

Testing the Capital Asset Pricing Model (CAPM): The Case of the Nigerian Securities Market

S.A. Olakojo and K.B. Ajide
Department of Economics, University of Ibadan, Ibadan, Nigeria

Abstract: The study examines the Capital Asset Pricing Model (CAPM) for the Nigeria stock market using monthly stock returns from 10 most listed companies on the Nigeria stock exchange for the period of January 2008 to December 2009. The findings of this study are not supportive of the theory's basic statement that higher risk (beta) is associated with higher levels of stock values or returns. The CAPM's prediction for the intercept is that it should equal zero and the slope should equal the excess returns on the market stock. The results of the study refute the above hypothesis and offer evidence against the CAPM. The tests conducted to examine the non-linearity of the relationship between return and betas do not also support the hypothesis that the expected return-beta relationship is linear. Additionally, this study investigates whether the CAPM adequately captures all important determinants of returns including the residual variance of stocks. The results demonstrate that residual risk has no effect on the expected returns of stocks. Tests may provide evidence against the CAPM but they do not necessarily constitute evidence in support of any alternative model.

Key words: CAPM, Nigerian stock exchange, stock returns, ARCH, stocks capitalization, volatility

INTRODUCTION

Investors may still be licking the wounds inflicted on them by the phenomenal global economic meltdown as they lost N1.97 trillion in the Nigerian stock market in 2008. Earlier 2009 Michael Bloomberg, a financial analyst declared the Nigerian stock exchange's all share index as the worst performing in the world having reviewed 91 largest indexes across the globe. Investors and financial researchers have paid considerable attention during the last 2 years to the Nigerian stock markets that are emerging during the global financial crises. This interest has undoubtedly been motivated by the seeming recent improvement in returns offered by these markets. Despite closing the year 2008 on a bad note amidst share price losses, key indicators of the Nigerian stock exchange showed optimism on the stabilization of the stabilized market.

The capital market all over world is a collection of all the financial institutions set up for the granting of medium and long-term funds. In this market, lenders (investors) provide long term funds in exchange for long term financial assets which are offered by borrowers (Bodie *et al.*, 2004). The capital market embraces both the primary and secondary markets whose securities are raised in an organized market such as the stock exchange. Thus, it involves consortium underwriting, syndicated loans and project financing (Akintoye, 2006; Edoko, 2004).

This is the mechanism through which economic units desirous to invest their surplus funds interact directly or through financial intermediaries with those who wish to procure funds for investment. Practitioners all over the world have used a plethora of models in their portfolio selection process and in their attempt to assess the risk exposure to different assets. One of the most important developments in modern capital theory is the Capital Asset Pricing Model (CAPM) as developed by Sharpe (1964), Lintner (1965) and Mossin (1966). CAPM suggests that high expected returns are associated with high levels of risk.

Simply stated, CAPM postulates that the expected return on an asset above the risk free rate is linearly related to the non-diversifiable risk as measured by the asset's beta and that there is a relationship between residual risk and the value of an asset. Although, the CAPM has been predominant in empirical work over the past 30 years and is the basis of modern portfolio theory, accumulating research has increasingly cast doubt on its ability to explain the actual movements of asset returns (Michailidis *et al.*, 2006).

The CAPM was developed as a model for investment appraisal and share valuation and is also a model for pricing an individual security or a portfolio. Given the situation in the capital market in the past few years in Nigeria where many stock values dropped due to global financial crises, many investors are not only interested in

the investments appraisal but eager to know what becomes of their investment. Also, there have been arguments that this period when the value of most stocks are at low ebb is the right time to invest in the capital market, given the fact that it cannot be worse than the present situation but this opinion does not seem to go well with many risk averse investors because such investors are only interested in investing when the market is on good shape. With this background, this study becomes indispensable for investors who wish to put their funds in the stocks market to identify which stocks is viable and which one is not (i.e., riskiness or otherwise of an investment).

However, this becomes relevance when we assumed that all investors are equally risk averse, lovers or neutral, it is understood that the risk lovers investors invest in stock that are mostly risky while the risk averse investors prefer less risky stocks.

According to CAMP, the riskiness of an asset has a direct relationship with its return (i.e., the most risky stocks are always associated with high return and vice versa). Intuitively, this is in line with utility maximization behaviour of investors meaning that for any investor to be motivated to invest in risky assets the return must be higher. This study is not going to only be useful to the investors in the capital market but also to all the participants in the market.

MATERIALS AND METHODS

The methodology adopted for this study is a variant of Michailidis *et al.* (2006). The first step was to estimate beta coefficients for each of the ten most quoted sample firms on the Nigerian stock exchange market.

The monthly stock values of these firms were estimated for the period of January 2008 to December 2009 using Ordinary Least Squares method (OLS) estimation technique. The beta coefficient was estimated by regressing each stock's value against the market value weighted index. The regression was according to the following equation:

$$R_t - R_{ft} = \alpha_i + \beta_i(R_{mt} - R_{ft}) + e_{it} \quad (1)$$

Where:

- R_t = The return on stock i ($i = 1, \dots, 10$)
- R_{ft} = The rate of return on a risk-free asset
- R_{mt} = The rate of return on the market index
- β_i = The estimate of beta for the stock i
- e_{it} = The corresponding random distributed term

The following equation was used to estimate the individual stock's beta.

$$r_{it} = \alpha_i + \beta_i r_{mt} + e_{it} \quad (2)$$

Where:

- r_{it} = Individual security market value (capitalization)
- β_i = Individual security beta
- r_{mt} = Market value weighted index

One of the hypothesis of CAPM is that the more risky stock will have a higher beta and will be discounted at a higher rate; less sensitive stock will have lower betas and be discounted at a lower rate. Given the accepted concave utility function, the CAPM is consistent with idea that investors require a higher return for holding a more risky asset. The market risk, the market as a whole by definition has a beta of one. This means that situation in market (risk and otherwise) reflects situation with the stock in question.

In order to avoid problems with misspecification in Eq. 2. A Lagrange Multiplier (LM) test was used to test for the presence of Autocorrelation Conditional Heteroskedasticity, ARCH (1) effects, since we are working with time varying variances (Heteroskedasticity) that depend (condition) on lagged effects (autocorrelation). This was done by saving the estimated residuals e_t and obtained their squares. First order ARCH (1) effects was tested by regressing on e_t^2 the square residuals lagged e_{t-1}^2 :

$$e_{it}^2 = \alpha_0 + \alpha_1 e_{i,t-1}^2 + v_{it} \quad (3)$$

Where v_{it} is the random term. The null hypothesis is:

$$H_0: \alpha_1 = 0 \quad H_1: \alpha_1 \neq 0$$

There is no ARCH effect then $\alpha_1 = 0$ and R^2 will be low. If there are ARCH effects, we expect the magnitude of e_t^2 to depend on its lagged values and R^2 will be relatively high. The LM test statistic is $(T-q) R^2$ when T is the sample size, q is the number of e_{t-1}^2 terms on the right hand side of Eq. 3 and R^2 is the coefficient of determination.

If the null hypothesis is true then the test statistics $(T-q) R^2$ is distributed (in large sample) as X^2 when q is the order of lag and $T-q$ is the number of completed observations: in this case, $q = 1$. If $(T-q) R^2 \geq X^2_{(1-\alpha, q)}$ then we reject the null hypothesis that $\alpha_1 = 0$ and conclude that Autocorrelation Conditional Heteroskedasticity (ARCH) effect is present (Hill *et al.*, 2008). That is the variable in question is volatile and less predictable and hence, risky. Thus, the ARCH model is intuitively appealing because it seems sensible to explain volatility as a function of the errors e_t . These errors are often call shocks

or news in financial analysis. The study continues by estimating the ex-post Security Market Line (SML) by regressing average stock values against the stock betas obtained in Eq. 2:

$$r_t = \delta_0 + \delta_1\beta + e_t \quad (4)$$

Where:

- r_t = The average stock values
- β = The estimated beta of the stocks
- δ_1 = The market price of risk, the risk premium for bearing one unit of beta risk
- δ_0 = The zero-beta rate, the expected value of an asset which has a beta of zero
- e_t = Random disturbance term in the regression equation

In order to test for non-linearity between stock values and betas, a regression was run on average stock values, calculated stock beta and beta-square as:

$$r_t = \delta_0 + \delta_1\beta + \delta_2\beta^2 + e_t \quad (5)$$

The estimated parameters allow us to test a series of hypothesis regarding the CAPM. The tests are:

- $\delta_1 = 0$ or residual risk does not affect capitalization or value
- $\delta_2 = 0$ or then are non-linearities in the security market line

RESULTS AND DISCUSSION

The study required the estimation of betas for individual stocks by using observations on capitalization for a sequence of dates. Useful remarks can be derived from the results of these procedures for the securities used in this study. The range of estimated stock betas is between 0.003941 (the minimum) and 6.847644 (the maximum). Some of the beta coefficients for individual stocks are statistically significant at 95% level (Table 1). For a more accurate result estimation of betas, an ARCH (1) effect was checked for each stock using Lagrangian multiplier test.

In the study, it was argued that certain hypothesis can be tested regardless of whether one believes in the validity of simple CAPM or any other version of the theory. First, the theory indicates that higher risk (beta) is associated with a higher level of return. Looking at the capitalization of each stock during the period under consideration, this study does not supports this hypothesis because the stock with highest capitalization (i.e., FBN) does not have the highest beta while the one with lowest capitalization does not have the

Table 1: Stock beta coefficient estimates

Stock names	Betas	t-statistics
¹ FBN	0.003941	1.249487
² NB	0.020635	0.457459
³ Zenith	0.020948	0.721976
⁴ Ecot	0.024639	1.409122
⁵ IBTC	0.028166	1.625349
⁶ Dangote sugar	0.032247	1.708691
⁷ UBN	0.040965	1.208511
⁸ UBA	0.043964	1.868328
⁹ Guinness	2.936850	45.86935
¹⁰ GTB	6.847644	63.56009

Stock: ¹First Bank Nig plc, ²Nigerian Breweries plc, ³Zenith Bank plc, ⁴Ecobank Transnational plc, ⁵Stanbic IBTC Bank plc, ⁶Dangote Sugar, ⁷Union Bank Nig. plc, ⁸UBA plc, ⁹Guinness Nigeria plc ¹⁰Guaranty Trust Bank plc

Table 2: ARCH (1) effects result on stocks

Stock names	E^2_{t-1}	t-value	R ²	LM test statistics
FBN	0.391457	1.608199	0.139151	2.365567
NB	0.363789	1.693289	0.151969	2.583473
Zenith	0.363857	1.668464	0.148201	2.519417
Ecot	0.295654	1.255767	0.089717	1.525189
IBTC	0.372283	1.587377	0.136058	2.312986
Dangote sugar	0.314762	1.347164	0.101873	1.731841
UBN	0.452828	1.851766	0.176490	3.000330
UBA	0.241752	1.028127	0.061971	1.053507
Guinness	-0.305653	-0.373083	0.008624	0.146608
GTB	0.044060	0.163425	0.001666	0.028322

$\chi^2(0.95,1) = 3.841$

slowest beta (i.e., Guinness) bearing in mind that capitalization reflects the value of each stock in the market. Table 2 shows none of the stocks are volatile. This is because their LM test statistics values are $< \chi^2_{(0.95,1)}$ value of 3.841. This means that there is no presence of ARCH (1) effects. This result contradict CAPM hypothesis because the two stocks that were rated as most risky by CAPM approach were not volatile hence, not risky using ARCH approach.

Also, another deviation of ARCH (1) effect approach from approach of CAPM is that the stocks rated with highest betas were not the ones showing tendency of being volatile under ARCH (1) approach. The ARCH (1) approach was used to show the robustness of our results and the ARCH result is consistent with the first result and both leads to the rejection of hypothesis of CAPM. The study continues by estimating the ex-post Security Market Line (SML) by regressing against the average stocks value on the stocks betas obtained by Eq. 4. The relationship is shown as follows:

$$r = 5.90E + 11 + 5.08E + 10\beta$$

$$(t) (2.369869) (0.480783) \quad R^2 = 0.028083$$

In order to test for linearity among total stocks values, a regression was run on average stock value, calculated stock beta and beta-square from Eq. 5 and the result is presented as follows:

$$r = 6.37E+11 - 3.06E + 11\beta + 5.58E + 10\beta^2$$

$$(t) = (2.430230) (-0.654753) = (0.785136) \quad R^2 = 0.106745$$

The two results will enable us to test two hypotheses regarding the CAPM. The test is as given:

- $\alpha_1 = 0$ = The residual risk that does not affect stock capitalization or value of stocks
- $\alpha_2 = 0$ = There is no linearity in the security market line
- α_0 = The expected value on a zero beta stock
- α_1 = The market price of risk

Which is the difference between the expected value on the market and a zero beta stock. Considering the two hypothesis, it shows that the hypothesis that α_1 is not significantly different from zero is retained at 0.05 significant level, meaning that the residual risk does not affect stock value. Also, the hypothesis that there is no linearity in the security market line is retained (i.e., $\alpha_2 = 0$) and we concluded that there is non-linearity in the security market line.

CONCLUSION

This study examined the validity of the CAPM for the Nigerian stock market. The study used monthly stock values from 10 most capitalized stocks listed on Nigerian stock exchange from January 2008 to December 2009. The findings of this study are not supportive of the theory's hypothesis which states that higher risk (beta) is associated with a higher capitalization or stock value. The results obtained do not also support the linear structure of the CAPM equation being a explanation of security capitalization. The findings do not support the hypothesis of CAPM. The inclusion of the square of the beta coefficient to test for the non-linearity in the relationship between values and betas indicates that the findings are not in accordance with CAPM hypothesis and the expected value-beta relationship is nonlinear.

RECOMMENDATIONS

It is a fact that the behaviour of financial variables are often not stable, they fluctuate over time. This has to do

with the forces of demand and supply in the market. This study confirms fact by examining the 10 most capitalized stocks in Nigerian capital market. Going by the findings of the study, some stocks were found to be less risky while some are riskier in nature. It is also believed that investors require a higher return from holding stocks with higher risk. Given this fact, there should be adequate pricing of each stock in order to encourage the risk loving investors to invest in the risky assets. On the other hand as indicated in the result of the findings, the risk averse investors could invest in less risky assets. Furthermore, it is understood that the purpose for which investors come into the market differs. Some come to the market for immediate gains while others come for long-term gain or to maximize their wealth. The later category of investors can afford to invest in less risky stocks (e.g., stocks that are not affected by the residual risk i.e., $\alpha_1 = 0$) while the reverse is the case for the former category since they can afford to invest in more volatile stocks.

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