Return Variability in CARICOM Equity Markets

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Abstract

This paper examines the validity of the Sharpe-Linter-Black Capital Asset Pricing Model (CAPM) to stocks traded on the Barbados, Jamaica and Trinidad & Tobago Stock Exchanges. Tests of the CAPM are based on portfolio Betas made up of stocks emanating from all exchanges, and tests are also made on alternative multifactor specification proposed by Fama and French, extended to include the possible pricing of idiosyncratic volatility. The CAPM tests are also carried out to account explicitly for negative excess market returns. The results support the contention that betas alone are not sufficient to account for the variation in equity returns in the CARICOM markets.

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1. Introduction

The Capital Asset-Pricing Model (CAPM) of Sharpe (1964), Linter (1965) and Black (1972) is one of the most influential contributions to modern financial theory and practice. Its fundamental prediction is that the market portfolio is mean-variance efficient and that the expected return of any security is a linear function of the market β. It received initial endorsement from papers like Fama and MacBeth (1973) but soon met with some stern resistance. In particular, in their seminal paper, Fama and French (1992) argue for a 3-factor model in which the excess return on a portfolio is explained by its sensitivity to three factors (i) the expected return on a broad market portfolio (ii) the difference between portfolios of small and large stocks (SMB) and (iii) the difference between returns on portfolios of the high and low book-to-market values (HML). The three factor model has been modified by Malkiel and Xu (1997) to introduce the difference between returns of portfolios with high and low idiosyncratic volatility (HIVMLIV). See also Xu and Malkiel (2003). Bartholdy and Peare (2005), Drew et al (2004, 2005) followed up and provided empirical support for the three-factor model in its various forms. In an interesting turn to defend the original CAPM specification against this intellectual onslaught, Pettengill, Sundaram and Mathur (PSM) (1995) introduced an interesting re-specification of the CAPM model that took into account periods when the excess return on the market was negative instead of the predicted positive sign.

It is clear that the validity of the original CAPM is an empirical matter. Yet, many a broker calculates the β and uses it as an objective measure of non systematic risk in determining portfolio choice. This includes Caribbean brokerage firms even in the absence of empirical verification of the CAPM. In this paper, the validity of the CAPM is tested for stocks traded on the Barbados, Jamaica and Trinidad & Tobago Stock Exchanges. Tests of the CAPM are based on portfolio Betas made up of stocks emanating from all exchanges, and tests are also made on alternative multifactor specification proposed by Fama and French, extended to include the possible pricing of idiosyncratic volatility. The CAPM tests are also carried out to account explicitly for negative excess market returns in the PSM framework.

The rest of the paper will be as follows. In the following section, some of the stylized facts of the Barbados, Jamaica and Trinidad & Tobago stock exchanges are provided. The data and methodology are then discussed, followed by the analysis of the results of the estimation exercise. The paper then concludes.

2. Equity Markets in the CARICOM sub-region: Some stylized facts

Trading of stocks takes place on formal exchanges located in the national jurisdictions that they serve. The Jamaica Stock Exchange (JSE), the oldest of the Exchanges in the CARICOM region, came into being in 1968. The Trinidad & Tobago Stock Exchange (TTSE) followed in 1981 and the Barbados Stock Exchange (BSE) in 1987. The newest kid on the block is the Guyana Stock Exchange, which was established in 2003. Three other exchanges exist in the CARICOM sub-region: the Eastern Caribbean Stock Exchange (ECSE, physically located in St. Kitts), the Bahamas Exchange and the Belize Stock Exchange.

The JSE was incorporated as a limited company in September 1968 and was opened for trading in February 1969. Prior to its establishment, trading in stocks and shares was carried out by a number of brokers on an informal basis. In fact, the Bank of Jamaica lists some twenty (20) publicly listed companies in 1964. By 1966, there were thirty-two (32) such companies and by 1969, when formal listing began, there were twenty-six (26). This later increased to thirty-four (34) by the end of 1969 and peaked at fifty-one (51) in 1995. The number of publicly listed companies currently stands at forty-three (43). As of January 2000, the JSE has been conducting trades using an automated trading platform. This benefits the market by allowing trading on all five (5) working days of the week.

Following the lead of Jamaica in 1968, the TTSE emerged in 1981 with the Securities Industry Act (SIA 1981). The TTSE replaced the Call Exchange and the Capital Issues Committees of the past. The securities market informally existed in Trinidad & Tobago for well over twenty (20) years prior to opening of the Stock Exchange. The change from this system was initiated in the early 1970s when the Government set out to localize the foreign owned commercial banking and manufacturing sectors of the economy. Alongside this development was the establishment of private institutions such as trust companies and stock broking firms to match the demands of investors in the market.

Faced with the need to harmonise the regulatory framework of the securities industry in Trinidad & Tobago, the SIA (1981) was repealed and replaced with the Securities Industry Act 1995 (SIA (1995)). This Act established the Trinidad & Tobago Securities and Exchange Commission (TTSEC) with its key function as regulator in the market. At the end of 1981, the number of listed companies stood at thirty-two (32) and peaked at thirty-six (36) in 1984 and 1985. The number of listed companies currently stands at thirty-five (35). As of May 1993, a formal Bond market was established and in March 2005, the TTSE became the last of the regional exchanges to move to an electronic trading system which allows for five-day instead of the typical three day trading.

The Securities Exchange of Barbados (SEB) was established in April 1987 under the Securities Exchange Act (1982) following government's mandate to stimulate growth of new ventures that would reduce the reliance on the banking system for long-term finance. The Act of 1982 was later repealed and replaced with the enactment of the Securities Act (2001). The BSE operates as a privately owned, non-profit organization administered by a Board of Directors. The number of listed companied is currently at twenty-three (23). In July 2001, the BSE introduced the electronic trading system, which replaced the open auction outcry method of trading.

The creation of a CARICOM Regional Stock Exchange (CRSE) was an initiative of the government of Jamaica in 1989. This led eventually to the Grand Anse Declaration which catered for the movement of capital across the region, starting with the three existing stock exchanges: the JSE, TTSE and BSE. Cross border trading in equity was recognized as an integral part to the deepening and widening of the integration process in CARICOM.

The objectives of the CRSE are to promote the movement of capital across the region; to increase the investment opportunities; to encourage optimum financing for CARICOM firms irrespective of where the entity resides and to increase the attractiveness of the region as an area for investment, both by regional and non-regional investors.

The CRSE is not an actual physical entity but an agreement of cooperation to facilitate the purchase and sale of cross border shares. It has been argued, however, that the exchange has been not performing up to mark as countries are faced with differing accounting standards and payments and settlements systems [2]. Complications also result from the different exchange control regimes, compounded by the lack of available hedging mechanisms or instruments.

The CARICOM stock markets are, however, still quite underdeveloped and remain quite passive compared to those of the developed countries. They are small and characterized by few market players[3]. They are privately owned and run by boards consisting mainly of brokers and corporate players and, in some cases, of government or Central Bank representatives. Electronic trading is a relatively recent phenomenon. The JSE was the first to introduce it in January 2000. In July 2001, the Barbados Stock Exchange followed, and in March 2005, the TTSE became the last of the regional exchanges to move to an electronic trading system. Clearings are done electronically across the board by central depositories. The ECSE, where electronic trading has existed since its inception in 2001, is the only Exchange to have dematerialised its record-keeping altogether, so that even stock certificates have been replaced by electronic records. The slow process of harmonization of the CARICOM markets has often blamed on the manual trading system that prevailed until quite recently and which is still employed in some of the markets.

The CARICOM markets are hybrids of what are typically labelled broker and dealer markets. Brokers tend to act in two capacities, both to execute trade orders, and to trade based on their own inventory. Yet, none of the exchanges allows short sales, which is a key component of dealer trades in more sophisticated markets, especially in the trading of derivatives. Further, on all the exchanges in question trades must take place through registered brokers and these are few in each market. Jamaica has the highest tally with a mere ten (10) brokers. The reason for this seems intuitive – the size of the market, both on the supply and demand side, simply does not warrant larger numbers.

Actual trading is quite limited in that it is only on the JSE and the ECSE that trading is conducted on all five (5) weekdays. On the BSE and TTSE, trades are allowed on

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[2] Wesley Gibbings, Trinidad Guardian, October 28, 2004

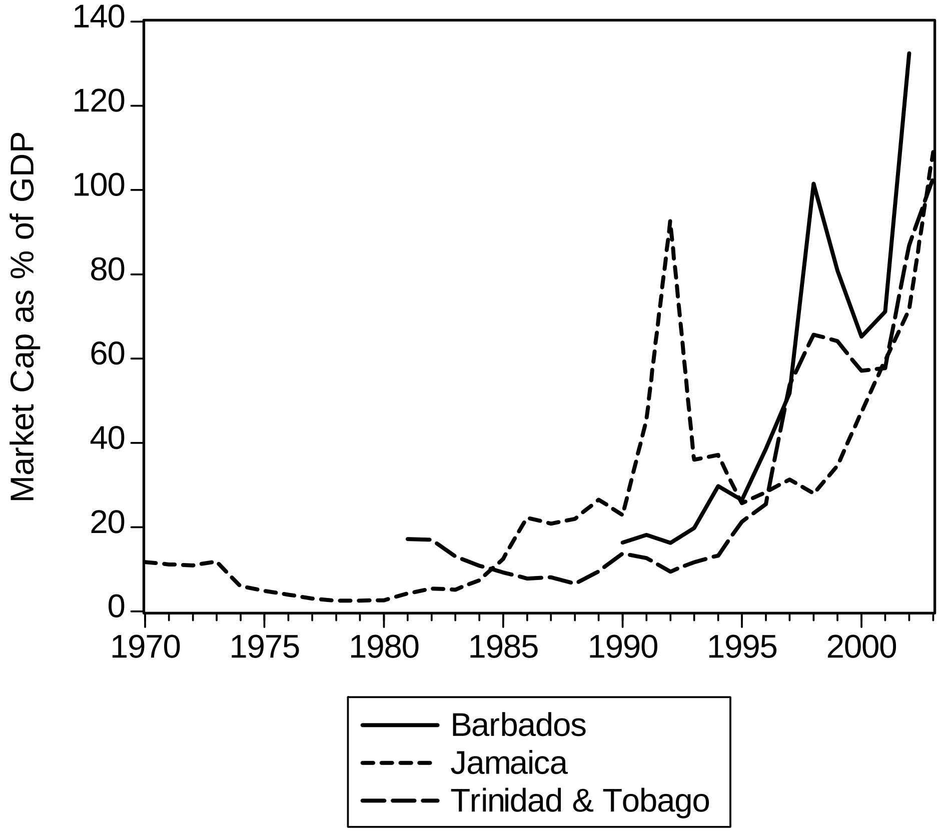
[3] See Bourne (1988) and Sergeant (1995) for studies of the Trinidad & Tobago Stock Exchange; Kitchen (1986) and Jackson (1986) for studies of the Jamaica Stock Exchange; Craigwell et al. (1996) for a study of the Barbados Stock Exchange.

Tuesdays, Wednesdays and Fridays only. However, with the introduction of electronic trading it is anticipated that this will change and all exchanges will be open for business on the five weekdays. The volume of trading is most heavy on the TTSE and the JSE. The BSE regularly experiences low volumes of trade, as does the ECSE which currently only has (6) listed securities. It should also be noted that the BSE, JSE, and TTSE explicitly restrict price movements of shares, while the ECSE also reserves the right to stop trades that may adversely affect the market.

Availability of information is fairly good, considering the actual structures of the markets. Information on past prices and volumes is available from the respective exchanges for at least the past 5 years. Current bid data is available from the JSE only, and in that case, only at the exchange's public gallery or to subscribers to their online service. The system of trade on the other exchanges does not lend to an automatic posting of prices while trades are being negotiated. These prices are only posted after trading is complete.

The stock exchanges of Barbados, Jamaica and Trinidad & Tobago have all been characterized as inefficient, performing disappointingly and still in an underdeveloped state (Kitchen 1986, Jackson 1986, Bourne 1988, Sargeant 1995 and Craigwell et al. 1996). Notwithstanding this, since their appearance in the CARICOM sub-region, market capitalization has grown phenomenally, especially since the 1990s, as an inspection of Figure 1 below reveals:

Figure 1
Evolution of Market Capitalization as a percentage of GDP



In the case of the JSE, market capitalization as a percentage of GDP stood at 12% at the end of 1969 and was 109% by the end of 2003. At the TTSE, the value of stock market capitalization grew from 17% of GDP in 1981 to 103% in 2003. In the case of the BSE, the value of stock market capitalization increased from 16% of GDP in 1990 to 132% in 2002.

The opinion on the role of the stock market in the economic developmental process was sought from some key market players. It was the general consensus of these key players that the stock exchange can, and does, play a major role in promoting economic growth and development in an economy. However, they viewed as major impediments to this process the lack of new issues coming onto the market[4]; the lack of confidence in the market with regards to issues relating to the accounting standards used, disclosure of firm

[4] One major market player pointed to the popularity of that the rights issues in Trinidad & Tobago which required no SEC approvals involved and were not as costly as issuing new shares.

activity and the system of trading at the stock exchange; the reluctance of Companies to divulge information[5] and the perception of firms that it is much easier to borrow from banks rather than raise funds through equity financing. Craigwell and Murray (1998) note that, with the formation of the SEB, the pool of resources available for investment increased tremendously, and opine that "the formation of the exchange had a dramatic impact on the leverage level of firms". Studies of the TTSE by Bourne (1988) and Sargeant (1995) both recognize the potential of the market in the development of the economy. Sargeant (1995) also suggests capital market innovations such as credit creating services, liquidity enhancing services, equity generating services, price risk covering services and debt-equity hybrid services. Similar comments on the JSE are made by Kitchen (1986).

3. Data and Methodology

The basic CAPM model is usually represented as:

$$E(R_p) = R_f + \beta_p\, E((R_m) - R_f)$$

$E(R_p)$ is the expected return on the risky portfolio p, R_f is the current risk-free rate, β_p is the 'beta' corresponding to the portfolio, which is measure of systematic risk of the portfolio, and $E(R_m)$ the expected return to the market. An empirically estimable specification is:

$$(R_{pt} - R_{ft}) = \alpha_p + \beta_p(R_{mt} - R_{ft}) + u_{pt} \qquad (1)$$

R_{pt} is the observed return on portfolio p at time t, R_{ft} and R_{mt} the corresponding risk free rate of interest and market return. α_p is a 'regression' coefficient that should be equal to zero and u_{pt} is a standard disturbance term. Leon et al. (2000) use a model like this one to test the CAPM hypothesis for the Trinidad & Tobago Stock Exchange.

The Fama-French (FF) 3-factor model may be specified as:

$$(R_{pt} - R_{ft}) = \alpha_p + \beta_p(R_{mt} - R_{ft}) + s_pSMB_t + h_pHML_t + u_{pt} \quad (2)$$

SMB is a measure of return based on the size of the market equity in the portfolio and HML a measure of the return based on the book-to-market equity ratio. The original

[5] Reasons advanced for this included fear of taxation laws, kidnapping and the competitor being able to gain access to 'trade secrets'.

CAPM is embedded in the FF model and is consistent with the data if β_p is positive and significant since this signals a significant and systematic relationship between beta and returns. However, the FF model cannot be rejected if at least one of s_p or h_p is significant. β_p is still a useful measure of risk in this case, and it would be improperly estimated in (1) if (2) is the correct specification. The Malkiel-Xu variant of the FF (FF-MX) model is:

$$(R_{pt} - R_{ft}) = \alpha_p + \beta_p (R_{mt} - R_{ft}) + s_p SMB_t + h_p HIVMLIV_t + u_{pt} \quad (3)$$

HIVMLIV is a measure of return associated with the 'idiosyncratic' or non-systematic risk of the portfolio. It too embeds the original CAPM model and similar considerations apply about the CAPM.

PSM. (1995) argue against all the specifications (1)-(3).Their main concern is the use in empirical studies of realized market returns to proxy expected market returns. They argue that when realized market returns fall below the risk-free rate, an inverse relationship is predicted between realized returns and beta. The following specification is consistent with their arguments:

$$(R_{pt} - R_{ft}) = \alpha_p + \delta\, \beta_p(R_{mt} - R_{ft}) + (1\text{-}\delta)\, \beta_p(R_{mt} - R_{ft}) + u_{pt} \quad (4)$$

$\delta = 1$ if $(R_{mt} - R_{ft})\geq 0$ and $\delta=0$ if not. This too may be embedded in a FF or FF-MX framework as, respectively:

$$(R_{pt} - R_{ft}) = \alpha_p + \delta\beta_p (R_{mt} - R_{ft}) + (1\text{-}\delta)\beta_p(R_{mt} - R_{ft}) + s_pSMB_t + h_pHML_t + u_{pt} \quad (5)$$

$$(R_{pt} - R_{ft}) = \alpha_p + \delta\beta_{p1}(R_{mt} - R_{ft}) + (1\text{-}\delta)\beta_{p2}(R_{mt} - R_{ft}) + s_pSMB_t + h_pHIVMLIV_t + u_{pt} \quad (6)$$

The PSM hypothesis is verified if $\beta_{p1}=\beta_{p2}$. but the FF and FF-MX frameworks cannot be rejected if either s_p or h_p is significant

Specifications (1)-(6) will be estimated and tested.

Leon et al. (2000) define four portfolios on the TTSEs, each associated with the shares whose prices are used in the calculation of the subsector indices: banking, conglomerates, financial and manufacturing. The approach taken in this paper is completely different. Two sets of six portfolios are selected from all jurisdictions based on the criteria of size, book-to market values and volatility. For the first set of portfolios, called selection (a), a firm in any jurisdiction is defined as 'small' (S) or 'big' (B) for the year t depending on the size of its market capitalization (MC) at the end of December of year t. A firm is small in year t if its MC at the end of December of that year falls below the median value of all firms. It is big if its MC is at least as large as the median value. A firm is defined as having low book to-market equity ratio (L), or medium book-to-market equity ratio (M), or high book-to-market equity ratio (H) for the year t depending on the size of its book-to-market equity ratio (BV/MC) at the end of December of year t. A firm is rated L in year t if its book-to-market equity ratio at the end of December of that year falls below the 33⅓ percentile value of all firms. It is rated H if the ratios at least as large as the 66⅔ percentile value. It is rated M otherwise.

The six portfolios in selection (a) are defined according to the following Tableau:

	L	**M**	**H**
S	S/L	S/M	S/H
B	B/L	B/M	B/H

For any portfolio containing n assets, the rate of return on the portfolio at time s is

$$R_{ps} = \frac{\text{Total Returns on Portfolio at time s}}{\text{Market Capitalization Value of Portfolio at time (s-1)}}, \text{ s=1, 2, .., T; p= 1,2, ., 6}$$

If we let MC_{is} be the market capitalization value of firm i at time s, then this may be written as

$$R_{ps}= \frac{\sum_{i=1}^{n}(MC_{is} - MC_{i,s-1})}{\sum_{i=1}^{n} MC_{i,s-1}}$$

SMB is calculated, at each point in time s, as the difference between the average of the three ‘big’ portfolios (B/L, B/M and B/H) and the three ‘small’ portfolios (S/L, S/M and S/H). HML is similarly calculated as the difference between the average of the two ‘high’ portfolios (S/H and B/H) and the two ‘low’ portfolios (S/L and B/L).

For the second set of six portfolios, called selection (b), a firm is defined as having low volatility (L), or medium volatility (M), or high volatility (H) for the year t depending on the size of its ‘idiosyncratic’ volatility in December of year t. Idiosyncratic volatility is defined as the difference between total risk and the systematic risk of a stock and the β for each stock in a portfolio may be estimated using the 'covariance' approach: the beta for each firm, β_i, may be estimated as $Cov(R_i, R_m)/\sigma_m$, where R_i is the return on the firm's equity. The risk associated with the i^{th} firm is $\sigma_i^2 = \beta_i^2 \sigma_m^2 + \sigma_{ui}^2$, or Total Risk = Systematic Risk + Idiosyncratic Risk[6]. To calculate $Cov(R_i, R_m)$, σ_i^2, and σ_m at point in time s, we use the 24 months of data preceding s.

A firm is rated L in year t if its idiosyncratic volatility in December of that year falls below the 33⅓ percentile value of all firms. It is rated H if its idiosyncratic volatility is at least as large as the 66⅔ percentile value. It is rated M otherwise. We can set up a Tableau similar to the one above to show the six potfolios in selection (b). HIVMLIV is calculated as the difference between the average of the two 'high' portfolios (S/H and B/H) and the two 'low' portfolios (S/L and B/L).

The risk-free rate used in this paper is a weighted average of the Barbados and Trinidad & Tobago 90-day, and the Jamaica 180-day Treasury Bill rates[7]. The weights used are the US dollar market capitalization values of the corresponding stock exchanges. The 'market' in this paper is the CARICOM market so for m use a CARICOM index as calculated by Pemberton and Watson (2004). For the period January 1998 to May 2005, daily composite stock market ex dividend and total return indices for stock prices quoted on the Barbados, Jamaica and Trinidad & Tobago Stock Exchanges were constructed using original data on listed companies supplied by the Exchanges. This 're-construction' of the indices was done to ensure comparability of the data. The indices so obtained were also used to construct a CARICOM-wide index, not only as a preliminary indicator of the yet unborn CARICOM regional stock exchange, but also to have a CARICOM market index. The CARICOM Composite Stock Price Index, CCSPI, is calculated as

$$\mathrm{CCSPI}_t = \sum_{j=1}^{m} \mathrm{SPI}_{j,t} \mathrm{W}_j$$

[6] Perhaps it is better to say $(\text{Total Risk})^2 = (\text{Systematic Risk})^2 + (\text{Idiosyncratic Risk})^2$, given that it is the standard deviation that is usually used as the measure of risk.

[7] The Treasury Bill rates are adjusted for changes in the exchange rate with the US dollar.

where W_j is the weight for each market based on the relative share of total market capitalization in US$, and SPI_j the stock price index of exchange j. The indices of the exchanges are weighted by their issued share capital and indeed this index is commonly referred to as a market capitalization weighted index. When amalgamated like this, CCSPI gives a composite picture of all equity price movements across the individual exchanges. See Pemberton and Watson (2004) for further details of index construction. Monthly data are used in this paper and the end-of-month values of the indices are used.

4. Results[8]

The FF version of the model (equation (2)) is estimated for the six portfolios in selection (a) as shown in Table 1 below:

Table 1

Estimation of $R_{pt}\text{-}R_{ft} = \alpha_p + \beta_p(R_{mt}\text{-}R_{ft}) + s_pSMB_t + h_pHML_t + u_{pt}$

Portfolio	β_p	s_p	h_p	$\bar{R}^2$	**DW**
	1.801594	1.5384	-0.5073		
S/L	[0.0000]	[0.0000]	[0.0002]	0.7467	2.4820
	0.9903	0.5801	0.3687		
S/M	[0.0000]	[0.0000]	[0.0001]	0.4731	2.2219
	1.1534	1.2900	0.9067		
S/H	[0.0000]	[0.0000]	[0.0000]	0.9316	1.8170
	0.9238	*-0.0248*	*-0.0351*		
B/L	[0.0000]	*[0.5421]*	*[0.2123]*	0.7223	1.5569
	1.44917	0.2092	0.2521		
B/M	[0.0000]	[0.0223]??	[0.0001]	0.6517	2.0010
	1.5721	*0.2238*	0.5510		
B/H	[0.0000]	*[0.2223]*	[0.0000]	0.4505	2.4900

The β-coefficients are all highly significant but the FF hypothesis is rejected outright only in the case of the B/L portfolio, where both the s and h coefficients are not significant. In the case of the B/H portfolio, the s coefficient is not significant but the h coefficient is. Given the reported β-values, the S/L, B/M and B/H portfolios are considerably riskier than the market portfolio, while the other three involve roughly the same amount of risk. The s-coefficient is positive and significant for all three small portfolios, which is consistent with Fama and French (1992, 1993, 1996) who show that small firms load positively on the SMB factor. However, the s-coefficient is also positive and significant for the B/M portfolio, which is not consistent with the Fama-French findings that big firms load negatively on the SMB factor. The h-coefficient is negative and significant for

[8] The estimated α-coefficients are not reported here and in the other tables since, as was expected, they are all insignificant.

the S/L portfolio and positive and significant for all medium and high book-to-market-value firms, which is consistent with the Fama-French findings that low book-to-market-value firms load negatively on the HML factor and high book-to-market-value firms load positively.

The FF-MX version of the model (equation (3)) is estimated for the six portfolios in selection (b) as shown in Table 2 below:

Table 2

Estimation of $R_{pt}-R_{ft} = \alpha_p + \beta_p(R_{mt}-R_{ft}) + s_p SMB_t + h_p HIVMLIV_t + u_{pt}$

Portfolio	β_p	s_p	h_p	$\bar{R}^2$	**DW**
	0.5652	0.1602	-0.1792		
S/L	[0.0000]	[0.0074]	[0.0004]	0.3635	1.5208
	1.8355	1.8465	*-0.0011*		
S/M	[0.0000]	[0.0000]	*[0.9946]*	0.7853	2.1860
	1.1188	0.2366	0.9153		
S/H	[0.0000]	[0.0448]	[0.0000]	0.8480	1.8774
	1.6362	-0.3150	-0.1941		
B/L	[0.0000]	[0.0121]	[0.0576]	0.5606	1.9200
	0.8005	*-0.0503*	0.2178		
B/M	[0.0000]	*[0.5080]*	[0.0009]	0.5544	1.7123
	1.0826	-0.3914	0.7114		
B/H	[0.0000]	[0.0001]	[0.0000]	0.7545	2.3533

Once again, the β-coefficients are all highly significant but the FF-MX model is never rejected outright. In the case of four of the portfolios – S/L, S/H, B/L and B/H - the s- and h-coefficients are significant at levels no higher than 6%. In the case of the S/M portfolio, the s coefficient is significant but the h coefficient is not and in the case of the B/M portfolio, the s coefficient is not significant but the h coefficient is. Given the reported β-values, the S/M and B/L portfolios appear considerably riskier, and the S/L and B/M portfolios markedly less risky, than the market portfolio. The other two involve roughly the same amount of risk as the market portfolio.

The s-coefficient is positive and significant for all three small portfolios, and is negative and significant in the case of the B/L and B/H portfolios, which is consistent with Fama and French (1992, 1993, 1996). The h-coefficient is negative and significant for the two low volatility portfolios, and positive and significant for the two high volatility portfolios, which is consistent with the Malkiel-Xu findings that low volatility firms load negatively on the HIVMLIV factor and high volatility firms load positively.

Table 3 below shows the results of the 'pure' CAPM model (equation (1)) using the portfolios associated with selections (a) and (b). The considerably lower values of $\bar{R}^2$ provide further evidence that it is misspecified.

Table 3

Estimation of $R_{pt}-R_{ft} = \alpha_p + \beta_p(R_{mt}-R_{ft}) + u_{pt}$

	Selection (a)			Selection (b)		
Portfolio	β_p	$\bar{R}^2$	**DW**	β_p	$\bar{R}^2$	**DW**
S/L	1.8265 [0.0041]	0.1095	2.1057	0.4653 [0.0000]	0.2401	1.4668
S/M	1.233 [0.0000]	0.2646	2.1545	2.4087 [0.0002]	0.1865	2.0909
S/H	1.7281 [0.0000]	0.2790	1.9048	1.9570 [0.0000]	0.2547	2.1294
B/L	0.9054 [0.0000]	0.7241	1.6591	1.3761 [0.0000]	0.3319	2.0745
B/M	1.5861 [0.0000]	0.5692	1.7119	0.9668 [0.0000]	0.4363	1.8088
B/H	1.8354 [0.0000]	0.2828	2.1932	1.5552 [0.0000]	0.3960	1.9561

The PSM variant of the FF model (equation (5)) is estimated for the six portfolios in selection (a) as shown in Table 4 below:

Table 4

Estimation of $R_{pt}-R_{ft} = \alpha_p + \delta\beta_{p1}(R_{mt}-R_{ft}) + (1-\delta)\beta_{p2}(R_{mt}-R_{ft}) + s_pSMB_t + h_pHML_t + u_{pt}$

Portfolio	β_{p1}	β_{p2}	s_p	h_p	$\bar{R}^2$	**DW**	**F**	χ^2
S/L	1.9056 [0.0002]	1.5694 [0.0602]	1.5441 [0.0000]	-0.5028 [0.0003]	0.7429	2.4649	0.0968 [0.7568]	0.0968 [0.7557]
S/M	1.0186 [0.0017]	0.9273 [0.0873]	0.5817 [0.0000]	0.3700 [0.0001]	0.4645	2.2192	0.0168 [0.8972]	0.0168 [0.8968]
S/H	1.2530 [0.0000]	0.9309 [0.0007]	1.2954 [0.0000]	0.9111 [0.0000]	0.9315	1.8500	0.8762 [0.3530]	0.8762 [0.3492]
B/L	0.9484 [0.0000]	0.8688 [0.0000]	*-0.0235 [0.5683]*	*-0.0340 [0.2327]*	0.7183	1.5531	0.1190 [0.7314]	0.1190 [0.7302]
B/M	1.6271 [0.0000]	1.0517 [0.0079]	0.2189 [0.0173]	0.2599 [0.0001]	0.6534	2.0447	1.3018 [0.2584]	1.3018 [0.2539]
B/H	1.6012 [0.0009]	1.5069 [0.0600]	*0.2254 [0.2250]*	0.5522 [0.0001]	0.4414	2.4833	0.0083 [0.9279]	0.0083 [0.9276]

Null of F and χ^2 tests: $\beta_{p1} = \beta_{p2}$

The β_{p1} are all significant at very low levels while the β_{p2} coefficients are significant at levels up to about 9%. The null of equality of the two β coefficients cannot be rejected for any portfolio, which gives credence to the PSM hypothesis but is not enough to reject the FF 3 factor model except in ths case of the B/L portfolio where both the s and h coefficients are not significant. The s-coefficient is significant and positive for all three small portfolios, which supports the FF findings, but the significant positive coefficient attached to the B/M portfolio does not. The h-coefficient is negative and significant in the case of the S/L, and is positive and significant in the case of both high book-to-market value portfolios, which is consistent with FF.

The PSM variant of the FF-MX model (equation (6)) is estimated for the six portfolios in selection (b) as shown in Table 5 below:

Table 5

Estimation of R_{pt}-R_{ft} = $\alpha_p + \delta\beta_{p1}(R_{mt}-R_{ft}) + (1-\delta)\beta_{p2}(R_{mt}-R_{ft}) + s_pSMB_t + h_pHIVMLIV_t + u_{pt}$

Portfolio	β_{p1}	β_{p2}	s_p	h_p	$\bar{R}^2$	**DW**	**F**	χ^2
S/L	0.6653 [0.0000]	*0.3329 [0.1601]*	0.1581 [0.0081]	-0.1719 [0.0007]	0.3654	1.5936	1.1890 [0.2799]	1.1890 [0.2755]
S/M	2.1838 [0.0000]	*1.0270 [0.1990]*	1.83941 [0.000]	*0.0241 [0.8823]*	0.7862	2.1205	1.2619 [0.2658]	1.2619 [0.2613]
S/H	1.1140 [0.0001]	1.1297 [0.0200]	0.23663 [0.0467]	0.9151 [0.000]	0.8455	1.8742	0.0007 [0.9797]	0.0007 [0.9796]
B/L	1.9103 [0.0000]	1.0002 [0.0457]	-0.3209 [0.0102]	-0.1741 [0.0884]	0.5679	2.0105	2.0337 [0.159]	2.0337 [0.1538]
B/M	0.5911 [0.0011]	1.2867 [0.0001]	*-0.0458 [0.5398]*	0.2025 [0.0017]	0.5696	1.6076	3.1426 [0.0813]	3.1426 [0.0763]
B/H	1.4617 [0.0000]	*0.2026 [0.5822]*	-0.3995 [0.0000]	0.73912 [0.0000]	0.7763	2.2914	6.9732 [0.0105]	6.9732 [0.0083]

Null of F and χ^2 tests: $\beta_{p1} = \beta_{p2}$

The results in this case are not as convincing, though there is still evidence in favour of the FF-XM variant of the model. The β_{p1} are all significant at very low levels but the β_{p2} coefficients are not significant in 3 of the 6 cases. In the three cases where both are significant, the null of equality of the two β coefficients cannot be rejected for any of the three portfolios. The s-coefficient is significant and positive for all three small portfolios, and is significant and negative in two of the three big portfolios, which supports the FF findings. The h-coefficient is negative and significant in the case of the low volatility portfolios, and is positive and significant in the case of both high volatility portfolios, which is consistent with the Malkiel-Xu findings.

The pure PSM model (equation (4)) is estimated for the six portfolios of selections (a) and (b) as shown in Table 4 below:

Table 6

Estimation of $R_{pt}-R_{ft} = \alpha_p + \delta\beta_{p1}(R_{mt}-R_{ft}) + (1-\delta)\beta_{p2}(R_{mt}-R_{ft}) + u_{pt}$

Selection (a)

Portfolio	β_{p1}	β_{p2}	$\bar{R}^2$	**DW**	**F**	χ^2
S/L	0.6165 [0.0001]	*0.1402 [0.5676]*	0.2536	1.5797	2.1353 [0.1490]	2.1353 [0.1439]
S/M	2.3745 [0.0091]	2.4822 [0.1018]	0.1735	2.0902	0.0029 [0.9572]	0.0029 [0.9570]
S/H	1.4800 [0.0143]	2.9827 [0.0039]	0.2580	2.0471	1.2774 [0.2627]	1.2774 [0.2584]
B/L	1.8134 [0.0000]	*0.4361 [0.4517]*	0.3545	2.1243	3.2061 [0.0782]	3.2061 [0.0734]
B/M	0.6624 [0.0009]	1.6214 [0.0000]	0.4699	1.6936	4.9875 [0.0292]	4.9875 [0.0255]
B/H	1.6990 [0.0000]	1.2461 [0.0360]	0.3896	1.9312	0.3399 [0.5620]	0.3399 [0.5599]

Selection (b)

Portfolio	β_{p1}	β_{p2}	$\bar{R}^2$	**DW**	**F**	χ^2
S/L	1.9060 [0.0360]	1.6557 [0.2760]	0.0953	2.1053	0.0155 [0.9015]	0.0155 [0.9011]
S/M	1.1292 [0.0029]	1.4549 [0.0215]	0.2546	2.1432	0.1561 [0.6942]	0.1561 [0.6928]
S/H	1.5165 [0.0031]	2.1830 [0.0111]	0.2716	1.8515	0.3578 [0.5519]	0.3578 [0.5497]
B/L	0.9402 [0.0000]	0.8306 [0.000]	0.7207	1.6446	0.2304 [0.6329]	0.2304 [0.6312]
B/M	1.6926 [0.0000]	1.3570 [0.0020]	0.5647	1.7388	0.3575 [0.5521]	0.3575 [0.5499]
B/H	1.7248 [0.0015]	2.0731 [0.0216]	0.2723	2.2075	0.0879 [0.7679]	0.0879 [0.7669]

Null of F and χ^2 tests: $\beta_{p1} = \beta_{p2}$

There is a marked deterioration in the $\bar{R}^2$ values, which is further evidence that the 'pure' form of the PSM model is misspecified, and that beta alone is insufficient to explain the variation in equity returns.

All variables in all models are I(0) and there was no evidence in any of the estimated equations of serial correlation, heteroscedscity, GARCH residuals. Furthermore, all residuals were normal based on the Jarque-Bera test. Our findings clearly show that beta alone is insufficient to explain the variation in equity returns.

5. Conclusion

The popularity of beta as the unique measure of systematic risk is challenged in this paper, and the evidence for the equity markets in the CARICOM region shows that, although it has considerable weight in explaining return volatility, it is not the only factor: size, book-to-market value and idiosyncratic volatility are all 'priced'.

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