.317	0.133
Start	2003/07/31	2004/07/31	2005/07/31
End	2004/06/30	2005/06/30	2006/06/30

Table 11: Orthogonalised Betas Itrix during test periods.

The positive values for the R/$ Beta confirm the belief that the Itrix should act as a natural hedge against Rand depreciation while the relatively low top40 Beta confirms that the Itrix's weak relationship with the performance in the South African market.

The returns for the simulated Itrix fund are displayed in the tables on the following page (tables 12-14). As can be seen the Itrix fund always performs better when the R/$ depreciates than it does when the R/$ appreciates. This comes at the expense of a lower return for the fund, this is due to the fact that as the shares are based in England they would not have been able to participate in the recent rapid growth seen on the JSE.

I1					
	Portfolio	**R/$**	**Top40**	**Portfolio when R/$ Appreciated**	**Portfolio when R/$ depreciated**
Average return	6.32%	-19.70%	21.20%	-27.35%	107.34%
Std. Deviation	21.63%	19.99%	15.45%	13.84%	10.28%
Return/std deviation	0.292	-0.986	1.372	-1.977	10.442
count	12	12	12	9	3

Table 12: Performance of I1 from 2003/07/31 to 2004/06/30

I2					
	Portfolio	**R/$**	**Top40**	**Portfolio when R/$ Appreciated**	**Portfolio when R/$ depreciated**
Average return	25.01%	8.10%	36.04%	-0.97%	61.37%
Std. Deviation	12.33%	18.80%	16.28%	5.91%	11.38%
Return/std deviation	2.028	0.431	2.214	-0.164	5.395
count	12	12	12	7	5

Table 13: Performance of I2 from 2004/07/31 to 2005/06/30

I3					
	Portfolio	**R/$**	**Top40**	**Portfolio when R/$ Appreciated**	**Portfolio when R/$ depreciated**
Average return	26.02%	6.21%	43.91%	13.23%	43.94%
Std. Deviation	9.11%	16.37%	16.16%	7.99%	8.67%
Return/std deviation	2.856	0.380	2.718	1.655	5.071
count	12	12	12	7	5

Table 14: Performance of I3 from 2005/07/31 to 2006/06/30

Where “count” refers to the number of months in the test period that is applicable to the column label.

The following tables provides a comparison of the three possible methods of R/$ hedging using portfolio allocation. Each method is compared on its return and average regression coefficients over the three estimation periods. P represents the portfolio that maximised the R/$ Beta. M refers to the portfolio derived from the multi index efficient frontier approach and I refers to the Itrix 100.

	Average return	Average return when R/$ Appreciated	Average return when R/$ depreciated
N	41.22%	26.98%	66.94%
M	37.38%	34.15%	45.90%
I	19.12%	-5.03%	70.89%

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Table 15: Performance of the three Rand hedge methods

	Average R/$ Beta	Average Top40 Beta
N	0.9026	1.1808
M	0.4790	0.9716
I	0.7040	0.2919

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Table 16: Regression coefficients of the three Rand hedge methods

If the R153 plus 4% is used to estimate the return on the Top40 instead of the average return over the estimation period then the following results are obtained for the efficient frontier model:

	Average return	Average return when R/$ Appreciated	Average return when R/$ depreciated
M'	39.69%	35.44%	52.44%

Table 17: Performance of efficient frontier method with R153+4% as expected Top40 return

	Average R/$ coefficient	Average Top40 coefficient
M'	0.5870	0.9743

Table 18: Regression coefficients of the efficient frontier method with R153+4% as expected Top40 return

These results are very similar to the results obtained for the efficient frontier method when the past performance of the Top40 Index was used to predict the future performance. Since the expected returns are similar this suggests that the results of the efficient frontier method are not greatly affected by the expectation placed on the Top40 Index.

The Itrix provides the highest average return when the Rand depreciates against the Dollar, and the lowest of the average returns when the Rand appreciates. This suggests that the Itrix is the most effective Rand Hedge of the methods surveyed. The Betas tell a different story. The R/$ beta maximisation method comes out with both the highest average R/$ Beta and the highest average top40 Beta, reflecting the higher risk inherent in this method. The efficient frontier approach has a lower R/$ beta than the Itrix but an average top40 Beta that is closer to 1 and higher than the Itrix Beta. These statistics reveal the problem associated with simply investing in the Itrix, that of lower exposure to the South African market. Recently this would have led to lower returns as the top40 has done extremely well recently. This is reflected by the fact that the Itrix had the lowest average return of the three methods investigated.

6. Conclusions:

The results show that it is possible, in general, to hedge against a R/$ depreciation by investing locally and that even a simple portfolio construction technique that does not pay attention to risk of the portfolio is able to perform better when the R/$ depreciates than when it appreciates. In terms of hedging against a R/$ depreciation the results show that while the Itrix fund provides more consistent hedging this comes at the expense of a weak relationship with the top40. Thus it would seem that the Multi-index efficient frontier approach is the best as it allows for higher risk-adjusted returns than the beta maximising approach, while allowing for more correlation with the market than the Itrix approach. The constituents of the multi-index optimisation method show that resource stocks are not necessarily the default Rand Hedges, in some cases dual listed shares perform better.

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Appendix

Categorisation of listed companies on the JSE in terms of exchange rate movement response

Share prices on the JSE clearly reflect the market's best attempt to find the present value of the expected benefits from owning a share of the company. These benefits will be derived from expected future earnings and dividends or from the sale or liquidation of the company.

These earnings and dividend flows from JSE listed companies may be generated from:

a) company operations that are almost completely SA-based. We define these companies listed on the JSE as *rand plays*, e.g. retailers (such as Pick 'n Pay) or banks (such as Absa) with almost all their revenues generated and costs incurred in South Africa in rands;

b) companies listed on the JSE that are almost completely foreign based, generating only foreign 'hard' currency income and incurring only foreign costs and known as *rand hedge* stocks, e.g. Liberty International, a UK property owner and developer, or Richemont;

c) companies that are SA-based and incur costs in SA but sell their products in hard currency, e.g. resource stocks such as Harmony, which we describe as *rand leverage* stocks.

We consider the dividend at time *t* (expressed in rands) and denoted Div_t for each of the cases above:

a) *Rand play*: Div_t is proportional to profit at time *t*,

$$(R)Rev_t - (R)Cost_t$$

b) *Rand hedge*: Div_t is proportional to profit at time *t* denominated in, say, US dollars and then converted into rand to give,

$$R/\$_t * (\$Rev_t - \$Cost_t)$$

hence the profits of a rand hedge company in dollars will be directly impacted upon by the rand/US$ exchange rate; a weaker exchange rate will increase the dividend flow in rands for any given profit in dollars.

c) *Rand leverage*: in the third group (typically resource companies), the rand price of their shares reacts to the dollar prices of their traded resources as well as to the rand/US$ exchange rate. A weaker rand increases the rand price of commodities and lowers the dollar-denominated costs of inputs, mainly labour. This effect would, primarily, be a short-term effect. Prices and particularly labour costs would be expected to rise as a PPP equilibrium was re-established and the real rand depreciation eliminated. Thus, a weaker rand would result in an increase in dollar earnings for as long as dollar costs were below their PPP value; as PPP is re-established, dollar prices of labour would rise.

In this case, as in (b) above, Div_t is proportional to dollar profit at time t denominated in dollars and then converted into rands. Although revenues are earned in dollars, costs are denominated in rands to give dollar profit at time *t*:

$$R/\$_t * \left(\$Rev_t - (R)Cost_t * \left(1/_{R/\$_t} \right)\right)$$

However, rand costs rise in line with the consumer price index. Thus, dollar costs will be linked to the relative movement of the CPI and the exchange rate. At time t+n, dollar profit will be:

$$R/\$_{t+n} * \left(\$Rev_{t+n} - (R)Cost_t * \left(CPI_{t+n}/_{CPI_t} \right) * \left(1/_{R/\$_{t+n}} \right)\right)$$

Thus, assuming dollar revenues are fairly stable, dollar profits *n* periods in the future are determined by the relative movement of the CPI to the rand/US$ exchange rate over the *n* periods. For example, rand depreciation will lower dollar costs and create a leveraged effect on dollar profits. But, as CPI catches up over time with any depreciation in the rand (or vice versa) and PPP is re-established, the leverage effect dissipates and the short-term improvement in dollar profits due to the real rand depreciation disappears. In other words, leverage effects measured in dollars which stem from an exchange rate depreciation are merely short-term effects and do not fundamentally affect long term value.

In rand terms, prices should reflect these leveraged dollar effects values but, assuming PPP will hold, the long term value should primarily be determined by expectations of dollar-denominated resource prices and expectations of rand/US$ exchange rates.