Asset Price Developments in an Emerging Stock Market: The Case of Mauritius

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Abstract

The Stock Exchange of Mauritius (SEM) has been in operation for more than 15 years. As at December 2004, there were 40 companies listed on the official market. The main objectives of this study were to analyse the risk return characteristics of all the companies listed on the SEM in terms of both total risk and systematic risk; to estimate time-varying betas; to investigate the existence of the size and book-to-market equity effects on the SEM and finally to augment the Fama and French (1993) three-factor model, by taking into account the time variation in betas. The period of study was January 1997 to June 2003 and using monthly returns.

The study found out that CAPM stationary betas are different from betas corrected for thin trading. It is therefore crucial to take thin trading into account when estimating systematic risk for markets characterized by thin trading. Time-varying betas are different from stationary betas and the result supports the hypothesis that the SEM behaves like a small market capitalization index. The Fama and French three-factor model holds for the SEM. In other words, both a size effect and a book-to-market equity effect are present on the SEM. The augmented Fama and French model shows that the time variation in betas is priced, but the size and book-to-market equity effects are still statistically significant. The FF model is therefore robust after taking into account the time-variation in beta. However, the results might be sample specific. The test must be extended across other stock exchanges.

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1. Introduction

The Stock Exchange of Mauritius has been in operation for more than 15 years. As at December 2004, there were 40 companies listed on the official market with a market capitalization of approximately 67 billion rupees[1] and on the Over The Counter (OTC) market there were 78 companies. Trading on the official market started in July 1989, with five listed companies and a market capitalization of 1.4 billion rupees. Summary statistics on the official market are given in Table 1. The trading frequency on the official market has increased progressively from twice weekly to three times weekly in January 1994 before moving to daily trading in November 1997. The stock exchange is run and managed by the Stock Exchange of Mauritius (SEM) Limited and is supervised and regulated by the Financial Services Commission under the Stock Exchange Act 1988. Semdex is the index of all listed ordinary shares and it is a value-weighted index.

Companies listed on the exchange are classified into seven main categories: Banks, insurance and other finance, industry, investments, sugar, commerce, leisure & hotels and transport. The rate of corporate tax paid by listed companies is 25 per cent instead of the normal 35 per cent. Firms that qualify for tax incentives pay 15 per cent.[2] There are 11 stockbroking companies in operation while trading on the exchange is done by an order-driven system. Orders by clients can be "at best", "limit" or "stop". The brokerage fee claimed by stockbroking companies varies from 0.50% to 0.75%. A Central Depository and Settlement (CDS) system is operational since January 1997 to speed up share transfer and settlement operations. Listing rules are being revised and harmonized with those of countries in the South African Development Community (SADC). The International Finance Corporation clasifies the SEM as a frontier market and within a broader definition as an emerging market.

There has been a significant increase and an impressive rate of growth in market capitalization over the past 15 years but in the past three years, no additional listing has been done. Despite a modest increase in the turnover ratio, the market is characterized by low levels of trading activity. The same situation is observed in other emerging markets in Africa (see Appendix 3). Unfortunately, information on P/E ratios and

Table 1: Stock Exchange of Mauritius: Market Highlights

	1989	1991	1994	1997	1999	2001	2003	2004
No. of Listed Companies (Equities)	6	19	34	42	43	40	40	40
Mkt Cap (Rsbillion)[1]	1.44	4.86	28.54	36.93	41.73	32.15	51.23	67.03
Mkt Cap to GDP (%)	4.31	10.97	45.35	43.05	39.1	24.2	32.7	38.6
Mkt Cap ($)[2]	93.26	309.52	1,578.32	1,754.63	1,643.31	1,601.85	1,953.4	2,395.78
Turnover Ratio (%)	0.97	1.67	5.45	8.11	4.74	10.24	5.83	4.21
SEMDEX	117.34	154.17	476.1	391.12	435.69	340.92	549.58	710.77
P/E Ratio	6.56	6.12	20.11	12.86	8.98	5.91	7.43	9.93
Div Yield (%)	5.42	5.11	2.08	3.62	5.03	8.30	5.73	4.84

(Source: SEM Factbooks, various issues)
1 market capitalization in billion rupees, to 2 d.p.
2 market capitalization in million US dollars, to 2 d.p.

dividend yield is either not available or not computed on a regular basis for the African markets of relevance to the Stock Exchange of Mauritius. The P/E ratio for the SEM is relatively low and given that the SEM is by international standards a small market captilization, the P/E anomaly may be present. But this hypothesis remains to be tested.

Given the government's objective of making the financial sector another pillar of the economy (in addition to sugar and by-products, manufacturing, tourism and information technology), it is opportune to have an in-depth study of risk return characteristics on the market.

The main objectives of the study are:

1. To analyse the risk return characteristics of all the companies listed on the Stock Exchange of Mauritius in terms of both total risk and systematic risk. In the estimation of systematic risk we will also take into account thin trading.
2. To estimate time-varying betas.
3. To investigate the existence of the size and book-to-market equity effects on the Stock Exchange of Mauritius.
4. To attempt an augmentation of the Fama and French (1993) three-factor model, by taking into account the time variation in betas[3].

The hypotheses of the study are that: First, unadjusted betas are different from those corrected for thin trading. Second, betas are not stable over the sample period (January 1997 to June 2003). Third, there is a size effect and a book-to-market equity effect on the SEM. In other words, there is support for the Fama and French (1993) three-factor model. Lastly, when the time variation in betas is taken into account, both the size effect and the book-to-market equity effect become statistically insignificant in the Fama and French model.

The rest of the study is structured as follows. Section 2 examines relevant literature while Section 3 presents the data and methodology before the results are analysed in Section 4. Section 5 concludes while Section 6 gives direction on further research.

2. Literature review

The Capital Asset Pricing Model (CAPM) by Sharpe (1964) and Lintner (1965) expresses expected return on an asset as the sum of the return on the risk-free asset and expected premium for risk, where the risk premium is a function of the asset covariance with the market return (beta).

$$E(R_{i,t}) = R_f + ß_i (E [(R_{m,t}) - R_f)]) \quad (1)$$

The risk of a stock can be decomposed into two components. The first component is the systematic risk (beta), which is related to the overall market and the second component is non-systematic risk, which is specific to the individual stock. The fundamental premise of the CAPM is that the market will reward only the holding of systematic risk as the unsystematic risk can be diversified away by holding a diversified portfolio of assets. Unfortunately, financial managers cannot directly observe beta but must estimate it. To estimate the beta of a firm, a time-series regression is used and requires the financial manager to select both a return interval and an estimation period.

It is important to have great precision in the individual estimate of beta as large standard errors of the estimated beta not only make the estimate not so reliable but also increase uncertainty about the computation of the cost of equity of a firm and this could have unintended consequences on capital budgeting decisions of firms and broader implications at the macro-economic level. The 1997/98 Asian crisis is a case in point, where asset values collapsed in general. Among the reasons was a wrong assessment of the fundamentals, including risk (Krugman, 1998).

However, researchers are confronted with an important dilemma when estimating beta: The more the observations used to estimate beta, the smaller the standard error. This improves the precision of the beta estimate but over a long period, many firms usually see a change in their structural characteristics, which changes the firm's systematic risk. Thus, if beta is not stationary, longer estimation periods may lead to biased estimates of beta. Longer estimation periods therefore appear to give a slightly more precise estimate of beta only if the firm's fundamental structure does not change but this is seldom the case.

Regarding beta estimation periods, a body of research concludes that the optimal estimation period ranges from four to nine years. For instance, Daves et al. (2000) show that an estimation period of three years captures most of the maximum reduction in the standard error of the estimated beta, when calculating beta from a one-year estimation period to an eight-year estimation period. Additionally, less than 50% of the firms experience a significant shift in beta over a three-year period. Many studies (see for example Fama and French, 1996) use an estimation period of 60 months when employing monthly returns.

Also considered is the time interval over which the return is measured. Most studies use daily, weekly and monthly return (see for example, Alexander and Chervany, 1980; Smith,1980). However, for the Stock Exchange of Mauritius, we will avoid using daily return because of thin trading as this will have the effect of producing many zero returns in the return series.

There is also a body of evidence[4] showing that equity beta coefficients are not stable over time. Fabozzi and Francis (1978) classify the factors that can lead to time-varying betas under four main categories: (1) Changes in microeconomic variables such as changes in the product, in the company's leverage, in the dividend policy and due to revised expectations by management; (2) Macroeconomic influences such as two-digit inflation, changes in price regulations, changes in the business cycle; (3) Political factors such as wars, changes in labour legislation, pollution control legislation, elections etc; and (4) Market factors such as bull and bear markets, increased dis-intermediation, credit squeeze, two-tier markets etc. In sum, there could be diverse quantifiable and qualitative variables, which can lead to time-variation in beta.

The non-stationarity of beta has implications for event studies and tests of market overreaction that rely on the assumption of a stationary beta. As mentioned before, it also has implications for calculating the cost of equity and for capital budgeting.

Schwert and Seguin (1990) propose and estimate a single factor market model of portfolio returns, which incorporates the estimation of the time-varying component of beta. The Schwert-Seguin (1990) model is derived as follows:

The market model is:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + e_{i,t} \quad (2)$$

Schwert and Seguin use a heteroscedastic market model showing that betas will vary with the level of aggregate market volatility as follows:

$$\beta_{i,t} = \beta_i + \frac{\delta_i}{\sigma^2_{m,t}} \quad (3)$$

where β_i[5] is a constant and the time-varying component is given by $\delta_i/\sigma^2_{m,t}$. Substitution of (3) into (2) yields the Schwert-Seguin (SS) market model, as follows:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \delta_i \qquad (4)$$

where $R_{i,t}$ = return on share i at time t

$R_{m,t}$ = market return at time t

$\sigma^2_{m,t}$ = the conditional market volatility

$e_{i,t}$ = the error term

α, β, δ = are coefficients

The conditional market volatility is estimated using a GARCH (1,1) model. The least squares estimate of δ_i is negative for the small-firm portfolio and it is positive for the large-firm portfolios.

As market volatility increases, the systematic risk of small firms increases at a faster rate than those of large firms, given that small firms are less diversified and more vulnerable to shocks. Therefore, the spread between the systematic risk of small and large firms is larger during periods of high aggregate market volatility. The Schwert and Seguin results show that the small-firm portfolio variances are four times more sensitive to market volatility changes than the large-firm portfolio variances.

Koutmos, Lee and Theodossiou (1994) extend the study of time-varying betas by applying the SS model to the stock market indexes of 10 international stock markets. They find that markets with high volatility persistence possess higher systematic risk during periods of high world market volatility. They find an inverse relationship between world market volatility and systematic risk of the large capitalization markets of Japan and the United States. On the other hand, they report that the systematic risk of the smaller capitalization markets like Australia, Germany and Switzerland tended to increase when world market volatility increased. Beta is, therefore, time varying and markets with small capitalization record higher systematic risk with increases in market volatility.

Episcopos (1996) applied the SS market model to a sample of 11 industry stock indexes from the Toronto Stock Exchange (TSE). Time-varying betas are computed for the industry indexes as a function of market volatility. The results confirm that the spread between the betas of the safe (large market capitalization) and risky (small market capitalization) sub-index portfolios increase during periods of increased aggregate market volatility on the TSE. He also finds that the difference between the conventional betas estimates and the time-varying betas can be considerable. The author reports a positive relationship between the systematic risk of the industry indexes representing small market capitalization firms and the volatility of the TSE composite index. His findings support the hypothesis that market volatility affects safer and riskier stocks differently.

Reyes (1999) examines the relationship between firm size and time-varying betas of UK stocks. His results show that the time-varying coefficient is of the expected signs (positive for large firms and negative for small firms) but not statistically significant for both small and large firms. This finding differs from Schwert and Seguin who found significant negative time-varying coefficient estimates for small firms and positive estimates for large firms. However, the author admits that Schwert and Seguin use size-ranked portfolios and a much longer sample period, which increases the power of their tests. He reports that accounting for Garch effects in the Schwert-Seguin market model yields beta estimates that are markedly different from those when conditional heteroscedasticity is ignored. He cautions about the use of stationary betas for event studies.

Grieb and Reyes (2001) apply the SS market model to examine the relationship between market capitalization and time-varying betas for a sample of Brazilian stocks during the period 1989-1995. Their results show that the systematic risk of Brazilian stocks tends to increase as aggregate market volatility increases. Out of the 38 stocks examined, 32 have negative δ estimates and only 16 stocks had δs' significant at the 10% level. Their results suggest that the Brazilian stock market behaves like a small capitalization market. They argue that ignoring the observed time-variation in betas may result in the underestimation of the systematic risk of small firms' stocks.

The Fama and French (1993) three-factor asset pricing model was developed as a result of increasing empirical evidence that the Capital Asset Pricing Model performed poorly in explaining realised returns. In fact, the Fama and French (1993) three-factor model is an offshoot of the Fama and French (1992) study where the joint roles of market beta, size, earnings/price (E/P) ratio, leverage and book-to-market equity ratio were investigated in the cross-section of average stock returns for NYSE, Amex and NASDAQ stocks over the period 1963-1990. In that study, the authors find that beta has almost no explanatory power. On the other hand, when used alone, size, E/P, leverage and book-to-market equity have significant power in explaining the cross-section of average returns. When used jointly however, size and book-to-market equity are significant and they seem to absorb the effects of leverage and E/P in explaining the cross section average stock returns. Fama and French (1992), therefore, argued that if stocks are priced rationally, risks must be multidimensional.

Fama and French (1993) extend the Fama and French (1992) study by using a time-series regression approach. The analysis was extended to both stocks and bonds. Monthly returns on stocks and bonds were regressed on five factors: Returns on a market portfolio, a portfolio for size and a portfolio for the book-to-market equity effect, a term premium and a default premium. For stocks, the first three factors were found to be significant and for bonds, the last two factors. As a result, Fama and French (1993) construct a three-factor asset pricing model for stocks that includes the conventional market (beta) factor and two additional risk factors related to size and book-to-market equity. They find that this expanded model captures much of the cross-section of average returns amongst US stocks.

The model says that the expected return on a portfolio in excess of the risk-free rate is explained by the sensitivity of its return to three factors: (i) the excess return on a broad market portfolio; (ii) the difference between the return on a portfolio of small stocks and the return on a portfolio of large stocks (SMB); and, (iii) the difference between the return on a portfolio of high-book-to-market stocks and the return on a portfolio of low book-to- market stocks (HML). The model is as follows:

$$(R_{pt}) = R_f + ß_p[(R_{mt}) - R_f] + s_p(SMB) + h_p(HML) + \varepsilon_{pt} \quad (5)$$

where: (R_{pt}) is the weighted return on portfolio p in period t.

R_f is the risk-free rate;

$ß_p$ is the coefficient loading for the excess return of the market portfolio over the risk-free rate;

s_p is the coefficient loading for the excess average return of portfolios with small equity class over portfolios of big equity class.

h_p is the coefficient loading for the excess average returns of portfolios with high book-to-market equity class over those with low book-to-market equity class.

ε_{pt} is the error term for portfolio p at time t.

It can be seen that the Fama and French three-factor model is more like an extension of the CAPM. It includes the two factors identified by Fama and French (1992), firm size and book-to-market equity (BE/ME), in addition to the market factor. In fact, the model augments the CAPM model by the size effect and the book-to- market equity effect. The small-firm effect is one of the most extensively studied anomalies in finance. The classic studies of the small-firm premium are those of Banz (1981) and Reinganum (1983). The size effect is the empirical regularity that firms with small market capitalization exhibit returns that on average significantly exceed those of large firms. Researchers have suggested the following possible explanations for the size effect. Small firms' stocks are more illiquid and trading in them attract greater transaction costs. There is also less information available about small firms and therefore the cost of monitoring a portfolio of small stocks will generally be greater than that of a portfolio of large firms, and also given that small shares trade less frequently, their beta estimates might be less reliable. However, all these remain hypothetical explanations for the size effect as there is no rigorous theory explaining convincingly why the size effect should be present. The book-to-market equity effect shows that average returns are greater the higher the book value to market-value ratio (BE/ME) and vice versa. It is also referred to as the value premium. The high book value firms are underpriced by the market and are therefore a good buy and hold targets as their price will rise later. This anomaly undermines the semi-strong form efficiency of the market. These two variables explain average return differences across portfolios that cannot be accounted for by beta.

In an attempt to identify the source of these additional risk factors, Fama and French (1995) explore the relationship between risk factors and profitability. They find that high book-to-market equity (BE/ME) firms tend to be persistently distressed and low BE/ME firms are associated with sustained profitability. The returns to holders of high BE/ME stocks are therefore a compensation for holding less profitable and riskier stocks. They show that book-to-market equity and slopes on HML in the three-factor model proxy for relative distress. Weak firms with persistently low earnings tend to have high BE/ME and positive slopes on HML; strong firms with high earnings have low BE/ME and negative slopes on HML.

Similarly, Chan and Chen (1988) posit that small and large firms have different risk and return characteristics. Small firms on the New York Stock Exchange are firms that have not been doing well, are less efficiently managed and are highly leveraged. As a result small firms tend to be riskier than large firms and that risk is not captured by the market index. After introducing multiple risk exposures to the market index; a leverage index and a dividend-decrease index to mimic the marginal firms, the size effect loses its explanatory power. Risk exposures to these indexes are as powerful as size in explaining average returns of size-ranked portfolios.

However, Kothari et al. (1995) argue that a substantial part of the premium is due to "survivor bias", the data source for book equity contains a disproportionate number of high-BE/ME firms that survive distress, so the average return for high-BE/ME firms is overstated. But a number of papers have weakened and even dismissed this survivorship-bias argument. For instance, Lakonishok et al. (1994) find a strong positive relation between average return and BE/ME for the largest 20 per cent of NYSE-Amex stocks, where survivor bias is not an issue. Similarly, Fama and French (1993) find that the relation between BE/ME and average return is strong for value-weight portfolios. As value-weight portfolios give most weight to larger stocks, any survivor bias in these portfolios is trivial.

Another argument is that the results of Fama and French (1993) are due to data snooping, where researchers fixation to search for variables that are related to average return, will find variables, but only in the sample used to identify them (MacKinlay, 1995). This criticism of the three-factor model also does not hold. Since the Fama and French (1993) study, there are many studies using different sample periods on US data and samples in different countries confirming the existence of the size and book-to-market equity effects. Barber and Lyon (1997) analyses the returns for a holdout sample of financial firms which Fama and French (1992) excluded from their analysis. They find that both financial and non-financial firms exhibit a significant size and book-to-market premium. They also present evidence showing that survivorship bias does not significantly affect the estimate of size and value premium for both financial and non-financial firms. The authors make the point that the critical issue, which remains unresolved, is whether they are proxies for unidentified risk factors or security mispricing.

Previous work has shown that average returns on common stocks are related to firm characteristics like size, earnings/price (E/P), cash-flow/price (C/P), book-to-market equity ratio, past sales growth, long-term past return and short-term past return. Because these patterns in average returns are not explained by the CAPM, they are usually called anomalies. Fama and French (1996) investigate whether these anomalies disappear in the three-factor model. They find that except for the continuation of short-term returns, the anomalies largely disappear in a three-factor model. The three-factor model captures the returns to portfolios formed on E/P, C/P and sales growth. The model also captures the reversal of long-term returns documented by De Bondt et al. (1985). Stocks with low long-term past returns tend to have positive SMB and HML slopes in the Fama and French three-factor model and higher future average returns.

Fama and French (1998) provide additional valuable out-of-sample evidence. They tested the Fama and French three-factor model in 13 different markets over the period 1975-1995. They find that 12 of the 13 markets record a premium of at least 7.68% per annum to value stocks (high BM/ME). Seven markets show statistically significant BM/ME betas.

Maroney and Protopapadakis (2002) tested the Fama and French three-factor model on stock markets of Australia, Canada, Germany, France, Japan, the UK and the US. The size effect and the value premium survive for all the countries examined. They conclude that the size and BE/ME effects are international in character. Using a Stochastic Discount Factor (SDF) model, and a variety of macroeconomic and financial variables, do not diminish the explanatory power of BE/ME and MVE. Their evidence suggests that the BE/ME and MVE effects are not artifacts of the inadequacies of the augmented CAPM as an asset-pricing model or of omitting macroeconomic and financial variables. The positive relation of returns with BE/ME and their negative relation with MVE remain strong under a general SDF model.

Faff (2001) use Australian data over the period 1991-1999 to examine the power of the Fama-French three-factor model. He finds strong support for the Fama-French three-factor model, but find a significant negative rather than the expected positive premium, to small size stocks. Faff (2001) concludes that his results appear to be consistent with other recent evidence of a reversal of the size effect.

Gaunt (2004) studies the Fama-French three-factor model in the Australian setting and provides further out-of-sample (non-US) tests of the model. The study covers the period 1991-2000 of firms listed on the Australian Stock Exchange. He finds that beta risk tends to be greater for smaller companies and those with lower BM ratios. Contrary to Fama and French, the betas are on average significantly less than one. There is also evidence of the BM/ME effect increasing monotonically from the lowest to the highest book-to-market equity portfolios. There is a monotonic increase in loading on the SMB factor as well, when moving from the largest to the smallest portfolios. They find large and positive intercepts for the small portfolios. The explained variation as measured by the adjusted R^2 is also much higher compared with the CAPM. The author concludes that the three-factor model provides a better explanation of observed Australian stock returns than the CAPM.

Drew and Veeraraghavan (2002) present evidence of the size and value premium for the case of Malaysia. They report that the factors identified by Fama and French explain the variation in stock returns in Malaysia and are not sample specific. The analysis was restricted to firms with available returns data from December 1992 to December 1999. The findings show that small and high book-to-market equity stocks generate higher returns than big and low book-to-market equity stocks in Malaysia. The size premium and value premium generate average annual returns of 17.70% and 17.69% per annum respectively. The average annual return generated by the market was only 1.92%. Returns on SMB and HML are substantially higher than that of the market. Their results also show that the explanatory power of the variables is powerful throughout the sample period and not solely in January. They reject the presence of the turn-of-the-year effect.

Drew and Veeraraghavan (2003) compare the explanatory power of the single index model with the multifactor asset pricing model of Fama and French (1993) for Hong Kong, Korea, Malaysia and the Philippines. They find that the size effect and book-to-equity effect are present in these markets and that the FF three-factor model explains the variation in returns better than the single index model. They suggest that the premium is a compensation for risk that is not captured by the CAPM.

There is a lack of empirical evidence of whether the size and value premium are present in emerging equity markets generally, and particularly in the emerging African stock markets. This study provides some empirical evidence in an emerging market and offers additional out-of-sample evidence that the size and the book-to-equity effects

3. Data and methodology

Data collection

The share price and market index data for the study have been obtained from the Stock Exchange of Mauritius. However, the data[6] was not in a form suitable for empirical analysis. So the database had to be prepared from scratch. Monthly closing prices were extracted for each company and the monthly returns were calculated as ln (P_1/P_o) from January 1997 to June 2003. Adjustments were made for bonus and rights issues where necessary. In the estimation of betas, two sets will be calculated, one inclusive of dividends and one ignoring the latter.

Various issues of the SEM FactBooks were used for descriptive statistics about the market in general. Companies' annual reports[7] were obtained from the listed companies for the years 1997 to 2003. This was quite a task, as given the timeframe we could not wait for the companies to send the annual reports. The annual reports were collected from the individual companies. In all, annual reports for 37 out of the 40 listed companies were obtained.

Methodology

(i) Estimation of traditional betas, correction for thin trading and estimate of time-varying betas

To measure systematic risk (beta) in a meaningful way, an asset-pricing model is needed. In this study, the betas of the shares are estimated using the Capital Asset Pricing Model (CAPM). To check the robustness of the results, they are re-estimated using the Market Model. In addition, two sets of monthly returns will be considered under each model; one inclusive of dividends and the other taking into account only price changes. The benchmark portfolio used is the monthly return on the SEMDEX. The SEMDEX is a value-weighted index which shows the market index and can be used to calculate the return on the market.

Using the CAPM, the beta values are estimated by regressing the monthly return of a share in excess of the risk-free rate on the monthly return of the SEMDEX in excess of the risk-free rate. The estimation period uses five-and-a-half years of monthly data from January 1998 to June 2003. The risk-free rate is proxied by using the weighted monthly Treasury Bill rate. The regression equation is of the following form:

$$(R_i - R_f) = \text{constant} + ß_1 (R_m - R_f) \tag{6}$$

where R_i = monthly return on a share

R_m = SEMDEX monthly return

R_f = Weighted monthly Treasury Bill rate

For the market model, the monthly share return is regressed on a constant and on the monthly market return.

To correct for thin trading, the excess monthly returns on a share are regressed on the contemporaneous monthly excess return on the market return and the lead and lag of the latter. The Dimson (1979) method is used to correct for thin trading. This involves a summation of the betas obtained from the last regression, which is called the Aggregate Coefficients Method (ACM). There are four additional approaches to correct for thin trading: (1) the Scholes and Williams (1977) approach; (2) adjusted simple regressions; (3) simple regressions with overlapping observations; and (4) trade-to-trade regressions. However, the main advantage of the Dimson method is that it requires neither the market index to be continuously traded nor supplementary data such as transaction information.

When shares are traded infrequently and sufficient lagged market returns have been introduced to eliminate all non-trading bias, the Dimson estimator is more efficient than the Scholes-Williams estimator. But for shares, which trade in almost every period, the Scholes-Williams approach compares favourably with the AC method.

We then use the Schwert-Seguin (1990) model to examine the temporal variation in betas of the companies listed on the Stock Exchange of Mauritius. This will enable us to compare the latter with the betas obtained from traditional asset pricing model.

The conditional market volatility ($s^2_{m,t}$) is estimated using an MA (1)-Garch (1,1) model following the approach of Koutmos, Lee and Theodossiou (1994). Numerous studies have shown the robustness of the Garch (1,1) as a model of stock returns (Bollerslev et al., 1992). The estimation of time-varying betas has not been done for the Stock Exchange of Mauritius and in previous research on African stock markets.

Our Garch specification for the SEMDEX monthly returns is shown below:

$$R_{mt} = \mu + \varepsilon_{mt} + \theta\varepsilon_{mt-} \tag{7}$$

$$\sigma^2_{mt} = a_m + b_m\varepsilon^2_{mt-1} + c_m\sigma^2_{mt-} \tag{8}$$

where ε_{mt} is distributed $N(0, \sigma^2_{mt})$.

R_{mt} is the monthly market return (SEMDEX Return) and σ^2_{mt} is the conditional variance of the SEMDEX return. Equation 7 is the conditional mean of the SEMDEX return, which is modelled as an MA (1) to account for the first-order serial correlation in market returns partly induced by non-synchronous trading. Equation 8 specifies the conditional variance as a linear function of past squared residual (ε^2_{mt-1}) and past conditional variance (σ^2_{mt-1}).

From the conditional variance equation, the ARCH coefficient, b, can be viewed as the news coefficient, whereas the Garch coefficient, c, reflects the impact of old news on volatility. The sum of the two coefficients (b+c) is the measure of volatility persistence. If b+c is close to 1, then a shock in a given period t, will persist for many periods into the future. Diagnostic tests will be performed to see whether the Garch model is well specified. Only then can we use the conditional variance series in the Schwert-Seguin market model.

(ii) Size and book-to-equity effects

The methodology used by Fama and French (1993) and others requires that the stocks be split into classes according to size and book-to-market equity ratio.

Classification by size

The stocks are divided into two classes: Stocks of small market equity and stocks of big market equity (where market equity (ME) = stock price times the number of issued ordinary shares). The median size of the whole sample is used as the breakpoint to establish the difference between the two classes. Firms with market equity less than the median value (x) of all firms' market equity are considered as small market equity firms and those with values greater than the median value are considered as big market equity firms. Table 2 illustrates the split values used in partitioning the stocks.

Classification according to book-to-market equity

Fama and French classified the stocks into three groups of portfolios: Low book-to-

Table 2: Split values for partition of securities by size

Median = Rs 378,088,950	
Small	**Big**
< 378,088,950 (Rs)	> 378,088,950 (Rs)

(Source: Author's Computations)

market equity (BE/ME) ratio, medium BE/ME ratio and high BE/ME ratio. Stocks below the 33.33% of the median BE/ME ratio are considered as low book-equity portfolios, those between 33.33% and less than 66.66% are medium portfolios and those above 66.66% are high portfolios. The split of the stocks into different categories (three BE/ME groups and two ME groups) was arbitrary and Fama and French argued that there was no reason that tests should be sensitive to this choice. Following this argument and given our small sample size, only two classes of book equity-to-market equity (BE/ME) value (low BE/ME and high BE/ME) will be created. The group of stocks of low BE/ME will be those with BE/ME values below or equal to the median BE/ME and those of high BE/ME will be the stocks with BE/ME values greater than the median BE/ME. This is shown in Table 3.

The book-equity value of the stocks is the respective book value of common shareholder's equity plus the balance sheet deferred tax (if any) minus the book value

Table 3 Split values for partition of securities by BE/ME

Book equity to Market equity ratio Median = 1.3686	
Low	**High**
< 1.3686	> 1.3686

(Source: Author's Computations)

of preferred stocks and the book-to-market equity ratio is constructed by dividing their book-equity value with their market-equity value.

Using this type of classification, it is possible to construct four portfolios: H/S (High book/Small mkt cap[8]), H/B (High book/Big mkt cap), L/S (Low book/Small mkt cap) and L/B (Low book/Big mkt cap). For our analysis therefore, we will use the four constructed portfolios (H/S, H/B, L/S, L/B) plus the portfolios of high and low BE/ME, which makes a total of six dependent variables. Value-weighted monthly returns are then calculated for each portfolio for each month from January to December over the period 1997 to 2003[9].

The Ordinary Least Squares method is used for the econometric analysis. The regressions showing serial correlation were corrected using the Cochrane-Orcutt procedure. Those showing heteroscedasticity were corrected using White's heteroscedasticity consistent variances and standard errors.

(iii) An augmented Fama and French model

The objective here is to attempt to integrate the two areas of research: (1) On estimation of time-varying betas and (2) on size and book-to-market equity effects. A common explanation in the literature is that the size and book-to-market equity may proxy for other risk factors not being taken into account by the Capital Asset Pricing Model. One may expect that a Fama and French three-factor model that takes into account the time-variation in betas, the significance of the size and book-to-market equity effects may be reduced or disappear as the time-varying risk premium is adjusting for the temporal variation in systematic risk. The results will also confirm whether the Fama and French model is robust after taking into account the time-variation in betas.

The augmented model is as follows:

$$(R_{pt}) = R_f + ß_p[(R_{mt}) - R_f] + s_p(SMB) + h_p(HML) + \delta_p\left(\frac{R_{m,t}}{\sigma^2_{m,t}}\right) + \varepsilon_{pt} \qquad (9)$$

This regression will be performed for the four different portfolios, that is, L/S, H/S, L/B and H/B. d_p is capturing the time-variation in beta and we expect that by taking into account time-variation in beta, s_p *and* h_p might no longer be statistically significant and that for the big market capitalization portfolios, d_p to be positive and negative for the small market-cap portfolios.

4. Analysis of results

The first part in this section presents descriptive statistics on monthly return for the listed companies. The second summarizes the results for the CAPM beta estimates. This is then followed by the results of the correction for thin trading and the decomposition of total risk into systematic and unsystematic risk. The fourth part shows the Garch estimation output, diagnostic tests and discussion of the time-varying betas. Finally the results for the Fama and French three-factor model and the augmented model are presented and discussed.

Return characteristics

Information on the maximum return, the minimum return, the mean monthly return and the standard deviation of return for each company over the period January 1998 to December 2003 is presented in Table 4. It can be seen that the dispersion of return is quite high. The monthly mean return ranges from 2.153% to negative 0.786%. The return properties of emerging markets have been investigated by a number of authors such as Wilcox (1992), Harvey (1995) and Claessens et al. (1995). The data agrees with the empirical evidence that the Mauritius stock market, like other emerging markets, offers the prospects of high return. However, the standard deviation of return over this period was also high compared with the monthly return. Casual observation tends to show that for most of the cases, a higher return is also associated with a higher standard deviation. However, the volatility of return though high, is not as high as in other emerging markets, a maximum monthly volatility of 16.76% is recorded. For instance, Harvey (1995) reports that the volatility of return is quite high for emerging markets ranging from 18% (in Jordan) to 105% (in Argentina). He also reported that 13 emerging markets have volatility greater than 33%.

Table 4: Descriptive Statistics of Monthly Return (%) of companies listed on the Stock Exchange of Mauritius: Period 1998M1 to 2003M12

BANKS & INSURANCE	MAXIMUM	MINIMUM	MEAN	STD DEVIATION
BAI	12.821	-11.364	-0.047	4.112
MCB	42.857	-76.387	-0.410	11.551
MEI	15.566	-13.978	0.360	4.501
MUA	18.750	-11.111	0.449	5.519
SBM	32.710	-18.440	0.890	8.146
SWAN	11.818	-10.309	0.394	3.915
COMMERCE				
CMPL	23.810	-13.793	0.560	6.065
COURTS	92.100	-20.630	0.610	14.530
HM	17.978	-9.825	0.834	4.730
HWF	14.286	-12.500	-0.084	4.355
IBL	13.043	-19.708	0.304	6.776
ROGERS	17.500	-59.603	0.467	8.801
SHELL	12.581	-7.770	1.368	4.119
INDUSTRY				
GCIVIC	22.727	-12.134	0.963	6.180
MBL	16.667	-10.753	-0.151	4.906
MCFI	21.490	-28.660	0.752	7.543
MOROIL	12.963	-23.577	0.333	5.438
MSM	23.210	-11.111	0.773	5.255
PIM	32.143	-15.361	3.218	8.916
UBP	12.903	-41.207	0.467	6.829
INVESTMENTS				
BMH	19.760	-10.710	0.886	5.111
CIT	46.667	-77.000	-0.786	13.390
FINCORP	75.926	-92.925	-0.337	16.765
GIDC	36.667	-27.731	0.444	11.560
LIT	22.500	-17.000	0.632	5.443
MDIT	18.644	-67.333	0.229	9.890
NIT	31.737	-16.814	0.956	7.736
PAD	36.364	-14.286	1.015	8.333
POLCY	32.609	-21.875	0.168	9.280
UDL	13.456	-9.627	0.290	4.977
LEISURE & HOTELS				
ASL	26.829	-16.164	0.057	6.676
GBH	14.167	-8.088	-0.139	4.048
NMH	18.868	-14.000	0.066	6.055
SUNRES	14.167	-31.081	-0.168	5.065
SUGAR				
HF	25.000	-18.367	0.349	7.247
MDA	39.286	-36.000	2.153	10.464
MOUNT	26.667	-13.333	0.168	6.702
SAVA	34.132	-26.154	-0.516	7.898
TRANSPORT				
AMTS	22.727	-49.677	0.030	9.833

(Source: Author's computations)

Beta estimates

From Table 5 we can see that 30 companies have betas, which are statistically significant at least at the 5% level and 33 companies have betas which are significant at least at the 10% level out of the 40 listed companies. Only nine companies have a level of systematic risk (> 1) higher than the market. Thirteen companies have significant beta estimates less than 0.50. When compared with the betas obtained using the market model as benchmark (see Table 6), only 28 companies have betas, which are significant at the 5% level and 31 at the 10% level. Moreover, only eight companies have significant betas greater than one.

However, the beta estimates are quite similar under each model with a few exceptions[10]. The beta estimates when dividends are taken into account in the calculation of return are quite similar. The results are reported in Appendix 1. Moreover, within each sector, we also see that companies can have quite different risk profiles. Serial correlation detected was corrected using the Cochrane-Orcutt method. Using the CAPM benchmark, the adjusted R^2 ranges from around 1.5% to 76.7% for the companies with a statistically significant beta.

Given that most companies have betas less than one, they may be regarded as defensive stocks. There is also wide variation in the adjusted R^2. This is common in the finance literature when analysing beta at company level. However, given that we are dealing in an emerging stock market, it cautions the reader about the appropriateness of solely relying on the capital asset pricing model or the market model in trying to measure risk. This therefore urges the need to look at other concepts of risk in addition to beta.

Table 5 Estimation of CAPM Betas

CODE	constant	Beta (β)	t-ratio (β)	DW	ADJ R^2
BANKS AND INSURANCE[11]					
BAI	-.0066624	0.42642	3.6110	1.8086	.25316
MCB	-.010010	0.91870	2.6543	1.9326	.092830
MEI	-.0037722	0.42273	3.1776	2.0035	.11358
MUA	-.0038624	0.37131	2.2765	2.0201	.062331
SBM	.0067831	1.8897	15.3343	2.0329	.76732
SWAN	-.0040154	0.30071	2.4316	1.9676	.059353
COMMERCE					
CMPL	-.0036747	.8352E-3	.0042375	1.9972	.025228
COURTS	.9758E-3	1.0498	2.3850	2.0419	.061944
HM	.0011366	0.29877	2.1250	1.9739	.14017
HWF	-.0075365	0.30429	2.2264	1.9868	.032762
IBL	-.0027415	1.1089	6.5182	1.9804	.36644
ROGERS	-.0015309	0.74945	2.8480	1.9579	.091035
SHELL	.0035836	0.20697	1.6152	1.9911	.019690
INDUSTRY					
GCIVIC	.0020821	0.28774	1.3997	1.9761	.0045725
MBL	-.0090907	0.28873	1.8302	1.9885	.025835
MCFI	.0014392	0.52018	2.5997	2.0451	.13982
MOROIL	-.0059847	0.17400	1.0314	1.9830	.018866
MSM	.8882E-3	0.46173	2.8385	1.9996	.052401
PIM	.026169	0.82475	2.8373	2.0180	.071989
UBP	.0027438	0.49006	3.5320	1.9508	.12631
AMTS	-.0033129	1.0953	3.8348	1.9930	.13136

CODE	constant	Beta (β)	t-ratio (β)	DW	ADJ R^2
INVESTMENTS					
BMH	.0013730	0.34995	2.1852	1.9956	.030733
CIT	.014764	0.95146	2.1823	2.0333	.014825
FINCORP	.0037650	1.0388	3.3619	2.0840	.22023
GIDC	.0012000	1.3082	3.9550	1.9898	.12565
LIT	-.0013048	0.34853	2.0441	2.0553	.084279
MDIT	-.0023802	0.76801	2.5422	1.9856	.061784
NIT	.0053103	0.78826	3.5155	2.0259	.12179
PAD	.0049017	1.0136	2.1727	2.1156	.20114
POLICY	-.002779	1.1799	4.8669	1.9877	.23281
UDL	-.0038217	0.34885	2.3258	1.9980	.050686
LEISURE & HOTELS					
ASL	-.0092819	0.34985	1.7023	1.9469	.0031858
GBH	-.0026588	0.87043	6.5100	2.0219	.42935
NMH	-.0027241	1.2356	9.2524	1.9201	.54884
SUNRES	-.0083534	0.82509	5.3657	1.9781	.29248
SUGAR					
HF	-.0055804	0.086586	0.36085	1.9832	.0077046
MDA	.014427	0.56568	1.6866	1.8119	.042356
MOUNT	-.0093558	0.20381	.94983	2.0063	.031647
MTMD	-.0051840	0.74722	3.6230	2.0694	.14588
SAVA	-.013125	0.25733	1.0409	2.0032	.0011752
TRANSPORT					
AMTS	-.0033129	1.0953	3.8348	1.9930	.13136

Table 6 Estimation of Market Model Betas

CODE	constant	eta ( )	t-ratio ( )	DW	ADJ R^2
BANKS AND INSURANCE					
BAI	-.0020555	0.34791	3.3665	1.9037	.21744
MCB	-.009432	1.0068	2.9038	2.2009	.094756
MEI	.0013940	0.41549	3.0982	2.0024	.10803
MUA	.0017913	0.36154	2.2006	2.0197	.059513
SBM	-.0011791	1.9009	15.3280	2.0353	.76717
SWAN	.0023074	0.30849	2.5965	1.9148	.074821
COMMERCE					
CMPL	.0036747	0.835E-3	0.004238	1.9972	.025228
COURTS	.5114E-3	1.0539	2.3730	2.0424	.061233
HM	.0074085	0.29363	2.0727	1.9733	.13726
HWF	-.0075365	0.30429	2.2264	1.9868	.032762
IBL	-.0028941	1.1190	6.6317	1.9293	.37708
ROGERS	.7602E-3	0.73707	2.7774	1.9582	.086392
SHELL	.010692	0.19923	1.5466	1.9904	.015176
INDUSTRY					
GCIVIC	.0020821	0.28774	1.3997	1.9761	.0045725
MBL	-.0030945	0.29954	1.9744	1.8234	.039219
MCFI	.0057815	0.50640	2.4972	2.0461	.13810
MOROIL	.0026569	0.12677	0.73653	2.2365	.0064859
MSM	.0056764	0.38810	2.4198	2.1561	.064007
PIM	.027679	0.83558	2.8625	2.0181	.073818
UBP	.0073218	0.48284	3.4435	1.9523	.12097

CODE	constant	Beta (β)	t-ratio (β)	DW	ADJ R^2
INVESTMENTS					
BMH	.0069785	0.35464	2.2622	1.9547	.054813
CIT	-.0098439	0.37420	0.88445	2.0250	.0030762
FINCORP	-.0069213	0.66913	1.2705	1.9276	.0085771
GIDC	-.001504	1.2998	3.8802	1.9896	.12173
LIT	0.004114	0.41565	2.5088	1.7265	.069392
MDIT	-.0017095	0.75394	2.5045	2.1922	.069128
NIT	.0057718	0.71536	3.1042	2.2101	.10845
PAD	.0047786	1.0140	4.3079	2.1156	.19826
POLICY	-.0043203	1.1672	4.7577	1.9877	.22658
UDL	.0020165	0.34110	2.2543	1.9976	.047312
LEISURE & HOTELS					
ASL	-.0092819	0.34985	1.7023	1.9469	.0031858
GBH	-.0035234	0.84725	6.1517	1.8694	.40676
NMH	-.0027241	1.2356	9.2524	1.9201	.54884
SUNRES	-.0083534	0.82509	5.3657	1.9781	.29248
SUGAR					
HF	.0041502	0.099162	0.41219	1.9839	.0068037
MDA	.014427	0.56568	1.6866	1.8119	.042356
MOUNT	-.0093558	0.20381	0.94983	2.0063	.031647
MTMD	-.0029294	0.74548	3.5822	2.0689	.14284
SAVA	-.0064661	0.24572	0.98593	2.0051	.3936E-3
TRANSPORT					
AMTS	-.0044671	0.90009	3.0687	2.1497	.10599

Betas adjusted for thin trading

In most cases, when thin trading is accounted for, most of the companies show a higher level of systematic risk. From Table 7, in practically all cases, the betas adjusted for thin trading are quite different from the traditional beta estimates.
Most of the companies with low systematic risk, record higher beta estimates when

Table 7: Comparison of CAPM Betas with Betas Adjusted for Thin Trading

COMPANY CODE	Uncorrected Beta	Adjusted Beta [Dimson (1979) ACM Method]
BANKS & INSURANCE		
BAI	0.42642	0.342271**
MCB	0.91870	0.460072**
MEI	0.42273	0.677590**
MUA	0.37131	0.502786**
SBM	1.8897	1.661950**
SWAN	0.30071	0.613106**
COMMERCE		
CMPL	.8352E-3	0.293545
COURTS	1.0498	1.727450*
HM	0.29877	0.516717**
HWF	0.30429	0.583290**
IBL	1.1089	1.196919**
ROGERS	0.74945	1.007680**
SHELL	0.20697	0.536360
INDUSTRY		
GCIVIC	0.28774	0.605047
MBL	0.28873	0.646480*
MCFI	0.52018	0.623843**
MOROIL	0.17400	0.514783
MSM	0.46173	0.881660**
PIM	0.82475	0.375543**
UBP	0.49006	0.678193**

COMPANY CODE	Uncorrected Beta	Adjusted Beta [Dimson (1979) ACM Method]
INVESTMENTS		
BMH	0.34995	0.448315**
CIT	0.95146	2.339740**
FINCORP	1.0388	1.141906**
GIDC	1.3082	2.124200**
LIT	0.34853	0.833450**
MDIT	0.76801	0.848708**
NIT	0.78826	1.029060**
PAD	1.0136	1.095465**
POLICY	1.1799	1.430036**
UDL	0.34885	0.408806**
LEISURE & HOTELS		
ASL	0.34985	0.615887*
GBH	0.87043	1.403770**
NMH	1.2356	1.134490**
SUNRES	0.82509	0.942874**
SUGAR		
HF	0.086586	0.042860
MDA	0.56568	1.850690*
MOUNT	0.20381	0.132950
MTMD	0.74722	0.817617**
SAVA	0.25733	0.388632
TRANSPORT		
AMTS	1.0953	1.774790**

(Source: Author's computations). Denotes: ** significant at 5% level; * significant at 10% level.

adjusted for thin trading. Similarly, for companies with high systematic risk (beta > 0.8), in many cases, the adjusted beta is lower. The results are consistent with the empirical finding that for companies with low beta, beta tends to be underestimated and for companies with high systematic risk, beta tends to be overestimated when the market is characterized by thin trading. This empirical regularity is confirmed by the data. Moreover, 33 companies show beta estimates, which are significant at the 10% level or better.

Estimation of unsystematic risk

Table 8 shows the decomposition of the total risk on a share (measured by the variance of return) into its systematic and unsystematic component. It can be seen that the share specific risk ranges from 0.03252 to 0.317918 per cent per month. The results from the CAPM model including dividends have been used for the decomposition.

Estimation of time-varying betas

Table 8 Decomposition of Total Risk into Systematic and Unsystematic Risk

$$\sigma^2_i = \beta^2 * \sigma^2_m + \sigma^2_e$$

Company	Variance of share Return	β^2*Var(market Return)	σ^2_e Unsystematic Variance	σ_e Unsystematic Risk
AMTS	0.009971	0.001708	0.008263	0.090903
ASL	0.004141	0.000188	0.003953	0.062876
BAI	0.001946	0.000257	0.001689	0.041097
BMH	0.002649	0.000165	0.002484	0.049842
CIT	0.037474	0.000779	0.036695	0.19156
CMPL	0.003862	6.85E-07	0.003861	0.062137
COURTS	0.021734	0.001647	0.020087	0.14173
FINCORP	0.103725	0.002653	0.101072	0.317918
GBH	0.002114	0.001056	0.001058	0.03252
GCIVIC	0.003864	0.000126	0.003738	0.061143
GIDC	0.013675	0.002377	0.011298	0.106293
HF	0.005503	1.96E-05	0.005483	0.07405
HM	0.002316	0.00012	0.002196	0.046859
HWF	0.001938	0.000132	0.001806	0.042502
IBL	0.004709	0.001765	0.002944	0.054259
LIT	0.003139	0.000177	0.002963	0.054432
MBL	0.002524	0.000109	0.002416	0.049149
MCB	0.013726	0.001195	0.012531	0.111942

Company	Variance of share Return	β^2*Var(market Return)	σ^2_e Unsystematic Variance	σ_e Unsystematic Risk
MCFI	0.005863	0.000358	0.005505	0.074198
MDA	0.011428	0.000416	0.011012	0.104937
MDIT	0.010204	0.000752	0.009452	0.097221
MEI	0.002038	0.000238	0.001801	0.042432
MOUNT	0.004153	5.13E-05	0.004102	0.064048
MOROIL	0.003003	3.62E-05	0.002966	0.054465
MSM	0.002883	0.000289	0.002594	0.05093
MTMD	0.007089	0.000672	0.006417	0.080106
MUA	0.003099	0.000183	0.002916	0.053996
NIT	0.006127	0.000843	0.005283	0.072688
NMH	0.003998	0.002171	0.001828	0.042752
PAD	0.007111	0.001487	0.005625	0.074998
PIM	0.00814	0.001004	0.007137	0.084478
POLICY	0.008895	0.001938	0.006958	0.083412
ROGERS	0.007866	0.000777	0.007089	0.084193
SAVA	0.006469	0.000112	0.006357	0.07973
SBM	0.006758	0.004855	0.001903	0.043621
SHELL	0.001607	5.05E-05	0.001556	0.039447
SUNRES	0.003225	0.000933	0.002292	0.047877
SWAN	0.001579	0.000118	0.001461	0.038227
UBP	0.002231	0.000323	0.001908	0.043676
UDL	0.002516	0.000163	0.002353	0.048506

(Source: Author's computations)

(i) Estimation of the MA (1)-Garch (1,1) model for the SEMDEX

We first estimate the MA (1)-Garch (1,1) and conduct several specification tests to see whether the chosen Garch model is properly specified. Only then do we generate the conditional variance series of the market return, which we use in the Schwert-Seguin market model.

We see from the conditional mean equation that the estimated coefficient of the moving average term, MA (1), is positive and statistically different from zero. This shows that non-synchronous trading effects are present on the SEM. The magnitude of the serial correlation in monthly returns is quite high. This suggests that past residual returns have an influence on current market returns.

Table 9 shows an ARCH coefficient, a, of 0.028488 and a Garch coefficient, b, of 0.849476. The ARCH coefficient is not only small but also insignificant whereas the GARCH coefficient is significant at the 1% level, showing that monthly return

Table 9 MA (1)-GARCH (1,1) Estimation Output

Dependent Variable: Monthly SEMDEX Return

Method: ML – ARCH

Included observations: 174
Convergence achieved after 22 iterations
Bollerslev-Wooldrige robust standard errors & covariance
Backcast: 1

		Coefficient	Std. Error	z-Statistic	Prob.
		Conditional Mean Equation			
C		0.009306	0.003504	2.656074	0.0079
MA(1)		0.187202	0.076862	2.435567	0.0149
		Variance Equation			
C		0.000208	0.000284	0.730128	0.4653
ARCH(1)	a	0.028488	0.042075	0.677081	0.4984
GARCH(1)	b	0.849476	0.175578	4.838163	0.0000

Diagnostic checks on the standardized residuals

	Statistic	p-value
Q (12)	13.1000	0.287
Q^2(12)	9.4576	0.580
Q^2(24)	17.256	0.797

(Source: Author's Computations using Eviews)

on the SEMDEX is influenced by the lagged conditional variance. The sum of the coefficients is 0.877964 and less than one, showing that shocks die out. This indicates a volatility persistence of 0.877964. In fact, a Wald test on the coefficients showing that the null hypothesis of the sum of the coefficients is one is strongly rejected. This is seen from Table 10.

Moreover, an ARCH test of the residuals, show no arch effects in the residuals(see Table 11).All the tests therefore confirm that the MA (1)-Garch (1,1) is well specified andfits the monthly SEMDEX return series data well.

Table 10 Wald Test

Test of a+ b =1 in the variance equation of the GARCH Model			
Null Hypothesis:	C(1)+C(2) =1		
F-statistic	106.7608	Probability	0.0000
Chi-square	106.7608	Probability	0.0000
Result: Rejection of the null.			

(Source: Author's Computations using Eviews)

Table 11 ARCH Test

LM test of residuals			
F-statistic	0.579557	Probability	0.793635
Obs*R-squared	4.761619	Probability	0.782724
Result: No Arch effects in the residuals			

(Source: Author's Computations using E-views)

(ii) Results on estimation of time-varying betas

Table 12 reports the results obtained from estimating the Schwert-Seguin (1990) model for the listed stocks on the Stock Exchange of Mauritius. The companies' monthly returns were used from 1998 to 2003 and regressed on a constant, on the monthly SEMDEX return and on the SEMDEX monthly return divided by its conditional variance as obtained from the Garch model above.

In this table we are interested in the sign, value and statistical significance of delta (ä). The point estimate of ä is negative for 31 out of the 40 stocks examined and positive for only nine stocks and delta ranges from -0.0009 to 0.0244[12]. These estimates are comparable to those obtained by Schwert and Seguin (1990), who report estimates of 0.0004 to +0.0001 and Reyes (1999) who report delta estimates of 0.0007 to 0.0001. Ten companies have ä's which are significant at least at the 10% level. The results are consistent with Grieb and Reyes (2001) who find that out of 38 stocks examined, for the Brazilian stock market, only 16 had ä's which were statistically significant. Similarly, Episcopos (1996) finds significant negative ä's in only three of the 11 industries examined and Reyes (1999) did not find the time-varying term statistically significant for the UK stock indexes examined.

In addition, Grieb and Reyes (2001) find that 32 out of the 38 stocks had negative ä's. They concluded that the Brazilian stock market behaved very much like a small capitalization market. The results in Table 12 concur with the fact that, relatively speaking, the SEM can be considered a small market capitalization index and, therefore, we should expect most of the ä's to be negative, which is in fact the case.

It must be stressed that the time-varying beta given by $\beta_{it} = \beta_i + \delta_i/\sigma^2_{m,t.}\ \beta_i$ is not the time-varying beta. For 25 companies, the time-varying beta (based on the mean market volatility) is higher than the OLS estimated beta. Overall, we also note that the time-varying betas are quite different from the stationary CAPM estimated betas.

Therefore, this shows that failure to take into account time-varying betas could lead to serious over or underestimation of expected return.

Moreover, a very interesting result is that for all of the companies with negative δs', as market volatility goes up the time-varying betas also increases and is in most cases

Table 12 Estimation of Time-Varying Betas based on SS (1990) market model

Code	SS model coefficients		Time-Varying Betas based on:			Ols Betas
	β_i	δ_i	Mean $\sigma^2_{m,t}$	Max $\sigma^2_{m,t}$	Min $\sigma^2_{m,t}$	
AMTS	0.816	0.0004	1.064	0.956	1.119	0.904
ASL	0.882	-0.0009	0.389	0.603	0.277	0.495
BAI	-1.110	0.0024	0.246	-0.344	0.552	0.675
BMH	0.697	-0.0006	0.374	0.515	0.301	0.442
CIT	1.062	-0.0011	0.455	0.719	0.318	0.571
CMPL	3.306	-0.0054	0.283	1.599	-0.399	0.406
COURTS	9.185*	-0.0132*	1.747	4.984	0.069	0.863
FINCORP	6.585*	-0.0091*	1.435	3.677	0.273	1.165
GBH	1.106	-0.0009	0.587	0.813	0.470	0.936
GCIVIC	2.615	-0.0038	0.480	1.409	-0.002	0.298
GIDC	6.586*	-0.0087	1.676	3.813	0.569	1.084
HF	-0.473	0.0006	-0.131	-0.280	-0.054	0.034
HM	2.849*	-0.0041*	0.543	1.547	0.023	0.400
HWF	1.270	-0.0016	0.379	0.767	0.178	0.365
IBL	2.630	-0.0025	1.238	1.844	0.924	1.143
LIT	1.960	-0.0026	0.489	1.129	0.157	0.448
MBL	-0.361	0.0010	0.227	-0.029	0.360	0.287
MCB	-14.052	0.0244	-0.264	-6.266	2.846	0.903

Code	SS model coefficients		Time-Varying Betas based on:			Ols Betas
	β_i	δ_i	Mean $\sigma^2_{m,t}$	Max $\sigma^2_{m,t}$	Min $\sigma^2_{m,t}$	
MCFI	2.057	-0.0025	0.622	1.247	0.299	0.571
MDA	6.059*	-0.0090	0.989	3.196	-0.155	0.725
MDIT	6.367*	-0.0091*	1.219	3.460	0.058	0.902
MEI	3.221**	-0.0045**	0.660	1.775	0.082	0.511
MOUNT	4.392**	-0.0068*	0.572	2.235	-0.290	0.478
MOROIL	3.299*	-0.0051*	0.412	1.668	-0.240	0.275
MSM	4.569**	-0.0067**	0.797	2.439	-0.054	0.492
MTMD	3.643	-0.0047	0.971	2.134	0.369	0.678
MUA	2.342	-0.0032	0.520	1.313	0.109	0.418
NIT	4.543*	-0.0061	1.079	2.587	0.297	0.789
NMH	-0.302	0.0025	1.102	0.491	1.419	1.292
PAD	0.770	0.0004	1.006	0.903	1.059	1.020
PIM	0.212	0.0009	0.787	0.537	0.916	0.759
POLICY	3.603	-0.0040	1.345	2.328	0.836	1.251
ROGERS	1.758	-0.0017	0.822	1.229	0.611	0.915
SAVA	3.015	-0.0045	0.501	1.595	-0.066	0.360
SBM	-0.830	0.0043**	1.607	0.546	2.157	1.722
SHELL	1.008	-0.0013	0.280	0.597	0.116	0.257
SUNRES	2.527	-0.0028	0.967	1.646	0.615	0.938
SWAN	1.313	-0.0016	0.392	0.793	0.184	0.393
UBP	1.870	-0.0023	0.596	1.151	0.309	0.585
UDL	3.948**	-0.0059**	0.619	2.068	-0.132	0.337

Source: Author's Computations
* denotes significance at 10% level;
** denotes significance at 5%level.

higher than the OLS betas. This can be seen in the fifth column [Max $\sigma^2_{m,t}$] from Table 12. On the other hand, for all companies with positive δs' as market volatility goes up, the time-varying betas fall. This is very much in accordance with the empirical findings of Schwert and Seguin (1990), Grieb and Reyes (2001) and others and confirms the a priori expectations in the literature.

Generally, the results also confirm that the spread between the systematic risk of small and large firms is larger during periods of high aggregate market volatility. Therefore in emerging markets, which are generally quite volatile, it is important to take into account the time variation in betas and not to rely solely on traditional CAPM betas as this can lead to under-estimation of systematic risk. From an investor's perspective, this is also quite important as emerging markets are generally characterized by high levels of volatility. This will also have implications in estimating the return on equity (ROE) and the weighted average cost of capital (WACC). Caution must also be exercised when using betas to calculate expected returns and eventually cumulative abnormal returns in event studies.

Table 13 Results for the Fama and French Three Factor Model on the Stock Exchange of Mauritius

Model: $(R_p t) - Rf = \alpha_p t + \beta_p (Rmt - Rf) + {}_p(SMB) + {}_p(HML) + \varepsilon_p t$

Portfolios excess returns	α coefficient	β coefficient	coefficient	coefficient	R-Bar Squared	DW-Stat
L/S	-0.5511E-4	0.59329	0.62728	-0.24452	.51408	1.9723
t-ratio[p-value]	-.017795[.986]	7.7359[.000]	7.0603[.000]	-2.9572[.004]		
L/B	-0.0014918	0.74881	-0.17156	-0.21849	.74156	2.0943
t-ratio[p-value]	-.74984[.456]	12.2351[.000]	-2.4750[.015]	-3.3081[.001]		
H/S	-0.0014918	0.74881	0.82844	0.78151	.83145	2.0943
t-ratio[p-value]	-0.74984[.456]	12.2351[.000]	11.9518[.000]	11.8326[.000]		
H/B	-0.5511E-4	0.59329	-0.37272	0.75548	.75162	1.9723
t-ratio[p-value]	-.017795[.986]	7.7359[.000]	-4.1951[.000]	9.1371[.000]		
LB/M	0.0079246	0.63505	0.21186	-0.24507	.70801	1.9907
t-ratio[p-value]	4.0379[.000]	12.4445[.000]	3.6425[.000]	-4.5522[.000]		
HB/M	0.0079246	0.63505	0.21186	0.75493	.85005	1.9907
t-ratio[p-value]	4.0379[.000]	12.4445[.000]	3.6425[.000]	14.0230[.000]		

Source: Computed by Author

Key: L/S = low book to equity and small mkt cap;
H/S = high book to equity and small mkt cap;
L/B= low book to equity and big mkt cap and
H/B=high book to equity and big mkt ca

Size and book-to-market equity effects

Table 13 shows the results for the Fama and French (1993) three-factor model for the Stock Exchange of Mauritius. Beta is significant for all the portfolios, but less than one. This is consistent with Gaunt (2004). The signs of the coefficients for all the portfolios are as expected and statistically significant at the 1% level. The s coefficient is positive for all the small market equity portfolios (L/S and H/S) and becomes negative for all the high market capitalization portfolios (L/B and H/B), thus confirming the existence of the small firm effect. Similarly, the h coefficient is negative for the low book-to-equity portfolios (L/S and L/B) and becomes positive for the high book-to-equity portfolios. The SEM also confirms the existence of the value premium. The adjusted R^2 ranges from 51.4% to 85%. Our findings are consistent with those of Fama and French (1993), Drew and Veeraraghavan (2002) and others who observe that small and high book-to-market equity firms have positive slopes on SMB and HML whereas big and low book-to-market-equity firms load negatively on SMB and HML. Small firms and firms with high book-to-market equity on average earn higher returns.

Table 14 Results of the Augmented Fama and French Three Factor Model on the Stock Exchange of Mauritius

Model: $(R_p t) - Rf = \alpha_p t + \beta_p(Rmt - Rf) + \ _p(SMB) + \ _p(HML) + \delta_p \left(\frac{R_{m,t}}{\sigma^2_{m,t}} \right) + \varepsilon_p t$

Portfolios excess returns	α coefficient	β coefficient	coefficient	coefficient	δ coefficient	R-Bar Squared	DW-Stat
L/S	0.010901	1.7883	0.60310	-0.25145	-0.0020749	.53083	1.99
t-ratio[p-value]	1.4966[.138]	2.3991[.019]	6.8104[.000]	-3.1405[.002]	-1.7036[.092]		
L/B	0.010848	2.1070	-0.21343	-0.20322	-0.0022533	.75527	2.07
t-ratio[p-value]	1.9322[.057]	3.6135[.001]	-3.0586[.003]	-3.1457[.002]	-2.3415[.022]		
H/S	0.010848	2.1070	0.78657	0.79678	-0.0022533	.84040	2.07
t-ratio[p-value]	1.9322[.057]	3.6135[.001]	11.2718[.000]	12.3338[.000]	-2.3415[.022]		
H/B	0.010901	1.7883	-0.39690	0.74855	-0.0020749	.75581	1.99
t-ratio[p-value]	1.4966[.138]	2.3991[.019]	-4.4819[.000]	9.3489[.000]	-1.7036[.092]		

Source: Computed by Author

An augmented Fama and French model

We find that for all the portfolios, the d coefficient is significant at the 10% level or better. This shows that the time variation in betas is priced. They are all negative in sign. This is expected for the small market capitalization portfolios. For the big market cap portfolios the negative sign confirms the finding earlier that the SEM is basically a small market capitalization stock and the deltas should be expected to be negative. The coefficients for the size effect and the book-to-market equity effect are all significant at the 1% level and with the expected signs. These effects do not disappear. This shows that the Fama and French three-factor model is robust to taking into account time-varying betas. They are therefore capturing other risk factors, which are ignored by the simple CAPM model. The R^2 ranges from 53.08% to 84.04%. However, the results must be interpreted with caution as they might be sample specific. This model must be tested across other stock exchanges to test the robustness of the findings. However, to say the least, the above is a very interesting result indeed.

5. Conclusion and policy implications

In Mauritius, the government has the objective of making the financial sector become the fourth pillar of the Mauritius economy. The Stock Exchange of Mauritius has been in operation for slightly more than 15 years. As at December 2004, there were 40 companies listed on the official market with a market capitalization of approximately 67 billion rupees and on the Over-The-Counter (OTC) market there were 78 companies. The stock exchange is run and managed by the Stock Exchange of Mauritius Limited and is supervised and regulated by the Financial Services Commission under the Stock Exchange Act 1988. The SEMDEX is the index of all listed ordinary shares and it is a value-weighted index.

Summary of major findings

Beta estimates

Thirty companies have betas, which are statistically significant at least at the 5% level and 33 companies have betas, which are significant at least at the 10% level out of the 40 listed companies. Only nine companies have a level of systematic risk (>1) higher than the market. Thirteen companies had significant beta estimates less than 0.50. When compared with the betas obtained using the market model as benchmark, only 28 companies have betas, which are significant at the 5% level and 31 at the 10%. Moreover, only eight companies have significant betas greater than one. However, the beta estimates are quite similar under each model with a few exceptions.

In most cases, when thin trading is accounted for, most of the companies show a higher level of systematic risk. We see that in practically all cases, the betas adjusted for thin trading are quite different from the traditional beta estimates. The results are consistent with the empirical finding that for companies with low beta, beta tends to be underestimated and for companies with high systematic risk, beta tends to be overestimated when the market is characterized by thin trading.

Time-varying betas

We first estimate an MA (1)-Garch (1,1) and conduct several specification tests to see whether the chosen Garch model is properly specified. Only then we generate the conditional variance series of the market return, which we use in the Schwert-Seguin market model. All the tests confirm that the MA (1)-Garch (1,1) is well specified and fits the monthly SEMDEX return series data well.

The point estimate of the term capturing the temporal variation in beta is negative for 31 out of the 40 stocks examined and positive for only nine stocks and ranges from -0.0009 to 0.0244[13]. These estimates are comparable to those obtained by Schwert-Seguin (1990), who report estimates of 0.0004 to +0.0001 and Reyes (1999) who report delta estimates of 0.0007 to 0.0001. Ten companies have ä's which are significant at least at the 10% level. The results are consistent with Grieb and Reyes (2001) who find that out of 38 stocks examined, for the Brazilian stock market, only 16 of them had äs which were statistically significant. Similarly, Episcopos (1996) finds significant negative ä's in only three of the 11 industries examined and Reyes (1999) did not find the time-varying term statistically significant for the UK stock indexes examined.

In addition, Grieb and Reyes (2001) find that 32 out of the 38 stocks had negative ä's. They concluded that the Brazilian stock market behaved very much like a small capitalization market. The results below concur with the fact that relatively speaking the SEM can be considered as a small market capitalization index and therefore we should expect most of the ä's to be negative, which is in fact the case.

Moreover, a very interesting result is that for all of the companies with negative äs, as market volatility goes up the time-varying betas also increases and is in most cases higher than the OLS betas. On the other hand, for all companies with positive ä's as market volatility goes up, the time-varying betas fall. The results therefore confirm that the spread between the systematic risk of small and large firms is larger during periods of high aggregate market volatility.

Size and value premium

The empirical results confirm that the Fama and French (1993) three-factor model holds for the Stock Exchange of Mauritius. In other words, both a size effect and a book-to-market equity are present on the SEM. The coefficients have the expected signs and are statistically significant at the 6% or better.

Augmented Fama and French model

We find that for all the portfolios, the d coefficient is significant at the 10% level or better. This shows that the time variation in betas is priced. They are all negative in sign. This is expected for the small market capitalization portfolios. For the big market capitalization portfolios the negative sign confirms the finding that the SEM is basically a small market capitalization stock and the deltas should be expected to be negative. The coefficients for the size effect and the book-to-market equity effect are all significant at the 1% level and with the expected signs. These effects do not disappear.
This shows that the Fama and French three-factor model is robust after taking into

account time-varying betas. However, the results must be interpreted with caution, as they might be sample specific. This model must be tested across other stock exchanges to test the robustness of the findings.

With the beta estimates, companies can calculate the required return on equity (ROE) and compute their weighted average cost of capital (WACC). This can then be compared with the discount rates which they use. There is also no ‘Beta Book’ at the SEM. This study can act as a first step towards the setting up of the latter with regular updating, say at three or five-year intervals. This will be useful not only for firms, but for the investment community at large. The size effect and the value premium may be used as investment strategies by portfolio managers and equity investors. We also know that returns on the SEM are better described by the Fama and French three-factor model rather than by the traditional capital asset pricing model. Given that betas are not stable over time, it is therefore crucial when considering long holding periods, that researchers and other stakeholders take into account the time-varying premium in systematic risk in their analysis.

6. Directions for further research

It would be interesting to replicate the above study in other emerging African stock markets in order to further enrich the literature on African stock markets research. It may be useful to further augment some of the asset pricing models by taking exchange rate risk into account, for instance, within an international capital asset pricing model or within an arbitrage pricing theory (APT) framework. In addition to the Fama and French three-factor model approach, it may be interesting to randomize portfolio membership and examine the ability of this model to explain the cross section of returns.

Notes

[1] Rupees are Mauritian rupees.

[2] The rates of corporate tax prevailing then, that is, as at June 2003.

[3] The author acknowledges that integration of these two components of research was suggested by Professor Senbet at the AERC research workshop in May-June 2005.

[4] Some of the major studies are discussed afterwards.

[5] b_i is the limit of b_{it} as the conditional market volatility goes to infinity.

[6] The share price data for each company was in row format. It had to be converted to column format.

[7] The financial statements are prepared according to the Mauritius Accounting Standards.

[8] "mkt cap" stands for market capitalization.

[9] For 2003, we stopped at 30th June, given that we had information on the weighted Treasury Bill rate up to June 2003.

[10] Only for four companies: MSM, CIT, FINCORP and LIT.

[11] Indicates the sector in which a company is operating.

[12] Ignoring the outliers, the range is in fact between 0.0009 to +0.0009

[13] Ignoring the outliers, the range is in fact between 0.0009 to +0.0009

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Appendixes

Estimation of CAPM and market model betas taking into account dividends

Table A1: Estimation of CAPM Betas

CODE	constant	Beta (β)	SE(β)	t-ratio (β)	DW	ADJ R^2
BANKS AND INSURANCE						
BAI	0.003938	0.439130	0.105776	4.151523	1.897447	0.237079
MCB	-0.007361	0.833784	0.344276	2.421850	2.005386	0.132039
MEI	0.003140	0.417183	0.137691	3.029846	2.039155	0.082585
MUA	0.002327	0.369515	0.164187	2.250574	2.019630	0.060402
SBM	0.012116	1.841083	0.115041	16.00370	1.973499	0.795437
SWAN	0.002499	0.295376	0.124709	2.368529	1.962444	0.056566
COMMERCE						
CMPL	0.002090	0.009830	0.201019	0.048899	1.985835	0.020440
COURTS	0.005979	1.074920	0.457405	2.350041	1.985098	0.038436
HM	0.008092	0.296443	0.141407	2.096388	1.973458	0.138835
HWF	-0.002086	0.306494	0.136988	2.237369	1.986376	0.033508
IBL	0.003765	1.113407	0.172018	6.472630	1.979947	0.363778
ROGERS	0.001987	0.753373	0.277361	2.716223	1.999501	0.061053
SHELL	0.014271	0.196435	0.128936	1.523503	1.988202	0.016723
INDUSTRY						
GCIVIC	0.008060	0.300960	0.204793	1.469580	1.976421	0.003257
MBL	-0.003577	0.286729	0.158860	1.804914	1.996547	0.031151
MCFI	0.009714	0.516764	0.202926	2.546570	2.040734	0.133570
MOROIL	0.000172	0.170834	0.169467	1.008069	1.982690	0.019663
MSM	0.007615	0.467690	0.164168	2.848857	1.997775	0.054186
PIM	0.034901	0.831119	0.291515	2.851036	2.017268	0.073289
UBP	0.007711	0.484772	0.139384	3.477952	1.951166	0.122468

CODE	constant	Beta (β)	SE(β)	t-ratio (β)	DW	ADJ R^2
INVESTMENTS						
CODE	**constant**	**Beta (β)**	**SE(β)**	**t-ratio (β)**	**DW**	**ADJ R^2**
BMH	0.008769	0.347750	0.160716	2.163756	1.996286	0.029551
CIT	-0.017787	0.741992	0.875869	0.847149	1.252113	0.008374
FINCORF	0.158442	1.728643	0.755965	2.286672	2.273468	0.364773
GIDC	0.007439	1.303746	0.331096	3.937668	1.990622	0.124806
LIT	0.004287	0.379309	0.169581	2.236749	1.959512	0.090179
MDIT	0.008826	0.739817	0.305436	2.422167	1.982769	0.054948
NIT	0.009939	0.776101	0.228201	3.400950	2.021059	0.112151
PAD	0.008810	1.024891	0.239843	4.273177	1.996254	0.181334
POLICY	0.003523	1.182842	0.243103	4.865600	1.987912	0.232705
UDL	0.001757	0.346880	0.150253	2.308637	1.998119	0.050092
LEISURE & HOTELS						
ASL	0.001591	0.375860	0.209412	1.794837	1.947742	0.008328
GBH	-0.006293	0.807585	0.125393	6.440409	1.986409	0.404732
NMH	0.001228	1.203600	0.136737	8.802284	1.990564	0.537895
SUNRES	-0.002469	0.815315	0.154606	5.273488	1.976642	0.285368
SUGAR						
HF	0.000645	0.105927	0.240910	0.439694	1.987192	0.014695
MDA	0.025873	0.617780	0.344470	1.793423	1.832152	0.033929
MOUNT	-0.001610	0.201947	0.217238	0.929613	2.003141	0.031961
MTMD	0.010430	0.688475	0.253630	2.714485	2.005192	0.126257
SAVA	-0.008439	0.293050	0.264855	1.106453	2.000269	0.022590
TRANSPORT						
AMTS	0.005027	1.110215	0.285797	3.884630	1.998182	0.134718

Source: Author’s computations

Table A2: Estimation of market model betas

CODE	constant	Beta (β)	SE(β)	t-ratio (β)	DW	ADJ R^2
BANKS AND INSURANCE						
BAI	0.009001	0.425972	0.107049	3.979241	1.898926	0.234444
MCB	-0.006150	0.919033	0.349424	2.630135	1.932741	0.091076
MEI	0.008366	0.409968	0.138941	2.950665	2.038815	0.077406
MUA	0.007996	0.359903	0.165377	2.176252	2.019142	0.057556
SBM	0.004560	1.852273	0.116035	15.96306	1.975190	0.795032
SWAN	0.008811	0.288931	0.125917	2.294608	1.961642	0.052061
COMMERCE						
CMPL	-.0036747	.8352E-3	0.202270	-0.108809	1.986945	0.020466
COURTS	0.005293	1.078695	0.461444	2.337650	1.985142	0.037663
HM	0.014384	0.291411	0.142481	2.045254	1.972857	0.136011
HWF	0.004101	0.304890	0.137834	2.212007	1.986553	0.032531
IBL	0.002741	1.116670	0.173171	6.448383	1.979839	0.361632
ROGERS	0.004241	0.741182	0.279830	2.648689	1.999535	0.056538
SHELL	0.021473	0.188891	0.129665	1.456765	1.987232	0.012450
INDUSTRY						
GCIVIC	0.014297	0.298334	0.206638	1.443749	1.975420	0.004250
MBL	0.002768	0.277146	0.159082	1.742157	1.991764	0.021537
MCFI	0.014087	0.503066	0.205629	2.446475	2.041735	0.131841
MOROIL	0.007611	0.159983	0.171046	0.935322	1.982589	0.020792
MSM	0.012430	0.452254	0.165220	2.737285	1.998351	0.047669
PIM	0.036353	0.842242	0.292763	2.876875	2.017375	0.075165
UBP	0.012335	0.477848	0.140868	3.392174	1.952628	0.117227

CODE	constant	Beta (β)	SE(β)	t-ratio (β)	DW	ADJ R^2
INVESTMENTS						
BMH	0.014607	0.341402	0.161959	2.107951	1.996552	0.025772
CIT	-0.015401	0.741745	0.882455	0.840547	1.251887	0.008707
FINCORP	0.235994	1.369314	0.610635	2.242445	2.314185	0.515211
GIDC	0.004772	1.295940	0.335339	3.864565	1.990407	0.121017
LIT	0.009855	0.353255	0.173386	2.037394	2.047339	0.084702
MDIT	0.011196	0.729018	0.307736	2.368970	1.982540	0.051634
NIT	0.011954	0.772056	0.230908	3.343571	2.021156	0.108929
PAD	0.008588	1.024954	0.242414	4.228107	1.996240	0.178423
POLICY	0.001955	1.170207	0.246013	4.756698	1.987978	0.226481
UDL	0.007613	0.339205	0.151604	2.237449	1.997676	0.046764
LEISURE & HOTELS						
ASL	0.007207	0.364089	0.210969	1.725795	1.948181	0.005093
GBH	-0.001468	0.864061	0.134465	6.425892	2.018764	0.422827
NMH	0.000393	1.238501	0.135186	9.161459	1.920341	0.544254
SUNRES	-0.000807	0.811795	0.155966	5.204959	1.976343	0.280004
SUGAR						
HF	0.010542	0.117774	0.241495	0.487687	1.987733	0.013814
MDA	0.028097	0.542113	0.340175	1.593629	1.816920	0.039773
MOUNT	0.005555	0.190324	0.219018	0.868988	2.002915	0.033585
MTMD	0.013200	0.689113	0.255201	2.700277	2.005017	0.125249
SAVA	-0.002082	0.280838	0.267337	1.050505	2.000770	0.024208
TRANSPORT						
AMTS	0.004103	1.098505	0.290041	3.787413	1.997392	0.129824

Table A3: Ordinary equities on the stock exchange of Mauritius by listing date

TICKER	COMPANY	LISTING DATE
MCB	Mauritius Commercial Bank Ltd	5- Jul-89
MDIT	Mauritius Development Investment Trust	5- Jul-89
MSM	Mauritius Stationary Manufacturers Ltd	5- Jul-89
MTMD	Mon Tresor Mon Desert Ltd	5- Jul-89
UBP	United Basalt Products Ltd	5- Jul-89
MCFI	Mauritius Chemical Fertilisers Industry Ltd	13-Dec-89
MDA	Mon Desert Alma Ltd	17-Jan-90
SAVA	Savanah Sugar Estates Ltd	24-Jan-90
MOROIL	Mauritius Oil Refineries Ltd	21-Feb-90
ROGERS	Rogers and Company Ltd	27-Jun-90
GIDC	General Investment and Development Trust	4-Jul-90
COURTS	Courts Ltd	12-Sep-90
SWAN	Swan Co. Ltd	19-Dec-90
HM	Harel Mallac ltd	20-Feb-91
HF	Harel Freres Ltd	20-Feb-91
MOUNT	Mount Ltd	27-Feb-91
CMPL	Compagnie des Magasins Populaires Ltee	6-Mar-91
SHELL	Shell Mauritius Ltd	13-Nov-91
UDL	United Docks Ltd	27-Nov-91
POLICY	Policy Ltd	8-Dec-92
CIT	Consolidated Investment Trust Ltd	17-Dec-92
SUNRE	Sun Resorts Ltd	26-Jan-93
BAI	British American Insurance Ltd	9-Feb-93
MBL	Mauritius Breweries Ltd	10-Jun-93
LIT	Liberty Investment Trust Ltd	22-Jun-93
PIM	Plastic Industries Mauritius Ltd	15-Jul-93
NIT	National Investment Trust Ltd	29-Jul-93
MUA	Mauritius Union Assurance Ltd	14-Dec-93
MEI	Mauritius Eagle Insurance Ltd	16-Dec-93
BMH	Belle Mare Holdings Ltd	7-Mar-94

TICKER	COMPANY	LISTING DATE
IBL	Ireland Blyth Ltd	17-Aug-94
FINCORP	Fincorp Investment Ltd	31-Aug-94
ASL	Automatic System Ltd	12-Oct-94
GCIVIC	Gamma Civic Ltd	30-Nov-94
AMTS	Air Mauritius Ltd	17-Feb-95
SBM	State Bank of Mauritius Ltd	30-Jun-95
GBH	Grand Baie Hotel Ltd	24-Nov-95
PAD	Promotion and Development Ltd	17-Jan-96
HWF	Happy World Foods Ltd	28-Feb-96
NMH	New Mauritius Hotels Ltd	12-Jun-96

Table A4: Summary market indicators on three African stock markets

BOTSWANA (BSE)	**92**	**94**	**96**	**98**	**2000**	**2002**
No Listed Companies	11	11	12	14	16	17
Mkt Cap (US Million)	295	377	326	322.5	524.5	940.3
Mkt Turnover Ratio	5.3	9.9	9.0	9.88	5.27	3.43
P/E Ratio	9.01	9.33	7.28	na	na	na
Dividend Yield	na	na	7.50	na	na	na
KENYA (NSE)	**92**	**94**	**96**	**98**	**2000**	**2002**
No Listed Companies	57	56	58	57	57	57
Mkt Cap (US Million)	610	3,100	1,790	1,720	1,352	1,494
Mkt Turnover Ratio	1.99	2.70	4.00	3.37	3.88	3.40
P/E Ratio	5.8	9.8	27.8	na	na	na
Dividend Yield	11.1	4.2	4.4	na	na	na
SOUTH AFRICA (JSE)	**92**	**94**	**96**	**98**	**2000**	**2002**
No Listed Companies	683	640	626	668	616	450
Mkt Cap (US Million)	103,537	225,718	241,571	na	204,952	184,628
Mkt Turnover Ratio	4.6	8.5	10.9	26.7	36.5	42.4

Table A5: Number of stocks in intersection portfolios

Portfolios	Number of Stocks
L/S	14
L/B	20
H/S	19
H/B	18

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