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# ESTIMATING BETAS AND THE SECURITY MARKET LINE: CAPITAL ASSET PRICING MODEL (CAPM) TEST ISSUES

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## Abstract
*This research work focuses on empirical testing of Capital Asset Pricing Model (CAPM) on 30 stocks of the Nigeria Stock Exchange (NSE), using the All Share Index as proxy for the market index and the government Treasury bills rate as the risk-free interest rate. The first and second pass regression methodology was applied on monthly data for a period of 5 years from January, 2014 to December, 2018. The study revealed that the slope (beta) of Security Market Line (SML) does not correspond to the market excess return and so the intercept (alpha) is not equal to the risk-free rate over the period. The t-statistics for both the intercept and slope are not statistically different from zero. Therefore, we conclude that the results did not support the CAPM standard theory in the selected study period,*

***Keywords:*** *Alpha, Beta, Capital Asset Pricing Model (CAPM), Security Market Line (SML)*

## Introduction
The Capital Asset Pricing Model (CAPM) is one of the most influential innovations in financial theory in the twentieth century developed by Sharpe, Lintner and Mossin. The CAPM explains that systematic (market) risk is the only component that determines the expected stock returns excluding the unsystematic risk and other factors. This is why; CAPM is also recognized as a

single factor model. The model explains the risk- return relationship for each individual asset to be in equilibrium, which is known as security market line (SML).

The CAPM is based on numerous assumptions and conditions for the equilibrium to take place. Some of the assumptions are achievable while others are not. The assumptions include; Individual investors are price takers (perfect competition in the market), all investors have single-period investment horizon, investments are limited to traded financial assets (only stocks excluding non-traded asset e.g education), and there are no taxes and transaction costs. Information is available at no cost to all investors; investors are rational mean-variance optimizers (Markowitz portfolio selection model) and there are homogeneous expectations. The conditions for CAPM to occur include;

- All investors will hold the same portfolio for risky assets – market portfolio.
- Market portfolio contains all securities and the proportion of each security is its market value as a percentage of total market value.
- Risk premium on the market corresponds to the average risk aversion of all market participants.
- Risk premium on an individual stock is a function of its beta coefficient and the market premium.

There are so many criticism of the CAPM by both the academicians and practitioners regarding beta (systematic risk) as the single factor being used in determination of stock prices and returns. The model did not take into consideration other behavioral aspect financial market. For instance, there is documented evidence that returns are positively correlated with beta when measured over a longer period Fama & French (1992) found that there is no relationship between return of portfolios and their betas risk measures, and introduced the three (3) factor model to include size and book to market ratio.

Although there are many research studies on various stock markets, this research work aim to test the validity of CAPM in the Nigeria stock market. This research work utilizes price data for 30 companies listed in the NSE, the study is based on the monthly adjusted stock prices of the 30 companies, All Share Index as market proxy and yield of government Treasury bills as risk free rate of return. The study covers 5 years starting from January 1, 2014 to

December 31, 2018. The monthly closing share prices of the sample companies and the market Index data were collected and used in this study.

## Literature review

The review of related literature shows that considerable number of studies has been conducted to test the validity of the CAPM in different markets and discover different results for different markets. Most of the tests of CAPM have been conducted on developed stock markets and are centered on the basic methodology adopted by (Sharpe, 1964; Lintner, 1965; Mossin, 1968; Ross, 1976). The empirical tests conducted by Friend and Blume (1970), Black, Jensen and Scholes (1972) and Fama and MacBeth (1973) show support to CAPM and concluded that return of risky assets are a linear function of the beta factor. Furthermore, Watson and Head, (1998), stated that this linear relationship is described by security market line (SML), which compares the systematic risk of a share and the return, along with the risk of the market and risk-free rate of return. In South African context, Keogh, (1994), found the fluctuations in beta, negatively affecting the significance of beta and CAPM, particularly in South Africa. Whereas, the results provided by Bradfield, Barr and Affleck-Graves's study (1988) supported the CAPM, and declared it to be a useful model, in the context of Johannesburg Stock Exchange. Different studies have been conducted in Nigeria which involved Nigerian Stock Exchange (NSE), by Olakojo and Ajide, (2010), where the outcomes of their study on CAPM in explaining the risk and return relationship, supported the assumptions that higher risk yields higher returns and vice versa for the lower risk stocks but subsequently, another study carried out by Nwude (2013) on food and beverages industry in the NSE, revealed the inapplicability of the CAPM.

The validity of CAPM was also brought to test, by Sohail Rizwan, et al. (2013), where the findings of their study on 15 stocks in cement sector listed on the Karachi Stock Exchange (KSE) is not valid in its application.

The capital asset pricing model has been criticized on many grounds, i.e. the investigating power of CAPM, has been discovered low, as it depends on a single beta for decision and uses market returns for calculation of returns Hanif and Bhatti, (2010). For e.g Watson and Head, (1998) and Harrington, (1987), found that the reason for the weaknesses of CAPM to be the numerous assumptions of the model that are unrealistic and impractical. The dynamic

work of Fama and French (1992, 1993 and 1995) weakened the fact that 'Beta' is the only factor which can explain the return generating process of risky assets. However, size factor and book to market ratio factor are two other important factors, which help in explaining the risk return relationship. Singla and Pastricha (2012) in their study did not find any positive relationship between the stocks' systematic risk, beta (β) and their expected returns. They found that the stocks' expected return is more closely related to their betas (β) in the negative return periods than in the positive return periods. In spite of its widespread treatment in the literature, the CAPM is getting condemnation as it is founded on several assumptions, such as the existence of a risk-free asset which undertakes a constant rate for borrowing. Likewise, the beta, as a measure of risk, has been the subject of numerous empirical researchers

## Data and Methodology

### Data

This study covers a period of 5 years starting from January 1, 2014 to December 31, 2018. Data is adjusted closing monthly prices of stocks listed on the Nigeria Sock Exchange downloaded from Thomson Reuters Eikon. All the 30 stocks considered which have been traded for a five years period of study continuously; we have taken log returns of the monthly closing prices of stocks to transform the non stationary associated with the time series to a stationary process. In addition, risk free rate of Treasury bill was also obtained from the CBN website for the same five year period.

### Methodology

The monthly returns in this study were calculated using the formula below;

$$r_{it} = \ln\left[\frac{p_{it}}{p_{it-1}}\right] \quad \text{..... (1)}$$

The above equation 1 provides the formula to calculate logarithmic returns of stocks.

Where;

$r_{it}$ is the logarithm return of stock for the month 't'

$p_{it}$ is the adjusted closing price of stock for month 't',

$p_{it-1}$ is the adjusted closing price of stock for month 't-1'.

Logarithmic returns of NGNSE index has been calculated in the same way. These index returns are used as a proxy for the market return. Proxy for risk free rate of return is the average yield of monthly government Treasury bills rate.

The CAPM is tested in two stages of regression. Equation 2 reports the first pass regression that determines the beta (β) for each of the stock by using the Excel function slope. The functions of Intercept and R-Sq were also used to calculate the alpha (α) and R-squared respectively. The α, β and R-squared for the NGNSE index was computed in the same way

$r_{it} = \alpha_i + \beta_i r_{m,t}$ …… (2)

Where;

$r_{it}$ is the return of stock 'i' at 't' point of time.

$\alpha_i$ is the intercept coefficient of the regression equation of stock 'i'

$\beta_i$ is the slope coefficient of the regression equation of stock 'i'

$r_{m,t}$ is the return of the NGNSE index at 't' point of time..

Calculation of beta of each stock by the help of equation 2 leads us to the second pass regression. In this second pass regression, the average excess return of market is regressed on beta of stock. The slope coefficient in this regression is the market risk premium of stock.

$\overline{r_i} = \Upsilon_0 + \Upsilon_1 \beta_i$ …… (3)

$\overline{r_i}$ is the average returns of the stocks

$\Upsilon_0$ is the intercept of the stocks

$\Upsilon_1$ is the slope of the stocks

$\beta_i$ is the estimated beta of each stocks

Finally, the average returns of the stocks are regressed on their respective betas as shown by equation 3 above.

**Results and Discussion**

To test the significance of CAPM on the Nigerian stock market, we have carried out two stages of regression. In the first pass regression, beta coefficient of each of the sample 30 stocks for the period of five years (January 2014 – December 2018) was calculated with the help MS Excel using the formula in equation (2) above. The second stage involves the regression of average returns of each stock with their respective betas as suggested by the formula in equation (3) above to estimate the security market line (SML). Results obtained in the second pass regression are fundamental in validating CAPM or otherwise.

**Table 1: Second pass regression**

| THE SECOND-PASS REGRESSION | | | | | | |
|---|---|---|---|---|---|---|
| Stock | **Average Monthly Returns** | **Beta** | **Alpha** | **R-squared** | | |
| **CEMENTCOY** | 0.0093 | 1.39 | 0.0149 | 0.2983 | **Intercept** | -0.00108 |
| **CONOIL** | -0.0190 | 1.01 | -0.0150 | 0.2343 | **Slope** | -0.00325 |
| **DANGCEM** | -0.0015 | 0.98 | 0.0024 | 0.7012 | **Rsquared** | 0.01228 |
| **DANGFLOUR** | -0.0058 | 2.03 | 0.0023 | 0.3497 | | |
| **DANSUGAR** | 0.0032 | 1.20 | 0.0081 | 0.4553 | **t-Stat, Intercept** | 13.13963 |
| **ECOBANK** | 0.0010 | 1.24 | 0.0059 | 0.4991 | **t-Stat, slope** | 0.00524 |
| **FBN HOLDING** | -0.0110 | 1.82 | -0.0037 | 0.6323 | | |
| **FCMB** | -0.0118 | 2.06 | -0.0035 | 0.4574 | | |
| **FIDELITY** | -0.0044 | 1.52 | 0.0017 | 0.4927 | | |
| **FIDSON** | 0.0115 | 1.14 | 0.0160 | 0.2671 | | |
| **FLOURMILL** | -0.0208 | 1.20 | -0.0160 | 0.4528 | | |
| **FORTEOIL** | -0.0221 | 0.46 | -0.0203 | 0.0307 | | |
| **GTB** | -0.0167 | 0.93 | -0.0130 | 0.2421 | | |
| **GLAXO** | 0.0042 | 1.22 | 0.0091 | 0.6279 | | |
| **INTBREW** | 0.0022 | 1.13 | 0.0067 | 0.4126 | | |
| **LIVESTOCK** | -0.0358 | 1.07 | -0.0316 | 0.4740 | | |
| **NESTLE** | 0.0041 | 0.87 | 0.0076 | 0.4046 | | |
| **OANDO** | -0.0207 | 1.72 | -0.0139 | 0.3901 | | |
| **OKOMUPALM** | 0.0092 | 0.42 | 0.0108 | 0.0852 | | |
| **PRESCO** | 0.0083 | 0.53 | 0.0104 | 0.1205 | | |
| **STANBIC** | 0.0144 | 1.14 | 0.0190 | 0.4742 | | |
| **STERLINBNK** | -0.0041 | 0.94 | -0.0004 | 0.2128 | | |
| **TOTAL** | 0.0030 | 0.45 | 0.0048 | 0.1379 | | |
| **UBA** | 0.0003 | 1.75 | 0.0073 | 0.7576 | | |
| **UBN** | -0.0090 | 0.74 | -0.0061 | 0.2373 | | |
| **UNILEVER** | -0.0056 | 0.86 | -0.0022 | 0.2113 | | |
| **UNITED CAPITAL** | 0.0094 | 0.94 | 0.0131 | 0.2565 | | |
| **VITAFFOAM** | -0.0009 | 0.63 | 0.0017 | 0.1366 | | |
| **WAPCO** | -0.0331 | 0.98 | -0.0292 | 0.2779 | | |
| **ZENITHBANK** | 0.0006 | 1.33 | 0.0059 | 0.6669 | | |
| | | | | | | |
| **Average** | -0.0047 | 1.1236 | -0.0002 | 0.3666 | | |

Table 1 above shown the results of second pass regression, the security market line (SML). From equation (2) $\overline{r_i} = \Upsilon_0 + \Upsilon_1\beta_i$ we deduce

$\overline{r_i}$ = -0.00108+ (-0.0040-0.03628) $\beta_i$

Based on the literature of CAPM theory, the coefficient of intercept -0.00108 did not correspond with the average Treasury bill rate of 0.03628, so also the

slope coefficient of -0.00325 did not correspond with the market risk premium of -0.04029.

**Table 2: SML Estimates of second pass regression**

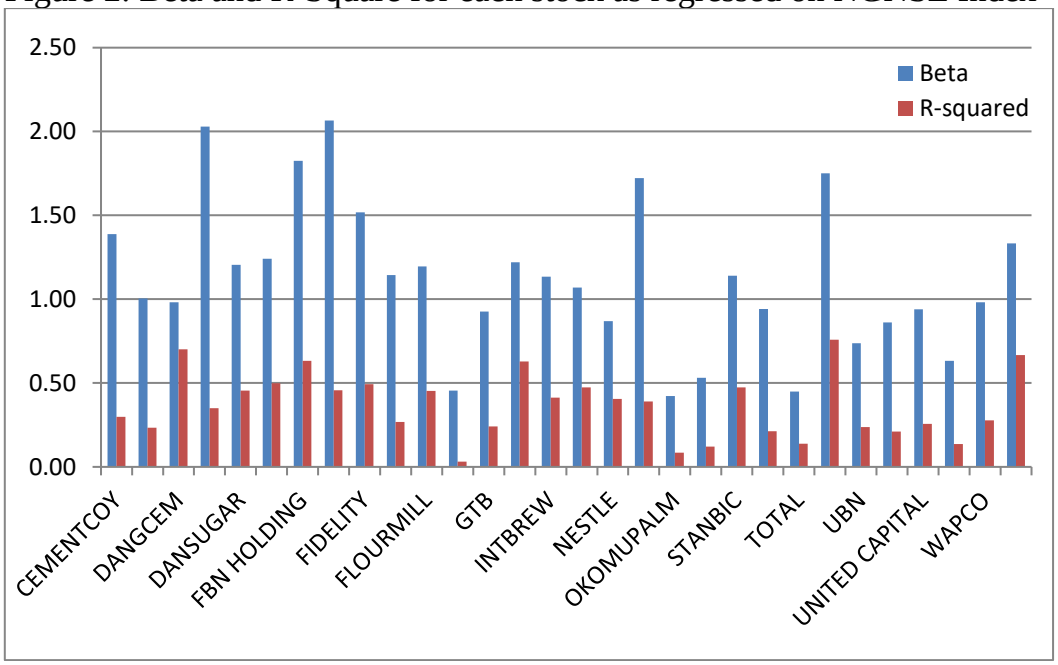
| | Coefficients | t-Stat | *P-value* |
|---|---|---|---|
| **Intercept (Alpha)** | -0.00108 | 13.13962*** | 3.02871E-13 |
| **Slope (Beta)** | -0.00325 | 0.00524 | 0.99585 |

R-Squared0.01228

***statistically significant at 99% confidence interval

From Table 2 above we can see that alpha coefficient is -0.00108 and the average risk free rate over the period of 5 years is 0.03628 as computed in the excel worksheet attached in the appendix are not equal. Similarly, the beta coefficient of -0.00325 is not equal to the market risk return of -0.04029 (average return of NGNSE market index -0.0040 minus average risk free rate 0.03628). The CAPM do not hold based on the analysis above. The t-statistics coefficient for intercept 13.13962 is greater than critical value even at 99% confidence level, this is clear to reject the null hypothesis and accept the alternative hypothesis that is statistically different from zero. Whereas with the slope coefficient of 0.00524 is less than critical value at 90% confidence level, we fail to reject the null hypothesis and this means that is not statistically different from zero.

Figure 2: Beta and R-Square for each stock as regressed on NGNSE Index



The graph above presents the regression model of Beta and $R^2$ on NGNSE. This regression model is able to describe individual asset returns in relation to the market index. The $R^2$ of 0.01228 in the second pass regression is very low this means that a small portion of variation of the 30 sample stocks is explained by NGNSE market index.

**Table 3: Average results of the regression**

| | **Coefficient** |
|---|---|
| **Average Alpha** | -0.0002 |
| **Average Beta** | 1.236 |
| **Average Rsquared** | 0.3666 |

Despite the results in the second pass regression are relatively disappointing, the model does a good job describing individual stock returns in relation to the NGNSE. Moreover, on average the market (NGNSE) describes about 36.6% ($R^2$ 0.3666) of the variability of the 30 sample stocks with an average beta 1.236 as shown in table 3. The result is commendable because the average beta of 1.236 is approximately equal to 1 which is the standard of CAPM theory $\beta = 1$, average alpha of -0.0002 is approximately zero also conforms to the theory $\alpha = 0$ and lastly the average $R^2$ of 36.6% is good number in finance.

The disappointment of CAPM could be due to numerous reasons; CAPM might hold only for portfolios and not for individual assets. The dataset might not be in the appropriate size to do the analysis. The proxies used in the study might not be efficient.

## Conclusion

The study concludes that the estimates of our SML are not in conformity with the CAPM theory. Findings on the 30 sample stocks of Nigerian stock market for the period of five years January, 2014 to December, 2018 indicates that the intercept ($\alpha$) did not correspond with the risk free rate over the period, so also the slope ($\beta$) coefficient of the stock is not equal to the excess market return. The t-statistics for both intercept and slope were not statistically different from zero.

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**Appendix**

| | | | |
|---|---|---|---|
| **31-Jan-2014** | **0.03603** | | |
| **28-Feb-2014** | 0.03940 | | |
| **31-Mar-2014** | 0.03973 | | |
| **30-Apr-2014** | 0.03753 | | |
| **30-May-2014** | 0.03377 | | |
| **30-Jun-2014** | 0.03327 | | |
| **31-Jul-2014** | 0.03293 | | |
| **29-Aug-2014** | 0.03317 | | |
| **30-Sep-2014** | 0.03250 | | |
| **31-Oct-2014** | 0.03277 | | |
| **28-Nov-2014** | 0.03273 | NGNSE return, **E(M)** | -0.00400 |
| **31-Dec-2014** | 0.03600 | Risk free rate, **(rf)** | 0.03628 |
| **30-Jan-2015** | 0.03733 | Excess market return, **E(m) - rf** | -0.04029 |
| **27-Feb-2015** | 0.03627 | | |

| | |
|---|---|
| **31-Mar-2015** | 0.03590 |
| **30-Apr-2015** | 0.03410 |
| **28-May-2015** | 0.03343 |
| **30-Jun-2015** | 0.03317 |
| **31-Jul-2015** | 0.03333 |
| **31-Aug-2015** | 0.03333 |
| **30-Sep-2015** | 0.03453 |
| **30-Oct-2015** | 0.03037 |
| **30-Nov-2015** | 0.01873 |
| **31-Dec-2015** | 0.01523 |
| **29-Jan-2016** | 0.01373 |
| **29-Feb-2016** | 0.01637 |
| **31-Mar-2016** | 0.01843 |
| **29-Apr-2016** | 0.02423 |
| **31-May-2016** | 0.02680 |
| **30-Jun-2016** | 0.02773 |
| **29-Jul-2016** | 0.04113 |
| **31-Aug-2016** | 0.04977 |
| **30-Sep-2016** | 0.04667 |
| **31-Oct-2016** | 0.04653 |
| **30-Nov-2016** | 0.04663 |
| **30-Dec-2016** | 0.04657 |
| **31-Jan-2017** | 0.04650 |
| **28-Feb-2017** | 0.04583 |
| **31-Mar-2017** | 0.04533 |
| **28-Apr-2017** | 0.04527 |
| **31-May-2017** | 0.04500 |
| **30-Jun-2017** | 0.04500 |
| **31-Jul-2017** | 0.04487 |
| **31-Aug-2017** | 0.04450 |
| **29-Sep-2017** | 0.04400 |
| **31-Oct-2017** | 0.04393 |
| **30-Nov-2017** | 0.04337 |
| **29-Dec-2017** | 0.04340 |
| **31-Jan-2018** | 0.04090 |
| **28-Feb-2018** | 0.03960 |
| **29-Mar-2018** | 0.03947 |
| **30-Apr-2018** | 0.03810 |
| **31-May-2018** | 0.03333 |
| **29-Jun-2018** | 0.03370 |
| **31-Jul-2018** | 0.03333 |
| **31-Aug-2018** | 0.03547 |
| **28-Sep-2018** | 0.03667 |
| **31-Oct-2018** | 0.03647 |
| **30-Nov-2018** | 0.03637 |
| **31-Dec-2018** | 0.03650 |
| **Average** | 0.03628 |