Multifactor explanation of security returns in South Africa

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Abstract: This paper evaluates the performance of Fama and French three factor model in South Africa for individual securities. We employed a multivariate time series methodology similar to Fama and French (1993). The empirical results contradict the theoretical proposition of the Fama-French model and inconsistent with results documented by most studies in the developed and some emerging markets. The size and value premia are very weak when included in the regression model. Furthermore, the Fama and French three factor model is unable to explain the return generating process of securities trading on Johannesburg Stock Exchange. This has important implication for corporate managers, investors as well as fund and portfolio managers in terms estimating cost of equity, rate of return and portfolio allocation.

Bibliographical notes:

Osita has a cumulative work experience of more than 33 years, which straddles three very important sectors in the public and private sectors - the academia, management consultancy, government/politics and international oil marketing. Currently, he is a Professor of Finance and a Minister of state for Economic Planning & Budget in Nigeria. He has supervised PhDs to completion and currently have five ongoing PhD students in quantitative finance and capital market theory.

Samuel is a lecturer in Finance at University of Birmingham Business School. Prior to joining the University of Birmingham as a lecturer, he held similar positions at the University of Wolverhampton Business School, University of Leicester and Kwame Nkrumah University of Science and Technology (Ghana). He also has extensive experience working in accountancy profession in both private and public sectors. Samuel is research active in the areas of corporate finance, banking competition and credit market performance. He has published in international peer reviewed journals and currently serves as a reviewer for a number of international journals including Emerging Markets Review, The Quarterly Review of Economics and Finance and Managerial Finance, amongst others.

William has a cumulative work experience of almost 15 years, which bestride five very important sectors in the public and private sectors - the academia, local government, charity, consultancy and industry. William teaches at both undergraduate and postgraduate modules in Finance, Econometrics and Accounting. His research interest lies in asset pricing & portfolio theory, volatility forecasting & correlations, time series & cross-sectional analysis, stock market efficiency, Africa and emerging markets finance and cost of capital.

1.Introduction

The Capital Asset Pricing Model (CAPM) as independently developed by Sharpe (1964) and Lintner (1965) has played an important role in modern finance especially capital theory. The model which has its route from modern portfolio theory (Markowitz, 1952; 1959) posits that an expected return of an individual security or a portfolio is related to a measure of its systematic risk. According to the CAPM, the systematic risk as measured by beta captures undiversifiable risk. The CAPM suggests that higher beta securities are expected to give higher expected return than lower beta securities. The CAPM has been extensively tested within the finance and economics literature and the evidence shows several empirical contradictions. For example, Banz (1981) finds that average returns are too high for small (low market equity, ME) stocks and too low for large stocks. Another contradiction of the Sharpe-Lintner CAPM is the positive relation found by Bhandari (1988) between leverage and average returns. Chan et al (1991) find that the ratio of a firm's book value to market equity (BE/ME) play a significant role in explaining security returns in Japan. In a joint test of beta, size and earnings-price, Basu (1983) finds that the ration of earnings-price play a significant role in explaining US stock returns. Consequently, Fama and French (1992) proposed a three factor model with size and BE/ME as additional variables for US stock returns. The Fama-French model suggests that size (ME) and value (BE/ME) premia are priced risk factors. The model has been widely tested in the finance literature but mostly in the developed capital markets. We present fresh evidence from South Africa by examining whether or not size and value premia affect the return generating process of individual securities in South Africa. To the best of our knowledge, this question has not been previously addressed. Since asset pricing models are developed with an individual asset in mind, accordingly, it is argued that it is important to establish the performance of the Fama-French model with regard to individual securities initially before jumping to portfolios in African market studies. This study will also help individual firms in South Africa to understand and evaluate the relevance of the Fama-

French model on the basis of their firm specific risk profile rather than the risk characteristics of a combination of portfolio of securities.

2.Literature Review

Roll (1977) criticised the CAPM's recommendation of stock market portfolio as the efficient portfolio and argued that the model has not yet been tested and almost certainly never will be, mainly because the market portfolio, which is at the heart of the model, is both theoretically and empirically indefinable. The argument suggests that the existing empirical tests of CAPM are largely uninformative since proxies rather than true market portfolios are used. Such market portfolios are unrealistic and could lie farther away from the minimum-variance frontier.

Basu (1977, 1983) was first to identify anomalies in CAPM application by investigating the relation between price-earnings ratio and equity investment performance using COMPUSTAT data file of NYSE equities, CRSP tape of stock returns and a delisted file containing accounting data and stock returns for equities delisted from the NYSE during the period of September 1956 – August 1971. Using the CAPM to evaluate performance, it was found that low P/E portfolios earn on average higher returns than high P/E portfolios. Their results question the view that P/E ratio information is fully reflected in asset prices instantaneously as proposed by the efficient market hypothesis. It is obvious that disequilibria, and, hence, arbitrage opportunities exist in capital markets for at least during the 14 year period of.

In the spirit of Roll's (1977) critique of CAPM's empirical test, Banz (1981) investigated the empirical relationship between total market capitalisation of NYSE equities and its return from 1926 to 1975. Banz selected three different market indices; two are pure equity indices – the CRSP equally-weighted index and value-weighted index. The third takes a more comprehensive nature: aggregation of value-weighted CRSP index and

return data on corporate and treasury bonds from Ibbotson and Sinquefield (1977), and in his own word termed this as the ‘‘market index’’(that is, the true market index). The results showed that on average high capitalisation equities have lower returns compared to small capitalisation equities and this was persistent for at least forty years. Banz asserts that the CAPM could be misspecified. Holding very small equities long and very large equities short provides average monthly excess return of 1.52% and annual excess return of 19.8%.

Fama and French (1992) evaluated the combined roles of market beta, firm size (ME) and book-to-market ratio (BE/ME) in the cross-section of average equity returns on the NYSE, AMEX, and NASDAQ stocks. Their results show a significant relationship between average return and size but no relationship is established for beta and average return. Besides they established a strong relationship between book-to-market equity and average returns. They concluded that size (ME) and value (BE/ME) variables have a consistently stronger role in explaining average returns than just the market risk premium.

To advance their argument, Fama and French (1993) adopted Jensen et al (1972) time series methodology. Their evidence showed that BE/ME and size have stronger explanatory powers in the return generating process and this provides additional evidence to support their earlier claim (i.e. Fama and French, 1992) that BE/ME and size represent sensitivity to asset risk. In the spirit of this, Fama and French (1992 & 1993) proposed a three-factor model of expected returns;

$$E(R_i) = R_f + \beta_i[E(R_M) - R_f] + \beta_s[E(SMB)] + \beta_h[E(HML)] \quad (1)$$

Where

R_i is stock return.

R_f is risk-free rate of return

$R_M - R_f$ is the market risk premium

SMB denotes the difference between the returns of small capitalisation and big capitalisation stocks.

HML denotes the difference between the returns of high book-to-market equity and low book-to-market equity.

Fama and French (1996) further stated that most of the abnormal return patterns found in the 1980s and early 1990s are in reality not abnormal patterns altogether. They concluded that these abnormal patterns were as a result of misspecification of the expected-returns model (see also Basu, 1983).These anomalies are related and, unlike the CAPM, can be captured by one single model which includes not only the market risk premium but also other risk factors relating to the *HML* and *SMB.*

Kothari *et al*. (1995) re-examined Fama and French (1992 & 1993) proposed model and the evidence showed that during the 1927 – 1990 periods, contrary to Fama and French (1992; 1993) evidence, considerable ex-post reward for beta risk was found when annual returns are employed. They argued that the effect of the book-to-market equity (BE/ME) ratio is due to a combination of survivorship bias (that is, dropping poor performing assets, resulting in overestimating past returns) or selection bias (that is, an error in selecting data used for empirical study) in the COMPUSTAT data files influencing the performance of high BE/ME equities and time specific performance of low BE/ME (past winner equities) and high BE/ME (past loser equities).

Fama and French (1998) extended their empirical work to cover other capital markets outside USA focusing on explanatory power of value premium. They examined the US

and 12 other developed capital markets in Europe, Australia and Japan using market returns and value and growth portfolios in the regression model. Their results show that international returns demonstrate consistent value premium. This result means that value premium documented in earlier research using US data is a global phenomenon rather than data and country specific issues.

Chui and Wei (1998) investigated the correlation between equity returns and return factors relating to beta, size and book-to-market equity by adopting Fama -MacBeth (1973) regression procedure for five Pacific Basin emerging capital markets, namely Hong Kong, Korea, Malaysia, Taiwan and Thailand. The evidence reported in all the markets investigated found that the market beta (CAPM factor) is weak in explaining realised equity returns. However, the researchers found that the book-to-market equity can explain the cross-sectional variation of realised equity returns in three countries (namely, Hong Kong, Korea and Malaysia) and the size factor is significant in all except Taiwan.

Following Fama and French (1996), Drew and Veeraraghavan (2002) tested the robustness of the value premium and the three factor model in Malaysia. The evidence suggest that small and high BE/ME equities offer higher returns than big and low BE/ME equities and further documented that the three factor model better explains the cross-section variation of average equity returns. However, Lau *et al*. (2002) investigated the relationship between stock returns and beta, size, E/P ratio, cash flow-to-price ratio, book-to-market ratio and sales growth in Singapore and Malaysian stock markets from 1988 to 1996 and found contrary results. Their evidence showed a conditional relationship between beta and stock returns for both countries. They found significant positive relationship during months of positive market risk premium and significant negative relationship during months of negative market risk premium.

Connor and Sehgal (2001) tested Fama-French three factor model in India by constructing six size-*BE/ME* portfolios *(S/L,S/M,S/H,B/L,B/M,B/H)* from the intersection of two size and three *BE/ME* (see Fama and French, 1992). Their results showed superiority of the three factor model over the standard one factor Sharpe-Lintner CAPM in explaining a cross-section of average returns. Also following the Fama and French (1996) methodology, Drew *et al.* (2005) found that the three factor model better explained average equity returns than the traditional CAPM on Shanghai Stock Exchange. Further, Li and Hong (2006) mimics Fama and French (1993; 1996) methodology to test the existence of the size and BE/ME on the Chinese stock markets. It was found that the model including the *SIZE* and *BE/ME* had a better fit and estimation properties than the standard one factor model, confirming the superiority of the three factor model over the standard CAPM.

Turning to Africa, Bundoo (2008) tested Fama and French three-factor model by taking into account time-variation in betas on the Mauritius capital market. The aim of his methodology was to establish whether the size and book-to-market equity effects would reduce or disappear as time-varying risk premium is adjusted for temporal variation in idiosyncratic risk. His findings were consistent with Fama and French (1992 and 1993), that the size and book-to-market effects are present in the stock exchange of Mauritius.

Hearn and Piesse (2009) apply the illiquidity measure of Amihud (2002) in forming illiquidity estimates for South Africa, Kenya, Morocco, Egypt and UK markets. These are used within an augmented CAPM framework to form risk firm illiquidity premiums in addition to premiums attributable to firm size. The evidence suggests that UK and South Africa have the lowest cost of equity followed by Morocco and Egypt. Hearn (2009) further investigated size and liquidity augmented CAPM and a time-varying parameter model for Uganda, Tanzania and Kenya together with UK and South Africa.

His evidence shows that size and liquidity premia have little significance in explaining returns in UK and South Africa. However, evidence from the three Eastern African markets suggest that size and illiquidity premia have considerable impact on explaining realised returns. Furthermore, his findings show that size premium drives the Kenyan returns whiles liquidity is a key driver of Ugandan returns. Besides, the application of the time-varying techniques produces similar results, that the market risk premium is sufficient to explain realised returns in UK and South Africa. In addition to market risk premium, size premium helps in explaining Kenyan returns while Ugandan returns are dominated by size and liquidity effects.

Hearn *et al.* (2010) investigated size and liquidity augmented CAPM in three West African countries (Cote d'Ivoire, Ghana and Nigeria), two North African markets (Morocco and Tunisia) and compares these with UK and French capital markets. They also contrasted the performance of augmented CAPM with GARCH and simple stochastic drift models. Whiles they estimated cost of equity for the markets using augmented CAPM, the potential for portfolio investment diversification is assessed from contrasting the conditional mean and variance-covriance matrices using GARCH and a stochastic model with drift. Their results show that Nigeria has the highest cost of equity followed by Tunisia and Morocco respectively and finally France and UK. This means that it will be expensive to raise capital from Nigerian domestic capital market to fund projects or expansion as compared to their North African and European counterparts. Despite the relatively small size and illiquid nature of both the Ghanaian and Ivorian capital markets, they found that investors would benefit from diversification by including assets from these markets. This benefit is possible because of lack of integration of these two markets from the rest of Africa and the world markets.

Al-Rjoub *et al*. (2010) also investigated the cross-sectional behaviour of stock returns in four MENA markets, namely, Egypt, Jordan, Morocco and Saudi Arabia. Their results show that in all four markets beta have significant explanatory powers in predicting stock returns however, other fundamentals namely, P/E, BE/ME and M-CAP (market capitalisation) failed to account for variations in stock returns. Other studies in Egypt and Morocco have shown that the market risk premium is significant in determining returns (Hearn *et al.,* 2010; Omran, 2007). Hearn (2011) also investigated an augmented CAPM and its time-varying counterpart by including size and liquidity as state variables present within stock returns in four North African Countries, Algeria, Morocco, Tunisia and Egypt. In addition, the time-varying technique was included to model the effects of the 2007/08 global financial crisis on domestic North African markets. The evidence suggests that size and illiquidity effects are least significant in Morocco, which reflected in its low cost of equity, while that of Egypt and Tunisia is significantly higher. Neither size nor liquidity influence the way returns are generated in Algeria. The time-varying parameter of liquidity betas provides evidence that the 2007/08 global financial crisis affected Egypt and Morocco while the Tunisian capital market was relatively unaffected.

Nel (2011) conducted a field research with accountants in view to determine the frequency and degree to which practitioners in South Africa use CAPM to estimate cost of equity. Accounting practitioners and academics were interviewed and they overwhelmingly agreed that CAPM is the best approach to calculate cost of equity. Surprisingly, all investment practitioners interviewed indicated that they use the CAPM frequently, whiles 74% of academic support its application. Reddy and Thomson (2011 & 2013) used the two step approach to test whether CAPM can be accepted for stochastic modelling of investment returns in typical actuarial applications. They conducted a separate regression for excess returns on sectoral indices and excess return on market portfolio for individual years as well as for all periods combined

against their corresponding estimated betas. Unlike this study and numerous others found in the literature, data used by Reddy and Thomson in their study were of yearly interval. Their results show that the CAPM was rejected and the performance of the beta was quite weak for sub-period samples. However, it was not possible for them to reject the CAPM for all periods combined as they found inconclusive results in this regard. Habib and Mounira (2012) investigated whether Tunisian average stock returns vary with liquidity risk factor by following Amihud (2002) methodology. Their results show that, on Tunisian market, liquidity is not a priced factor even after adjusting for market returns and size factor. However, beta provides significant explanation to realised returns. Also, Coffie and Chukwu-lobelu (2012) investigated the equity return generating process in Ghana using CAPM. Jensen (1968) methodology was adopted and they found that the market beta plays a very significant role in determining equity returns.

Distinct from the above studies, the current study extends the existing literature by examining the empirical strength of the Fama and French three factor model in explaining the return generating process for sample of securities trading on Johannesburg Stock Exchange.

3. Methodology

3.1 Sample and Data Sources

The sample for this study is selected from the Johannesburg Stock Exchange (JSE), a leading stock market representing about 75% of the total African market capitalisation, over the period 1995 to 2009. Care is taken in the sample selection to ensure adequate representation of all industries in the South African capital markets, which are mainly manufacturing, banking/financial services, real estate, mining, agriculture and trading. Three main inclusion criteria were followed: Firstly, the

company must have at least three years of complete price data over the period covered by the stud. This is to enable sufficient price observations for each company in the study. Secondly, to minimise the problem of infrequent trading, the company must have traded at least once a month in each of those three-year period. And thirdly, the share price must be denominated in local currency, Rand. Out of an initial total population of 250 companies, 55 listed companies on the South African exchange satisfied these criteria.

The stock price-data for the individual companies and for the value-weighted All-Share Index of the Johannesburg Stock Exchange, as well as the yield on South African government's Treasury bill are obtained from Thomson Reuters DataStream. This database is attractive because it has already been adjusted for all capital changes such as rights issue, stock splits, and stock dividends, as well as the effects of corporate restructuring such as merger, acquisition and spin offs/demerger.

Table 1: Summary Statistics

Company	Mean	Median	S D	Skew	Kurt	J-B
ABSA Group	8.5819	7.9719	8.5505	-0.4320	9.4037	300.9721**
Acucap Properties	9.1857	9.4384	5.9429	-0.7145	4.6094	70.7553**
AECI	8.2729	9.0972	11.0569	-1.1651	8.5462	260.8742**
African Rainbow	7.9637	8.2125	13.1269	-0.5763	5.1399	42.5836**
African Oxygen	8.1175	8.5709	8.7013	-0.4378	4.3899	19.4522**
AG Industries	9.2032	6.6401	35.3791	9.0297	94.4942	44936.2100**
Allied Technologies	0.3219	0.2259	10.7434	0.2512	4.9519	29.2824**
AngloGold Ashanti	8.4735	7.7119	11.9398	0.3505	4.0489	11.4724**
Anglo Platinum	9.1588	9.2797	12.7299	-0.7735	5.6786	68.9699**

Aspen Pharmaceutical Holdings	10.0469	8.8681	15.6703	2.7605	20.8814	2524.5370**
Aveng	8.6762	10.4513	10.4423	-1.3240	6.4019	96.0237**
Basil Read	8.6895	9.3631	18.0258	0.2143	4.9467	28.6398**
Ceramic Industries	9.3267	9.4260	9.0918	-0.6566	6.1662	80.2902**
City Lodge Hotels	8.6485	9.0069	10.9284	-0.0378	10.4215	397.0686**
COM AIR	7.8182	8.1179	14.8705	-0.4534	3.8541	8.7939**
Cullinan	2.4783	2.7660	20.8117	-0.6310	5.1632	45.2139**
Delta EMD	7.6996	7.7403	11.2818	-0.9582	8.4030	236.9024**
Discovery	3.3078	4.1837	8.3552	-0.3272	3.2827	2.5623
Distell Group	2.3350	2.5989	9.8565	-0.3069	3.3123	3.4184
DRD Gold	-1.1873	-3.2341	19.0021	0.6139	3.9213	16.9865**
DS&WHSG Network	3.5165	4.2535	20.2259	0.4539	8.8256	250.5709**
First Rand Bank	9.1388	9.6468	10.2899	-0.6472	9.2936	297.5978**
Glenrand M I B	6.1790	8.1361	3.6935	-1.3400	2.8261	41.1738**
Gold Reef Resorts	7.6406	7.6799	14.0853	-0.3467	6.8249	102.6263**
Gold Fields	8.1477	7.8265	12.7826	0.1549	2.5587	2.0959
Group Five	8.7539	9.7238	13.4355	-0.1703	3.4364	2.1452
Growthpoint Properties	8.5659	9.0841	10.9926	-3.7232	32.3792	6621.4700**
Harmony Gold Mining	5.3319	4.5465	16.5426	0.0897	3.5185	2.1695

Impala Platinum	9.3996	9.5607	13.0357	-0.3534	3.9038	9.4885**
Liberty Holdings	8.1356	7.9639	7.8622	-0.8193	5.3108	57.8475**
Masonite Africa	7.0945	7.6218	10.6249	-0.2621	5.4159	44.0547**
Merafe Resources	0.2919	-1.0430	19.0271	-0.2356	4.9860	30.0329**
MMI Holdings	8.5952	9.3387	10.5372	-0.6550	7.6477	168.0788**
MTN Group	9.4030	9.2778	12.6728	-0.6889	7.5787	158.1364**
Murray & Roberts	8.3725	8.8512	12.4262	-0.4940	3.5677	9.3606**
NED Bank Group	3.8349	4.6968	9.8486	-0.7073	6.0406	81.0678**
Octodec Investments	9.5094	9.1274	8.6071	-1.1293	7.5302	184.7244**
Omnia	8.3870	8.0625	11.2051	0.0615	5.5877	48.3790**
Pangbourne Properties	9.4516	9.8926	6.4022	-0.0480	2.7018	0.7074
Premium Properties	9.7690	9.2141	8.9289	0.2162	3.8763	6.8824*
Pretoria Port CMT	8.6943	9.7372	8.9855	-0.5445	3.9466	15.0067**
RMB Bank	8.9970	9.6540	10.1337.	-0.7134	9.7114	339.3595**
SABLE	7.3732	7.6592	14.8890	-0.1909	7.0239	117.7671**
SACOIL Holdings	-2.7638	-0.9960	32.3018	0.7237	4.6303	34.2583**
Saambou Bank	8.0095	8.5318	9.8252	-0.7734	11.4498	531.9097**
Sanlam	8.5307	8.2483	7.6512	-0.3250	3.8394	6.1999*
SASOL	9.0280	9.0730	10.5198	0.0095	3.2207	0.3539

Spanjaard	8.6083	7.7128	11.8790	1.9513	15.3505	1209.3080**
Standard Bank Group	8.9100	0.6242	10.1349	-1.1122	14.4956	988.2434**
Sun International	8.2682	9.2204	9.5909	-0.4769	3.3773	7.5854*
TELKOM	9.2870	8.6695	8.8330	0.0552	3.4138	0.6115
VOX Telecom	-0.9922	-0.7895	40.4853	1.4193	14.8232	825.4762**
White Water Resources	-1.6962	-1.4596	24.7681	-0.3315	4.6872	23.6874**
WLSN Bayly Holmes-Ovcon	10.0145	9.9922	11.7940	0.1249	5.4711	44.4674**
Zurich Insurance	8.5819	7.9719	8.5505	-0.4319	9.4037	300.9721**

The mean, median, standard deviation, skewness, kurtosis and Jarque-Bera statistics are shown for each security in South Africa. The significance tests were set at 1 and 5 per cent levels.
** and * denote statistical significance at 1 and 5 per cent levels respectively.

As the descriptive statistics show the highest mean return in South Africa is recorded by Aspen Pharmaceuticals at 10.0469%, while Sacoil recorded the lowest at -2.7638%. Volatility as measured by standard deviation varies considerably among stocks. AG Industries registered the highest standard deviation at 35.3791%. The distribution for all stocks return data is non-normal. They are either positively or negatively skewed with fat tails as seen in the significant kurtosis well above the critical value of 3. The Jarque-Bera (*JB*) which test the joint hypothesis that 'the data used in this study are normally distributed, with skewness of 0, and kurtosis of 3', is rejected, as demonstrated by statistically significant *JB* statistics at 1 or 5 per cent levels for most firms.

3.2. Empirical Method

The study follows a methodology similar to Fama and French (1993) time-series approach. Parameters are estimated using ordinary least squares (OLS). Most research in capital asset pricing in Africa has been conducted using cross sectional studies. This means that the CAPM performance is measured at one particular point in time. However, this study adopts time series approach and therefore is designed to measure asset performance across time. The coefficients of the regression slopes represent the risk sensitivities for assets as follows:

$$R_{it} - R_{ft} = \hat{\alpha}_t + \hat{\beta}_M \left(R_{Mt} - R_{ft}\right) + \hat{\beta}_S \left(SMB\right)_t + \hat{\beta}_{\mathrm{H}} \left(HML\right)_t + \varepsilon_{it} \qquad (2)$$

Rewriting the excess returns on the individual securities and the market portfolio respectively as

$$R_{it} - R_{ft} = r_{it} \qquad (3)$$

and

$$R_{Mt} - R_{ft} = r_{Mt}, \qquad (4)$$

we obtain

$$r_{it} = \hat{\alpha}_t + \hat{\beta}_M r_{Mt} + \hat{\beta}_{St} \left(SMB\right)_t + \hat{\beta}_{\mathrm{H}t} \left(HML\right)_t + \varepsilon_t . \qquad (5)$$

Note that

$$R_{it} = \ln\left(P_{it} \big/ P_{it-1}\right) * 100 \qquad (6)$$

and

$$R_{Mt} = \ln\left(P_{Mt} \big/ P_{Mt-1}\right) * 100. \qquad (7)$$

R_{ft} is the one-month annualised yield on South African government's Treasury bill, observed at the beginning of the month *t*. Equations 6 and 7 are the monthly compound returns of individual assets and the market portfolio respectively. Also, lognormal return estimation methodology is preferred in order to overcome the problem of non-normality

of returns data used in this study. *SMB* is the difference between return on a portfolio of small equities and the return on large equities. *HML* is the difference between the return on a portfolio of high BE/ME (i.e. value stocks) and low BE/ME (i.e. growth stocks).

3.3. Categorizing size and book to market portfolios

This study adapted Fama and French (1993 and 1996) approach to construct size and book-to-market equity (*SIZE-BE/ME*) portfolios. Due to data differences, a direct replication of Fama and French approach is impossible.

In the last week of each month from January to December of year *t*, the listed equities are classified according to size and book-to-market indices. In respect to size, JSE indices are classified into CAP40 (top 40 largest companies), Mid CAP (medium sized companies) and Small CAP (smaller sized companies). The Mid CAP serves as a breakpoint between the largest and the smallest companies. Similarly, from January to December of each year *t*, the equity index for JSE is categorized into four book-to-market equity *(BE/ME)* groups (value, low growth, medium growth and growth). Low and medium growths serve as a breakpoint between value and growth equities. Value-weighted monthly returns on each portfolio are calculated for each month *t,* from January to December of each year *t*. *SMB* is the difference between the average returns of the small CAP portfolio and CAP40 portfolio:

$$SMB = (\log SmallCAP - \log CAP40) * 100 \qquad (7)$$

HML is the difference between the returns on the value (*V*) portfolio (that is, HB/ME) and growth (*G*) portfolio (LB/ME).

$$HML = (\log V - \log G) * 100 \qquad (8)$$

4 Empirical results and analysis

Beta coefficient, intercept and other key parameters are estimated using time series regression via OLS. The series are estimated using stationary data at first difference. The aim of this test is to establish whether size (SMB) and BE/ME (HML) contribute to security returns in South Africa. A result for ABSA Group is presented in the equation below for demonstrative purposes. Results for the remaining firms are presented in the table below.

$$r_{it} = \hat{\alpha}_{it} + \hat{\beta}_{it} r_{Mt} + \hat{\beta}_{S}\left(SMB\right)_{t} + \hat{\beta}_{H}\left(HML\right)_{t} + \varepsilon_{it}$$

$$r_{it} = 8.3249 - 0.0032\, r_{Mt} + 0.0514\, SMB + 0.1180\, HML + \varepsilon_{it}$$

$$t = (8.0484)^{**} \quad (-0.3716) \quad (0.3091) \quad (0.4906)$$

Table 2: time series regression estimates of equation 4

Company	***α***	***β***	***SMB***	***HML***	$\overline{R}$	***F-Statistic [p-value]***	***AIC***	***SC***
ABSA Group	8.3249 (8.0484)**	-0.0032 (-0.3716)	0.0514 (0.3091)	0.1180 (0.4906)	0.0288	0.1705 [***0.9160***]	7.3564	7.4675
Acucap Properties	8.9548 (13.4033) **	0.1928 (1.4432)	0.3390 (1.9043)	0.2161 (1.9145)	0.0674	3.1435 [***0.0293***]	6.3965	6.5076
AECI	7.5822 (4.6601)**	-0.0019 (-0.4365)	0.0507 (0.1682)	0.0492 (0.2412)	0.0341	0.0226 [***0.9954***]	8.1197	8.2308
African Rainbow	6.4618 (4.3479) **	0.0119 (0.8032)	0.2853 (0.8156	0.0778 (0.2801)	0.02197	0.3621 [***0.7805***]	8.1500	8.2611
African Oxygen	7.7213 (7.4930) **	0.0029 (0.2789)	0.1771 (0.7300)	0.1930 (1.0025)	0.0198	0.4230 [***0.7363***]	7.4174	7.5285
AG Industries	8.9142 (8.0893) **	0.1668 (0.8627)	0.2611 (1.0372)	-0.2084 (-1.0187)	0.0105	1.3164 [***0.2743***]	7.5376	7.6487
Allied Technologies	0.0548 (0.0415)	0.0057 (0.4335)	-0.2809 (-0.9027)	-0.1828 (-0.7401)	0.0177	0.4845 [***0.6939***]	7.9159	7.9159
AngloGold Ashanti	8.9284 (6.2163)**	0.0005 (0.0323)	-0.1482 (-0.4382)	0.1014 (0.3779)	0.0291	0.1623 [***0.9214***]	8.0818	8.1929

Anglo Platinum	9.5080 (7.7531) **	0.0075 (0.6085)	-0.3919 (-1.3575)	-0.1329 -0.5790	0.0020	0.9110 [***0.4387***]	7.7657	7.8768
Aspen Pharmaceutical Holdings	9.8794 (4.5393) **	-0.0015 (-0.0691)	-0.2474 (-0.4828)	-0.3296 (-0.8103)	0.0261	0.2445 [***0.8650***]	8.9130	9.0241
Aveng	8.5024 (9.3459) **	0.5960 (3.7404)**	0.0782 (0.3766)	0.1103 (0.6529)	0.1145	4.8346 [***0.0037***]	7.1542	7.2653
Basil Read	6.4086 (3.1740) **	-0.0034 (-0.1683)	-0.3016 (-0.6348)	0.3718 (0.9854)	0.0132	0.6146 [***0.6074***]	8.7629	8.8740
Ceramic Industries	9.7826 (9.4380) **	-0.0077 (-0.7458)	0.0556 (0.2298)	-0.1987 (-1.0252)	0.0097	0.7130 [***0.5463***]	7.4296	7.5407
City Lodge Hotels	7.7526 (5.1601) **	-0.0030 (-0.2015)	-0.4693 (-1.3260)	0.1004 (0.3576)	0.0076	0.7771 [***0.5099***]	8.1718	8.2829
COM AIR	7.5315 (4.7854) **	0.8794 (3.9922)**	-0.3612 (-0.9865)	-0.4674 (-1.5889)	0.1529	6.3565 [***0.0006***]	8.2636	8.3747
Cullinan	-3.3898 (-1.3404)	-0.0221 (-2.5342)*	-0.0279 (-0.0416)	-0.8805 (-1.7780)	0.0227	1.6890 [***0.1754***]	9.1572	9.2683
Delta EMD	8.9445 (7.8364)**	0.0172 (1.5048)	0.0021 (0.0078)	-0.1891 (-0.8865)	0.0001	1.0025 [***0.3958***]	7.6222	7.7333
Discovery	1.6855 (1.9562)	0.3636 (2.4020) *	-0.2667 (-1.3495)	-0.0030 (-0.0249)	0.0624	2.9737 [***0.0361***]	7.0309	7.1410
Distell Group	-0.1582 (-0.1491)	-0.0008 (-0.0755)	-0.4761 (-1.9058)	0.0909 (0.4586)	0.0202	1.6118 [***0.1925***]	7.4765	7.5876
DRD Gold	-0.8961 (-0.3953)	0.0096 (0.4210)	-0.1414 (-0.2650)	-0.0915 (-0.2150)	0.0300	0.1082 [***0.9551***]	8.9945	9.1056
DS&WHSG Network	-0.8859 (-0.3202)	0.0178 (0.6405)	0.5770 (0.8873)	0.1122 (0.2170)	0.0230	0.3315 [***0.8026***]	9.3930	9.5041

First Rand Bank	9.2497 (6.9716) **	-0.0125 -(0.9408)	-0.1280 (-0.4120)	0.1965 (0.7927)	0.0151	0.5597 [***0.6430***]	7.9231	8.0342
Glenrand M I B	8.1401 (124.0538) **	0.0086 (1.2805)	-0.0015 -(0.1206)	0.0061 (1.1391)	0.0163	1.4904 [***0.2229***]	0.6297	0.7408
Gold Reef Resorts	5.9298 (3.2199)**	0.0148 (0.8221)	-0.0702 (-0.1654)	-0.1273 (-0.3696)	0.0249	0.2799 [***0.8397***]	8.5795	8.6906
Gold Fields	8.5889 (5.8943) **	0.0257 (1.7577)	-0.0546 (-0.1591)	0.1549 (0.5689)	0.0115	1.3454 [***0.2650***]	8.1106	8.2217
Group Five	7.5133 (4.5499) **	0.0042 (0.2602)	-0.1750 (-0.4635)	-0.1089 (-0.3526)	0.0308	0.1139 [***0.9517***]	8.3617	8.4728
Growthpoint Properties	7.4498 (5.2891) **	-0.0136 (-2.5376)*	0.3938 (1.7497)	1.0573 (2.0930)*	0.1380	5.7881 [***0.0012***]	8.0234	8.1345
Harmony Gold Mining	7.3656 (4.0437) **	0.0069 (0.3775)	-0.4714 (-1.0993)	-0.0253 (-0.0744)	0.0149	0.5648 [***0.6397***]	8.5569	8.6681
Impala Platinum	9.7789 (6.7997) **	0.0094 (0.6555)	-0.2629 (-0.7764)	0.2216 (0.8244)	0.0041	0.8794 [***0.4551***]	8.0843	8.1954
Liberty Holdings	7.7919 (7.6580) **	-0.0063 (-1.2642)	-0.0197 (-0.0982)	0.0082 (0.0510)	0.0301	0.1327 [***0.9404***]	7.3649	7.4760
Masonite Africa	7.5399 (5.9860) **	-0.0006 (-0.0507)	-0.3418 (-1.1520)	-0.0811 (-0.3444)	0.0186	0.4581 [***0.7123***]	7.8189	7.9290
Merafe Resources	0.5507 (0.2462)	0.0084 (0.3735)	0.3659 (0.6951)	0.5392 (1.2904)	0.0125	0.6340 [***0.5951***]	8.9672	9.0783
Merchant & Industrial Properties	11632.93 (1.9462)	-6.2813 (-0.7123)	-479.0101 (-0.9780)	-71.7310 (-0.1414)	0.0298	0.1418 [***0.9347***]	23.4618	23.5729
MMI Holdings	8.1613 (5.7813) **	-0.0109 (-1.4415)	-0.0684 (-0.2397) [***0.8111***]	0.1525 (0.6131)	0.0235	0.3195 [***0.8113***]	8.0421	8.1532
MTN Group	8.3184 (5.0487) **	0.0052 (0.8305)	0.4456 (1.2127)	0.0997 (0.4487)	0.0171	0.5006 [***0.6828***]	8.3743	8.4854

Murray & Roberts	7.6089 (5.0344) **	-0.0042 (-0.2793)	-0.4535 (-1.2745)	-0.2216 (-0.7846)	0.0132	0.6128 [***0.6085***]	8.1837	8.2948
NED Bank Group	-0.0494 (-0.0462)	0.0024 (0.4275)	0.1068 (0.5156)	0.1896 (0.9497)	0.0226	0.3441 [***0.7935***]	7.4342	7.5453
Octodec Investments	8.6131 (8.7785)**	0.0031 (0.9127)	0.1168 (0.6748)	0.2326 (1.0575)	0.0146	0.5718 [***0.6351***]	7.3296	7.4407
Omnia	7.0674 (5.0863) **	0.0086 (0.6156)	0.6276 (1.9186)	0.1524 (0.5868)	0.0081	1.2426 [***0.2993***]	8.0155	8.1266
Pangbourne Properties	9.0901 (13.6743) **	-0.0093 (-1.3887)	-0.1803 (-1.1521)	0.2918 (2.3489) *	0.0709	3.2641 [***0.0252***]	6.5400	6.6521
Premium Properties	8.9249 (8.6528)**	-0.0051 (-0.4966)	-0.0912 (-0.3758)	0.1395 (0.7237)	0.0230	0.3322 [***0.8021***]	7.4196	7.5307
Pretoria Port CMT	8.1633 (8.1205) **	-0.0162 (-5.0287)**	-0.3082 (-1.6592)	-0.0248 (-0.1248)	0.0018	1.0552 [***0.3725***]	7.4782	7.5893
RMB Bank	8.8630 (6.5196) **	-0.0082 (-1.0239)	-0.1488 (-0.5882)	0.0801 (0.2799)	0.0269	0.2229 [***0.8803***]	7.9368	8.0479
SABLE	5.6533 (3.0674) **	0.0093 (0.5038)	0.4609 (1.0623)	0.2404 (0.6970)	0.0182	0.4703 [***0.7037***]	8.5804	8.6916
SACOIL Holdings	-3.6313 (-1.2398)	-0.0618 (-2.1039)*	0.0064 (0.0094)	0.0884 (0.1614)	0.0184	1.5552 [***0.2062***]	9.5068	9.6179
Saambou Bank	7.5188 (5.1021)**	0.0116 (0.7850)	0.0439 (0.1265)	0.0882 (0.3201)	0.0259	0.2509 [***0.8604***]	8.1331	8.2442
Sanlam	7.8313 (10.2469) **	0.5862 (4.4666)**	0.1053 (0.6024)	0.1957 (1.3804)	0.1779	7.4207 [***0.0002***]	6.8055	6.9166
SASOL	8.9554 (7.0777)**	0.0071 (0.5569)	-0.0867 (-0.2910)	-0.3646 (-1.5419)	0.0039	0.8846 [***0.4525***]	7.8282	7.9393

Spanjaard	8.2972 (6.2221) **	0.0009 (0.0687)	-0.3237 (-1.0310)	-0.4005 (-1.6070)	0.0001	1.0029 [***0.3956***]	7.9333	8.0444
Standard Bank Group	8.4274 (6.1671) **	-0.0038 (-0.6897)	0.0166 (0.0749)	0.0391 (0.1472)	0.0335	0.0379 [***0.9900***]	7.9130	8.0241
Sun International	7.3278 (6.3067) **	0.0008 (0.0683)	0.1684 (0.6156)	0.0978 (0.4504)	0.0293	0.1564 [***0.9253***]	7.6577	7.7688
Telkom	8.8491 (8.8786) **	0.4189 (2.3616)*	0.0727 (0.3105)	-0.0449 (-0.2491)	0.0348	1.9505 [***0.1286***]	7.2081	7.3272
VOX Telecom	1.0792 (0.1808)	-0.8673 (-0.6618)	-2.1689 (-2.0822)*	0.1179 (0.1761)	0.0167	1.5044 [***0.2192***]	10.5967	10.7078
White Water Resources	-1.2280 (-0.4058)	-0.0099 (-0.3265)	-0.4336 (-0.6086)	-0.0364 (-0.0644)	0.0299	0.1387 [***0.9366***]	9.5724	9.6835
Bayly Holmes-Ovcon	9.6371 (6.2659) **	-0.0180 (-1.1684)	-0.2604 (-0.7191)	0.2912 (1.0130)	0.0006	0.9829 [***0.4048***]	8.2186	8.3297
Zurich Insurance	8.3249 (8.0484) **	-0.0032 (-0.3716)	0.0514 (0.3090)	0.1170 (0.4906)	0.0288	0.1705 [***0.9160***]	7.3564	7.4675

There are three fundamental propositions of the Fama-French model: (i) that the coefficients of the market, size and BE/ME proxies must be positive, (ii) that in order to contribute to return generation, the respective coefficients must be statistically significant, (iii) that the impact of size and BE/ME factors to return variation is greater than that of the systematic risk (i.e. the market risk premium). As can be seen from table 2, proposition (i) is supported by thirty one firms which have positive beta coefficients. However, only Aveng, Com Air, Discovery, Sanlam and Telkom are positively significant at 1 and 5 per cent levels. The beta coefficient for the remaining twenty five firms are negative, however, only Cullinan, Growthpoint, Pretoria and Sacoil exhibit statistically significant negative coefficients at 1 and 5 per cent levels.

With respect to BE/ME (HML), the coefficients of thirty five firms are positive and satisfy the condition of proposition (i) however, only Growthpoint and Pangbourne exhibit significant coefficient at 5 per cent. The size (SMB) premium is positive in twenty four firms, while none of the fifty six firms' exhibit significant size coefficient. This finding is similar to those documented elsewhere in both the developed and emerging markets. For example, Kothari *et al*. (1995) found that in the US, size and BE/ME failed to account for any variation in returns. Al-Rjoub *et al*. (2010) results also show that in four MENA (Middle East and North Africa) markets firm fundamentals, namely, P/E, BE/ME and M-CAP failed to account for variations in stock returns.

According to the testable implication of Fama-French model the intercept (or alpha value) should be zero. However, this prediction is violated per the evidence as the intercepts for all the fifty six firms is either positive and thus, greater than zero or negative and thus, less than zero. Statistically, intercept for forty four firms are positively significant at 1 per cent level. This finding contradicts evidences documented by Fama and French (1992, 1993, and 1996), Ashanapalli *et al*. (1998), Bundoo (2008) etc. This means that there are still significant unidentified risk factors that affect assets return and price in South Africa but they are simply not size (i.e. SMB premium) and value (i.e BE/ME premium). Michailidis *et al.* (2006) document similar results in Greece which rejects the Fama-French three factor model and went on to say that the size premium and BE/ME premium play no significant role in explaining asset returns. Further evidence found in Hearn *et al.* (2010) shows that the impact of size premium on asset returns is both small and statistically insignificant in certain African countries.

The R^2 for the individual regressions are very low and this is buttressed by high Akaike Information Criterion (AIC) and Schwarz Criterion (SC), which are all well above the critical value of 3. The highest total variation in equity returns in South Africa which can be explained by the Fama-French model, as measured by adjusted R^2 , is only 17.79%

(for Sanlam), leaving more than 80 per cent of the variations in the company's returns unexplained by the model. For companies like Delta and Spanjaard with adjusted R^2 of 0.01%, the unexplained variation of 99.99% renders the appropriateness of Fama-French model more problematic. The adjusted R^2 measures the amount of risk contained in the total variation in returns however, the combined factors of market risk, size and BE/ME explain very small amount of return variation across South African firms, rendering the Fama-French three factor model unimportant in predicting assets return or pricing equities or estimating cost of capital in this market. This implies that there are other risk factors other than systematic, size (SMB) and BE/ME risks, including perhaps other company-specific and industry/economy wide risk factors, which equity investors seek compensations for in South Africa. A similar result was reported in Morocco by Hearn (2011) that although the market beta was significant, the adjusted R^2 for the Fama-French model was low (0.1030 or 10.30 per cent). However, as can be seen from table 2, the combined role of beta, size (SMB) and value premia (HML) is statistically significant in only seven firms at 1 and 5 per cent levels as prescribed by *F*-statistics. This again contradicts some established literature elsewhere which states that the combined role of these fundamentals is compelling in determining risk-return relationship (For example, Fama and French, 1992, 1993 & 1996; Drew *et al*., 2005).

5.Conclusion

For almost five centuries now, financial economists have attempted to resolve the puzzle of determining rate of return and asset prices. Since the initial proposition of modern portfolio theory by Nobel price economist Harry Markowitz in 1952 many alternative asset pricing models have been developed over half a century. Some have gained prominence such as CAPM (Sharpe, 1964; Lintner, 1965 and Mossin, 1966) while others have gone unnoticed such as the Intertemporal-CAPM (Merton, 1973) and Consumption-CAPM (Breeden, 1979). Fama and French (1992) provides further extension to the puzzle by identifying two firm specific variables (size and value) in addition to the market risk premium that may affect asset prices. This latter multifactor

model has gained prominence at least in the academic literature for the past twenty years. However, both the Sharpe-Lintner-Mossin single factor and Fama-French multifactor models have received mixed results in the empirical literature around the world. Turning to Africa, although a number of studies have investigated the performance of the single factor model in South Africa (Coffie, 2014; Reddy & Thomson, 2012 & 2013; Nel 2011) none have investigated the performance of the Fama-French multifactor model to individual securities trading on Johannesburg Stock Exchange. This paper fills the gap by exploring the explanatory power of Fama-French three factor model to individual security returns generating process in South Africa.

The empirical evidence suggest that the Fama-French three factor model is not valid for explaining individual security returns in South Africa. This has important implication for corporate managers, investors and portfolio/fund managers. Traditionally, corporate managers have used the single factor CAPM to estimate cost of equity. Incorporating size and value (BE/ME) factors in the model does not impact significantly on the estimation of cost of equity, and, therefore, has no implications for project evaluation, choice of financing and composition of capital. Furthermore, the evidence presented in Table 2 suggests that the risk return structure of securities will not change by including size and value premia. Inclusion of size and value premia is not necessary for investment analysis, hence investors in South Africa are likely not to allocate assets or construct portfolios based on size and value investment strategies.

It is proposed that the model is tested for size and BE/ME sorted portfolios using the same data set for the same time period. Besides the robustness of the model should be checked for subperiods.

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