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Application of the CAPM on the DS30 Index: A time series and cross-sectional approach to examine the risk and return paradigm for the desired blue-chip stocks listed within the Dhaka Stock Exchange

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Abstract

An examination of the risk-return paradigm as originally proposed by Sharpe and Lintner is visited upon once again in association with the Capital Asset Pricing Model (CAPM) structure but emphasizing on data obtained from the Dhaka Stock Exchange (DSE). The purpose was to examine if the CAPM when applied to the DSE context could be used to predict the expected returns given their systematic risk factored in. 42 such companies excluding the financial stocks that appeared within the DS30 blue chip index over the period 1st January 2016 until 31st December 2019 were used as our primary data points. Prior to examining the risk-return tradeoff for the sample of individual stocks under consideration, we converted the daily price data into monthly formats and all the other factors were converted into monthly terms using the same technique. We applied Omran's (2007) two stage regression model on to the basic version of the CAPM. Going in line with textbook definitions, "empirical analysis utilizing the CAPM for individual companies/ stocks, the intercept term was observed to be significantly different from zero and the slope was not equal to the excess return obtained from the market portfolio". The results of the study nullify our hypothesis and provide evidence against the use of the CAPM yielding conclusive evidence that the CAPM is not suitable to analyze risk-return probabilities for individual companies within the DSE.

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1.0 Introduction

A vibrant stock market has proven to be an essential lifeblood for most of the major economies across the globe, including the likes of most first world countries such as the United States of America, Japan, Australia, United Kingdom, Canada and even developing markets such as India and China. However, when applied in the context of emerging markets such as Bangladesh it seems that conventional theory cannot support the general stock market movement neither predict with precision of what the likely forecast is going to be like down the road. Most finance literature enthusiasts have long resorted to the CAPM as the baseline to predict what the potential expected return of a stock might be based on one single factor: the beta. Essentially the correlation of a stock with the overall market can be used as a metric to gauge future expected returns not only for the stock in question but it is applicable to an entire range of stocks within the listed universe of public limited companies. The CAPM has now been further modified by scholars to include parameters such as country specific risk, sovereign bond yield status, default risk etc., essentially spiraling into some form of a multifactor model or in other words an arbitrage pricing model (APT).

However, less developed markets such as the likes of the Bangladeshi Stock Market lack research and valid data for a vast majority of firms listed on its primary bourse, the DSE (Dhaka Stock Exchange). In context to the research question, we need to be able to address "whether or not the CAPM or any of its modified versions be used to predict future expected returns considering systematic risk only given this limited price data set"? This study is an attempt of empirically analyzing the DSE using the most recent available data for a four-year period commencing from 1st January 2016 until 31st December 2019 by using the regurgitated version of the CAPM theory and a few of its modified versions to provide useful insights with regards to predict future trends within the market.

1.1. A brief overview of the Dhaka Stock Exchange (DSE)

Commencing operations as the East Pakistan Stock Exchange in 1954, it was not until two years later, in 1956, that the DSE had officially started trading securities on its exchange. Even though the stock exchange was formerly established, up until 1971, it operated as a subsidiary wing of the East Pakistan Stock Exchange. The major stock exchange up until that point was the Karachi Stock Exchange (KSE). Post the independence of West Pakistan from its Eastern counterpart, Bangladesh, officially began its operations as an "independent country" but the events that led up to the liberation war meant that the DSE along with the rest of the country had to reform its major operation hubs to bring about economic prosperity. The DSE was shut down and was later restarted in 1986, whereby it operated with a handful of companies in which individual investors could opt to invest their savings.

Major investments started to flow into Bangladesh towards the end of 1990, when neighbouring countries such as India, opened their borders for cross border trade and investment through their '*liberalization*' scheme. However, unlike its Indian counterpart the Bombay Stock Exchange (BSE), the DSE was yet to launch their automated trading platform prior to 1st January 2001.

Consequently, the lack of a proper ledger or tracking mechanism during this time facilitated the country's first stock market crash in 1996, whereby '*the rise of a kerb market*', with multiple copies of the same company's "*paper-backed shares*" being traded without proper verification until the next transaction settlement, left ordinary shareholders in disarray.

Despite a low P/E ratio, the DSE has failed to bring in adequate foreign investment or local institutional funding heading up to the recent years; and has managed to experience a "*financial crash*" twice. The DSE is yet to introduce hedging instruments such as futures, options, or any kind of derivatives, and solely offers equity and government bonds within its product listings. Although multiple reasons for a loss of investor confidence exist there was no proper way to verify the claim without proper data. The lack of daily share-price-price data for most of the listed companies meant that there was no precise way to analyse the markets correctly. However, since 2007, the DSE has managed to archive the daily share-price-data for some of its most prominent

companies, and to improve the reliability of the analysis heading forward, price data from 1st January 2016 until 31st December 2019 were used to avoid any discrepancy that could arise from the use of back-logged data.

2.0. Literature Review

Studies conducted in the context of applying the CAPM or related to any of it's modified versions have survived the test of time and global markets alike. Sharpe (1964), in addition to Lintner (1965), & Mossin (1968) developed an independent and standardized form of the CAPM, whereby the authors have openly gone onto advocate for the effectiveness of all forms of the CAPM. Other studies conducted by "Black et al. (1972), Black (1972), (1993) and Fama & MacBeth (1973) have mostly advocated and sworn by the basic and standard version of the CAPM. Other studies conducted during the 1970's disregarded the linear risk-return relationship of the CAPM and ended up incorporating disassociated variables; which until then was not implemented into the equation. Banz (1981) employed the firm size as an extra factor, while company specific boom value to equity was deployed by Rosenberg et al. (1985) along with Chan et al. (1991). Similarly, the earnings yield (Basu, 1983), leverage (Bhandari, 1988), dividend yield (Black and Scholes, (1974); historical sales growth (Davis, (1994) and Lakonishok et al. (1994)), in addition to various other parameters such as industrial structure Roll (1992), Litzenberger and Ramaswamy (1979) and Chu (1997), cash flow yield (Chan et al. [1991] and Davis, [1994]), and trading volume (Lakonishok and Smidt (1989), Amihud and Mendelson (1991))" were used to form what we have already described as an example of an extended and a more reliable version of the formula.

However, Michailidis et al. (2006) when conducting tests on the Greek Stock Market found conclusive proof against the validity of the CAPM. In addition to that, Rejepova and Gürsoy (2007) also failed to find any evocative relationship in the Turkish Stock Exchange between ex-post risk premiums and corresponding beta coefficients when considering the MacBeth & Fama approach. However, a strong beta-risk premium relationship was observed by applying Pettengill et al. (1995) methodology with their original premise. Analytical tools utilizing higher statistical moments were adopted by Théoret and Racicot (2007) which discarded the errors due to specification and other components of white noise. Cooper et al. (2008), examined a firm's annual asset growth rate and found it to be a statistically significant predictor when examining a large cross section of the S&P500 and the US stock market. Subsequently, the rate at which industrial production appeared to grow also appeared to be a risk factor that had been priced in for conventional asset pricing tests as demonstrated by Laura and Zhang (2008).

As such, even though there have multiple studies conducted on the application of CAPM for developed and developing markets, there is limited literature available pertaining directly to the Dhaka Stock Exchange or the overall Bangladeshi Stock Market itself. "The time-varying risk-return relationship studied by Hassan et al. (1999) clearly demonstrated that the DSE equity returns displayed excess kurtosis, positive skewness, along with significant deviation from the mean". Haque et al. (2001), started researching about the stock market after the "*kerb market scandal*" of November 1996 by applying the CAPM and Efficient Market Hypothesis (EMH), but no conclusive evidence could be drawn due to the lack of data from that period, whereby one stock used to trade at multiple prices during the same time frame giving rise to arbitrage pricing opportunities. Mobarek and Mollah (2005) pointed towards certain factors (beta, company size, the total volume of shares traded, leverage, the price to book value, the earnings yield in conjunction to the cash flow & dividend yields) that could potentially influence stock price returns from the DSE. But Rahman et al. (2006) eventual reversion to using the Fama-French five factor model (1992) for the Bangladeshi asset pricing context proved to be a great determinant subsequently.

3.0 Methodology

3.1 Sample selection

The DSE is labelled as the primary stock exchange of Bangladesh by the S&P's Emerging Stock Markets Fact Book 2000. It consists of a wide array of companies currently in its bourse. The research shall aim to analyze the data of 42 production based non-financial companies ranging from engineering to textiles that have been part of the DS30 Index for the period of 1st January 2016 up to 31st December 2019. Even though the DS30 primarily include 30 of the blue-chip stocks, periodic reshuffling of the DS30 with regards to S&P standards meant that certain companies which were part of the DS30 were excluded from the indices from time to time. With the wave of the COVID-19 pandemic, the DSE experienced a staggering delay and closure of its operations for a substantial portion of 2020 and heading forward the imposition of floor price and other similar mechanisms meant that the price data of the aforementioned companies did not follow a random walk principle. Thus, in order to ensure the reliability of our data when applying the CAPM we shall seek to use continuous price and time data. The study excludes banking and any related non-bank financial and insurance companies due to their reporting aspects in Bangladesh, which is quite different from those of non-financial company accounts and their attached financial disclosures (Mollah, (2009)).

3.2 Data description

The daily price data of the 42 companies were averaged and adjusted for tail risk, after which we collected the required variables for our observation. A filtered version of the monthly data which was converted from the daily share price data, were used for all variables due to the excessive white noise with the daily return observations (Basu, (2010)). Multiple researchers have confirmed that stock price data regardless of stock dividend adjustments for cash or stock dividends; and/ or bonus, right issues and stock splits (Lakonishok and Smidt (1988) & Fishe et al. (1993)) do not affect the monthly component of the returns. The filtered monthly return data was then converted to the logarithm scale because logarithmic returns seemed to justify both the empirical and theoretical aspects. Theoretically, log returns are more compliant when linking returns across longer time horizons; and empirically, they have a higher tendency to be normally distributed as demonstrated by Strong (1992); which is a prerequisite for utilizing such standard statistical techniques.

We have utilized the DSE and BSEC websites to obtain the company profile data, and Reuters Eikon for cross examining the daily price returns, the monthly returns and the company beta. The returns generated by the DSEX index was used as a representation for the market portfolio return, since it serves as the country's broad market index, whilst the Bangladesh government T-bill rate has been used as a proxy for the risk-free rate of return. The returns for each company were selected to be the dependent variable; whilst the independent variables ranged from the company's beta, its squared beta component and unique risk respectively.

3.3 Estimating the return-risk relationship

The standard textbook definition of Sharpe & Lintner's CAPM is illustrated in equation (1):

$$R_{it} = R_{ft} + b_i\left(R_{mt} - R_{ft}\right) \qquad (1)$$

"where, R_{it} displays the rate of return on any company i at time t, R_{ft} is the risk free asset return at time t, R_{mt} is the market rate of return for time t and β_i is the beta of company i, which can alternatively be written as $Cov(R_i, R_m)/Var(R_m)$."

"Utilizing (Omran (2007)), the following two stages regression was applied to derive at our version of the CAPM which we shall be using to analyze all of our following data. The first stage utilizes equations (2) and (3), for estimating the systematic and unique risk portions:

$$R_{it} - R_{ft} = \alpha_i + \beta_i (R_{mt} - R_{ft}) + e_{it} \quad (2)$$

$$UR = \sigma_i^2 - \beta_i^2 \sigma_m^2 \quad (3)$$

the random disturbance is denoted by e_{it} in the regression equation at time t whilst UR is the unique risk component (in other words the variance of the regression residuals, e_{it}), σ_i^2 is the variance of the returns for the individual company and σ_m^2 is the variance of the returns for index; the proxy for the market portfolio.

The ordinary least squares (OLS) approach was applied for estimating equation (2). R_{it} is regressed on to R_{mt} to estimate beta, β, for all the companies under consideration. The unique risk (UR), defined as the total variance of the returns on the company minus the company's market risk has been comprehensively computed by equation (3).

In the second stage, the following regression was used:

$$\bar{r}_i = \gamma_0 + \gamma_1 \beta_i + \gamma_2 \beta_i^2 + \gamma_3 UR + e_i \quad (4)$$

where $\bar{r}$ refers to the average excess returns for company i over the whole sample t, β_i represents the systematic risk within a particular company i derived from the first stage regression in equation (2), β_i^2 is the square of β_i, UR represents the unique risk estimate obtained from equation (3) and e_i are the regression residuals. $\hat{\gamma}_0$, $\hat{\gamma}_1$, $\hat{\gamma}_2$ and $\hat{\gamma}_3$ are the parameter estimates. Equation (4) is a regression of the average excess returns for each company on β, β and unique risk of returns for each company."

3.4. Primary research objective and testing the hypothesis

As mentioned above, the primary research objective is to gauge whether the CAPM is applicable for the Bangladeshi Stock Market. The primary companies that will be analyzed will be the companies that are currently included or were included in the DS30 blue-chip index for the aforementioned time frame. A modified version of the simple CAPM proposed by Sharpe (1964) and Lintner (1965) will be subsequently applied and tests of significance at 1%, 5% and 10% for all the data points shall be examined. The daily price data for the 42 companies will be converted to monthly returns and converted to the logarithmic scale to ensure uniformity for the regression and OLS estimates both prior and heading forward into the data analysis.

A direct application of Elton and Gruber (1995) will be used to test for the significance. The version by Elton and Gruber (1995) states that the CAPM hypothesis can be tested if the following conditions are aligned:

1) $\hat{\gamma}_0 = 0$, implying that $\hat{\gamma}_0$ shouldn't deviate significantly from zero,

2) $\hat{\gamma}_1 > 0$, implying a positive price of risk being present in the stock markets,

3) $\hat{\gamma}_2 = 0$ implying a represent a linear relationship with the Security Market Line (SML),

4) $\hat{\gamma}_3 = 0$ implying an unique risk easily diversifiable with no impact on the returns.

4.0 Results and Discussion

4.1 OLS Estimation

Theoretically, in the preliminary estimation of the Security Market Line (SML), Û0 when applied in conjunction to the CAPM prediction model should be equal to zero. The value of the intercept (-0.014) was significantly different from zero in accordance with table 1. "According to the assumptions laid forward by Markowitz in the efficient market hypothesis, the CAPM, the SML slope should equal to the excess return on the market portfolio". The risk premium, otherwise known as the market excess rate of return (Rm - Rf) appears to be -0.0292 while the estimated SML slope is approximately 0.129. For developed markets whereby the market rate of return is well in excess of the risk-free rates, a high money market rate of return for most fixed deposit and commercial banking instruments in Bangladesh has resulted in a negative risk premium for the time frame under observation. Hence, the CAPM hypothesis could clearly be rejected for the individual companies under the DS30 based on the intercept and slope criterion alone. The coefficient of the square beta was -0.251 and statistically insignificant. Thus, the results obtained were consistent with the earlier hypothesis of a linear relationship pertaining to the "expected return-beta". The unique risk was not a significant factor affecting the return generating process since the estimates of Û3 also statistically insignificant.

Table 1: The results of the OLS regression

Variables	Parameters	Coefficients	S.E.	t-value
Constant	$\hat{U}_0$	-0.014*	0.005	-4.087
Beta	$\hat{U}_1$	0.129@	0.044	0.341
Beta square	$\hat{U}_2$	-0.251@	0.092	-0.479
Unique risk	$\hat{U}_3$	-0.152@	0.072	-1.070

*, **, *** Significance level at 1%, 5%, 10% consecutively, @ = insignificant, S.E = Standard Error

4.2 Beta coefficient parameters for individual firms

As depicted in table 2 attached below, estimated stock betas ranged from 0.0655 up to 0.4938. At the 1% confidence interval level, 14 individual firms had statistically significant beta coefficients, whilst it was statistically significant for 4 of the individual companies at the 5% confidence interval level, and 2 individual firms at the 10% confidence interval level respectively.
The remaining companies were deemed to be statistically insignificant. According to the CAPM, and general finance theories a higher risk (including both systematic risk (beta) and unsystematic risk) (beta) is associated with a higher level of return and vice versa. The results we obtained from analyzing the 42 companies listed within the DS30 from time to time, with the heaviest of market capitalizations (excluding the financial stocks) clearly did not support this hypothesis.

Table 2: Stock beta coefficient estimates

Company	AR	beta	t- value	Company	beta	AR	t-value
Linde Bangladesh	-0.0388	0.4938*	-0.0388	PowerGrid	0.1926@	-0.0201	1.49
Confidence Cement	-0.0141	0.4599*	-0.0141	ACI Formula	0.1639@	-0.0305	1.26
GrameenPhone	-0.0325	0.4452*	-0.0325	Aamra Network	0.1625@	-0.0177	1.25
Beximco Ltd	-0.0245	0.4174*	-0.0245	BSCCL	0.1614@	-0.0343	1.25
Marico BD Ltd	-0.0335	0.4123*	-0.0335	Renwick Jagjeswar	0.1520@	-0.0144	1.17
Beximco Pharma	-0.0412	0.3959*	-0.0412	Pharma Aids Ltd	0.1512@	-0.0049	1.16
Lafarge Holcim	-0.0357	0.3913*	-0.0357	Meghna Petroleum	0.1441@	-0.0477	1.11
Reckitt Benckiser	-0.0085	0.3891*	-0.0085	RFL	0.1440@	-0.0248	1.10
BATBC	-0.0321	0.3780*	-0.0321	Shasha Denim	0.1040@	-0.0330	0.80
Ibn Sina	-0.0385	0.3761*	-0.0385	Legacy Footwear	0.0972@	-0.0209	0.74
United Power	-0.0280	0.3660*	-0.0280	Fu-Wang Ceramic	0.0968@	-0.0280	0.74
Paramount Textile	-0.0368	0.3632*	-0.0368	BSRM Ltd	0.0923@	-0.0243	0.70
Olympic Industries	-0.0181	0.3514*	-0.0181	Stylecraft	0.0898@	-0.0352	0.69
Renata Ltd.	-0.0279	0.3479*	-0.0279	Unique Hotel	0.0754@	-0.0195	0.58
Apex Tannery	-0.0281	0.3470*	-0.0281	Fortune Shoes	0.0733@	-0.0142	0.56
Bata Shoe	-0.0332	0.3382*	-0.0332	Aftab Automobiles	0.0726@	-0.0301	0.55
ACI Limited.	-0.0241	0.3330*	-0.0241	National Polymer	0.0717@	-0.0262	0.55
AMCL (Pran)	-0.0341	0.3306*	-0.0341	Beacon Pharma	0.0679@	-0.0225	0.52
Square Pharma	-0.0546	0.3229*	-0.0546	Orion Pharma	0.0661@	-0.0303	0.50
Jamuna Oil Co.	-0.0139	0.2959*	-0.0139	GPH Ispat Ltd	0.0660@	-0.0145	0.50
Padma Oil Co.	-0.0414	0.2761**	-0.0414	Titas Gas	0.0655@	-0.0421	0.50

*, **, *** Significance level at 1%, 5%, 10% consecutively @ = insignificant, S.E = Standard Error

The market capitalization of the financial stocks is the heaviest in the DSE, as a result a discrepancy in the results could have occurred due to including the largest companies in our analysis due to accounting policy restrictions and uniformity. Including the banking, non-bank financial institutions and insurance companies may have significantly improved the t-statistic portion of our analysis for the factors under consideration. The company that attained the highest beta "Linde Bangladesh" did not seem to obtain the highest return (-0.0388), which is what our original hypothesis had stated, but companies with a higher market capitalization did seem to exhibit higher t-values/ return parameters.

5.0 Limitations and Concluding Remarks

The purpose of the research was to validate the hypothesis of utilizing the CAPM to predict risk-return parameters with a desired level of accuracy when analyzing the DSE. Heading into the year 2020, a vast majority of government T-bills had offered rates of return well in excess of the market rate of return. Excluding 2016, fixed income securities and government bonds all provided higher returns compared to the overall broad market index, in accordance with the central bank of Bangladesh and the DSE archive data. Thus, the component which depicts the risk premium had been negative for most of the time under observation. Unlike developed nations, where the risk premiums are significantly well spread out, the risk premium factor alone for the DSE is essentially negative; thus, leading to the basic premise that a majority of companies yielded negative/ lower rates of return. An ordinal data approach combining the factors which influence stock market volatility could have been incorporated as a preliminary research information to better estimate what other factors could have improved the results centered around the DSE specifically.

The results of the study which we obtained clearly contradict the CAPM's hypotheses when taking into account the intercept and slope of the results under observation. Since the analysis regarding the monthly logarithmic returns indicates strong evidence against the CAPM observing the yearly parameters might prove useful. Considering the four-year period of the study however also yields strong evidence against the CAPM when

considering Bangladeshi Companies and their risk-return trade-off parameters as displayed by the table below. The observations were standardized at the same 1%, 5% and 10% intervals respectively similar to all of the data above. The results showcased in table 3 didn't support the CAPM hypothesis as the intercept term for all of the four years under observation was not equal to zero and statistically significant. The coefficient of square beta was significant only for 2019 whereas in the other three years it was insignificant. Unique risk also had little effect on the return generating process. A multifactor model such as the arbitrage pricing theory (APT) could better serve the purpose of such studies heading forward since the company beta alone seems to provide an inadequate response to the overall expected returns. Factors such as inflation, GDP growth, trading volume, interest rates and foreign exchange reserves; along with their sensitivities are all important parameters when considering an analysis of an emerging market such as the case for Bangladesh. o

Table 3: Yearly OLS regression results

Year	Variables	Parameters	Coefficients	S.E.	t-value
2016	Constant	$\ddot{u}_0$	-0.058*	0.012	-5.197
	Beta	$\ddot{u}_1$	-0.237@	0.101	-0.729
	Beta square	$\ddot{u}_2$	-0.018@	0.211	0.017
	Unique risk	$\ddot{u}_3$	-0.467*	0.166	-2.778
2017	Constant	$\ddot{u}_0$	-0.061*	0.013	-3.816
	Beta	$\ddot{u}_1$	-0.426@	0.116	-0.572
	Beta square	$\ddot{u}_2$	0.437@	0.243	0.789
	Unique risk	$\ddot{u}_3$	0.212***	0.192	1.993
2018	Constant	$\ddot{u}_0$	-0.036**	0.014	-2.502
	Beta	$\ddot{u}_1$	0.452@	0.126	0.889
	Beta square	$\ddot{u}_2$	0.028@	0.264	0.055
	Unique risk	$\ddot{u}_3$	-0.033@	0.208	-0.261
2019	Constant	$\ddot{u}_0$	-0.041*	0.014	-2.864
	Beta	$\ddot{u}_1$	1.235**	0.126	2.442
	Beta square	$\ddot{u}_2$	-1.345*	0.264	-2.667

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