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Measuring Risk on the Barbadian Stock Exchange

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Abstract

Measuring the risk of an asset or portfolio of assets is pertinent to decision making in finance. There are several measures available with the most popular being "beta" of the mean variance Capital Asset Pricing Model (CAPM). In light, of empirical and theoretical criticism aimed at beta, alternative models have been proposed. This paper investigates which of the three models- the CAPM, Lower Partial CAPM (LPM-CAPM) and the Asymmetric Response Model (ARM) – best fits the stock returns on the Barbados Stock Exchange (BSE). The results show that the returns of the financial, general trading and public utilities portfolios indicate a choice for the ARM, while the LPM-CAPM appears to be a reasonable candidate for the manufacturing and other assets categories.

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1. Introduction

Measuring the risk of an asset, or a portfolio of assets, is pertinent to decision making in Finance. Several measures are available in the literature but one of, if not, the most popular and widely used, is the systematic market risk, or "beta" of the mean variance Capital Asset Pricing Model (CAPM) of Sharpe (1963, 1964), Lintner (1965) and Mossin (1969) – see, in the Caribbean context, Leon, Nicholls and Sergeant (2000) and Alleyne and Craigwell (2004). However, for sometime now, there has been theoretical and empirical criticism aimed at beta (see the survey of Jaganathan and McGratten, 1995). Such criticism has been especially acute in emerging markets, with the most notable comment focusing on the lack of empirical relationship between beta and stock returns (see Harvey, 1995; Godfrey and Espinosa, 1996; Erb, Harvey and Viskanta, 1995, 1996; Diamonte, Liew and Stevens, 1996, Estrada, 2000).

Given the above, several useful alternatives to the CAPM have been proposed, which are beginning to gain increasing recognition by theorists and practitioners alike. A class of these models typically assumes that risk is related more to shortfall than volatility of returns, and implies downside or asymmetric betas (see Bawa and Lindenberg, 1977; Harlow and Rao, 1989; Satchell, 1996; Pedersen, 1999). Moreover, these models have found empirical support in emerging market stock returns (see Estrada, 2000; Hwang and Pedersen, 2002b). However, the latter studies have shown that the choice of risk measures varies greatly across different regions and time periods, making the choice of a risk measure data and country specific.

With this in mind, this paper investigates which of the three models – CAPM, Lower Partial Moment CAPM (LPM – CAPM) of Bawa and Lindenberg (1977), and the more general data-generating Asymmetric Response Model (ARM) of Bawa, Brown and Klein (1981) – best fits the stock returns on the Barbados Stock Exchange (BSE). The approach, pioneered by Harlow and Rao (1989) and Eftekhari and Satchell (1996), and applied to mature markets by Pedersen and Hwang (2002a, 2003) and emerging markets by Estrada (2000) and Hwang and Pedersen (2002b), nests the three models (CAPM, LPM – CAPM and ARM) in each other and thus gives a statistical test of which model is preferred based on conventional econometric conditions. The LPM – CAPM and ARM are chosen not only because they have a sound theoretical foundation (see Pedersen and Satchell, 2002), but because there are suitable for non-normal returns and illiquid markets, both found to be evident in the BSE by Alleyne and Craigwell (2004) and Craigwell and Grandbois (1999) – see Section 2 below as well.

The plan of this paper is as follows. Section 1 gives a brief background to the Barbadian Stock Exchange. Section 2 looks at the Capital Asset Pricing Model (CAPM). Section 3 discusses some problems with the CAPM as it relates to emerging markets. Section 4 presents the test procedure. Section 5 reviews the data. Section 6 assesses the empirical results, and finally conclusions are made.

2. History and Development of the Barbados Stock Exchange

The Barbados Stock Exchange (BSE) was established in June 1987 under the provision of the Securities Exchange Act of 1982. The types of securities traded on the exchange included ordinary shares, preferred shares, government bonds and debentures. Trades were done two days per week, on Tuesdays and Fridays, using a manual open auction outcry method.

One of the first steps towards the creation of a regional securities market took place in April 1991, with the commencement of cross-border trading of companies listed on the Barbados, Jamaican and Trinidad and Tobago Stock Exchanges. Another major development on the BSE was the launch of the junior market, formally known as the unlisted securities market, in January 1992. This market had less onerous admission requirements and it was created to assist small companies, which were in need of capital.

In July 2001 the BSE switched from the manual system of trading to electronic trading using the order routing method. One month later the BSE was reincorporated simultaneously with the enactment of the Securities Act 2001 –13, which replaced and repealed the Act of 1982. Additionally, effective February 2003, the exchange began trading on Wednesday, resulting in an increase in the number of trading days from two to three. In 2003, the Barbados Securities Commission (BSC) was established to regulate the activity of the BSE and ensure that it operates fairly and efficiently. Prior to the establishment of the BSC, the market was self-regulatory.

Performance of the Barbados Stock Exchange

Stock Market Size

The stock market size as indicated by the number of companies listed on the stock market and the market capitalisation to GDP ratio are two measures of stock market development. The number of companies listed on the BSE increased from 13 to 24 over the period of 1989 to 2003. Similarly, market capitalisation improved significantly from about 16.2% of GDP at the end of 1989 to 132.1% at the end of 2003. The movements in these two indicators suggest that the BSE has grown appreciably over the period of operation.

Liquidity

It has been said (see, for example, Agarwal, 2000) that the stock market aids in economic development through the creation of liquidity, which, in turn, makes investment less risky while at the same time allowing companies to have permanent access to capital. Consequently, stock markets improve the allocation of capital and enhance prospects for economic growth by facilitating longer, more profitable investments.

To investigate how stock market activity is linked to economic growth, indicators of liquidity may be used. The first method is the turnover to GDP ratio, which indicates the varying ease of trading and as a result the level of liquidity of the market. The turnover ratio (turnover/ market capitalisation) is the second measure of liquidity. The greater these two ratios are, the higher the liquidity; hence the overall contribution in economic activity should be significant.

The BSE turnover and turnover to GDP ratios are relatively small having annual average of about 1.0% and 1.7%, respectively. These averages exclude 1998 and 2002, when exceptionally high volumes of securities crossed the floor.

A Comparison of the Regional Stock Exchanges

The BSE was the last of the three stock exchanges in the region to be formed. It followed the Jamaica Stock Exchange (JSE) in February 1969 and the Trinidad and Tobago Stock Exchange (TTSE) in October 1981. This section evaluates the performance of these three exchanges in terms of growth and level of activity. As it can be seen from Table 2, the indices and market capitalisation of the JSE and TTSE grew at faster annual rates, than those of the BSE. In contrast, the average rate of growth in the number of companies listed on the BSE exceeded those of the JSE and TTSE. Furthermore, the JSE and TTSE had higher average turnover ratios than the BSE. The above results indicate that the JSE and TTSE are the more active exchanges and have experienced faster growth. Recently, Alleyne and Craigwell (2004) also noted that the volatility in Barbados is relatively low, possibly due to the share ownership on the BSE.

3. The Capital Asset Pricing Model

The Capital Asset Pricing Model (CAPM) is an equilibrium model for expected returns and is based on the following set of rather strict conditions: (i) many price taking investors; (ii) investors planning horizons are similar; (iii) non-existent taxes or transactions costs; (iv) investors borrow and lend at the same risk-free rate over the planned investment horizon; (v) investors only interest is in the expected return variance. (A sufficient condition for this is a normal distribution of returns); (vi) investors have the same information set concerning the distribution of returns; and (vii) the market portfolio comprises all publicly traded assets.

Several implications can be derived from the above assumptions. One, investors utilise the Markowitz (1952) algorithm to determine the same set of efficient portfolios, which are combinations of the risk-free asset and the tangency portfolio. Two, risk averse investors lend at the risk-free rate whereas risk tolerant investors borrow at the risk-free rate and leverage their holdings of the tangency portfolio. In equilibrium total borrowing equals total lending implying a zero net supply risk-free asset when aggregated across investors. Three, given the same tangency portfolio and the zero net supply risk-free asset in the aggregate, the aggregate demand for assets is the tangency portfolio. The supply of assets is the market portfolio and since, in equilibrium supply equals demand, the tangency portfolio is the market portfolio. Four, given that the market portfolio equals the tangency portfolio and the latter is (mean-variance) efficient, the market portfolio is also (mean-variance) efficient. Finally, given the efficient market portfolio and risk-free asset, the security market line (SML) pricing relationship holds for all assets (and portfolios)

$$E[R_i(t)] = R_f(t) + \beta_{i,m}\left(E[R_m(t)] - R_f(t)\right)$$

where $R_i(t)$ is the return on any asset or portfolio i, R_m is the return on the market portfolio and $\beta_{i,m} = cov\left(R_i(t), R_m(t)\right)/var\left(R_m(t)\right)$. The SML states that there is a positive linear relationship between the expected return on an asset and the "beta" of that asset with the market portfolio.

By subtracting R_f from both sides of the above equation, an expression in terms of risk premia can be obtained. Formally,

$$E[R_i(t)] - R_f(t) = \beta_{i,m}\left(E[R_m(t)] - R_f(t)\right)$$

Low beta assets (less than 1) have a risk premia less than the market and vice versa.

4. The CAPM and Emerging Markets

As discussed above, the CAPM postulates that investors have mean-variance preferences which suggest that either (i) investors are only interested in the first two moments of the returns distribution or (ii) return distributions are jointly spherically symmetric (for example, normal, t-distribution and so on). The former implies a quadratic utility function with its known empirical weaknesses (existence of a bliss point, symmetry, decreasing risk aversion and so on), whilst the latter has often been rejected in many financial settings, particularly in thinly traded or default-driven markets such as those normally found in emerging markets. For more on these arguments see the survey of Jagannathan and McGrattan (1995).

There are other more specific problems reported by studies on emerging markets. Firstly, the CAPM implicit postulate that emerging markets are fully integrated with the world market is not well collaborated with the empirical evidence as beta and equity returns are far less correlated and too low to explain the high cost of equity in emerging markets (see Harvey, 1995; Bekaert, 1995; Bekaert and Harvey, 1995; Korajczyk, 1996 and Bekaert, Harvey; Lumsdaine, 2002). As a result several studies have attempted to explain the difference between beta and the cost of equity by directly adjusting beta (Godfrey and Espana, 1996) or using a method based on credit ratings (Erb, Harvey and Viskanta, 1995, 1996; and Diamonte, Liew and Stevens, 1996). Whilst these have provided useful insights into the economics of emerging markets, they either lack theoretical rigour or are difficult to directly compare with the CAPM from an empirical performance point of view.

Secondly, the underlying risk measure and data generating functions of the CAPM may be inappropriate in the emerging markets context so that alternative approaches may be required to produce more accurate and realistic results. Estrada (2000) argues that risk is ultimately linked to shortfall rather than volatility, and proposed a downside risk model to explain the cost of equity in emerging markets based on the following semi-standard deviation:

$$\sum_{i=1}^{n}\left(\tau - R_i(t)\right)^2 \quad \text{where} \quad R_i(t) < \tau \qquad (1)$$

where the semi-standard deviation replaces the variance as a risk measure and τ is a target return, typically set at a risk-free or some other rate that reflects an acceptable performance. Estrada (2000) findings indicate that Equation (1) explains a greater proportion of the risk of the stock returns in emerging markets than other measures like beta and Value at Risk. This, and related measures, has also been supported by a number of practitioners like Sortino and Price (1994), Sortino and Van De Meer (1991) and Efthekari and Satchell (1996), and has a sound theoretical foundation in Microeconomics, Decision Theory and Psychology (see Pedersen and Satchell, 1998).

5. The Empirical Methodology

The test procedure utilised here was first introduced by Bawa, Brown, and Klein (1981) and developed further by Harlow and Rao (1989), Eftekhari and Satchell (1996), Pedersen (1998) and Pedersen and Hwang (2002a). The main point of the method is to split excess market returns into two parts, positive and negative, in order to capture asymmetric responses of portfolio returns to changes in market conditions. The model – labelled the Asymmetric Response Model (ARM) – is described by the following process:

$$R_i(t)-R_f(t)=\beta_{i1}R_m^-(t)+\beta_{i2}R_m^+(t)+\pi\delta(t)+\varepsilon_i(t) \quad (2)$$

where $R_m^-(t)=R_m(t)-R_f(t)$ when $R_m(t)<R_f(t)$ and zero otherwise, $R_m^+(t)=R_m(t)-R_f(t)$ when $R_m(t)>R_f(t)$ and zero otherwise, and $\delta(t)$ is an index function which is one when $R_m(t)>R_f(t)$ and zero otherwise. π represents the expectation of the market return given that it falls above the target rate, that is, it is the truncated moment of the return on the market portfolio. The disturbances, $\varepsilon(t)$, are serially uncorrelated and independent of all other variables, with mean zero. It is clear that this model captures the asymmetry in excess market returns through β_{i1} and β_{i2}.

The CAPM and LPM-CAPM can be linked to (2) by first setting $\pi=\phi(\beta_{i1}-\beta_{i2})$ in (2), where ϕ is the conditional expectation of $R_m(t)$ given that $R_m(t)>R_f(t)$, that is,

$$\phi=E\left[R_m(t)-R_f(t)/R_m(t)>R_f(t)\right]=\frac{E\left[R_m^+(t)\right]}{Pr\left(R_m(t)>R_f(t)\right)} \quad (3)$$

Now taking expectations, (2) reduces to the LPM-CAPM equation in Bawa and Lindenberg (1977) and

$$\beta_{i1}=\frac{E\left\{\left(R_i(t)-R_f(t)\right)min\left(0,R_m(t)-R_f(t)\right)\right\}}{E\left\{\left(min\left(0,R_m(t)-R_f(t)\right)\right)^2\right\}} \quad (4)$$

which is the 'LPM-beta'. It is notable that all the assumptions in this model is the same as the CAPM except that the variance is replaced by (1) as the risk measure and the target return is the risk-free rate, $R_f(t)$. Hence, the linear models relating cost of equity, expected returns and risk premia all remained with

(4) replacing the traditional CAPM beta, whilst capturing only downside influences in returns. Given the above β_{i2} can be interpreted as the response of the portfolio to upside market returns. By further imposing $\beta_{i1} = \beta_{i2}$ (and so by (3), $\pi = 0$) in (2) and taking expectations, the traditional CAPM beta can be expressed as:

$$\beta_{i1} = \beta_{CAPM} = \frac{E\{(R_i(t) - R_f(t))(R_m(t) - R_f(t))\}}{E\{R_m(t) - R_f(t)^2\}} \tag{5}$$

Thus, in order to test for the differences between the three models, begin with (2) and then test

$$H_1 : \pi = \phi(\beta_{i1} - \beta_{i2}) \tag{6}$$

against

$$H_{1A} : \pi \neq \phi(\beta_{i1} - \beta_{i2}) \tag{7}$$

A rejection of H_1 implies that the data are not well described by either the LPM-CAPM or the CAPM, therefore, the correct model to use is the ARM in (2). If H_1 is not rejected, then test

$$H_2 : \beta_{i1} = \beta_{i2} \tag{8}$$

against

$$H_{2A} : \beta_{i1} \neq \beta_{i2} \tag{9}$$

which allows a distinction between the CAPM (H_2 not rejected) and the LPM-CAPM (H_2 rejected). The above methodology describes a nested econometric framework to directly compare the three models, and to choose one model over the other.

Assumptions on the Distribution Functions

In order to test the hypotheses in the previous subsection, assumptions concerning the relevant distribution functions must be made. Given the joint marginal distribution of $R_m^-(t)$, $R_m^+(t)$ and $\delta(t)$, a full joint probability density function of $\{R_i(t), R_m^-(t), R_m^+(t), \delta(t)\}$ can be calculated as follows:

$$pdf\left(R_i(t), R_m^-(t), R_m^+(t), \delta(t)\right) = pdf\left(R_i(t) \middle| R_m^-(t), R_m^+(t), \delta(t)\right) pdf\left(R_m^-(t), R_m^+(t), \delta(t)\right) \quad (10)$$

It is typical in most finance studies to assume that the first term on the right hand side, the conditional distribution of portfolio returns, is normally distributed. That is, the conditional likelihood of $R_i(t)$ given $R_m^+(t)$, $R_m^-(t)$ and $\delta(t)$ is given by

$$pdf\left(R_i(t) \middle| R_m^-(t), R_m^+(t), \delta(t)\right) = \frac{1}{\sigma\sqrt{2\pi}} \exp\left[-\frac{1}{2\sigma^2}\left(R_i(t) - \beta_{i1} R_m^-(t) - \beta_{i2} R_m^+(t) - \pi\delta(t)\right)^2\right] \quad (11)$$

However, the second term on the right hand side - the probability density function of excess market returns – is data specific. If excess returns are symmetric, a normal distribution will suffice. In the case of asymmetric excess returns, a distribution that reflect this must be adopted, possibly a continuous truncated normal distribution (CMTN) or a mixed Gamma distribution (LMG) as used in, for example, Pedersen and Hwang (2002a). Note that even if excess returns on the market were normal, this joint distribution (10) is not necessarily multivariate normal, since $R_m^+(t), R_m^-(t)$ and $\delta(t)$ are explicitly conditioned on (11) and weighed by the coefficients β_{i1}, β_{i2} and π respectively.[1] Hence, even in such conditions, the CAPM will not be implied within this framework unless certain parameter restrictions are satisfied.

Once a marginal distribution is determined for the excess market returns and the full unrestricted likelihood function of $\{R_i(t), R_m^-(t), R_m^+(t), \delta(t)\}$ identified, likelihood ratio (LR) tests can be constructed by explicitly imposing the restrictions (6) and (8) in turn, and comparing the resulting likelihood estimates.

6. The Data

The stock returns data used in this study are taken form the Barbados Stock Exchange and consists of monthly returns spanning the period 1989 to 2004. Twenty-seven companies from five different sectors – financial (six), manufacturing (seven), public utilities (four), general trading (nine) and other (one) are examined. The market portfolio employed is the composite market index of the Barbados Stock Exchange. Stock market returns are defined as continuously compounded returns at time t, calculated as the natural logarithm difference in the closing market index between two dates, P_t being the stock market index at time t:

$$r_t = \ln \left|\frac{P_t}{P_{t-1}}\right| = \ln(P_t) - \ln(P_{t-1})$$

Dividends are assumed away on the grounds that they are very small or nonexistent (see Campbell, Lo and Mackinlay, 1997). The three month treasury bill rate is used as the risk-free rate and this was taken from the Central Bank of Barbados data files.

[1] In fact, the functional form for the density function of $R_i(t)$ cannot be obtained, in general. However, the moment-generating function can be computed and consequently expressions for the central moments of $R_i(t)$ can be deduced (see Pedersen, 1999).

7. Empirical Results

The first step in presenting the results is to determine the marginal distribution for the excess market returns. The summary statistics in Table 3 indicate that the monthly returns data suffers from non-normality as a result of significant skewness and excess kurtosis, hence assuming normality may not adequately reflect the properties of the excess market returns.

Following Knight, Satchell and Tran (1995), a density function which splits the contributions of upside and downside excess returns (as in the asymmetric model in (2)) is needed. Formally,

$$R_m(t) - R_f(t) = \delta(t) R_m^+(t) - (1 - \delta(t))\left[-R_m^-(t)\right] \tag{12}$$

such that the excess returns are equivalent to $R_m^+(t)$ when $\delta(t)=1$ and $R_m^-(t)$ when $\delta(t)=0$. Then the joint marginal density function of $R_m^+(t)$, $R_m^-(t)$ and $\delta(t)$ is given by

$$\left[pdf\left(R_m^+(t)\right)\right]^{\delta(t)}\left[pdf\left(-R_m^-(t)\right)\right]^{1-\delta(t)} \tag{13}$$

Depending on the data, different assumptions can be made about $R_m^+(t)$, $R_m^-(t)$ and $\delta(t)$ and the explicit unconditional likelihood of $\{R_i(t), R_m^-(t), R_m^+(t), \delta(t)\}$ thus readily derived using (10).

The literature has utilised the continuous truncated normal distribution (CMTN) and the mixed Gamma distribution (MG), but have found that they are both well suited for the task at hand as they gave very similar results. Consequently, in this paper, only the MG is examined. To derive this function, initially suppose that $R_m^+(t)$ and $-R_m^-(t)$ are given by gamma distributions, that is,

$$pdf(x) = \left\{ \begin{array}{ll} \dfrac{\lambda^{\alpha} x^{\alpha-1} \exp(-\lambda x)}{\Gamma(\alpha)} & x > 0 \\ 0 & otherwise \end{array} \right\} \tag{14}$$

where Γ denotes the Gamma function, $\alpha > 0$ and $\lambda > 0$. Under these assumptions, Knight, Satchell and Tran (1995) show that the joint likelihood of $R_m^+(t)$, $R_m^-(t)$ and $\delta(t)$ can be given as

$$\left\{ \frac{p\lambda_1^{\alpha_1} [R_m^+(t)]^{\alpha_1 - 1} \exp\left(-\lambda_1 R_m^+(t)\right)}{\Gamma(\alpha_1)} \right\}^{\delta(t)} \times \left\{ \frac{(1-p)\lambda_2^{\alpha_2} [-R_m^-(t)]^{\alpha_2 - 1} \exp\left(-\lambda_2 (-R_m^-(t))\right)}{\Gamma(\alpha_2)} \right\}^{1-\delta(t)} \tag{15}$$

where the parameters (α_1 , λ_1) are from the Gamma distribution for $R_m^+(t)$, (α_2 , λ_2) for $-R_m^-(t)$ and $\delta(t)$ is an independent Bernoulli switching variable which is one with probability p and zero with probability 1-p .

Now that the marginal distributions are specified, the log-likelihood function of $\{R_i(t), R_m^-(t), R_m^+(t), \delta(t)\}$ can be derived from the probability density function of (10), when the conditional density of $R_i(t)$ given $R_m^+(t)$, $R_m^-(t)$ and $\delta(t)$ is (11) and the marginal distribution as specified by (15).

The results of the tests of the main hypothesis (6) and (8) distinguishing between the risk measurements models proposed are reported in Table 4 for 5 portfolios of assets over various time periods. The findings indicate that in all the cases of the financial, general trading and public utilities portfolios the ARM is chosen over the two other models, that is, hypothesis (6) is always rejected. For the manufacturing and other categories hypothesis (6) is not rejected, so hypothesis (8) must be imposed. These results indicate that the null hypothesis should be rejected in favour of the LPM – CAPM model.

Conclusion

This paper investigates the appropriateness of the conventional CAPM, the LPM-CAPM and ARM to measuring risk of portfolio returns on the Barbadian stock exchange. The results of the monthly returns for the financial, general trading and public utilities portfolios indicate a choice for the ARM, which allows for both downside and upside risks and fat-tails distributions. On the other hand, the LPM-CAPM appears to be a reasonable candidate for the manufacturing and other assets. In essence, the popular industry choice of the CAPM is not in practice the best model, and practitioners should be aware that there may be inaccuracies in how they measure financial risk which fortunately can be improved by using more sophisticated models. Models of the asymmetry type could be recommended not only because of the results contained within but because the classical performance measurement of shares and investors by Sharpe (1966), Treynor (1965) and Jensen (1972) can be located with in this general framework (see Sortino and Price, 1994; Pedersen and Satchell, 1999). Of course, to be comprehensive and fully useful, this analysis must be undertaken for higher frequencies like daily or weekly data and indeed for other asymmetric distributions. In addition, there are other ways of measuring asymmetry in excess returns, for example, higher moment modeling as in Harvey and Siddique (2000) and Hwang and Satchell(1999) which remains an alternative avenue for future research.

References

Agarwal, R. N. (2000), Financial Integration and Capital Markets in Developing Countries: A Study of Growth, Volatility and Efficiency in the Indian Capital Market, Discussion Paper Series Number 20, Institute of Economic Growth, Delhi.

Alleyne, K. and R. Craigwell, 2004, Information Efficiency and Volatility in the Barbados Stock Exchange, Central Bank of Barbados, mimeo.

Bawa, V., Brown, S. and R. Klein, 1981, Asymmetric response asset pricing models: Testable alternatives to mean-variance, mimeo.

Bawa, V. and E. Lindenberg, 1977. Capital market equilibrium in a mean-lower partial moment framework. *Journal of Financial Economics* 5, 89-200.

Bekaert, G., 1995, Market Integration and Investment Barriers in Emerging Equity Markets, *World Bank Economic Review* 9, 75-107.

Bekaert, G. and C. Harvey, 1995, Time-Varying World Market Integration. *Journal of Finance*, 403-444.

Bekaert, G., C. Harvey, and R. Lumsdaine, 2002, The Dynamics of Emerging Market Equity Flows, *Journal of International Money and Finance* (21)3, 295-350.

Campbell, J., Lo, A. and A. MacKinlay 1997, *The Econometrics of Financial Markets*, Princeton: New Jersey.

Craigwell and Grandbois, 1999, The Performance of the Securities Exchange of Barbados, *Savings and Development,* 23 (4), 433-457.

Diamonte, R., Liew, J. and R. Stevens, 1996. Political Risk in Emerging and Developed Markets. *Financial Analysts Journal*, May/Jun, 71-76.

Eftekhari, B. and S. Satchell, 1996, Non-normality of returns in emerging markets. *Research in International Business and Finance*, Supplement 1, 267-277.

Erb, C., Harvey, C. and T. Viskanta, 1995. Country Risk and Global Equity Selection. *Journal of Portfolio Management*, Winter, 74-83.

Erb, C., Harvey, C. and T. Viskanta, 1996. Expected Returns and Volatility in 135 Countries. *Journal of Portfolio Management*, Spring, 46-58.

Estrada, J., 2000. The Cost of Equity in Emerging Markets: A Downside Risk Approach. *Emerging Markets Quarterly*, Fall, 19-30.

Godfrey, S. and Ramon Espinosa, 1996. A practical Approach to Calculating Costs of Equity for Investment in Emerging Markets. *Journal of Applied Corporate Finance*, Fall, 80-89.

Harlow, W. and R. Rao, 1989, Asset-pricing in a generalised mean-lower partial moment framework: Theory and evidence. *Journal of Financial and Quantitative Analysis*, 24, 285-311.

Harvey, C., 1995. Predictable Risk and Returns in Emerging Markets. *Review of Financial Studies*, Fall, 773-816.

Harvey, C.R. and A. Siddique, 1999, Autoregressive Conditional Skewness. *Journal of Financial and Quantitative Analysis* 34 (4), 465-488.

Homaifar, G. and D.B. Graddy, Winter 1990, Variance and lower partial moment betas as alternative risk measures in cost of capital estimation: A defence of the CAPM beta. *Journal of Business Finance and Accounting* 17, 677-688.

Hwang, S. and C.C. Pedersen, 2002, Best Practice Risk Measurement in Emerging Markets: Empirical Test of Asymmetric Alternatives to CAPM, mimeo, August.

Hwang, S. and S.E. Satchell, 1999a, Modelling Emerging Risk Premia Using Higher Moments, *International Journal of Finance and Economics*, Vol. 4, No. 4, 271-296.

Hwang, S., and S. E. Satchell, 1999b, Empirical Identification of Common Factors in Emerging Markets Return, *Emerging Markets Quarterly*, Vol. 3, No. 4, 7-26.

Jagannathan, R. and E. McGrattan, Fall 1995, The CAPM debate. *Federal Reserve Bank of Minneapolis Quarterly Review* 19, 2-17.

Jensen, M., 1972, Capital Markets: Theory and Evidence, *Bell Journal of Economics*, 3, 357-398.

Knight, J., Satchell, S. and K. Tran, 1995, Statistical modelling of asymmetric risk in asset returns. *Applied Mathematical Finance* 2, 155-172.

Korajczyk, R. A., 1996, A Measure of Stock Market Integration for developed and Emerging Markets, *World Bank Economic Review* 10, 265-289.

Leon, Nicholls and Sergeant, 2000, Testing Volatility on the Trinidad and Tobago Stock Exchange, *Applied Financial Economics,* 15 (2), 207-220.

Lintner, J., 1965, The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets, *Review of Economics and Statistics*, 47, 13-37.

Markowitz, H., 1952, Portfolio selection. *Journal of Finance* 7, 77-91.

Mossin, J. 1969, Security Pricing and Investment Criteria in Competitive Markets, *American Economic Review*, 59, 749-756.

Pedersen, C., 1998, Empirical tests for differences in equilibrium risk measure with application to downside risk in small and large UK companies, *Cambridge Discussion papers in Accounting and Finance*, No. 41.

Pedersen, C., 1999, Four Essays on Risk in Finance PhD thesis, Trinity College, University of Cambridge, England.

Pedersen, C. and S. Hwang, 2002a, On Empirical Risk Measurement with Asymmetric Equilibrium Risk Measures, mimeo August.

Pedersen, C. and S. Hwang, 2002b, Best Practice Risk Measurement in Emerging Markets: Empirical Test of Asymmetric Alternatives to CAPM, mimeo, August.

Pedersen, C. and S. Hwang, 2003, Does Downside Beta matter in Asset Pricing?, mimeo, August.

Pedersen, C. and S. Satchell, 1998, An extended family of financial risk measures. *Geneva papers on Risk and insurance*: Theory 23, 89-117.

Pedersen, C. and S. Satchell, 2000, Small Sample Analysis of performance Measures in the Asymmetric Response Model, *Journal of Financial and Quantitative Analysis* 35(3), 425-450.

Pedersen, C. and S. Satchell, 2002, On the Foundation of Performance Measures under Asymmetric Returns, *Quantitative Finance* 3, 217-223.

Satchell, S., 1996, Lower Partial Moment Capital Asset Pricing Model: A Re-examination, IFR Birbeck College Discussion Paper, No. 20.

Sharpe, W., January 1963, A simplified model for portfolio analysis. *Management Science*, 277-293.

Sharpe, W., 1964, Capital asset prices: A theory of capital market equilibrium under conditions of risk. *Journal of Finance* 19, 425-442.

Sharpe, W., 1996. Mutual performance. *Journal of Business*, 119-138.

Sortino, F. and R. Van der Meer, Summer, 1991. Downside risk. *The Journal of Portfolio Management*, 27-31.

Sortino, F., and L. Price, Fall 1994, Performance measurement in a downside risk framework. *The Journal of Investing*, 59-65.

Treynor, J., 1965, How to rate management of investment funds. *Harvard Business Review*, 63-75.

Table 1: Performance Indicators of the Barbados Stock Exchange

Year	Listed Companies	MCAP/GDP	Turnover/GDP	Turnover Ratio
1989	13	16.2%	0.2%	1.2%
1990	14	16.3%	0.3%	1.8%
1991	14	18.3%	0.5%	2.9%
1992	15	16.3%	0.1%	0.8%
1993	16	19.9%	0.3%	1.4%
1994	18	29.5%	0.3%	1.1%
1995	18	26.4%	0.2%	0.6%
1996	19	38.6%	0.3%	0.8%
1997	18	52.0%	1.1%	2.0%
1998	20	101.8%	43.0%	42.3%
1999	22	81.0%	0.8%	1.0%
2000	22	66.0%	1.9%	2.8%
2001	25	71.8%	0.4%	0.6%
2002	23	137.0%	32.9%	24.0%
2003	24	132.1%	6.8%	5.2%

Notes: MCAP is defined as market capitalisation, that is, the value of all outstanding shares on the stock exchange.
GDP is defined as Nominal Gross Domestic Product (GDP) at market prices.
Turnover is defined as the market value of all shares traded during the year.
Turnover ratio is defined as turnover divided by market capitalisation.

Table 2: Average Annual Growth Rate for the Performance Indicators of the Regional Stock Exchanges: 1989-2003

Country	Number of Listed Companies	Turnover Ratio	MCAP	Index
Barbados	4.9%	1.7%	25.5%	7.3%
Jamaica	0.8%	5.9%	37.1%	30.9%
Trinidad and Tobago	0.8%	5.9%	36.4%	13.8%

Notes: MCAP is defined as market capitalisation, that is, the value of all outstanding shares on the stock exchange.
Turnover ratio is defined as turnover divided by market capitalisation; turnover being the market value of all shares traded during the year.