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# THE APPLICATION OF THE CAPITAL ASSET PRICING MODEL (CAPM) IN THE NIGERIAN CHEMICALS AND PAINTS INDUSTRIAL SECTOR

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**ABSTRACT:** *This paper calculated the (historical) betas of listed stocks in the chemicals and paints sector of the Nigerian Stock Exchange over a 13-year period (2000-2012). The beta estimation of listed stocks showed that the beta content of the entire sector ranges between 1.04% and -0.13 or between 6.78 and -2.31% providing an average beta content of 0.37 or 1.50% of the total risk for the sector. The results indicate that the unsystematic risk content in chemicals/paints sector stocks constitutes the bulk of the sector's risk profile and that most of the stocks' betas had defensive attributes over the study period. The investment implication is that including an appropriate mix of chemical and paints stocks in the investors' portfolios would, ceteris paribus, help investors to achieve a combination of investments that are not highly correlated with larger economic cycle as well as higher-risk equity securities that can potentially yield higher returns than the market.*

**KEYWORDS:** Alpha Risk, Beta, Beta Risk, Capital Asset Pricing Model, Equity, Market Risk, Total Risk, Volatility Level, Systematic Risk, Unsystematic Risk, Nigerian Stock Exchange

## INTRODUCTION

Central to the Capital Asset Pricing Model (CAPM) of William Sharpe (1964) and John Lintner (1965) is the risk-return relationship of an asset, precisely the relationship between (systematic) risk and expected return for a financial asset. The development of the model was inspired by Markowitz's (1952) portfolio theory, which is based on optimizing the relationship between risk and return. Sharpe and Lintner propounded that under conditions of market equilibrium, the expected return on a given asset should be both above the risk-free rate and proportional to its non-diversifiable risk (that is, market risk) measured by beta, β. More than half a century since the birth of the model, it is still widely used in the pricing of a risky asset by (a) determining a theoretically required rate of return, (b) making decisions about portfolio management, and (c) estimating a firm's cost of capital. The universality of the CAPM resonates in two ways. First, it offers a powerful and intuitively pleasing predictions about how to measure risk and the relation between expected return and risk (Fama and French, 2004).

Second, the CAPM is so important that it is the cornerstone of undergraduate final year and Master's investment courses. Although theoretically, every asset pricing model is a capital asset pricing model, the unremitting reference in both finance literature and profession/practice is to the specific model of Sharpe (1964), Lintner (1965) and Black (1972), commonly referred



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to as the Sharpe-Lintner-Black version of the CAPM. The basic notion of CAPM is that the expected return of a security or a portfolio equals the rate on a risk-free (or riskless) security plus a risk premium. A risk premium is the return in excess of the risk-free rate of return expected from a risky investment. It represents a compensation for investing in the market thereby taking extra investment risk, in place of a risk-free investment in Government treasury bills (TB). In essence, a risk premium is the minimum return by which the expected return on a risky asset must exceed the known return on a risk-free asset in order to induce an investment in the risky asset rather than the risk-free asset. Thus, *Market Risk Premium* $= R_m - R_f$.

The CAPM proposes that the expected return on a financial asset increases with risk. While the CAPM recognizes two types of risk, the relevant risk is the market risk, which connotes the sensitivity of the asset's returns to the returns of the market as a whole, reflected in beta. The risk of the market is referred to as systematic risk. In contrast, unsystematic risk is the amount of risk associated with one particular investment and is not related to the market. More technically, unsystematic risk represents the component of a stock's return which is not correlated with general market movements. As an investor diversifies his/her investment portfolios (by adding more unrelated investments into the portfolios), the amount of risk approaches that of the market. Systematic and unsystematic risk and their relation to returns on investment underlie the cliché of investment portfolio diversification.

Developed in the mid 1960s with the objective of expressing the relationship between an asset's risk and return, the underlying principle of the CAPM is that firm- or industry-specific events or characteristics have very little or no impact on an asset's required return. The classical Sharpe-Lintner CAPM identifies three factors that simultaneously influence an asset's expected return, to wit: the risk-free rate ($R_f$) (as proxied by Treasury bill), beta ($\beta$), and the expected market return ($R_m$). (Mathematically expressed as $E(R_i) = R_f + \beta_i[E(R_m) - R_f]$). The beta ($\beta$) is a measure of the volatility, or systematic risk, of a security or a portfolio in relation to the market as a whole. With respect to stocks or Stock Exchanges, the term 'the market' refers to an entire index of stocks such as the All-Share Index (ASI)[1] of the Nigerian Stock Exchange (NSE, or "The Exchange"), FTSE All-Share Index, NYSE Composite Index, S&P 500 or the Dow Jones Industrial Average.

This CAPM theory has both dominated finance literature and significantly influenced the world of finance and business since it was enunciated. It gives a precise definition of risk and builds on the work of Markowitz (1952) and his cohorts on the reliance on standard deviation as a measure of risk. A principal tenet of the CAPM is that systematic risk, as measured by beta, is the only factor affecting the level of return required on a financial asset for a well-diversified investment. The systematic risk controls the extent to which the return on a financial asset moves with the return of the market as a whole. The total risk of an investment consists of two components: diversifiable (alpha) and non-diversifiable (beta) risks, also known as non-market and market risks, or unsystematic and systematic risks respectively. Unsystematic risk represents the portion of an investment's total risk that can be eliminated by holding a well-diversified portfolio. This risk results from controllable but uncontrolled events that are unique to an industry and/or a company such as management changes, labour changes and industrial action, lawsuits and regulatory actions, competition and development of new products.

Non-diversifiable or systematic risk is external to an industry and/or a company and is attributable to a broad range of forces including economic (interest rates, inflation, exchange rates), political (regulation changes, tax changes, political stability), and natural causative (earthquake and other forms of natural disaster) factors. Such forces impact on all investments



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and are not idiosyncratic or unique to a given company or sector. Research has shown that any knowledgeable investor can eliminate diversifiable risk by holding a well-diversified portfolio which typically consists of a large number of securities (Fischer and Jordan, 1995). This implies that the risk that should be of concern to an investor is non-diversifiable risk as it is not only unavoidable but includes portions unique to each security in relation to the market, measured with the financial metric known as beta ($\beta$).

Beta coefficients measure the sensitivity of a financial assets' (typically a share or stock) return to movements in the market's return. It shows how the price of a security responds to market forces. It may further be viewed as a measure of the sensitivity of a stock to the market index. The more responsive the price of a security is to changes in the market, the higher will its beta be. The overall market beta is equal to 1 and this serves as a benchmark beta against which the betas of other financial assets are viewed. As beta may be positive or negative, investors find it beneficial in assessing systematic risk and understanding the impact of market movements on the expected return of a stock. If, for example, the market is expected to yield a 10% rate of return over the next year, a stock having a beta of 1.50 would be expected to witness an increase in return of approximately 15% (1.50 x10% =15%) over the same period. This particular stock is then deemed to be more volatile than the market because fluctuations in market returns will lead to a more than correspondent increase or decrease in the stock's return, and therein lies the risk. So, if the expectation is that the market will experience a negative return of 10% over the next year, then the stock with a beta of 1.50 would, *ceteris paribus*, experience a 15% decrease in its return (1.50 x -10% = -15%). Stocks with betas of less than 1 are expected to be less responsive to fluctuations in market returns and hence considered less risky.

Generally, the CAPM and its beta component are presumed to be good predictors of asset returns in finance literature. However, while several studies have been undertaken to capture the beta values of assets and portfolios in advanced economies with developed stock markets, such comparative evaluations are few and far between in African stock markets in general and the Sub-Saharan African (SSA) stock markets in particular with Nigeria a leading economy and market. As African stock markets develop and integrate in response to the imperatives of globalization, it has become essential to study a broad range of related topical development issues. One of such topical areas of interest in corporate finance and financial management practice is the risk-return relationship of not just financial assets but all investment decisions. The decision framework explicitly or implicitly entails understanding the beta components of such assets, especially if the involved firms' stocks are listed on the stock exchange. Studies of risk-return relationships of financial assets across the various industrial sectors may provide useful insights into investment decision making, enrich academic research and support policy formulation by regulatory authorities and professional bodies.

In emerging markets, the measurement of beta coefficients, β, can be a complex, costly and laborious task due largely to: (1) the dearth of long-term historical data as are commonly available in developed stock markets; (2) the high cost of collating historical data from numerous sources as wells as the length of time and amount of effort required; and (3) the relatively low reliability of historical information in making predictive analyses in developing economies. Added to the above is the fact that local firms do not always have comparable data with their counterparts in developed markets, thus making international comparison of computed beta coefficients nebulous and, where done, unreliable. To be sure, the reliability and fitness of calculated betas must cohere with valuation and investment in the market, irrespective of level of capital market development. Beta serves at least four useful purposes



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via the CAPM, to wit: (1) the determination of expected rate of return for a risky asset, (2) the determination of cost of equity capital, (3) the determination of portfolio risk, and (4) stock classification into aggressive, conservative and defensive stocks.

Against this conceptual background, this study sets out to determine the beta coefficients of the equity stocks on the Nigerian Stock Exchange (NSE), with sectoral focus on the chemicals and paints industry. The empirical questions of interest are: (1) What are the beta values for the listed chemical and paints industry stocks in Nigeria? (2) Are the calculated beta values reflective of the trends in the chemicals and paints industry vis-à-vis the market? (3) What are the implications of the calculated beta coefficients for investment decisions in this industry? This study assumes a priori that the chemicals and paints industry stocks are volatile with beta values greater or less than one. As already mentioned, this study focuses on stocks of the chemicals and paints sector of the NSE, which is an active sector. The analysis covers a thirteen-year period, from 2000-2012, inclusive. The choice of this study period in this fourth Nigerian Republic is apt for several reasons. First, this period is the longest in Nigeria's experimentation with democratic governance. Second, and in consequence, it is the longest period of political and economic stability in the country. Third, the period has witnessed the rise and fall of many industries and financial institutions as well as social and economic upheavals and dislocations as a result of Niger Delta militancy and Boko Haram in the North East. Fourth, Nigeria has witnessed more challenges in governance and politics in this fourth Republic than at any other time in its checkered history which not only has threatened its sovereignty, but would in the past have easily swerved toward the edge of the precipice. For these reasons and more, investment and behavioural finance[2] investigations covering this period may provide a useful context and relevance to the phenomenon of interest.

This study is significant in that it contributes to the debate on the application of CAPM on specific sectors of the NSE. The chemicals and paints industrial sector plays a nontrivial role in Nigeria's socioeconomic development drive. Thus, the empirical attempt to determine the value of beta coefficients of stocks in such an important sector of the Nigerian economy is a desirable venture, more so as CAPM research in SSA is sparse. Along with similar studies by Nwude (2013a, b) on the phenomenon of interest, the results may open the corridor for more research in the area, assist investors in making informed decisions, and support better corporate financial policies. Given the paucity of research in this topical area of finance in SSA in particular, this study, together with its prior related research (Nwude, 2013a, b), may be prone to first-mover shortcomings, such as inadequate data or analytical robustness. This presumed limitation notwithstanding, the study (along with its earlier counterparts) may be a useful contribution to the CAPM literature. Additionally, the study may provide investors, financial institutions, companies and regulatory authorities with evidence to support policy formulation in relation to investments and organization of listed equity stocks. Above all, studies of this kind resonate with Damodaran's (2005) contention that valuation is central to corporate finance and financial management practice. By investigating the potential deviation of market prices from true values of financial assets, market valuation helps analysts and portfolio investors to identify undervalued stocks (that is, those trading at below their true values), and then profit from them when they attain their equilibrium price levels.

The remainder of this paper is structured as follows. A summary of Sharpe's Portfolio theory and capital markets is sketched in the next section as the antecedent literature to CAPM. Section 3 presents the research methodology. Section 4 discusses the data analyses and results, while section 5 presents the concluding remarks.



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**Conspectus of William F. Sharpe Portfolio Theory and Capital Market**[3]

The Modern Portfolio Theory (MPT) is the fundamental brainwork of Professor William F. Sharpe, a Winner of the 1990 Nobel Prize in Economics. The genesis of his classic work on CAPM is traceable to his doctoral dissertation topic, *Portfolio Analysis Based on a Simplified Model of the Relationships Among Securities*, in 1961. Since then, CAPM has become not just an authoritative and often-cited theoretical framework but also a linchpin of modern investment theory. His dissertation dwelt on the positive theory of securities market behavior, in particular with the securities market line relationship under the restricted conditions of a one-factor model. The conclusions drawn from his dissertation constituted a basis both in terms of title and contents of the Capital Asset Pricing Model (CAPM).

Professor Sharpe is most celebrated for his development of the Capital Asset Pricing Model. In an interview with Jason Zweig of *Money Magazine* published in *Econ Journal Watch*[4], Sharpe was asked to summarize his work. He responded: *I wanted to answer why people act in certain ways when they invest and how risk and return are related. The bottom line: Yes, Virginia, some investments do have higher expected returns than others. Which ones? Well, by and large they're the ones that will do the worst in bad times*. (Sharpe, 2007).

The presupposition of Markowitz's theory of portfolio choice is that the prices of securities are given. Against this milieu, Markowitz defined a procedure to be followed by investors in optimizing their investment behaviour. The next necessary analytical step therefore was to explain how prices of various assets are determined. On the surface, the answer might appear to lie in the realms of market forces of demand and supply of securities. How does one then identify the determinants of this demand and supply? The search for an answer or resolution led William Sharpe to the economic equilibrium path of determining the price mechanism operating in the capital market. It is generally conceded that the current market price of any security must always be at a level where the demand for the particular security must equal the supply (that is, the number of the security offered). In Sharpe's view, from among the array of factors determining the capital market demand and supply of securities, the equilibrium relationship between the risk and return is a decisive factor. This determinative conclusion is based on a model known as The Capital Asset Pricing Model – CAPM.

As with other models, the CAPM is predicated on six simplifying assumptions that : (1) investors appraise their portfolios according to expected return and standard deviation over a certain period of time; (2) investors are rational and risk-averse; (3) there is a risk-free rate, at which an investor may lend or borrow money, which is identical for all investors; (4) taxes and transaction costs are negligible; (5) there is no information asymmetry, that is, information is costlessly, instantaneously and unambiguously available to all investors; and (6) all investors have homogenous expectations about the uncertain future, implying that they have the same attitudes with respect to the expected returns, standard deviation and covariance of securities.

At least three important deductions about CAPM are evident from these assumptions. First, securities are assumed to be perfectly competitive under this model. These assumptions allowed Sharpe to examine the resultant effect on the prices of securities if investors acted in a similar fashion, by, for example, investing in a similar manner. From this he derived the essence of the resulting equilibrium relationship between the risk and return of any security. Second, the CAPM incorporates an important feature of Fisher's separation theorem[5] (or what may also be termed 'invariant hypothesis'), which postulates that an optimum combination of risky securities can be determined without prior knowledge about the investor's attitude towards risk


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and return. The separation theorem is nested on the attribute of a linear efficient set, by which is meant that all the portfolios located within the linear efficient set consist of a combination of one portfolio solely formed of risky assets, involving either a risk-free investment or risk-free lending. It follows therefore that the risky portion of any investment portfolio is independent of the investor's attitude towards return and risk.

The third important attribute of the CAPM, based on the separation theorem, is that it simplifies the individual portfolio theory with respect to securities investment. It states that the return on any asset or portfolio is related to the riskless (or risk-free) rate of return and the expected return on the market in a linear fashion. It shows the relationship between expected return of a security and its unavoidable systematic risk thus: $R = R_f + \beta(R_m - R_f)$, where $R$ represents the expected rate of return on a security or a portfolio, $R_f$ the risk-free rate of return, $R_m$ the expected market rate of return and $\beta$ the systemic risk of the security (the beta) relative to the market. The model submits that only risk which cannot be diversified away (systemic risk) is worthy of being rewarded with a risk premium for financial valuation purposes. The remaining risk (unsystematic or diversifiable risk) may be reduced to zero by portfolio diversification and does not warrant a risk premium. The line that reflects the combination of systemic risk and return available on alternative investments at a given time is referred to as the security market line (SML). Any security that lies on the SML is presumed to be correctly priced.

If there is a temporary disequilibrium in the market and the returns on some assets become higher than that given by the SML, then the security is deemed to be underpriced. Under this market condition, if the market mechanism is efficient, investors will demand more of such securities as 'superior' investments, and the price will continuously rise until that higher level of return reaches the SML value. If, on the other hand, the level of return is below that given by the SML because of market disequilibrium, then the security is deemed to be overpriced. With efficient market mechanism, investors will be predisposed to offload such overpriced securities as 'inferior' investments, and the prices will continuously adjust to the level of return dictated by the SML value. Thus, investors would select those investments which accord with their risk preferences. While some investors consider only low risk investments with low returns, others welcome high risk investments with high returns. In general, investment decisions are guided by the following CAPM-based criteria: (i) if actual return minus CAPM required return is equal to positive alpha, the security is deemed to be underpriced; (ii) if actual return minus CAPM required return is equal to zero alpha, the security is said to be correctly priced; and (iii) if actual return minus CAPM required return is equal to negative alpha, the security is regarded as overpriced. With these considerations, rational investors would, *ceteris paribus*, consider a trichotomy of investment options: (a) sell, rather than hold, overpriced securities; (b) seek to buy underpriced securities; and (c) hold onto correctly priced securities. Contextually speaking, the CAPM is an instrumental decision framework for valuation of securities, consistent with finance literature consensus that valuation is at the core of what finance does, whether it is about market efficiency, corporate governance or investment decision rules in capital budgeting (Brealey, Myers and Marcus, 2001, 2011; Damodaran, 2005; Fama and French, 2006).

## General Comments on CAPM

Consistent with life in general, the path to all fields of human endeavor - be it commerce, science or the arts - is strewn with risk. Hence, no matter how much investors diversify their investments, it is impossible to dispose or get rid of all the risk factors. At best, investors seek for a rate of return that compensates for taking on risk. As such, the higher the risk, the higher the expected return, vice versa. As explained above, the model delineates two types of risk that are intrinsic in any type of investment: systematic risk and unsystematic risk. The CAPM uses these risk components to (a) calculate investment risk and (b) the return on investment which an investor can expect. While modern portfolio theory posits that firm-specific risk can be eliminated through diversification, however, the ubiquity of systematic risk means that it cannot really be completely eliminated, even in a portfolio of all the shares in the stock market. Thus, systematic risk remains an enigma for investors in determining or calculating a deserved return. William Sharpe developed CAPM as a way to measure this non-diversifiable risk component – systematic risk.

From Markowitz's (1952, 1959) intellectual praxis on diversification and modern portfolio theory to the pioneering works of Treynor (1961, 1962), Sharpe (1961, 1963, 1964, 1970, 1978), Lintner (1965) and Mossin (1966) on CAPM, finance literature has considerably expanded the academic and professional space for understanding the significance and relevance of risk-return relationship, especially in advanced economies with highly developed capital markets. Thus, the antecedent seminal work of Markowitz laid the foundation for the relationship between risk and return which has become a fundamental notion in finance whose principles have received universal appeal. Essentially, modern finance theory gravitates around maximizing an investor's return at a given level of risk. The idea is that the greater the amount of risk an investor is willing to take, the greater the potential return. The CAPM's postulation is based not just on the risk and return of a particular asset alone but on the relationship, that is, how a particular asset's risk-return profile affects or shapes the entire portfolio's risk-return relationship.

Conceptually, an investment's total return is the sum of two components: income and price change (Fischer & Jordan, 1995; Fernandez, Aguirreamalloa & Corres, 2010; Arnold, 2008; Berk & DeMarzo, 2009; Brealey, Myers & Marcus, 2001; Copeland, Weston & Shastri, 2005; Damodaran, 2001, 2002, 2006; Howells & Bain, 2008; Pandian, 2005; Ross, Westerfield & Jaffe, 1996; Weston, Besley & Brigham, 1996). Therefore, the return across time or from different securities can be measured and compared using the total return concept. The total return for a given holding period relates all the cash flows received by an investor during any designated time period to the amount of money invested in the asset. That is:

$$\textit{Total Return } (R_i) = (D_t + P_t - P_{t-1})/P_{t-1}$$

where: $D_t$ represents cash payments received, $P_t$ the price change over the period and $P_{t-1}$ the purchase price of the asset.

Fernández and Bermejo (2009) computed the correlations of the annual stock returns of Dow Jones listed companies over a 10-year period (1989-2008) against the market return of S&P 500. They found that, on average, the composite stock market with a beta = 1 did better than the calculated betas. They also observed that the adjusted betas (that is, 0.67 (calculated beta) + 0.33) have higher correlation than calculated betas and that the adjusted betas have lower correlation than beta = 1. In a related earlier study, Fernández (2009) conducted a survey of betas used by Professors. He found that a little over 97% of the academics used regressions, web sources, databases, textbooks or papers, while only 0.9% of them justified the beta they used exclusively from personal judgment (namely, qualitative betas, common sense betas, intuitive betas, logical magnitude betas and own judgment betas by different professors).



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In a study of 173 firms quoted on the Nigerian Stock Exchange (NSE) over a 96-month period (January 1992 - December 1999), Akintola-Bello (2004) estimated their betas based on security returns. For the market rate of return, he used growth rates in the NSE's All-Share Index (ASI) as proxy. He argued that due to statistical factors, it is generally accepted that the estimated betas using the regression analysis are not unbiased estimates of the underlying beta of a firm's securities. The underlying beta of a security is likely to be closer to 1 than the sample estimate. To correct for this bias, Merrill Lynch developed an adjustment technique. After using the ordinary least squares to gain a preliminary estimate of beta, using 60 monthly returns, the beta is adjusted as follows: Adjusted Beta = 2/3(Computed Sample Beta) + 1/3(1) = 0.67(Raw beta) + 0.33(1). The formula pushes high betas down toward 1.0 and low betas up toward 1.0. The raw betas computed are adjusted to remove individual securities bias.

In three related studies, Nwude (2013a, b, c) examined the predictive power of CAPM in determining the required rates of return of 18 listed banking stocks on the NSE over a 144-month period (that is, a 12-year period, 2000-2011). He tried to establish the expected and required rates of return of Nigerian banking stocks and leasing and real estate stocks from 2000-2011 and compare these with the actual rates of return in the corresponding periods in order to identify the valuation status of the stocks. The findings of the study showed that the CAPM did not correctly estimate the values of the stocks in 9 of the 12 years, 2000-2006 and 2008-2010. It was only one banking stock that was correctly valued in 2007 and 2011. The 2013b and c were a voyage to explore the appropriate beta coefficients for the equity stocks of quoted Nigerian banks and leasing and real estate stocks. He therefore concluded that over the study period the CAPM was not a good predictor of the valuation and pricing of equity stocks in the NSE. The author calculated correlations of the annual banks' stock returns with the entire market returns (the historical betas of the banks) over a 12-year period (2000-2011). From the findings, the study concluded that the bank stocks, in general, did not generate returns symmetrically according to their systematic risk levels.

Therefore, the conventional approach for estimating betas used by most investment firms, analysts and financial service providers is to use historical market data for firms that have been quoted for a long period (Nwude, 2013b, c). One can estimate returns that an investor would have made on their investments in intervals (such as weekly or monthly) over that period. These returns can then be related to a proxy for the market portfolio to get a beta in the CAPM. The beta of the overall stock market is + 1.0 and every other stock beta is viewed in relation to this value. A stock with beta =1 will, on the average, move by just 1% for every 1% movement by the market. A stock with a beta of 1.5 tends to be 50% more volatile than the average stock market index, while the stock with a beta of 0.5 is half as volatile. If a stock with a beta of 1 moves 10% another stock with a beta of 2 can be expected to move twice as much (i.e. 20%).

In a bear (declining) market, a stock with a beta of less than one is preferable. This is because the rate at which that stock experiences a decline is less than the market. Conversely, in a bull (rising) market, the stock is expected to underperform relative to the overall market. When the overall market is rising, a stock with a high beta is expected to outperform the market. Because the direction of the market is a major force affecting an investor's portfolio, an investor's goal of profit maximization in the stock selection process may be guided by the need to identify stocks that will prospectively (a) rise faster than the average stock during a bull market, and (b) decline less than the average stock during a bear market. Huy (2013) captures the views of Sharpe (1964) and Black (1972), that the expected stock return is linearly proportional to its market beta and goes on to affirm that beta, as a market risk measure, has certain influence on expected stock returns. He corroborated the earlier assertion by Fama and French (2004) in their three factor model that 'value' and 'size' are significant components which can affect stock returns. In effect, a stock's return not only depends on market beta, but also on market capitalization beta. The market beta is used in the three factor model developed by Fama and French (2006), which is the successor or expansion to the Sharpe's (1964) CAPM.

**Empirical Contradictions of CAPM**

Despite the attraction and intuitive appeal of the CAPM, its empirical record has been described as poor and full of contradictions; indeed, "poor enough to invalidate its applicability" (Fama and French, 2004). The empirical contradictions about the CAPM stem from a trichotomy of sources. First, it is claimed that the model's empirical troubles are a reflection of its theoretical flaws, due mainly to its simplifying assumptions. Fama and French (2004) further aver that the CAPM's empirical travails might also have been triggered by difficulties in implementing valid tests of the model. Second, there is an inherent problem in the CAPM's prescription of estimating a stock's market beta and joining it with the risk-free interest rate and the average market risk premium to generate an estimate of the cost of equity. As Fama and French (2004) emphasize, the typical market portfolio in the CAPM's empirical investigations includes just common stocks, whereas historical empirical work maintains that the relation between beta and average return is flatter than predicted by the Sharpe-Lintner CAPM. While research, as cited in the next paragraph, has uncovered other explanatory variables, such as size and various price ratios, to average returns provided by beta, finance textbooks often recommend the use of the Sharpe-Lintner CAPM risk-return relationship to estimate the cost of equity capital.

Third, the evidence from a number of empirical studies putatively offers empirical contradictions to the CAPM which parenthetically conclude that much of the variations in the expected return is unrelated to market beta. For example, in his test of the efficient market hypothesis based on the performance of common stocks in relation to their E/P ratios, Basu (1977) found that when common stocks are sorted on the basis of E/P ratios, future returns on high E/P stocks are higher than predicted by the CAPM. Banz (1981) studied the relationship between return and market value of common stocks. Employing size effect by classifying stocks on the basis of market capitalization (price times shares outstanding), he found that average returns on small stocks were higher than predicted by the CAPM. Bhandari (1988) documents that high debt-equity ratios (book value of debt/market value of equity – which is a measure of leverage) are associated with higher returns relative to their market betas. Other studies such as Statman (1980) and Rosenberg, Reid and Lanstein (1985) have also documented evidence that shows that stocks with high book-to-market equity ratios (book value of common stock/its market value) have high average returns that are not captured by their betas. More recently, Noda, Martelanc and Kayo (2014) found that stocks with high (low) E/P ratios, signifying high (low) cost of equity, had abnormally high (low) realized returns not captured by the CAPM.

In the end, the conclusive view is that whether the CAPM's problems reflect weaknesses in the theory or in its empirical implementation, its failure in empirical studies implies that most applications of the model are invalid (Fama and French, 2004). Despite the empirical contradictions, the CAPM, like Markowitz's (1952, 1959) portfolio model on which it is built, is nevertheless a theoretical tour de force based on its seductive simplicity. Its universality among finance academics and professionals makes it central to the teaching and learning of portfolio theory and asset pricing. In view of the criticisms, attempts to design more accurate asset pricing models by adding risk factors other than market risk from the CAPM include the



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works of Fama and French (1992, 1993, 1995,1996, 2002, 2004, 2006, 2012), and Carhart (1997).

**Estimation of Beta Coefficient (β)**

The conventional approach for estimating betas, as used by Value Line Investment Services, Merrill Lynch, and the London Business School Risk Management Service, is to relate historical returns on an investment to a proxy for the market portfolio returns, using ordinary least square (OLS) techniques. Fischer and Jordan (1995), also computed the beta coefficient for equity using OLS techniques (See also, Akintola-Bello, 2004). Grinblatt and Titman (1998) aver that in practice, with historical return data, the beta value is the ratio of covariance of the financial asset returns and the market returns to variance of the market return (beta = $Cov[R_i, R_m]/\sigma^2 m$). Grinblatt and Titman (ibid) adopt the return of the S&P 500 as proxy for market return and posit that there exist estimation errors in computing beta value and support the idea of correcting the errors by adjusting the estimated beta value using the Bloomberg adjustment formula, to wit: adjusted beta = 0.66(unadjusted beta) + 0.34. Grinblatt and Titman (1998) further suggest that analysts should avoid using daily returns and instead estimate betas with weekly or monthly returns where the effect of delayed or lagging reaction to market movements tends to be less severe.

Black (1972) shows how the CAPM changes when there is no risk-free asset or when investors face restrictions on, or extra cost of, borrowing. In estimating the relationship between beta and return on US shares over a 66-year period (1926-1991), Black (1993) established a weak relationship after 1965 (that is, from the fortieth year). On the assessment of risk, Blume (1971) found out that betas change over time. In his study on betas and their regression tendencies, Blume (1975) established that betas tend towards 1 over time. On short term stationarity of beta coefficients, Levy (1971) confirms that betas change over time.

## RESEARCH METHODOLOGY

The present study used data on quoted firms on the NSE obtained from the Daily Official List (DOL) which provides daily information on quoted stock prices. The DOL was used to compute changes in stock prices to determine capital gains or losses over the study period. Also, the DOL was used to determine the return on the market through the NSE's composite market index, the All-Share Index (ASI). The proxy for the market portfolio is therefore the NSE All-Share Index (ASI), which encompasses the total market value of all quoted equity stocks. The NSE ASI was established on January 2, 1984 which is also the base date, with 100 as a base value to which all subsequent values of the index can be related. It is a real time index because it is recalculated at the end of every trading day and captures the population of all listed shares. Capital gains and losses were computed for the financial assets as the difference between the monthly average market price of the stock at the beginning of each month and the monthly average market price at the end of the month. The average return for each year, both for the market and the stocks were obtained from the geometric mean of the 12-monthly returns for each year. The geometric mean has been described as the most appropriate measure of means when an average rate of change over a number of time periods is being calculated (Watsham and Parramore, 2007:54). It is a single measure of periodic growth rate which if repeated n times will transform the opening value into the terminal value. To measure the annual growth rate over n years, the appropriate model for the geometric mean is as follows:

$$GM = (1+g_1)(1+g_2)(1+g_3)\ldots\ldots\ldots(1+g_n)1/n - 1$$

where $g$ is the periodic growth rates expressed in decimals. The growth rate in earnings is computed using the geometric mean of the respective year's earnings growth rates.

For the purpose of this study, monthly returns for 156 months, covering January 2000 to December 2012 (inclusive), were used to estimate beta for each selected financial asset on the NSE. The beta estimation for the stocks was done using the linear regression model. The total rate of return on each share is obtained by computing the relative values of prices between a holding period (monthly) plus dividend, as exemplified in Akintola-Bello (2005:70), and Pandian (2001:149-150). The return on a security is computed as:

$$(D_t + P_t - P_{t-1})/P_{t-1}$$

where $D_t$ = dividend paid in period $t$, $P_t$ = closing price in period $t$, $P_{t-1}$ = closing price in immediate preceding period $t-1$.

However, in this study, only monthly capital gains (or losses) were used as a proxy for rates of return to compute the beta in order to compare like with like. That is, since market return does not include dividend, then return from equity should be determined without the dividend element in order to place the two items on the same basis for reasonable comparison. The 12 monthly returns for each share were chain-linked to obtain the annual return for stock using the geometric mean. The population of the study comprised all listed companies on the NSE. This population is also same as the total firms on the ASI. The study sample comprises all the quoted firms on the chemicals and paints sector of the NSE. The relatively small number of firms in the chemicals and paints sector allows the adoption of the entire sector as the study sample. There are seven (7) firms in this sector namely: African Paints, Berger Paints, CAP, DN Meyer, IPWA, NGC, and Premier Paints.

## 4. Data presentation and analysis

Table 1 presents the total risk for the chemicals and paints stocks over the 13-year period (2000-2012), computed from their monthly rates of return.

**Table 1: Total risks of chemicals and paints stocks**

| Year | African Paints | Berger Paints | CAP | DN Meyer | IPWA | NGC | Premier Paints | AVG | Market Risk |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 1.84 | 14.70 | 5.62 | 16.72 | 0.00 | 46.48 | 2.48 | 12.55 | 3.82 |
| 2001 | 14.28 | 8.44 | 20.36 | 31.42 | 0.00 | 18.38 | 2.80 | 13.67 | 5.36 |
| 2002 | 3.24 | 6.11 | 10.06 | 12.49 | 0.00 | 6.50 | 2.86 | 5.89 | 4.02 |
| 2003 | 1.67 | 9.69 | 14.22 | 11.06 | 0.80 | 23.12 | 0.00 | 8.65 | 5.64 |
| 2004 | 1.24 | 11.26 | 22.61 | 10.50 | 14.38 | 24.03 | 9.19 | 13.32 | 7.68 |
| 2005 | 2.68 | 9.74 | 8.31 | 11.69 | 4.98 | 10.08 | 0.00 | 6.78 | 4.48 |
| 2006 | 1.90 | 9.36 | 17.85 | 14.17 | 11.18 | 8.86 | 0.00 | 9.05 | 5.33 |
| 2007 | 33.73 | 12.39 | 10.75 | 18.48 | 43.39 | 18.62 | 6.78 | 20.59 | 4.87 |
| 2008 | 0.16 | 20.49 | 13.54 | 21.57 | 19.60 | 8.99 | 56.13 | 20.07 | 8.19 |
| 2009 | 0.00 | 9.53 | 5.45 | 5.32 | 6.19 | 2.52 | 3.71 | 4.67 | 11.22 |
| 2010 | 0.96 | 21.17 | 3.98 | 17.52 | 3.57 | 1.40 | 0.00 | 6.94 | 5.34 |
| 2011 | 2.25 | 8.36 | 18.01 | 8.31 | 1.28 | 4.14 | 3.74 | 6.58 | 4.60 |
| 2012 | 0.00 | 6.16 | 12.75 | 54.94 | 5.91 | 1.95 | 0.00 | 11.67 | 3.73 |
| AVG | 4.92 | 11.34 | 12.58 | 18.01 | 8.56 | 13.47 | 6.75 | 10.80 | 6.19 |


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Table 1 shows the returns for each of the companies alongside the average for each period. While the sectoral average total risk is 10.80, the market risk is 6.19, for the period under consideration. The 13-year average total risk of DN Meyer at 18.01 is the highest in the sector followed by Nigerian-German Chemicals (NGC) with 13.47, while Chemical & Allied Products (CAP) with 12.58 make up the top three for highest total risks. International Paints West Africa (IPWA), Premier Paints and African Paints have average total risks of 8.56, 6.75 and 4.92, respectively. The table further indicates that most of the stocks were highly volatile during the period, with five of the seven stocks showing average total risks in excess of 8.50. The beta for the overall market is 1 and the betas of traded stocks on the Exchange are viewed in relation to this value. An asset that is riskier than this market average will have a beta greater than 1. The asset that is safer than market average will have a beta less than 1. A riskless asset, such as a Treasury bill, has a beta of 0. Table 2 presents the computed betas for the listed chemicals and paints stocks on the NSE.

**Table 2: Beta of chemicals and paints stocks listed in NSE, 2000-2012**

| Year | African Paints | Berger Paints | CAP | DN Meyer | IPWA | NGC | Premier Paints | AVG |
|---|---|---|---|---|---|---|---|---|
| 2000 | -0.17 | -0.48 | -0.75 | -0.20 | 0.00 | -0.49 | -0.05 | -0.31 |
| 2001 | 1.69 | 1.11 | 1.33 | 2.30 | 0.00 | 1.08 | -0.15 | 1.05 |
| 2002 | -0.13 | -0.06 | 0.26 | 0.28 | 0.00 | -0.19 | 0.04 | 0.03 |
| 2003 | -0.08 | 0.94 | -0.04 | -0.04 | -0.03 | 0.33 | 0.00 | 0.15 |
| 2004 | -0.07 | 0.79 | 1.27 | 0.05 | 0.01 | 1.77 | 0.22 | 0.58 |
| 2005 | -0.15 | 1.55 | 1.11 | 1.17 | 0.36 | 0.76 | 0.00 | 0.69 |
| 2006 | -0.16 | 0.35 | 0.95 | 1.21 | -0.63 | 0.65 | 0.00 | 0.34 |
| 2007 | -1.82 | 1.83 | 0.46 | 2.42 | 2.86 | 2.27 | -0.87 | 1.02 |
| 2008 | -0.01 | 1.73 | 0.57 | 1.55 | 1.55 | 0.33 | 4.17 | 1.41 |
| 2009 | 0.00 | 0.31 | 0.27 | -0.08 | 0.10 | 0.01 | 0.02 | 0.09 |
| 2010 | 0.08 | 2.91 | -0.20 | 0.18 | -0.31 | -0.04 | 0.00 | 0.37 |
| 2011 | -0.02 | 0.37 | -0.02 | -0.29 | -0.01 | -0.23 | 0.02 | -0.03 |
| 2012 | 0.00 | -0.11 | 0.53 | 5.01 | 0.06 | 0.15 | 0.00 | 0.81 |
| AVG | -0.06 | 0.86 | 0.44 | 1.04 | 0.30 | 0.49 | 0.26 | 0.48 |

As shown in Table 2, beta for each stock changes from period to period. This is helpful in determining systematic risk and understanding the impact market movements can have on the returns expected from the stocks. For example, if the market is expected to provide a 10% rate of return in 2012, stocks such as DN Meyer and Berger Paints, with beta of 1.04 and 0.86 respectively, will correspondingly appreciate by 10.4% and 8.6%, respectively. On the other hand, return from CAP will appreciate by 4.4%, NGC by 4.9%, IPWA by 3%, while African paints a negative beta will experience a drop in their returns during the period. The converse situations will similarly prevail in all the stocks if the market falls by any percentage.


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**Table 3: Alpha risks of chemical and paints stocks listed in NSE, 2000-2012**

| Year | African Paints | Berger Paints | CAP | DN Meyer | IPWA | NGC | Premier Paints | AVG |
|---|---|---|---|---|---|---|---|---|
| 2000 | 2.01 | 15.18 | 6.37 | 16.92 | 0.00 | 46.97 | 2.53 | 12.85 |
| 2001 | 12.59 | 7.33 | 19.03 | 29.12 | 0.00 | 17.3 | 2.95 | 12.62 |
| 2002 | 3.37 | 6.17 | 9.80 | 12.21 | 0.00 | 6.69 | 2.82 | 5.87 |
| 2003 | 1.75 | 8.75 | 14.26 | 11.10 | -0.03 | 22.79 | 0.00 | 8.37 |
| 2004 | 1.31 | 10.47 | 21.34 | 10.45 | 0.01 | 22.26 | 8.97 | 10.69 |
| 2005 | 2.83 | 8.19 | 7.20 | 10.52 | 0.36 | 9.32 | 0.00 | 5.49 |
| 2006 | 2.06 | 9.01 | 16.90 | 12.96 | -0.63 | 8.21 | 0.00 | 6.93 |
| 2007 | 35.55 | 10.56 | 10.29 | 16.06 | 2.86 | 16.35 | 7.65 | 14.19 |
| 2008 | 0.17 | 18.76 | 12.97 | 20.02 | 1.55 | 8.66 | 51.96 | 16.30 |
| 2009 | 0.00 | 9.22 | 5.18 | 5.40 | 0.10 | 2.51 | 3.69 | 3.73 |
| 2010 | 0.88 | 18.26 | 4.18 | 17.34 | -0.31 | 1.44 | 0.00 | 5.97 |
| 2011 | 2.27 | 7.99 | 18.03 | 8.60 | -0.01 | 4.37 | 3.72 | 6.42 |
| 2012 | 0.00 | 6.27 | 12.22 | 49.93 | 0.06 | 1.8 | 0.00 | 10.04 |
| AVG | 4.98 | 10.47 | 12.14 | 16.97 | 0.30 | 12.97 | 6.48 | 9.19 |

Unsystematic risk (alpha) is that portion of the total risk that is unique or peculiar to a firm or an industry, above and beyond that affecting securities markets in general. Table 3 presents the values of alpha risk (unsystematic or idiosyncratic risk, unique or specific non-market risk) that can be reduced through diversification. On the average, DN Meyer has the highest unsystematic risk of 16.97 followed by NGC with 12.97. With a sectoral average unsystematic risk of 9.19, African Paints, IPWA and Premier Paints all have alpha risks below the average.

**Table 4: Percentage of beta risks of chemical and paints stocks listed in NSE, 2000-2012**

| Year | African Paints | Berger Paints | CAP | DN Meyer | IPWA | NGC | Premier Paints | AVG |
|---|---|---|---|---|---|---|---|---|
| 2000 | -9.24 | -3.27 | - 13.35 | -1.20 | 0.00 | -1.05 | -2.02 | -4.30 |
| 2001 | 11.83 | 13.15 | 6.53 | 7.32 | 0.00 | 5.88 | -5.36 | 5.62 |
| 2002 | -4.01 | -0.98 | 2.58 | 2.24 | 0.00 | -2.92 | 1.40 | -0.24 |
| 2003 | -4.79 | 9.70 | -0.28 | -0.36 | -3.75 | 1.43 | 0.00 | 0.28 |
| 2004 | -5.65 | 7.02 | 5.62 | 0.48 | 0.07 | 7.37 | 2.39 | 2.47 |
| 2005 | -5.6 | 15.91 | 13.36 | 10.01 | 7.23 | 7.54 | 0.00 | 6.92 |
| 2006 | -8.42 | 3.74 | 5.32 | 8.54 | -5.64 | 7.34 | 0.00 | 1.55 |
| 2007 | -5.4 | 14.77 | 4.28 | 13.10 | 6.59 | 12.19 | -12.83 | 4.67 |
| 2008 | -6.25 | 8.44 | 4.21 | 7.19 | 7.91 | 3.67 | 7.43 | 4.66 |
| 2009 | 0.00 | 3.25 | 4.95 | -1.50 | 1.62 | 0.40 | 0.54 | 1.32 |
| 2010 | 8.33 | 13.75 | -5.03 | 1.03 | -8.68 | -2.86 | 0.00 | 0.93 |
| 2011 | -0.89 | 4.43 | -0.11 | -3.49 | -0.78 | -5.56 | 0.53 | -0.84 |
| 2012 | 0.00 | -1.79 | 4.16 | 9.12 | 1.02 | 7.69 | 0.00 | 2.89 |
| AVG | -2.31 | 6.78 | 2.48 | 4.04 | 0.43 | 3.16 | -0.61 | 2.00 |

As Table 4 depicts, the overall average percentage of beta risk content in chemical and paints sector stocks during the period was 2%, much lower than that recorded by Berger Paints, DN Meyer, NGC, and CAP at 6.78, 4.04, 3.16 and 2.48, respectively. On the other hand, African Paints, and Premier Paints both recorded negative averages of -2.31 and -0.61% respectively, which are lower than the sectoral average. Over the 156 months, the sector witnessed a mix of



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aggressive (high volatility) stocks and defensive (low volatility) stocks in the market. In all, 4 stocks (Berger paints, DN Meyer, NGC, and CAP) had high beta content in total risk compared to the average indicating high volatility, while the others (African Paints, IPWA and Premier Paints) had negative or lower beta content, signifying lower volatility.

Table 5 presents the alpha risks for the sector stocks. Over the 156 months, the sector stocks recorded average percentage of alpha risk of 87.02%, with CAP, NGC, DN Meyer, and Berger Paints recording alpha risks in excess of the average, and African Paints, IPWA and Premier Paints with below the sector average risk. The relatively high unsystematic risk content of total risk in this sector is noteworthy. The implication is that with the exception of Premier Paints (62.15%) and IPWA (76.49%), the unsystematic risks of all other stocks can be eliminated via diversification to the extent of their alpha risks (over 86%).

**Table 5: Percentages of alpha risks of chemicals and paints stocks listed in NSE, 2000-2012**

| Year | African Paints | Berger Paints | CAP | DN Meyer | IPWA | NGC | Premier Paints | AVG |
|---|---|---|---|---|---|---|---|---|
| 2000 | 109.24 | 103.27 | 113.35 | 101.2 | 0.00 | 101.05 | 102.02 | 90.02 |
| 2001 | 88.17 | 86.85 | 93.47 | 92.68 | 0.00 | 94.12 | 105.36 | 80.09 |
| 2002 | 104.01 | 100.98 | 97.42 | 97.76 | 0.00 | 102.92 | 98.60 | 85.96 |
| 2003 | 104.79 | 90.30 | 100.28 | 100.36 | 103.75 | 98.57 | 0.00 | 85.44 |
| 2004 | 105.65 | 92.98 | 94.38 | 99.52 | 99.93 | 92.63 | 97.61 | 97.53 |
| 2005 | 105.6 | 84.09 | 86.64 | 89.99 | 92.77 | 92.46 | 0.00 | 78.79 |
| 2006 | 108.42 | 96.26 | 94.68 | 91.46 | 105.64 | 92.66 | 0.00 | 84.16 |
| 2007 | 105.4 | 85.23 | 95.72 | 86.9 | 93.41 | 87.81 | 112.83 | 95.33 |
| 2008 | 106.25 | 91.56 | 95.79 | 92.81 | 92.09 | 96.33 | 92.57 | 95.34 |
| 2009 | 0.00 | 96.75 | 95.05 | 101.5 | 98.38 | 99.60 | 99.46 | 84.39 |
| 2010 | 91.67 | 86.25 | 105.03 | 98.97 | 108.68 | 102.86 | 0.00 | 84.78 |
| 2011 | 100.89 | 95.57 | 100.11 | 103.49 | 100.78 | 105.56 | 99.47 | 100.84 |
| 2012 | 0.00 | 101.79 | 95.84 | 90.88 | 98.98 | 92.31 | 0.00 | 68.54 |
| AVG | 86.93 | 93.22 | 97.52 | 95.96 | 76.49 | 96.84 | 62.15 | 87.02 |

**Table 6: Capital gains yield (%) of chemicals and paints stocks listed in NSE, 2000-2012**

| Year | African Paints | Berger Paints | CAP | DN Meyer | IPWA | NGC | Premier Paints | AVG | Market Return |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | -6.24 | -37.75 | -74.30 | 53.75 | 0.00 | 19.30 | -16.68 | -8.85 | 37.91 |
| 2001 | 87.3 | -8.15 | 88.04 | 74.95 | 0.00 | -66.74 | 11.56 | 26.71 | 38.28 |
| 2002 | -21.43 | -19.86 | 12.38 | -81.17 | 0.00 | -72.04 | 14.25 | -23.98 | 7.07 |
| 2003 | -12.79 | 29.92 | 22.77 | 59.07 | 0.00 | 34.72 | 0.00 | 19.10 | 51.82 |
| 2004 | -6.05 | 42.97 | 50.65 | -43.89 | -88.22 | 59.79 | -45.01 | -4.25 | 17.13 |
| 2005 | -13.28 | -15.39 | 22.79 | -22.25 | -23.14 | 24.75 | 0.00 | -3.79 | 4.06 |
| 2006 | -9.97 | -13.42 | 110.02 | -17.85 | -17.06 | 15.51 | 0.00 | 9.60 | 31.43 |
| 2007 | 244.25 | 97.80 | 89.81 | 81.20 | 290.65 | 154.43 | 57.96 | 145.16 | 53.05 |
| 2008 | -0.57 | 8.10 | -26.91 | 45.70 | 13.49 | -19.50 | 291.89 | 44.60 | -58.54 |
| 2009 | 0.00 | -102.59 | -40.95 | -71.62 | -112.86 | -25.29 | -18.16 | -53.07 | -36.64 |
| 2010 | -4.98 | 103.5 | 14.45 | -35.65 | -41.48 | -15.17 | 0.00 | 2.95 | 17.18 |
| 2011 | -14.82 | -3.15 | -74.64 | -120.98 | -8.40 | -36.52 | -20.20 | -39.82 | -20.03 |
| 2012 | 0.00 | 0.12 | 60.25 | 75.73 | -58.41 | -8.64 | 0.00 | 9.86 | 30.57 |
| AVG | 18.57 | 6.32 | 19.57 | -0.23 | -3.49 | 4.97 | 21.20 | 9.56 | 13.33 |


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In terms of the rise in the price of the stocks, Table 6 shows that the average return of capital gains yield of the sector is 9.56% against the market return of 13.33. Premier Paints and CAP recorded the highest capital gains yield of 21.20% and 19.57%, respectively. Two stocks - IPWA (-3.49%) and DN Meyer (-0.23) recorded capital losses over the study period.

**Table 7: Volatility ranking of chemicals and paints stocks listed in NSE, 2000-2012**

| Year | African Paints | Berger Paints | CAP | DN Meyer | IPWA | NGC | Premier Paints | AVG |
|---|---|---|---|---|---|---|---|---|
| 2000 | -0.17 (5) | -0.48 (3) | -0.75 (1) | -0.20 (4) | 0.00 (7) | -0.49 (2) | -0.05 (6) | -0.31(9) |
| 2001 | 1.69 (2) | 1.11 (4) | 1.33 (3) | 2.30 (1) | 0.00 (7) | 1.08 (5) | -0.15 (6) | 1.05 (2) |
| 2002 | -0.13 (5) | -0.06 (6) | 0.26 (2) | 0.28 (1) | 0.00 (7) | -0.19 (4) | 0.04 (4) | 0.03 (12) |
| 2003 | -0.08 (3) | 0.94 (1) | -0.04 (4) | -0.04 (4) | -0.03(6) | 0.33 (2) | 0.00 (7) | 0.15 (10) |
| 2004 | -0.07 (7) | 0.79 (3) | 1.27 (2) | 0.05 (5) | 0.01 (6) | 1.77 (1) | 0.22 (4) | 0.58 (6) |
| 2005 | -0.15 (6) | 1.55 (1) | 1.11 (3) | 1.17 (2) | 0.36 (5) | 0.76 (4) | 0.00 (7) | 0.69 (4) |
| 2006 | -0.16 (6) | 0.35 (4) | 0.95 (2) | 1.21 (1) | -0.63(5) | 0.65 (3) | 0.00 (7) | 0.34 (8) |
| 2007 | -1.82 (6) | 1.83 (4) | 0.46 (5) | 2.42 (2) | 2.86 (1) | 2.27 (3) | -0.87 (7) | 1.02 (3) |
| 2008 | -0.01 (7) | 1.73 (2) | 0.57 (5) | 1.55 (3) | 1.55 (4) | 0.33 (6) | 4.17 (1) | 1.41 (1) |
| 2009 | 0.00 (7) | 0.31 (1) | 0.27 (2) | -0.08 (6) | 0.10 (3) | 0.01 (5) | 0.02 (4) | 0.09 (11) |
| 2010 | 0.08 (3) | 2.91 (1) | -0.20 (5) | 0.18 (2) | -0.31(4) | -0.04 (6) | 0.00 (7) | 0.37 (7) |
| 2011 | -0.02 (4) | 0.37 (1) | -0.02 (4) | -0.29 (2) | -0.01(7) | -0.23 (3) | 0.02 (4) | -0.03(12) |
| 2012 | 0.00 (6) | -0.11 (4) | 0.53 (2) | 5.01 (1) | 0.06 (5) | 0.15 (3) | 0.00 (6) | 0.81 (5) |
| AVG | -0.06 (7) | 0.86 (2) | 0.44 (4) | 1.04 (1) | 0.30 (5) | 0.49 (3) | 0.26 (6) | 0.48 |

The volatility, or fluctuation of each stock to changes in the overall stock market, was computed over the period and ranked (in parenthesis). The results are presented in Table 7. In general, the stocks had differential rankings over the period. For instance, in the year 2000, CAP ranked highest with a β of -0.75, while in 2001, 2002, 2006 and 2012, DN Meyer led the volatility rankings with β = 2.30, 1.21, 0.28 and 5.01, respectively. Berger Paints (β = 0.94) and NGC (β = 1.77) ranked highest in 2003 and 2004, respectively. Over the 156 months' period, DN Meyer (1), Berger Paints (2), NGC (3), and CAP (4) led the overall average volatility chart with β = 1.04, 0.86, 0.49, and 0.44, respectively.

**Table 8: Ranking of stocks according to annual return/beta (%)**

| Year | African Paints | Berger Paints | CAP | DN Meyer | IPWA | NGC | Premier Paints | AVG | Marke t RR |
|---|---|---|---|---|---|---|---|---|---|
| 2000 | 36.71 (4) | 78.65 (3) | 99.07 (2) | -268.75 (7) | 0.00 (5) | -39.39 (6) | 333.60 (1) | 34.7 | 9.92 |
| 2001 | 51.66 (2) | -7.34 (5) | 66.20 (1) | 32.59 (3) | 0.00 (4) | -61.80 (6) | -77.07 (7) | 0.60 | 7.14 |
| 2002 | 164.85(4) | 331.00(3) | 47.62 (5) | -289.89 (7) | 0.00 (6) | 379.16 (1) | 356.25 (2) | 141.28 | 1.76 |
| 2003 | 159.88 (1) | 31.83 (3) | -569.25(6) | -1476.75(7) | 0.00 (4) | 105.21 (2) | 0.00 (4) | -249.87 | 9.19 |
| 2004 | 86.43 (1) | 54.39 (2) | 39.88 (3) | -877.80 (6) | -8822.00(7) | 33.78 (4) | -204.59 (5) | -1384.27 | 2.23 |
| 2005 | 88.53 (1) | -9.93 (5) | 20.53 (3) | -19.02 (6) | -64.28 (7) | 32.57 (2) | 0.00 (4) | 6.92 | 0.91 |
| 2006 | 62.31 (2) | -38.84 (7) | 115.81 (1) | -14.75 (6) | 27.08 (3) | 23.86 (4) | 0.00 (5) | 25.14 | 5.90 |
| 2007 | -134.20(7) | 53.44 (4) | 195.24 (1) | 33.55 (5) | 101.63 (2) | 68.03 (3) | -66.62 (6) | 35.87 | 10.89 |
| 2008 | 57.00 (2) | 4.68 (5) | -47.21 (6) | 29.49 (3) | 8.70 (4) | -59.09 | 70.00 (1) | 9.08 | -7.15 |
| 2009 | 0.00 (2) | -330.94 (4) | -151.67 (3) | 895.25 (1) | -112.60 (6) | -2529.00(7) | -908.00 (5) | -593.38 | -3.27 |
| 2010 | -62.25(6) | 35.57 (3) | -72.25 (7) | -198.06 (8) | 133.81 (2) | 379.25 (1) | 0.00 (4) | 30.87 | 3.22 |
| 2011 | 741.00(3) | -8.51 (6) | 3732.00(1) | 417.17 (4) | 840.00 (2) | 158.78 (5) | -1010.00(7) | 695.78 | -4.35 |
| 2012 | 0.00 (3) | -1.09 (5) | 113.68 (1) | 15.12 (2) | -973.5 (7) | -57.6 (6) | 0.00 (3) | -129.06 | 8.20 |
| AVG | 96.30 (2) | 14.88 (3) | 276.13 (1) | -132.45 (6) | -759.78 (7) | -120.48 (5) | -115.88 (4) | -105.90 | 2.15 |

Table 8 presents the yearly ranking of the stocks according to the magnitude of their relative returns (annual return per unit of beta). Premier Paints had the highest comparative returns in 2000 and 2008 with 333.6% and 70% per unit of systematic risk, respectively. The table further



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shows that CAP had the highest returns in 2001, 2006, 2007, 2011 and 2012 with 66.20%, 115.81%, 195.24%, 3732%, and 113.68%, respectively. The range of the industry average was from -1384.27% to 695.7% over the period while the market average was from -7.15% to 10.89%. In effect, the sector underperformed the market (average of 2.15% as against the sector average of -105.90%).

**Table 9: Classification of the stocks according to the nature of volatility**

| Year | Very Low | Low | Moderately Low | Normal | Moderately High | High | Very High | Total |
|---|---|---|---|---|---|---|---|---|
| 2000 | 4 (57) | 2 (29) | 1 (14) | - | - | - | - | 7 |
| 2001 | 2 (29) | - | - | - | 4 (57) | - | 1 (14) | 7 |
| 2002 | 7 (100) | - | - | - | - | - | - | 7 |
| 2003 | 6 (86) | - | 1 (14) | - | - | - | - | 7 |
| 2004 | 4(58) | - | 1 (14) | - | 1 (14) | 1 (14) | - | 7 |
| 2005 | 3 (43) | - | 1 (14) | - | 2 (29) | 1 (14) | - | 7 |
| 2006 | 3 (43) | - | 3 (43) | - | 1 (14) | - | - | 7 |
| 2007 | - | 1 (14) | 1 (14) | - | - | 2 (29) | 3 (43) | 7 |
| 2008 | 2 (29) | - | 1 (14) | - | - | 3 (43) | 1 (14) | 7 |
| 2009 | 7 (100) | - | - | - | - | - | - | 7 |
| 2010 | 6 (86) | - | - | - | - | - | 1 (14) | 7 |
| 2011 | 7 (100) | | - | - | - | - | - | 7 |
| 2012 | 5 (72) | - | 1 (14) | - | - | - | 1 (14) | 7 |
| Stock Periods | 56(61.5) | 3 (3.3) | 10 (11.0) | - | 8 (8.8) | 7 (7.7) | 7 (7.7) | 91 |
| AVG | 4.3 (56) | 0.2 (4) | 0.8 (18) | - | 0.6 (8) | 0.5 (6) | 0.5 (8) | 7 |

*Key: 0 <β< 0.4 = Very Low; 0.4 <β< 0.5 = Low; 0.5 <β< 1.0 = Moderately Low; β = 1.0 = Normal (same as market); 1.0 <β< 1.5 = Moderately High; 1.5 <β< 2.0 = High; β > 2.0=Very High. Percentages in parenthesis*

Table 9 shows the number and percentage of stocks in various classifications for the thirteen-year period, which translates to 91 stock-periods. The volatility classification is on a scale of 'very low', 'low' to 'high' and 'very high' beta. As summarized in Table 9.1, most stocks had beta in the low region over the 91-stock period with 61.5% having very low beta, 3.3% low beta, and 11% moderately low beta. In effect, about 76% of stocks had beta less than 1 over the 91-stock periods. Interestingly, no stock directly mirrored the market beta of 1 across the 91 stock periods, indicating that all stocks were either more or less risky than the market. Only about 7% of stocks had very high beta over the period.


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**Table 9.1: Summary of volatility classification**

| Very Low | Low | Moderately Low | Normal (same as market) | Moderately High | High | Very High |
|---|---|---|---|---|---|---|
| 0 <β< 0.4 | 0.4 <β< 0.5 | 0.5 <β< 1.0 | β = 1.0 | 1.0 <β< 1.5 | 1.5 <β< 2.0 | β > 2.0 |
| 61.5% | 3.3% | 11.0% | - | 8.8% | 7.7% | 7.7% |

Table 10 is a classification of the 91-stock-periods into Aggressive, Conservative and Defensive stocks6. Recorded betas for 67 stock-periods were defensive, while 2 and 22 stock-periods recorded conservative and aggressive betas, respectively. The overall industry beta for the 13-year period was defensive, indicating a less than proportionate change in the industry's returns with respect to changes in the market returns during the period.

**Table 10: Classification into Aggressive, Conservative and Defensive Stocks**

| Year | African Paints | Berger Paints | CAP | DN Meyer | IPWA | NGC | Premier Paints | AVG |
|---|---|---|---|---|---|---|---|---|
| 2000 | D | D | D | D | D | D | D | D |
| 2001 | A | A | A | A | D | A | D | C |
| 2002 | D | D | D | D | D | D | D | D |
| 2003 | D | C | D | D | D | D | D | D |
| 2004 | D | D | A | D | D | A | D | D |
| 2005 | D | A | A | A | D | D | D | D |
| 2006 | D | D | C | A | D | D | D | D |
| 2007 | A | A | D | A | A | A | D | C |
| 2008 | D | A | D | A | A | D | A | A |
| 2009 | D | D | D | D | D | D | D | D |
| 2010 | D | A | D | D | D | D | D | D |
| 2011 | D | D | D | D | D | D | D | D |
| 2012 | D | D | D | A | D | D | D | D |
| AVG | D | D | D | C | D | D | D | D |

*Key: Aggressive (A) = above 1.06; Conservative (C) = 1.05 – 0.93; Defensive (D) = below 0.92. Stat: A = 22; C = 2; D = 67.*

## CONCLUDING REMARKS

A number of conclusions can be drawn from the foregoing analysis. First, stocks in the chemicals and paints industry exhibited risky features during the 13-year study period. Six of the seven stocks considered had total risks higher than the market risk. Second, the beta contents of the total risks of the sector stocks evince the presence of a mix of high and low volatility stocks during the period. Four of the seven stocks had high beta content of total risk compared to the sector average, indicating aggressive profile in stock returns, while the other three with low beta content, displayed defensive features in stock returns. Third, in terms of capital gains, the sector's average return was lower than that of the market for the period indicating comparative lower returns to investors relative to the market. In addition, DN Meyer,



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Berger Paints and NGC were the most volatile stocks over the 13-year period. Their average beta exceeded that of the sector, and in the case of DN Meyer, by a wide margin. Finally, it is observed that over the 91-stock periods considered, there were more stock periods (67) with defensive beta attributes as against aggressive (22) and conservative (2) betas. This is consistent with the third conclusion above of lower capital gains compared to the market, indicating a sectoral tendency towards the defensive attributes in terms of stock returns.

The implication from an investment point of view is that investors seeking to build defensive buffers to portfolio losses during periods of recession, or looking to diversify their portfolios and protect against downside risk may look towards the chemical and paints sector of the NSE. Including an appropriate mix of chemical and paints stocks in the investors' portfolios would, *ceteris paribus,* help investors to achieve a combination of investments that are not highly correlated with larger economic cycles as well as higher-risk equity securities that can potentially yield higher returns than the market. These are the attractive attributes of the stocks of chemicals and paints industrial sector for which the plausibility of arguments of CAPM were reexamined with more self-conscious attention to the details of the stocks' beta profiles.

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**End Notes**

[1]The All-Share Index (ASI) (the NSE 30 Index) tracks the general market movement of all listed equities on the NSE, including those listed on the Alternative Securities Market (ASeM), regardless of capitalization. The 2017 (latest) NSE-30 comprises 7 sectoral indices of the Exchange, namely: NSE Consumer Goods, NSE Banking, NSE Insurance, NSE Industrial, NSE Oil & Gas, NSE Pension and the NSE Lotus Islamic Indices.

[2]Behavioral finance is a field of finance that studies the influence of psychology and applies psychology-based theories to explain the behaviours of financial practitioners, especially investment interactions of human beings.

It uses such psychological biases and traits that humans possess to explain investment behaviour, such as stock market rallies, bubbles or abnormal rise and fall in stock prices. A typical human behaviour, imbued with psychological bias or emotion, is the herd instinct which propels people to follow popular trends consciously or unconsciously, born out of empathy gap, where this refers to the inability to make rational decisions under emotional strains such as excitement, anxiety or anger. Therefore, contextual studies about behavioural finance are of immense interest to investors and portfolio managers, business community, government and society at large. For more information on behavioural finance, see Sewell (2001).

[3]The materials in this section are in no sense a survey of the enormous literature on CAPM. Rather, they are drawn from the Compilation of Profiles of World Economists, in acknowledgement of the contributions of William F. Sharpe (along with Harry M. Markowitz and Merton Miller) for the Nobel prize for economics in 1990.

[4]See, Klein, Daza, and Mead (2013).

[5]The separation theorem, propounded by Irving Fisher, is the keystone of the shareholder wealth maximization objective of a firm. The theorem asserts that the goal of a firm is to maximize its present value, regardless of the preferences of its owners. The theorem leads to a trichotomy of key assertions. First, a firm's investment decisions are distinct from the investment preferences or attitudes of its owners. Second, a firm's investment decisions are separate from its financing decisions. Third, following from the second, a firm’s value is invariant to its mode of financing. In other words, a firm’s value is not determined by the way it is financed or the dividends paid to the firm's owners. Put differently, a firm’s investment is distinct from its mode of financing (or its mix of methods of financing the investment).

[6]***Aggressive stocks*** are higher-risk equity securities that can potentially yield higher returns, but also have equal potential for bigger losses. With beta in excess of 1.0, aggressive stocks can generate returns that vary by a large proportion than overall market returns. Such stocks are expected to grow at a faster rate than the overall stock market. Stocks of fledgling companies or those having problems and new industries that attract aggressive growth fund fall into this category. ***Conservative stocks*** are lower-risk equity securities issued by blue-chip or large-cap companies as well as fixed-income and money-market securities that do not expose investors to much risk but do not pay comparatively high returns either. Conservative investments provide shield against market downturns for which the expected returns are low but stable. ***Defensive stocks***, as their name suggests, are non-cyclical stocks of companies whose business performance and revenues are not highly correlated with or highly affected by the larger economic cycle. Such stocks or investments act as defensive buffers to portfolio losses during periods of recession. Because defensive stocks, such as utilities stocks, have low betas (of less than 1), they tend to perform better than the market during periods of recession, and below the market during expansionary periods.


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