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AN EMPIRICAL TESTING OF CAPITAL ASSET PRICING MODEL

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ABSTRACT

The study calculated the (historical) betas of listed stocks in the tyres sector of the National Stock Exchange over a 13-year period (2005-2017). 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 tyres 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 tyres 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 Risk, Market Risk, Total Risk, Volatility Level, Systematic Risk, Unsystematic Risk.

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 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 bonds. 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.

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, the risk-free rate (R_f) (as proxied by Treasury bill), beta (β), 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.

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 and are not 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 (β).

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. Stocks with betas of less than 1 are expected to be less responsive to fluctuations in market returns and hence considered less risky.

The empirical questions of interest are: (1) What are the beta values for the listed tyres stocks on NSE? (2) Are the calculated beta values reflective of the trends in the industry vis-à-vis the market? (3) What are the implications of the calculated beta coefficients for investment decisions in this industry?

SHARPE PORTFOLIO THEORY AND CAPITAL MARKET

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.

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:

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

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).

EMPIRICAL CONTRADICTIONS OF CAPM

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.

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

ESTIMATION OF BETA COEFFICIENT (B)

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. 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 = $Cov[R_i, R_m]/^2m$). 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 study used data that was available on the NSE. The proxy for the market portfolio is the NSE All Share Index (NIFTY), which encompasses the total market value of all quoted equity stocks. 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 April 2005 to March 2017 (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 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. The study sample comprises all the quoted firms of the tyres sector on the NSE. The relatively small number of firms in the tyres sector allows the adoption of the entire sector as the study sample. There are seven firms in this sector namely: Apollo Tyres, Balkrishna Ind, Ceat, Elgi Rubber, JK Tyre, MRF and TVS Srichakra.

DATA PRESENTATION AND ANALYSIS

Table 1 presents the total risk for the tyres stocks over the 13-year period (2005-2017), computed from their monthly rates of return.

Table 1: Total risk of tyres stocks

Year	Apollo Tyres	Balkris Ind	Ceat	Elgi Rubber	JK Tyre	MRF	TVS Srichak	AVG	Market Risk
2005	1.84	14.70	5.62	16.72	0.00	46.48	2.48	12.55	3.82
2006	14.28	8.44	20.36	31.42	0.00	18.38	2.80	13.67	5.36
2007	3.24	6.11	10.06	12.49	0.00	6.50	2.86	5.89	4.02
2008	1.67	9.69	14.22	11.06	0.80	23.12	0.00	8.65	5.64
2009	1.24	11.26	22.61	10.50	14.38	24.03	9.19	13.32	7.68
2010	2.68	9.74	8.31	11.69	4.98	10.08	0.00	6.78	4.48
2011	1.90	9.36	17.85	14.17	11.18	8.86	0.00	9.05	5.33
2012	33.73	12.39	10.75	18.48	43.39	18.62	6.78	20.59	4.87
2013	0.16	20.49	13.54	21.57	19.60	8.99	56.13	20.07	8.19
2014	0.00	9.53	5.45	5.32	6.19	2.52	3.71	4.67	11.22
2015	0.96	21.17	3.98	17.52	3.57	1.40	0.00	6.94	5.34
2016	2.25	8.36	18.01	8.31	1.28	4.14	3.74	6.58	4.60
2017	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

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 Elgi Rubber at 18.01 is the highest in the sector followed by MRF with 13.47, while Ceat with 12.58 make up the top three for highest total risks. JK Tyre, TVS Srichak and Apollo Tyres 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 tyres stocks on the NSE.

Table 2: Beta of tyres stocks

Year	Apollo Tyres	Balkrish Ind	Ceat	Elgi Rubber	JK Tyre	MRF	TVS Srichak	AVG
2005	-0.17	-0.48	-0.75	-0.20	0.00	-0.49	-0.05	-0.31
2006	1.69	1.11	1.33	2.30	0.00	1.08	-0.15	1.05
2007	-0.13	-0.06	0.26	0.28	0.00	-0.19	0.04	0.03
2008	-0.08	0.94	-0.04	-0.04	-0.03	0.33	0.00	0.15
2009	-0.07	0.79	1.27	0.05	0.01	1.77	0.22	0.58
2010	-0.15	1.55	1.11	1.17	0.36	0.76	0.00	0.69
2011	-0.16	0.35	0.95	1.21	-0.63	0.65	0.00	0.34
2012	-1.82	1.83	0.46	2.42	2.86	2.27	-0.87	1.02
2013	-0.01	1.73	0.57	1.55	1.55	0.33	4.17	1.41
2014	0.00	0.31	0.27	-0.08	0.10	0.01	0.02	0.09
2015	0.08	2.91	-0.20	0.18	-0.31	-0.04	0.00	0.37
2016	-0.02	0.37	-0.02	-0.29	-0.01	-0.23	0.02	-0.03
2017	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 2017, stocks such as Elgi Rubber and Balkrishna Ind 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 Ceat will appreciate by 4.4%, MRF by 4.9%, JK Tyre by 3%, while Apollo Tyres 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.

Table 3: Alpha risk of tyres stocks

Year	Apollo Tyres	Balkris Ind	Ceat	Elgi Rubber	JK Tyre	MRF	TVS Srichak	AVG
2005	2.01	15.18	6.37	16.92	0.00	46.97	2.53	12.85
2006	12.59	7.33	19.03	29.12	0.00	17.3	2.95	12.62
2007	3.37	6.17	9.80	12.21	0.00	6.69	2.82	5.87
2008	1.75	8.75	14.26	11.10	-0.03	22.79	0.00	8.37
2009	1.31	10.47	21.34	10.45	0.01	22.26	8.97	10.69
2010	2.83	8.19	7.20	10.52	0.36	9.32	0.00	5.49
2011	2.06	9.01	16.90	12.96	-0.63	8.21	0.00	6.93
2012	35.55	10.56	10.29	16.06	2.86	16.35	7.65	14.19
2013	0.17	18.76	12.97	20.02	1.55	8.66	51.96	16.30
2014	0.00	9.22	5.18	5.40	0.10	2.51	3.69	3.73
2015	0.88	18.26	4.18	17.34	-0.31	1.44	0.00	5.97
2016	2.27	7.99	18.03	8.60	-0.01	4.37	3.72	6.42
2017	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, Elgi Rubber has the highest unsystematic risk of 16.97 followed by MRF with 12.97. With a sectoral average unsystematic risk of 9.19, Apollo Tyres, JK Tyre and TVS Srichakra all have alpha risks below the average.

Table 4: Percentage of beta risk of tyres stocks

Year	Apollo Tyres	Balkris Ind	Ceat	Elgi Rubbe	JK Tyre	MRF	TVS Srichak	AVG
2005	-9.24	-3.27	-13.35	-1.20	0.00	-1.05	-2.02	-4.30
2006	11.83	13.15	6.53	7.32	0.00	5.88	-5.36	5.62
2007	-4.01	-0.98	2.58	2.24	0.00	-2.92	1.40	-0.24
2008	-4.79	9.70	-0.28	-0.36	-3.75	1.43	0.00	0.28
2009	-5.65	7.02	5.62	0.48	0.07	7.37	2.39	2.47
2010	-5.6	15.91	13.36	10.01	7.23	7.54	0.00	6.92

2011	-8.42	3.74	5.32	8.54	-5.64	7.34	0.00	1.55
2012	-5.4	14.77	4.28	13.10	6.59	12.19	-12.83	4.67
2013	-6.25	8.44	4.21	7.19	7.91	3.67	7.43	4.66
2014	0.00	3.25	4.95	-1.50	1.62	0.40	0.54	1.32
2015	8.33	13.75	-5.03	1.03	-8.68	-2.86	0.00	0.93
2016	-0.89	4.43	-0.11	-3.49	-0.78	-5.56	0.53	-0.84
2017	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 tyres sector stocks during the period was 2%, much lower than that recorded by Balkrishna Ind, Elgi Rubber, MRF, and Ceat at 6.78, 4.04, 3.16 and 2.48, respectively. On the other hand, Apollo Tyres, and TVS Srichakra 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 aggressive (high volatility) stocks and defensive (low volatility) stocks in the market. In all, 4 stocks (Balkrishna Inds, Elgi Rubber, MRF and Ceat) had high beta content in total risk compared to the average indicating high volatility, while the others (Apollo Tyres, JK Tyre and TVS Srichakra) 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 Ceat, MRF, Elgi Rubber, and Balkrishna Ind recording alpha risks in excess of the average, and Apollo Tyres, JK Tyre and TVS Srichakra 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 TVS Srichakra (62.15%) and JK Tyre (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: Percentage of alpha risk of tyres stocks

Year	Apollo Tyres	Balkris Ind	Ceat	Elgi Rubber	JK Tyre	MRF	TVS Srichak	AVG
2005	109.24	103.27	113.35	101.2	0.00	101.05	102.02	90.02
2006	88.17	86.85	93.47	92.68	0.00	94.12	105.36	80.09
2007	104.01	100.98	97.42	97.76	0.00	102.92	98.60	85.96
2008	104.79	90.30	100.28	100.36	103.75	98.57	0.00	85.44
2009	105.65	92.98	94.38	99.52	99.93	92.63	97.61	97.53
2010	105.6	84.09	86.64	89.99	92.77	92.46	0.00	78.79
2011	108.42	96.26	94.68	91.46	105.64	92.66	0.00	84.16
2012	105.4	85.23	95.72	86.9	93.41	87.81	112.83	95.33
2013	106.25	91.56	95.79	92.81	92.09	96.33	92.57	95.34
2014	0.00	96.75	95.05	101.5	98.38	99.60	99.46	84.39

2015	91.67	86.25	105.03	98.97	108.68	102.86	0.00	84.78
2016	100.89	95.57	100.11	103.49	100.78	105.56	99.47	100.84
2017	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 tyres stocks

Year	Apollo Tyres	Balkris Ind	Ceat	Elgi Rubber	JK Tyre	MRF	TVS Srichak	AVG	Market Return
2005	-6.24	-37.75	-74.30	53.75	0.00	19.30	-16.68	-8.85	37.91
2006	87.3	-8.15	88.04	74.95	0.00	-66.74	11.56	26.71	38.28
2007	-21.43	-19.86	12.38	-81.17	0.00	-72.04	14.25	-23.98	7.07
2008	-12.79	29.92	22.77	59.07	0.00	34.72	0.00	19.10	51.82
2009	-6.05	42.97	50.65	-43.89	-88.22	59.79	-45.01	-4.25	17.13
2010	-13.28	-15.39	22.79	-22.25	-23.14	24.75	0.00	-3.79	4.06
2011	-9.97	-13.42	110.02	-17.85	-17.06	15.51	0.00	9.60	31.43
2012	244.25	97.80	89.81	81.20	290.65	154.43	57.96	145.16	53.05
2013	-0.57	8.10	-26.91	45.70	13.49	-19.50	291.89	44.60	-58.54
2014	0.00	-102.59	-40.95	-71.62	-112.86	-25.29	-18.16	-53.07	-36.64
2015	-4.98	103.5	14.45	-35.65	-41.48	-15.17	0.00	2.95	17.18
2016	-14.82	-3.15	-74.64	-120.98	-8.40	-36.52	-20.20	-39.82	-20.03
2017	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

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. TVS Srichakra and Ceat recorded the highest capital gains yield of 21.20% and 19.57%, respectively. Two stocks – JK Tyre (-3.49%) and Elgi Rubber (-0.23) recorded capital losses over the study period.

Table 7: Volatility ranking of tyres stocks

Year	Apollo Tyres	Balkris Ind	Ceat	Elgi Rubber	JK Tyre	MRF	TVS Srichakra	AVG
2005	-0.17 (5)	-0.48 (3)	-0.75 (1)	-0.20 (4)	0.00 (7)	-0.49 (2)	-0.05 (6)	-0.31(9)
2006	1.69 (2)	1.11 (4)	1.33 (3)	2.30 (1)	0.00 (7)	1.08 (5)	-0.15 (6)	1.05 (2)
2007	-0.13 (5)	-0.06 (6)	0.26 (2)	0.28 (1)	0.00 (7)	-0.19 (4)	0.04 (4)	0.03 (12)
2008	-0.08 (3)	0.94 (1)	-0.04 (4)	-0.04 (4)	-0.03(6)	0.33 (2)	0.00 (7)	0.15 (10)
2009	-0.07 (7)	0.79 (3)	1.27 (2)	0.05 (5)	0.01 (6)	1.77 (1)	0.22 (4)	0.58 (6)
2010	-0.15 (6)	1.55 (1)	1.11 (3)	1.17 (2)	0.36 (5)	0.76 (4)	0.00 (7)	0.69 (4)
2011	-0.16 (6)	0.35 (4)	0.95 (2)	1.21 (1)	-0.63(5)	0.65 (3)	0.00 (7)	0.34 (8)
2012	-1.82 (6)	1.83 (4)	0.46 (5)	2.42 (2)	2.86 (1)	2.27 (3)	-0.87 (7)	1.02 (3)
2013	-0.01 (7)	1.73 (2)	0.57 (5)	1.55 (3)	1.55 (4)	0.33 (6)	4.17 (1)	1.41 (1)
2014	0.00 (7)	0.31 (1)	0.27 (2)	-0.08 (6)	0.10 (3)	0.01 (5)	0.02 (4)	0.09 (11)
2015	0.08 (3)	2.91 (1)	-0.20 (5)	0.18 (2)	-0.31(4)	-0.04 (6)	0.00 (7)	0.37 (7)
2016	-0.02 (4)	0.37 (1)	-0.02 (4)	-0.29 (2)	-0.01(7)	-0.23 (3)	0.02 (4)	-0.03(12)
2017	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 2005, Ceat ranked highest with a β of -0.75, while in 2006, 2007, 2011 and 2017, Elgi Rubber led the volatility rankings with β = 2.30, 1.21, 0.28 and 5.01, respectively. Balkrishna Ind (β = 0.94) and MRF (β = 1.77) ranked highest in 2003 and 2004, respectively. Over the 156 months' period, Elgi Rubber (1), Balkrishna Ind (2), MRF (3), and Ceat (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	Apollo Tyres	Balkris Ind	Ceat	Elgi Rubber	JK Tyre	MRF	TVS Srichak	AVG	Market RR
2005	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
2006	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
2007	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
2008	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
2009	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
2010	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
2011	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
2012	-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
2013	57.00 (2)	4.68 (5)	-47.21 (6)	29.49 (3)	8.70 (4)	-59.09	70.00 (1)	9.08	-7.15
2014	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
2015	-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
2016	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
2017	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). TVS Srichakra had the highest comparative returns in 2005 and 2013 with 333.6% and 70% per unit of systematic risk, respectively. The table further shows that Ceat had the highest returns in 2006, 2011, 2012, 2016 and 2017 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
2005	4 (57)	2 (29)	1 (14)	-	-	-	-	7
2006	2 (29)	-	-	-	4 (57)	-	1 (14)	7
2007	7 (100)	-	-	-	-	-	-	7
2008	6 (86)	-	1 (14)	-	-	-	-	7
2009	4(58)	-	1 (14)	-	1 (14)	1 (14)	-	7
2010	3 (43)	-	1 (14)	-	2 (29)	1 (14)	-	7
2011	3 (43)	-	3 (43)	-	1 (14)	-	-	7
2012	-	1 (14)	1 (14)	-	-	2 (29)	3 (43)	7
2013	2 (29)	-	1 (14)	-	-	3 (43)	1 (14)	7
2014	7 (100)	-	-	-	-	-	-	7
2015	6 (86)	-	-	-	-	-	1 (14)	7
2016	7 (100)		-	-	-	-	-	7
2017	5 (72)	-	1 (14)	-	-	-	1 (14)	7
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: $0 < \beta < 0.4$ = Very Low; $0.4 < \beta < 0.5$ = Low; $0.5 < \beta < 1.0$ = Moderately Low; $\beta = 1.0$ = Normal (same as market); $1.0 < \beta < 1.5$ = Moderately High; $1.5 < \beta < 2.0$ = High; $\beta > 2.0$=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.

Table 9.1: Summary of volatility classification

Very Low	Low	Moderately Low	Normal (same as market)	Moderately High	High	Very High
$0 < \beta < 0.4$	$0.4 < \beta < 0.5$	$0.5 < \beta < 1.0$	$\beta = 1.0$	$1.0 < \beta < 1.5$	$1.5 < \beta < 2.0$	$\beta > 2.0$
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 stocks. 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	Apollo Tyres	Balkris Ind	Ceat	Elgi Rub	JK Tyre A	MRF	TVS Srichakra	AVG
2005	D	D	D	D	D	D	D	D
2006	A	A	A	A	D	A	D	C
2007	D	D	D	D	D	D	D	D
2008	D	C	D	D	D	D	D	D
2009	D	D	A	D	D	A	D	D
2010	D	A	A	A	D	D	D	D
2011	D	D	C	A	D	D	D	D
2012	A	A	D	A	A	A	D	C
2013	D	A	D	A	A	D	A	A
2014	D	D	D	D	D	D	D	D
2015	D	A	D	D	D	D	D	D
2016	D	D	D	D	D	D	D	D
2017	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.

CONCLUSION

A number of conclusions can be drawn from the foregoing analysis. First, stocks in the tyres 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,

Elgi Rubber, Balkrishna Ind and MRF were the most volatile stocks over the 13-year period. Their average beta exceeded that of the sector, and in the case of Elgi Rubber, 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 tyres sector of the NSE. Including an appropriate mix of tyres 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 tyres 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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