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A decomposition of style-based risk on the JSE

1. INTRODUCTION

South African finance research has often taken its lead from prominent trends in the more developed US literature[1]. Recently, there has been a pronounced shift in focus in US asset pricing research as a result of the empirical success of, what have become labelled as, "*style variables*" in explaining the cross-section of equity returns. To cite a striking example, Baker and Haugen (1996:435-436) examine over fifty candidate factors, including the Chen, Roll and Ross (1986) priced macrovariables over

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five economies and conclude *"... it is noteworthy that none of the factors related to sensitivities to macroeconomic variables seem to be important determinants of expected stock returns*"[2]. While, this avenue of enquiry has had particular attention drawn to it in the wake of the controversial Fama and French (1992) study, the pre-1990 US literature abounds with evidence on the size effect (Banz, 1981, Reinganum, 1981a, 1981b); the price-earnings effect (Basu, 1977, 1983); the January effect (Rozeff and Kinney, 1976, Keim, 1983 and Roll, 1983); the market-to-book effect (Statman, 1980, Rosenberg, Reid and Lanstein, 1985); the dividend yield effect (Keim, 1984) and the leverage effect (Bhandari, 1988). Indeed, the central debate appears to have been on the interrelationships between these effects rather than the issue of their existence (see Cook and Rozeff, 1984 and Jaffe, Kiem and Westerfield, 1989).

This paper aims to investigate empiricaly the identity of the style factors that explain the expected returns of JSE industrial shares. A cluster analysis methodology is applied to examine the interrelationships between these factors in order to extracting a parsimonious decomposition of style-based risk. The article is organised as follows. In Section 2 a detailed review of both international and South African prior research is

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presented. The focus of this review is on the Fama and French (1992) study and the interpretation of its findings. Section 3 outlines the methodology and data to be used in the empirical portion of this paper and candidate style factors are suggested within the framework of the Gordon and Shapiro (1956) constant growth dividend discount model. In section 4 the results of the empirical analysis are presented and discussed. Section 5 concludes the paper.

2. A REVIEW OF PRIOR RESEARCH

2.1 A review of international research

In a widely acclaimed study[3], Fama and French (1992:428) found that over the period 1963 to 1990, the 'anomalies' size, price-earnings ratio (P/E), leverage and book to market ratio (B/M) were found to have strong individual relationships with the average returns realised on portfolios sorted according to these characteristics. In the search for a parsimonious model, Fama and French found that size and B/M subsumed the influences of leverage, P/E ratios and a negative earnings dummy. It was also found that portfolios ranked according to P/E and M/B are not closely related to market betas. Indeed,

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(1982), Fama and French are dubious as to whether defenders of the capital asset pricing model (CAPM) will be able to specify a market portfolio that will lead to beta estimates that (i) are characterised by a positive relation with average returns and (ii) subsume the strong influence of the 'anomalies'. Fama and French suggest a ancillary role to the once deified beta *"... if there is a role for β in average returns, it is likely to be found in a multifactor model that transforms the flat simple relation between average return and β into a positively sloped conditional relation*" (1992:449).

A body of literature has rapidly developed attempting to ascertain the most appropriate economic interpretation of these findings. These papers can be classified into the following groupings: (i) Arguments of methodological bias (Lo and MacKinlay, 1988; Black, 1993; Mackinlay, 1995 and Kothari, Shanken and Sloan, 1995); (ii) Arguments of investor irrationality (De Bondt, 1991; Lakonishock, Shiefer and Vishny, 1994; Haugen, 1995 and La Porta, 1996) and (iii) arguments of investor rationality (Fama and French, 1993, 1995, 1996a, 1996b).

2.1.1 Interpretation of findings: arguments of methodological bias

These arguments do not take a position on which branch of the CAPM-market efficiency joint hypothesis should be rejected as a result of these empirical findings. Rather, it is contended that the 'anomalies' identified in explaining the cross-section of returns are spurious and, therefore, the need for economic interpretation is obviated. This section discusses recent evidence regarding the methodological concerns of 'look ahead' bias, 'survivorship' bias, 'data snooping' and thin-trading.

Banz and Breen (1986) and, more recently, Kothari, Shanken and Sloan (1995) raise the issues of 'look-ahead' and 'survivorship' bias, with both arguing that the former is the more serious of the two maladies. Look-ahead bias occurs when predictor variables are used which were unknown to market participants at the time they are dated in the data set. For example, a firm may announce unexpectedly high earnings, raising its current share price. If this earnings figure is used to construct the firm's price-earnings ratio in a period predating the earnings announcement (such as the financial year-end), the firm will be ascribed a misleadingly low multiple and its 'subsequent' superior share price performance will follow by construction (Banz and Breen, 1986:789). This argument is not disputed in the international literature.

The debate regarding survivorship bias has been closely linked to a consideration of the nature of the data used in empirical investigations of asset pricing relationships. The Center for Research into Security Prices (CRSP) monthly share-price data set is the most popular return data employed by US researchers. Financial statement information from 1963 onwards may be obtained from the COMPUSTAT tapes. Kothari, Shanken and Sloan (1995) argue that while the CRSP database does not suffer from a survivorship bias problem (1995:187), Fama and French (1992) only examine firms which also have accounting data available over the 1963-1990 period on the COMPUSTAT tapes. Kothari *et al* draw particular attention to the 1978 expansion of the COMPUSTAT database from 2700 NYSE, AMEX and NASDAQ securities to approximately 6000 survivors for whom five years of data was retroactively added. If survivorship bias is evident in the COMPUSTAT database, Kothari *et al* reason that those firms listed on the CRSP tapes but not on COMPUSTAT would comprise a disproportionate number of distressed firms. Consistent with this conjecture, it was found that the mean annual returns of the COMPUSTAT portfolio was significantly larger than the 'relatively distressed' CRSP minus COMPUSTAT portfolio. This difference could not be attributed to market betas. As the average market capitalisation of COMPUSTAT firms were approximately twice that of CRSP firms this result could clearly not be attributed to a small-firm effect either. In order to avoid the survivorship bias present in the COMPUSTAT tapes, Kothari *et al* collected accounting data from the S&P Analysts Handbook. Kothari *et al* found that the book-market (B/M) effect persisted but that it was much weaker than that estimated by Fama and French (1992). In addition, when estimating βs using annual data it was found that β was significantly positively related to the cross-section of returns even after controlling for size. However, as Fama and French (1996a) clarify, even this evidence cannot be interpreted as supportive of the CAPM[5].

Davis (1994) provides findings that seriously dilute the impact of Kothari *et al's* arguments[6]. Davis collects fresh accounting data from Moody's Industrial Manuals which are void of look-ahead or survivorship bias. A random

(and supportive) CAPM tests of Black, Jensen and Scholes (1972) and Fama and MacBeth (1973). However, even in over this period, β did not have any explanatory power when controlling for firm size.

[5] *"... the main implication of the CAPM is that in a market equilibrium, the value weighted market portfolio, M, is mean-variance efficient. The mean-variance efficiency of M, in turn, says that:*

(i) *β, the slope in the regression of a security's return on the market return, is the only risk needed to explain expected return;*

(ii) *There is a positive expected premium for β risk.*

Our main point is that evidence of (ii)...is only support for the CAPM if (i) also holds" (Fama and French ,1996a:1948)

[6] Kothari *et al (*1995:footnote 1), indeed, acknowledge this fact and state that they were only aware of the findings of Davis (1994) in the final stages of their work.

sample of 100 firms in the top half of the CRSP size ranking over the, pre-COMPUSTAT and previously unexamined, 1940-1963 period was selected for analysis. It was found that B/M, E/P and the cash-flow to price ratio (CF/P) are able to explain the cross-section of portfolio returns with each of these variables having stronger explanatory power in January. However, Davis found no clear pattern of dominance between these effects. Of importance with regard to the CAPM-market efficiency joint hypothesis, the univariate relationship between both β and returns was estimated to be flat. Similarly, it was found that firm size was unable to explain the cross-section of returns. These last two findings were attributed to (i) β's negative correlation with size and (ii) the fact that small firms were (deliberately) excluded from the sample, reducing the power of the tests. Davis unambiguously interprets his results as supporting the findings of Fama and French (1992): "*While there is no guarantee that these fundamental accounting variables will continue to be related to subsequent stock returns, the evidence presented here, together with the evidence in Fama and French (1992) and other studies of the period from 1963 forward, demonstrates that such relationships have been present for at least the past half century. These relationships are not artefacts of data snooping or survivorship bias in the accounting data*" (1994:1593).

Chan, Jegadeesh and Lakonishok (1995) conduct a thorough investigation on the impact of selection bias. Surprisingly, they find that the primary reasons for delisting from the COMPUSTAT database are, in reality, entirely unrelated to financial distress (e.g. due to mergers, non standard accounting information, listed closed end investment funds etc.). Their investigations reveal that at most only 3.1% of the company-years in the CRSP sample are omitted because of financial distress. Chan *et al* conduct an empirical analysis on the largest 20% of NYSE-Amex shares, which they consider are immune from survivorship bias (Fama and French, 1996a:1949 also hold this view). When accounting data on those securities omitted from the COMPUSTAT database is collected and these firms are included in the sample, no appreciable difference in the magnitude of the P/E effect is observed. Note that the arguments of Chan *et al* (1995) and Fama and French (1996a) above suggest that survivorship bias is unlikely to be a major distorting influence in those South African studies that employ large non-thinly traded firms in their samples.

MacKinlay (1988), Black (1993) and Lo and MacKinlay (1995) highlight the methodological problem of "*data-snooping*". Due to the intensive study of the CRSP equity price database by a growing number of academics, it is inevitable that 'spurious' (sample-specific) predictors of returns are likely to be identified. Using these anomalies to specify an asset pricing model and testing it on the same database results in a self-fulfilling and economically vacuous account of reality. However, rigorously applied, the data-snooping argument gives rise to the falsifiable prediction that the spurious relationship should not persist in independent samples. The fact that international evidence has found evidence of M/B and P/E effects in foreign markets indicates that they are not sample specific (Chan, Hamao and Lakonichok, 1991; Capaul Rowley and Sharpe, 1993; Haugen and Baker, 1996 see also Plaistowe and Knight, 1987 and Page and Palmer, 1991 to be discussed in section 2.2). Haugen and Baker (1996) further find that payoffs of similar signs and magnitudes were estimated for the twelve most important factors across their sample of five of the major world equity markets. This being despite the fact that these payoffs were not found to be temporally correlated across markets. To the extent that the South African dataset employed in this study is "fresh", its findings are untainted by accusations of data snooping. Section 4 outlines how the potential problems of look ahead and survivorship bias are catered for in the empirical analysis conducted in this study.

2.1.2 Interpretation of findings: accounts of investor irrationality

The international literature provides empirical evidence that has been interpreted to support the overreaction hypothesis. In an influential study using monthly return data over the period 1926 to 1982, De Bondt and Thaler (1985) found that shares that performed poorly over the previous three to five year period ('losers') tend to significantly outperform the past 'winners' in the next three to five years. In addition, it was found that the average β of the loser portfolio was lower than that of the winner portfolio. De Bondt and Thaler attribute the P/E effect to investor overreaction: "*... companies with very low P/E ratios are thought to be temporarily undervalued because investors become excessively pessimistic after a series of bad earnings reports or other bad news. Once the future turns out to be better than the unreasonably gloomy forecasts the price adjusts*" (1985:794). De Bondt and Thaler (1987:579) confirm their earlier results and also assert that the overreaction effect is not due to firm size.

Jegadeesh and Titman (1993) apply a revealing methodology to NYSE data over the period 1980 to 1990. Firms are ranked according to the returns realised over the previous six months, the upper and lower deciles being classified as 'winners' and 'losers' respectively. The performance of these firms is then observed over the subsequent 36 months. However, in each month only those firms that report earnings during that month are examined. Furthermore, in each case returns are only measured over the three days prior to and including the announcement day. It was found that the winner portfolio shares were subject to positive 'earnings surprises' over the seven months following portfolio formation while the converse was the case with the loser portfolio. However, after the eighth month it was found that the winner portfolio was persistently being negatively 'surprised' by earnings announcements and *vice versa*. By the end of the three year period the cumulative performance of the loser portfolio was significantly greater than that of the winner portfolio. This result provides convincing evidence of overreaction (persistence) and subsequent correction (mean reversion) in investor perceptions.

After adjusting for survivorship and look-ahead bias, Lakonishok, Shliefer and Vishny (1994) compare annual returns realised on 'growth' and 'value' portfolios over the period 1968-1989. On the basis of (i) the consistency of returns; (ii) performance during 'bad' periods; (iii) β and (iv) the standard deviation of returns, no evidence was found that value strategies are more risky that the purchase of growth stocks. Lakonishok *et al* also test the extrapolation hypothesis. It was found that poor past performance (as measured by returns, earnings, cash-flow and sales growth) was associated with low expectations of future growth (as measured by earnings, cash-flow and sales to price ratios). Looking at realised future performance it was found that expectations were borne out in the short run but after the first few years the earnings growth of all firms had reverted to the mean. These results are interpreted as positive evidence of investor extrapolation of past performance in a manner that overvalues past winners and undervalues past losers.

La Porta (1996) directly examined expectations of (five year) earnings growth as taken from the Institutional Brokers Estimate System (IBES) earnings forecasts. As institutional investors both subscribe and contribute to this service, La Porta argues that it provides a reasonable representation of investor expectations. Portfolios of securities are ranked according to their expected future growth rate of earnings and are empirically compared. It was found that returns on the value (low expected growth) portfolios significantly outperformed glamour (high expected growth) portfolios. It was also found that the value portfolios were associated with lower standard deviations, market betas and superior performance in 'bad years' than the glamour stocks. Thus, it was concluded that conventional measures of risk could not explain the superior performance of the portfolios of lower esteemed firms. La Porta also empirically examines the link between B/M and expectations of earnings growth. It was found that B/M was able to significantly explain both the sign of investor forecast errors and the direction of revision of subsequent forecasts. La porta concludes *"... part of the reason why B/M explains stock returns in my sample is that it is correlated with errors in expectations"* (1996:1732)[7].

In explaining why the effects of irrationality are not removed by competition between investors, Haugen (1995) argues that due to agency related problems, institutional investors will be disproportionately attracted to highly esteemed glamour stocks. The inclusion of these shares, which have provided good returns in the past and are unlikely to go bankrupt in the foreseeable future, are favourably perceived by naïve investors and attract their funds. As institutional investors are typically remunerated in terms of a proportion of the funds under their control, agency concerns thereby prompt 'window dressing' through including (excessively) highly esteemed companies in their portfolio. In addition, the incentive structure of institutional fund managers is further focused on short-term returns rather than the longer horizons required for value investing to consistently pay-off. A picture is painted of portfolio managers earnestly competing between each other to consistently 'surf the wave' of short-term over-reactionary persistence in the returns of glamour stocks and paying less attention to their longer term mean reversion. Lakonishok *et al* (1994:1576) also suggests that evidence of underperformance on the part of institutional portfolios may in part be attributed to their preoccupation with growth stocks and points out that institutional buying policies often automatically screen out firms with any possibility of future financial distress. Haugen (1995) consolidates an holistic interpretation of prior research starkly at odds with the efficient market hypothesis. Haugen argues that P/E ratios are able to predict levels of earnings growth up to five years in the future. However, these predictions are biased in that they do not adequately take account of the fact that future earnings are mean reverting in nature (Fuller, Herberts and Levinson, 1993). Haugen argues that investors project recent rates of earnings growth in to the future and in doing so underestimate the influence of future competition in the underlying markets for goods and services. Consequently, the P/E anomaly is attributed to overreaction on the part of investors and Haugen, thus, interprets value stock investing as essentially being a contrarian strategy.

2.1.3 Interpretation of findings: accounts of investor rationality

Fama and French (1992, 1993, 1995, 1996a) consistently point out that their findings are compatible with efficient markets and multifactor asset pricing models such as the

[7] Of interest to the investor is La Porta's finding that 'value' firms that were also characterised by high sales growth in the five years prior to portfolio formation, strongly outperformed those value stocks that had poor prior sales growth. The conjunction of these two features is reminiscent of Graham and Dodd (1934).

APT. This argument rests on the interpretation that size and B/M constitute proxies for unobserved risk factors (Fama and French, 1995:131 *inter alia*). This argument was first propounded by Ball (1978). As riskier firms will tend to have higher expected returns and, hence, *ceteris paribus* lower prices, Ball proposes that the P/E ratio captures the effects of omitted risk factors in asset pricing tests. Thus, the reason for the P/E, and related price to accounting variable anomalies is ascribed to inadequately specified asset pricing models rather than informational inefficiency.

Fama and French (1995) find high M/B firms are characterised by *persistently* higher profitability as measured by return on equity (E/B) than low M/B firms. Controlling for M/B, size was similarly related to profitability. Unlike Lakonishok *et al*, Fama and French (1995) find that market prices reflect unbiased estimates of future earnings growth. In particular, it is argued that mean reversion in growth rates is adequately discounted in current prices. Further it is proposed the persistence of the higher returns observed to be associated with low M/B and small firm supports the contention that these returns are the product of equilibrium pricing rather than, a necessarily temporary, correction to overreaction. The empirical analysis revealed that size, M/B and market factors were also present in earnings i.e. analogous to the case of returns, the earnings of factor mimicking portfolios were able to explain the cross-section of earnings. Fama and French's economic account is further supported by the finding that the size and market factors in earnings could significantly explain the variation of these factors in returns. However, no similar relationship was found between the M/B mimicking portfolios. Fama and French attribute this latter finding to noisy measurements of shocks to expected earnings but wryly concede that "*...our colleagues in behavioural finance will surely suggest another explanation*" (1995:155).

Reviewing previous findings, Fama and French (1996a) make a case for the appropriateness of their three factor model in applications such as the estimation of companies' cost of capital, portfolio performance evaluation, investment portfolio selection and measuring abnormal returns in event studies conducted in the US financial environment. They argue that their model can be cast within the theoretical framework of the APT or Merton's (1973) intertemporal CAPM and contend that it explains "*much of*" the cross-sectional variation in stock returns. Fama and French (1996a) empirically investigate to what extent the model can explain the return anomalies associated with the CAPM. They find that the model subsumes the influences of past sales, P/E, CF/P and the long-term return reversals documented by De Bondt and Thaler (1985, 1987). However, it was found that size, M/B and a market factor could not account for the medium-term persistence in returns observed by Jegadeesh and Titman (1993). Fama and French (1996a) concede that despite the demonstrated empirical superiority of their model over the CAPM, the economic interpretation of the factors, still remains an key unresolved issue. While Fama and French (1995) provide evidence that M/B may proxy for relative distress, Fama and French (1996a) view this work as preliminary to the outstanding task of couching this empirically inspired model within a firmer theoretical framework.

2.2. A review of the South African literature

Van Rensburg (1998) provides an integrated review of South African asset pricing research employing the factor analytic and prespecifed macroeconomic variable approaches to identifying priced sources of risk on the JSE. It is suggested that the returns on the JSE Industrial and JSE All-Gold Indices may be employed as observable proxies for the first two principal components extracted from the covariance matrix of JSE returns. van Rensburg and Slaney (1997) demonstrate that a two factor APT model specified in this manner provides a superior account of the asset pricing relation operational on the JSE than the CAPM. Furthermore, van Rensburg (2000) demonstrates that the factor analytically inspired two factor model subsumes the influence of the macroeconomic variables found to be priced on the JSE and, thus, can be seen as a parsimonious account of the relationship between economic forces and JSE returns. Following the recent (March 1999) reclassification of the JSE Indices, van Rensburg and Zhu (2000) found that the JSE Financial-Industrial (CI21) and Resources (CI11) Indices could be used as the two factor proxies in future applications of the model. The arguments surrounding this branch of research are discussed in considerable detail in the references alluded to above. Suffice to say, for the purposes of this paper they motivate the investigation of whether any of the style-based 'anomalies' identified persist in the presence of the two factor APT model and, thereby, whether a style-based augmentation is required to the two factor model.

Prior research on CAPM anomalies, which provide important evidence on the ability of 'non-β' variables to explain the cross-section of returns, reveal further features of the JSE that serve to distinguish it from the NYSE. While the *"most prominent"* (Fama and French, 1992:450) anomaly in the US environment is the size effect of Banz (1981), De Villiers, Lowlings, Petit and Affleck-Graves (1986) found no evidence of a size-effect over the period 1976-1980. Indeed, firms of smaller market capitalization were found to insignificantly underperform larger firms according to the Sharpe measure. In contrast to the well established documentation of a January effect on the NYSE (Rozeff and Kinney, 1976; Kiem, 1983 and Roll, 1983 inter alia), Bradfield (1990) found no evidence of a January effect on the JSE. He did, however, find evidence of a mild December effect, and a July effect for mining shares. The excess returns in the month of December were found to be less than the annualised figure of 3% He attributed his findings to thin trading over these holiday periods rather than being an opportunity for exploitable gain.

In their test of the CAPM on the JSE, Bradfield, Barr and Affleck-Graves (1988) found no evidence of dividend yield, firm size or liquidity 'anomalies' over the period 1973 to 1984. Page and Palmer (1991) also found no evidence of a size effect on the JSE but did find that a (Basu, 1977, 1983) P/E effect existed. Over the period 1978 to 1987 they found that a portfolio of low P/E securities outperformed a portfolio of high P/E securities by 6.5% per annum. Page (1996) extended the analysis and examined whether the size and P/E effects persisted in multifactor depictions of the return generating process. Employing one three and five factor models based on both principal components and principal factor analysis, it was found that the P/E effect persisted across different benchmarks. Again, there was no evidence of a size effect. Of related significance is Plaistowe and Knight (1987) who found evidence of market-to-book effect on the JSE over the period 1973 to 1980. Two portfolios of shares selling at a premium and a discount to book value respectively were formed. A variant of the Fama-Fisher, Jensen and Roll (1969) event study methodology was applied to compare the abnormal performance of the two portfolios over the annual period subsequent to the release of earnings reports. It was found that the 'discount' firms significantly outperformed the 'premium' firms over this period.

Fraser and Page (1999) adopt the methodology of Asness (1997) to investigate the interaction of value (low B/M and D/P) and momentum (prior year returns) for industrial JSE shares. Aggregate one month returns for portfolios sorted by these criteria were examined over the period 1977 to 1997. It was found that low B/M shares were associated with higher returns than high B/M shares but that this relation did not hold when D/P was used as a measure of value. Apart from the case of negative momentum shares, higher momentum was associated with higher returns. For shares that earned negative returns over the previous year a 'reversal' effect was found where this group of assets earned average returns between those of (high momentum) quintiles four and five. Fraser and Page found no evidence of any interaction between these effects i.e. momentum strategies were not found to be stronger amongst value shares and *vice versa*.

4. METHODOLOGY AND DATA

Monthly dividend-adjusted share return data from February 1983 to March 1999 on JSE industrial shares is employed in the analysis. All share price, dividend and financial statement information was obtained from the Quant database maintained by Futuregrowth Asset Management. The sources of raw data for this database were many but primarily included INET, BFA Net and various issues of JSE handbooks. Information has either been retained or backfilled on firms that have delisted since 1983 and capital events such a rights offers, unbundlings and share splits have been adjusted for throughout. A trial run of the tests conducted in the empirical portion of this paper was done and suspicious data points were checked. To avoid the influence of look-ahead bias it was insured that all accounting information used in the construction of portfolios is obtained from a financial year-end at least three months prior to the data of portfolio construction. In the case of shares that delisted during the sample period, a return of -100% was earned in the period of delisting and any liquidation dividend was added to the portfolio's returns in the period it was paid, mitigating the influence of survivorship bias. A tradability filter was applied. All the shares in the sample were ranked by their median monthly rand value traded during their period of listing. Those most thinly traded shares that cumulatively accounted for 5% of median monthly total trade in the industrial sector of the JSE were omitted from the sample. The 5% cut-off level ensured that all of the shares included the analysis had traded during each month of the sample period. Not all data was reliably available for the entire sample period. In particular, IBES analysts consensus earnings growth forecast data (IBESGI) was only used from April 1996 onwards. As a result, the price-earnings to expected earnings growth ratio (PEGI) could also only be calculated over this subperiod. Rolled two year's historic earnings growth (ROLLE2) was similarly only available over this same subperiod. Five year's historic earnings growth (E5I) was used from February 1988 onwards.

The selection of candidate style factors for testing is motivated by the following rearrangement of the Gordon-Shapiro (1956) constant growth model:

$$E(R_i) = \frac{E(D_{i1})}{P_{i0}} + E(g_i) \quad \ldots (1)$$

where:

$E(R_{it})$ = the expected return for asset i
$E(D_{i1})$ = expected dividend at time 1 = $D_{i0}(1+g_i)$
P_{i0} = share price of asset i at t=0

$E(g_i)$ = the expected (constant) growth rate of dividends of asset i, assuming $g_i < E(R_{it})$, else $P_{i0}=\infty$

As can be seen, this security valuation model implies that measures of 'value' (the first term on the right hand side of equation 1) and expected future growth (the second term on the rigt hand side of equation 1) are positively related to expected returns[8].

While the dividend yield is specified as the measure of 'value' above, it is clear that by construction that this variable will share a close relationship with other measures of this characteristic. To illustrate this point, the relationship between the measures of value: earnings yield (E/P), dividend yield (D/P), and the book-to-market ratio (B/P), is demonstrated below:

$$\frac{E}{P}=\frac{D}{P}\left(\frac{1}{b}\right)=\frac{B}{P}\left(\frac{E}{B}\right)=\frac{B}{P}(ROE)$$

where:

E = earnings per share
D/E = b where D is dividends per share and b is the payout ratio
B = book or net asset value per share
ROE = E/B = return on equity

All three ratios display analytic interrelationships and, thus, by construction are likely to convey, to a certain degree, the same information More specifically, when selecting the E/P ratio as a benchmark, the dividend yield and market to book ratios convey additional information regarding the firm's payout ratio (b) and return on equity (ROE) respectively. It is empirical question which, if any, of these *a priori* equally motivated formulations is most appropriately specified in an asset pricing model and it is this type of empirical question that this study aims to address.

Of course, it may also be the case that certain variables that are *prima facie* associated with a violation of the fair game model also determine the cross-section of equity returns such as measures of price momentum and overreaction (see, for example, Jegadeesh and Titman (1993) and De Bondt and Thaler (1986) reviewed in section 2.1.2). In accordance with the above, the candidate factors are classified as being (i) Measures of 'value'; (ii) Measures of expected 'future earnings growth' and (iii) Measures of investor 'irrationality' (i.e. overreaction, persistence and neglect). Table 1 lists the style factors tested in this paper. The code assigned to each styles factor is mentioned in brackets. With regard to interpreting the codes assigned, the "*I*" suffix is a reminder that only industrial shares were included in the analysis. Where market capitalisation weightings were used in the construction of the portfolio (in preference to equal weighting) the "*M*" suffix applies. Finally following the findings on Fraser and Page, the momentum variables were also calculated by only ranking those firms that exhibited positive past price movement and, when this was the case the "*P*" suffix, is applied to distinguish them from the cases when all shares were included in the ranking.

Table 1: Style strategies tested (1983-1999)

(i) **Measures of 'Value'**
- (a) Earnings Yield (EARNYLDI)
- (b) Dividend Yield (DIVYLDI)
- (c) Turnover to Price (TURNTOPI)
- (d) Net Asset Value to Price (NAVTOPI)
- (e) Cash-Flow to Price (CFTOPI)
- (f) Price-Earnings to Expected Growth (PEGI)
- (g) Two year lagged Price-Earnings (LAGEPEI)

(ii) **Measures of Future Earnings Growth**

(A) Earnings Growth
- (a) One year consensus forecast earnings growth (IBESGI)
- (b) Past Two Years' Rolled Earnings Growth (ROLLE2I)
- (c) Past Five Years' Earnings Growth (E5I)

(B) Measures of 'Bankruptcy Improbability'
- (a) Market capitalisation (SIZEMI)
- (b) The Return on Equity Ratio (ROEI)
- (c) The Cash-Flow to Debt Ratio (CFTOPI)
- (d) The Assets to Debt Ratio (ATODI)
- (e) The Quick Ratio (QUICKI)

(iii) **Measures of Irrationality and Neglect**

(A) Price Momentum
- (a) Previous one month's return (MOM1I)
- (b) Previous three month's return (MOM3I)
- (c) Previous six month's return (MOM6I)
- (d) Previous one year's return (MOM12I)
- (e) Previous two year's return (MOM24I)

(B) Neglect (all portfolios are market value weighted)
- (a) Close price (CLOSEMI)
- (b) Trade (TRADEMI)
- (c) Turnover (TURNOVERMI)

A monthly time series of the 'reward' to each style is calculated as follows. At the end of the last trading of the previous month all of the shares in the sample are ranked

[8]Interestingly, the theoretically motivated decomposition of expected returns into the contribution of 'value' and earnings growth in equation (1) above also accords with the practice of investment analysts in forecasting returns. The questionnaire survey of Fouche and van Rensburg (1997) found "*an estimate of market value by applying an appropriate P/E ratio* [i.e. a measure of value] *to an earnings forecast*" is the most popular security valuation technique employed by South African unit-trust portfolio managers, with a mean usage of 89,6%.

by the style criterion concerned. Three equally weighted portfolios are then formed, with the top one third of the ranked shares forming portfolio 1 and the lowest one third constituting portfolio 3. The returns on these portfolios during the ensuing month are calculated and the portfolios are once again rebalanced at the end of its last trading day. The procedure is repeated every month of the sample period. The time-series of porfolio 1 minus portfolio 3 returns is thereby calculated for each style, providing what is essentially the monthly returns on a hedge fund going long portfolio 1 and short portfolio 3. No allowance is made for the transaction costs incurred in rebalancing.

Student's t statistic is employed to ascertain whether the difference in these portfolios mean returns is significantly

$$t = \frac{\bar{f}\sqrt{n}}{\sigma_f}$$

different from zero:
where :

$\bar{f}$ = the mean value of the returns to style f
n = the number of (monthly) observations
σ_f = the standard deviation of the returns of style f

Thereafter, risk-adjusted performance evaluation is conducted on each of the portfolios concerned using both the traditional CAPM and two factor APT model specifications respectively:

$$f_t - R_{ft} = \alpha_f + \beta_f (R_{mt} - R_{ft}) + \varepsilon_{ft}$$

$$f_t - R_{ft} = \alpha_f + b_{fFINDI}(R_{FINDIt} - R_{ft}) + b_{fRESI}(R_{RESIt} - R_{ft}) + \varepsilon_{ft}$$

where:

f_t = the returns to style portfolio f in period t
R_{ft} = the default free rate in period t (proxied by the return on three month Treasury Bills)
R_{mt} = the return on the 'market' portfolio in period t (proxied by the JSE All-Share Index)
R_{1t} = the return on principal component 1 (proxied by the JSE Financial-Industrial Index)
R_{2t} = the return on principal component 2 (proxied by the JSE Resources Index)
β_f, b_{fFINDI} and b_{fRESI} = risk parameters to be estimated
ε_{ft} = a residual error term that obeys the classical assumptions

In the above framework a significance test is conducted on the intercept terms of the above models (α_f) to evaluate the risk- adjusted performance of the portfolios concerned. Following van Rensburg and Zhu (2000), the JSE Financial Industrial and Resources Index were used as observable proxies for the first two factor analytically extracted factors on the JSE. However, backdated data on the reclassified indices is only provided by the JSE back to January 1993. For the purposes of the analysis, these indices were dovetailed with the old Industrial and All-Gold Indices, motivated by van Rensburg and Slaney (1997), which were used to represent the returns to the factor proxies prior to 1993. Details of the cluster analysis methodology adopted in this study are discussed together with the interpretation of its results in section 5.

5. RESULTS

Table 2 presents the results of the evaluation of the raw returns of the style portfolios formed using the methodology described above. The portfolios are ranked in descending order of the absolute value of their t statistics. Where the mean returns are significantly different from zero at the 95% level of confidence they are asterisked and portrayed in bold.

Table 2: Evaluation of style portfolios' raw returns (1983.02-1999.03)

Style Factor	Mean Returns	Standard Deviation	Number of Observations	t Statistic
Earnyldi	**1,41***	5,04	193	3,88
Mom12pi	**1,52***	5,57	193	3,79
Sizemi	**-1,12***	4,37	193	-3,57
Divyldi	**1,21***	5,27	193	3,20
Mom12i	**1,07***	5,01	193	2,98
Mom6i	**1,00***	5,11	193	2,72
Atodi	**0,85***	4,84	193	2,43
Cftodi	**0,85***	5,13	193	2,30
Turnmi	**0,85***	5,20	193	2,27
Mom3pi	**1,00***	6,14	193	2,27
Mom6pi	**0,85***	5,66	193	2,10
Mom1i	-0,66	5,11	193	-1,79
Tradei	-0,58	4,46	193	-1,79
E5i	-0,89	6,35	150	-1,72
Ptonavi	-0,59	5,08	193	-1,61
Mom24pi	0,53	4,99	193	1,47
Pegi	-1,57	6,68	35	-1,39
Rolle2i	-1,67	7,51	35	-1,32
Quicki	0,41	4,40	193	1,30
Mom1pi	0,36	6,28	193	0,79
Ibesgi	0,49	9,02	35	0,76
Lagpei	0,22	4,39	178	0,68
Closemi	-0,25	5,84	193	-0,59
Payouti	-0,15	5,12	193	-0,42
Roei	0,10	5,23	193	0,26
Cftopi	-0,07	3,60	193	-0,26
Mom3i	0,21	4,55	193	0,04

It can be seen that the following measures of 'value' were found to outperform on a raw returns basis: the earnings yield (EARNYLDI) and the dividend yield (DIVYLDI), with the former being the more significant of the two. Low price to net asset value stocks (PTONAVI) were also found to earn higher returns but insignificantly so. The price-earnings to expected growth portfolio (PEGI), in fact, earned the highest mean returns amongst the measures of value but, due to the smaller number of observations associated with this portfolio, the results were not found to be statistically significant. Amongst the measures of 'momentum' sampled, prior twelve month return ranked only amongst those shares that exhibited positive values of this characteristic (MOM12PI) was found to be the best performer. In accordance with the findings of Fraser and Page, this variable outperformed its cousin MOM12I. Similarly, this refinement was found to enhance returns in the case of three month momentum (compare MOM3PI and MOM3I). However, in the case of past two year's returns, MOM24I and MOM24PI were found to be close to identical[9]. Consequently, only MOM24PI's results are discussed in the remainder of the paper. While six month price momentum (MOM6I) also yielded a significantly positive return it was surprising to note that winner stocks over the past month under performed losers by a marginally insignificant amount (MOM1I). This accords with the short-term reversal effect documented by Baker and Haugen (1996). With regard to measures of 'future earnings growth' (which includes bankruptcy improbability), it was found that smaller stocks tended to outperform larger stocks (SIZEMI). Shares that exhibited higher assets to debt (ATODI) and cash flow to debt (CFTODI) ratios were found to outperform there less geared counterparts. In unreported tests it was found that the times series returns of SIZEMI was positively correlated to both ATODI and CFTODI implying a potentially useful filtering rule to apply when selecting smaller shares.

In Table 3 the results of the risk-adjusted performance evaluation of the style portfolios is reported. Note that because the portfolios being evaluated are style-based hedge funds, their betas will be considerably larger in absolute magnitude than conventional funds that do not entail short-selling. As all of the shares in the analysis are drawn from the industrial sector on the JSE, this is not the most appropriate application for the two factor risk decomposition of the APT model. Nevertheless, the alpha terms, their t statistics and the R-squared values of these models are presented to address the important question of whether any style-based anomalies identified within the framework of the CAPM persist in the case of the two factor model.

[9]This result implies that almost all shares that survived for two years in the sample also yielded a non-negative return over this period.

Table 3 reveals that, in general, risk-adjustment using either the CAPM or APT models does not influence the outcome of the performance evaluation of the style portfolios' returns. In both cases, this is evident through a glance down the column labelled "*R-Squared*" were only the well documented downward bias in the estimated betas of thinly traded stocks manifests itself as exhibiting any explanatory power. The only style whose raw return outperformance was found not to be significant on a risk-adjusted basis is MOM12I. Otherwise, similar 'style-based' anomalies exist across both the CAPM and APT model specifications. Indeed, after risk-adjustment using the APT model, it was found that two of the styles that did not have mean returns significantly different from zero on a raw returns or beta-adjusted basis were, in fact, found to outperform. Value stocks with low price to net asset values (PTONAVI) were found to be associated with higher returns while shares with higher past five years earnings growth rates (E5I) were found to underperform. The lower returns associated with firms with higher long term past earnings growth is in accordance with Haugen's mean reversion arguments discussed in section 2.1.2. It is interesting to observe that, not only was it found that value stocks tended to outperform but these shares also tended to have lower βs than their more glamorous counterparts. This is in conformity with the US findings reviewed earlier. However, only in the case of DIVYLDI was this difference found to be statistically significant at the 95% level. Momentum was found to be insignificantly positively related to betas across all measures of this characteristic. Surprisingly, large South African firms were found to associated with higher betas that their smaller counterparts. A similar positive relationship between β and size on the JSE was found by Ward and Hargreaves (1998). This appears to be counter to the negative relationship observed in the US environment and may, perhaps, be ascribed to the effects of thin-trading and market-segmentation (where the larger firms would include all conglomerates with both industrial and resource based operations). The lower beta's exhibited by lower priced shares (CLOSEMI) and by shares with less value traded (TRADEMI) are clearly more likely to be explained by the former of these two arguments. The reasons for the higher betas found to exist for shares with higher cash-flow to debt ratios (CFTODI) and lower payout ratios (PAYOUTI) remain open to speculation.

Only those style portfolios that had return data over the entire period of the sample (February 1983 to March 1999) were included the cluster analysis procedure. Unfortunately, this resulted in the style portfolios that required measures of earnings growth in their construction (E5I, ROLLE2, IBESGI and PEGI) being omitted from the analysis. Nevertheless, in order to obtain some insight into the determinants of analyst's expectations of earnings growth, the correlations between IBESGI and the other style portfolios over the three year period this variable was in the sample was examined. It was found that expected earnings growth was negatively related to all measures of value with the strongest relationship existing between DIVYLDI and IBESGI (correlation =-0.5). Measures of momentum tended to be positively related to IBESGI with MOM24I exhibiting the highest correlation here (correlation = 0.4). The style found to most be closely related to one year-ahead earnings growth expectations was ROEI (correlation=0.6). Lower gearing (ATODI) and lower payout ratios (PAYOUTI) were also found to be significantly related to higher expectations of earnings growth.

The cluster analysis routine used the correlations between the returns of the style portfolios as its measure of similarity or 'distance'. An agglomerative heirarchical approach was adopted in forming the clusters. The criterion selected for combining clusters is the average within group linkage method. Here the distance between two clusters is defined as the unweighted average correlation between all pairs of cases in which one member of the pair is from each of the clusters. Thus, at the first level of the routine, the two style portfolios with the highest correlation are grouped together to form a cluster. At each iteration the two most closely related clusters (one or both of which may comprise an individual case) are merged together. Thereby, starting at the level of the individual style portfolios, larger and larger clusters are formed until all the styles are grouped together in a single cluster. Note that style portfolios assigned to clusters cannot be reassigned at a later stage in the routine.

Table 3: Risk-adjusted style portfolio performance evaluation (1983.02-1999.03)

Style Factor	CAPM					APT		
	α	$t(\alpha)$	β	$t(\beta)$	R-squared	α	$t(\alpha)$	R-squared
Earnyldi	**1,36***	3,78	-11,24	-1,97	0,02	**1,36***	3,71	0,01
Mom12pi	**1,54***	3,84	9,53	1,51	0,01	**1,52***	3,75	0,01
Sizemi	**-1,09***	-3,53	**15,85***	3,26	0,05	**-1,10***	-3,54	0,06
Divyldi	**1,16***	3,08	**-14,72***	5,92	0,03	**1,15***	3,00	0,02
Mom12i	0,52	1,44	1,48	0,26	0,00	0,46	1,26	0,01
Mom6i	**0,99***	2,69	0,98	0,17	0,00	**1,05***	2,83	0,01
Atodi	**0,83***	2,38	-1,12	-0,20	0,00	**0,77***	2,19	0,01
Cftodi	**0,90***	2,51	**21,27***	3,76	0,07	**0,86***	2,40	0,09
Turnmi	**0,87***	2,33	10,35	1,75	0,02	**0,85***	2,25	0,01
Mom3pi	**0,99***	2,24	1,39	0,20	0,00	**1,02***	2,27	0,00
Mom6pi	**0,87***	2,12	8,42	1,31	0,01	**0,87***	2,09	0,00
Mom1i	-0,69	-1,87	-5,78	-0,99	0,01	-0,61	-1,65	0,03
Tradei	-0,21	-0,67	**24,08***	4,81	0,11	0,07	0,24	0,31
E5i	-0,92	-1,74	-4,55	-0,56	0,00	**-1,18***	-2,25	0,05
Ptonavi	-0,60	-1,63	0,29	0,05	0,00	**-0,74***	-2,04	0,05
Mom24pi	0,52	1,44	1,48	0,26	0,00	0,46	1,26	0,01
Pegi	-1,63	-1,37	-2,57	-0,18	0,00	-1,65	-1,34	0,00
Rolle2i	-1,32	-1,03	22,60	1,42	0,06	-1,59	-1,22	0,08
Quicki	0,38	1,21	-5,34	-1,07	0,01	0,42	1,30	0,01
Mom1pi	0,33	0,73	-4,39	-0,61	0,00	0,37	0,80	0,01
Ibisgi	0,91	0,58	25,39	1,32	0,05	0,53	0,33	0,07
Lagpei	0,18	0,57	-11,09	-2,13	0,02	0,23	0,71	0,03
Closemi	-0,18	-0,45	**26,90***	4,21	0,09	-0,13	-0,31	0,07
Payouti	-0,21	-0,58	**-15,04***	-2,61	0,03	-0,14	-0,40	0,06
Roei	0,06	0,15	-10,65	-1,80	0,02	-0,08	-0,23	0,06
Cftopi	1,73	4,93	7,84	1,41	0,01	1,78	5,02	0,01
Mom3i	0,20	0,60	0,15	0,03	0,00	0,25	0,76	0,01

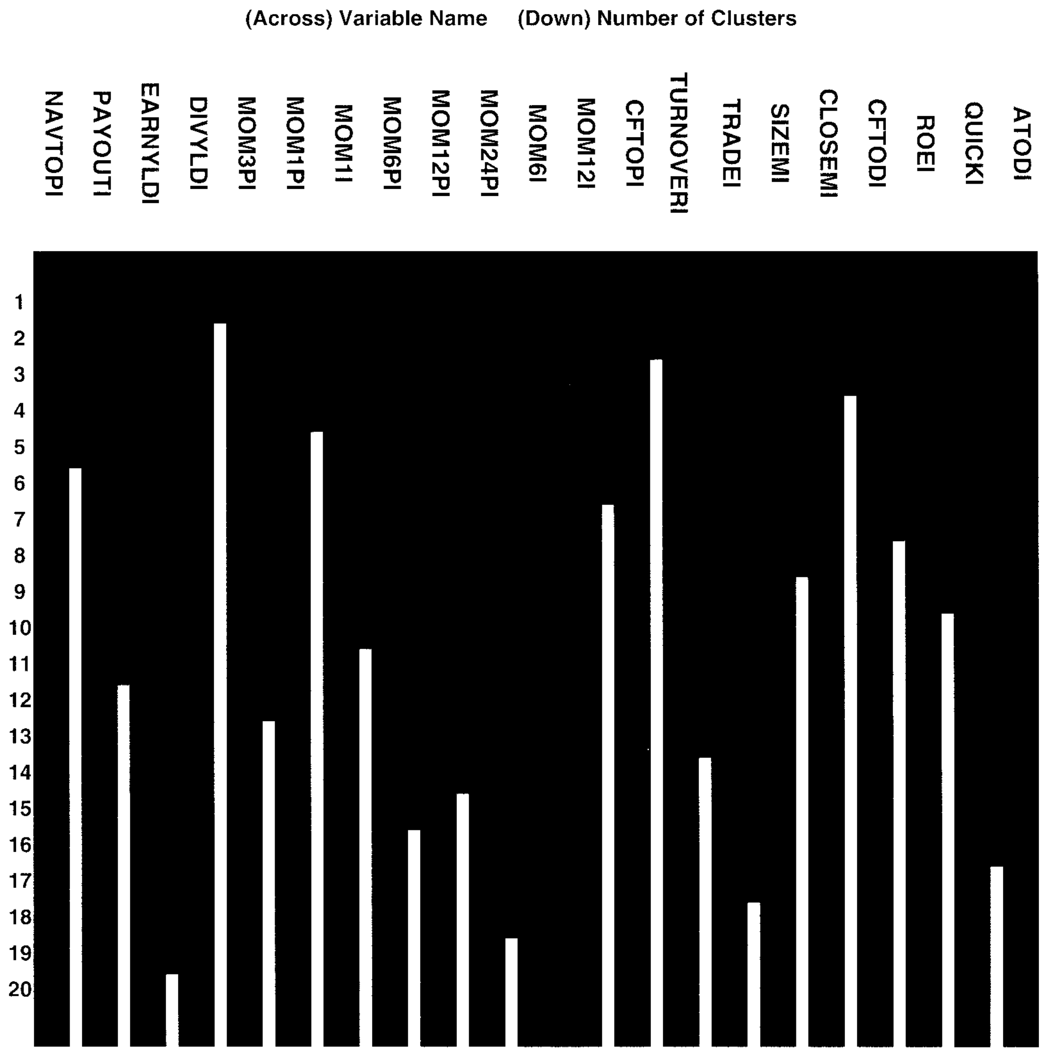

Figure 1: Vertical icicle-plot of cluster analysis results

The results of the cluster analysis are depicted in the vertical icicle plot in figure 1. Note that, in order to interpret this figure, the solid lines and not the vacant spaces between them are the object of interest. Each column represents a particular style and is labelled along the top of the diagram. The row labels on the left-hand side of the diagram represent the number of clusters formed at each iteration. The figure is read from bottom to top. Studying figure 1 it can be seen that the first cluster that formed was the joining of MOM12I and MOM6I. Second, DIVYLDI and EARNYLDI merged. In this way the cluster seeds for the 'momentum' and 'value' clusters formed. At the third iteration, two years past returns (MOM12PI) joined the momentum cluster. Thereafter, the seeds for the 'size' (SIZEMI, TRADEI) and 'bankrupcy improbability' (ATODI, QUICKI) subclusters formed. In order to obtain a feel for the nature of the common variation in the style portfolios, it is recommended that the reader place the top edge of a piece of paper at the bottom of the graph and move it upwards, observing the clusters that form at each iteration. It can be seen that at the third to last iteration the 'size' and 'bankruptcy improbability' clusters merge to form a single large 'quality' cluster. It is suggested that three clusters are extracted form the analysis: a value, momentum and quality cluster. From the performance results presented in tables 2 and 3 the following styles are selected to represent each of the clusters respectively: the earnings yield, twelve month positive momentum and market capitalisation. Futhermore, the style criteria selected above have the pragmatic advantage of being directly observable on a daily basis through standard commercially available information services and are easily available to a wide range of users.

6. CONCLUSION

This study documents CAPM anomalies associated with the following style factors on the JSE: (i) earnings yield, (ii) past twelve month (positive) returns, (iii) market capitalisation, (iv) dividend yield, (v) six month's past returns, (vi) leverage, (vii) cash-flow to debt, (viii) turnover and (ix) three month's positive past returns. These anomalies persist after risk-adjustment using the two factor APT model of van Rensburg and Slaney (1997). Indeed, in the latter case, a price to NAV and prior five year's earnings growth effect also emerge. The returns on the style portfolios were cluster analysed. The results suggest that three style factors: earnings to price (representing the 'value' cluster), market capitalisation (representing the 'quality' cluster) and twelve month past positive returns (representing the momentum cluster) form a parsimonious representation of style-based risk on the JSE. In summary, the results indicate that, at least for industrial shares, the two factor APT model needs to be augmented with measures of securities' exposures to these three sources of style-based risk.

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