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Modelling systematic risk in Indian stock market

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Abstract
Capital Asset Pricing Model is widely used for estimating systematic risk in the form of Beta. Present study is an attempt to estimate systematic risk of top 10 companies of SENSEX, an index of Bombay Stock Exchange. For the purpose of the study monthly prices, converted to simple return, of the selected companies and SENSEX for 11 calendar years have been analysed. For risk free return, return on 91 days Treasury Bills has been considered. Results of the study show that Beta of 7 companies out of 10 companies considered, is greater than 1, indicating that these companies return is more volatile than the market return.

Keywords: CAPM, systematic risk, beta, risk free return

Introduction
Risk is defined as variability or volatility in return. Various types of risks are considered by an investor while taking investment decision. Broadly speaking, these risks may be systematic risk or unsystematic risk. Systematic risk includes market risk, interest rate risk and purchasing power risk whereas unsystematic risk includes business risk and financial risk (Pandian, 2013) [9] Systematic risk affects the whole stock market, so it may be avoided by investing in other assets like gold, real estate etc. along with investing in stock market. Unsystematic risk affects a particular company or a particular industry, so it may be avoided by diversification over various companies or industries. Though systematic risk affects the whole stock market, it impacts various companies differently. Systematic risk may be quantified by finding the relationship between return of various companies and the return of market index. Present study is an attempt to quantify systematic risk.
Capital Asset Pricing Model developed by William Sharpe (Sharpe, 1964) [10] addresses one of the major concerns - what is the relationship between return and risk of individual securities. While calculating risk under CAPM, more emphasis is on systematic risk, also known as market risk. CAPM discusses about Capital Market Line and Security Market Line. Capital Market Line depicts the efficient portfolios. It examines the relationship between standard deviation and expected return of efficient portfolios. Security Market Line, on the other hand, examines the linear relationship between expected return of individual securities and their covariance with market portfolio (Chandra, 2018) [5]. Examples of market portfolios in India are S&P BSE SENSEX and NIFTY 50. The most commonly quoted equation for the CAPM is

$$E(R_i) = R_f + \beta_i [(E(R_m) - R_f]$$

Where E (R_i) is expected return of any security R_f is the risk free rate of interest, β_i is systematic risk and [E (R_m) -R_f] is market risk premium (Brooks, 2014) [3].
Risk free rate is generally the rate of return on Treasury Bills issued by Reserve Bank of India with a normal maturity period of 91 days, 182 days and 365 days (Paldon, 2022) [8]

Literature Review
Donghui and Xi (2007) [1] tested the validity of CAPM on the Chinese Stock Market in their work. For the study weekly stock return data of securities of 100 companies listed on Shanghai Stock Exchange (SSE) from January, 2000 to December, 2005 was used. Black,

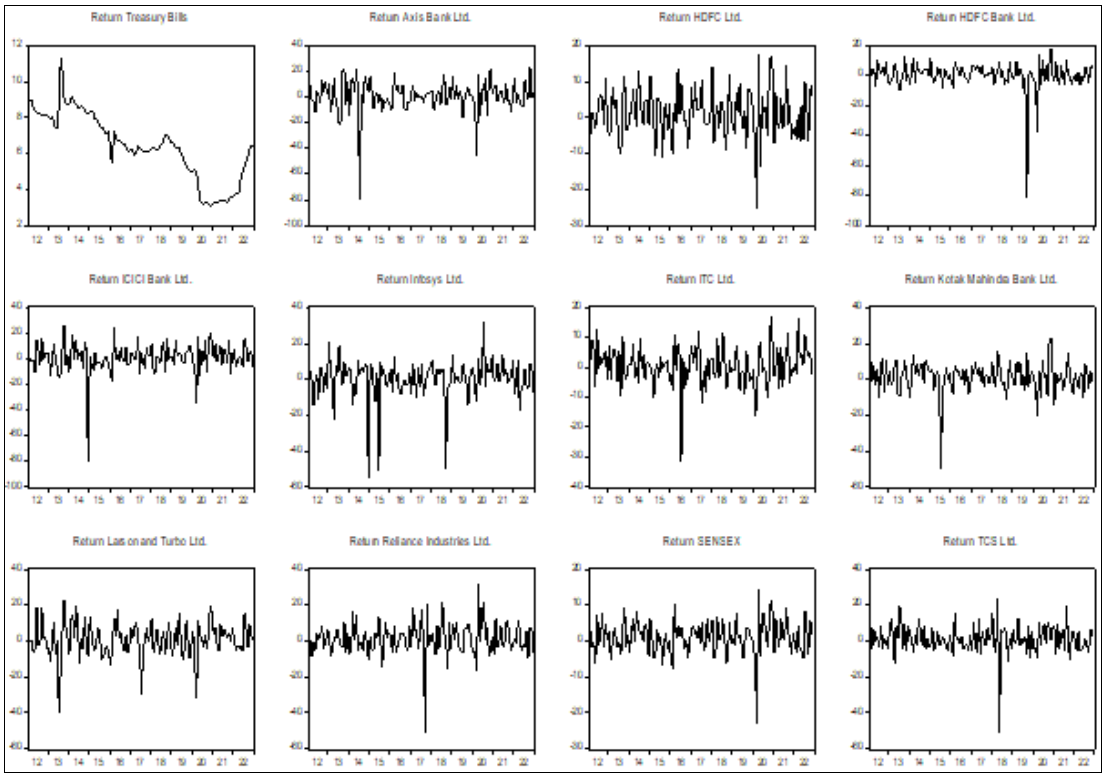
Jensen and Scholes (1972) (time-series test) and Fama and MacBeth (1973) (cross-sectional test) methods were used to test the CAPM. The study found that expected returns and betas were linearly related with each other during the study and implied a strong support to CAPM hypothesis. On the other hand, study also checked the hypothesis that the intercept should be equal to zero and the slope should be equal to the average risk premium. However, the results from the test refuted the above hypothesizes and offered evidence against the CAPM. The study concluded that CAPM did not fully hold true in the Chinese Stock Market during the study period. Basu and Chawla (2010) [2] tested the empirical validity and efficiency of CAPM in Indian Stock Market. The study analyzed 10 portfolio covering 50 stocks for the period of five years from January, 2003 to February, 2008. The study found that CAPM failed completely in Indian capital market. The intercept term, which is expected to be zero, is found to be significant for all 10 portfolios. A negative relationship between beta and excess return was found during the study period, indicating an inefficient capital market. The study also found that unsystematic risk (which is represented by residual variance), was significant in certain cases. The study concluded that CAPM is not a suitable explicator of asset prices in India over the chosen sample period. The work of Uzair and Muhammad (2010) [4] checked the validity of CAPM on the Karachi Stock Exchange (KSE). The study analyzed 60 companies from KSE-100 index for the period 2003 to 2008. The study used historical returns in calculating the results. The study concluded that CAPM gave accurate results for a limited period of time and only for few companies hence model was rejected in the Pakistan Institutional framework. Out of 360 observations, 28 results supported CAPM while 332 were against it. Theriou *et al*. (2010) [6] conducted the research work to study the relationship between systematic risk and returns in the Athens stock exchange (ASE), by taking into account the difference between positive and negative market excess returns' yield. The study was based on the data of risks and returns of 12 years collected from DataStream database. Regression analysis was applied, using both the traditional (Unconditional) test procedure and the conditional approach. A flat unconditional relationship between beta and return was found when authors did not differentiate between positive and negative market excess returns. But significant positive relationship in up market conditions and a significant negative relationship in down market conditions were found when the conditional capital asset pricing model and cross- sectional regression analysis were used in the study. Mehrara, M., Falahati, Z., & Zahiri, N. H. (2014) [7] examined the relationship between stock returns and systematic risk based on capital asset pricing model (CAPM) in Tehran Stock Exchange. The study used panel data for 50 top companies of Tehran Stock Exchange over a five year period from 1387 to 1392. Eviews and Matlab Software were used for the estimation. The results showed that the relationship between systematic risk and stock returns were statistically significant. Moreover, the nonlinear (quadratic) function outperforms the linear one explaining the relationship between systematic risk and stock returns. It means that the assumption of linearity between systematic risk and stock returns could be rejected in the Tehran Stock Exchange. The capital asset pricing model in the sample WAS rejected as linear relationship between systematic risk and stock returns was not found in the sample. Nalini, G. S. & Paldon, T. (2022) [8] described how an investor can avoid systematic risk and unsystematic risk. Various terms used in CAPM are clearly explained with suitable examples in the form of a case study. Industry considered in the case study is FMCG. Monthly data for three companies *viz*. HUL, GCPL and Dabur India are considered. As benchmark index, the NIFTY FMCG Index, that covers 15 stocks, has been considered

Data and Analysis

For the present study monthly data of ten top constituents of Sensex for 11 years from January 2012 to December 2022 has been analysed. SENSEX has been considered as benchmark index representing the market. Data for all the ten companies considered in the present study and that for SENSEX have been downloaded from the official website of Bombay Stock Exchange https://www.bseindia.com/ For the risk free return, return on 91-Days Treasury bills has been considered. It has been downloaded from the official website of Reserve Bank of India https://www.rbi.org.in/. Weekly return for treasury bills is available on Reserve Bank of India website. Weekly Return has been converted to monthly return with the help of pivot table. For analysis purpose prices are converted to simple return for all the concerned companies and SENSEX with the following formula:

Return = ((Current Month Price) – (Previous Month Price)) *100/(Previous Month Price)

Simple return has been considered in the study as for treasury bills return is calculated as simple return not continuous compound return. For January 2012 no previous period data is considered in the present study, so for first month, i.e. for January 2012, return is skipped in final analysis. All the return series have been presented graphically in Graph 1



Graph 1: Return of Treasury Bills, Sensex and 10 Top Constituent Companies of Sensex

Before further analysis Descriptive Statistics of all the series is calculated and analysed. Descriptive Statistics of all the return series is presented in Table 1

Table 1: Descriptive Statistics

Statistics	Return on Treasury Bills	Return on Axis Bank Ltd.	Return on HDFC Ltd.	Return on HDFC Bank Ltd.	Return on ICICI Bank Ltd.	Return on Infosys Ltd.
Mean	6.39999237	1.02456878	1.25044979	0.54961358	1.02397379	0.32473224
Maximum	11.336	23.4969325	17.5810359	17.8559034	26.6794734	31.3018073
Minimum	3.055	-79.6060164	-25.0953278	-81.6026398	-79.8814545	-54.7812124
Std. Dev.	1.86598494	12.2098629	6.78108462	9.5605663	11.5282866	11.0527143
Skewness	-0.19109737	-2.46186712	-0.20918467	-5.20257465	-2.64023326	-2.27708692
Kurtosis	2.37033245	17.2954419	3.93509304	44.3322812	20.4405224	12.7640976
Jarque-Bera	2.9614408	1247.79038	5.72814911	9915.74263	1812.46768	633.592974
Probability	0.22747376	0	0.05703589	0	0	0
Statistics	Return on ITC Ltd.	Return on Kotak Mahindra Bank Ltd.	Return on Larson and Turbo	Return On Reliance Industries Ltd.	Return on Sensex	Return on TCS Ltd.
Mean	0.59807654	1.38926026	0.82594726	1.32733951	1.08082199	1.18330325
Maximum	17.2163389	22.8773585	23.3261476	31.8755899	14.4192322	23.9392131
Minimum	-31.4180929	-49.8684922	-39.7179788	-50.9162222	-23.0533283	-50.5918333
Std. Dev.	6.5830295	8.31105508	9.41391345	9.1030793	4.69321008	8.08879971
Skewness	-0.7392365	-1.68526432	-0.75450198	-0.90173737	-0.7291863	-1.60083366
Kurtosis	6.45473302	12.974827	6.10121389	10.8081973	7.30566752	14.6199505
Jarque-Bera	77.0774671	605.097938	64.924804	350.536713	112.799861	792.9535
Probability	0	0	0	0	0	0

Source: Researchers own calculation with e-views 9

If we compare the mean return, highest return is earned by Treasury bills and the least return is earned by Infosys ltd. If we observe the maximum return, it is highest for Infosys Ltd. and lowest for Treasury Bills. Highest range i.e. difference between maximum and minimum return is bagged by ICICI Bank Ltd. and lowest range is that of treasury bills. Standard deviation is the historical measure of volatility. In the present study, as expected, it is lowest for Treasury Bills. Highest standard deviation is for Axis Bank ltd. stock return followed by ICICI Bank Ltd. Skewness is negative for all the return series and it is maximum for HDFC Bank Ltd. stock return and minimum for SENSEX return. Kurtosis, a symbol of peaked ness is highest for HDFC Bank Ltd. return and lowest for treasury bills return. Jarque-Bera test statistic tests whether the distribution is normally distributed or not, null hypothesis for the same is that distribution is normally distributed. If the probability of this statistic is less than 0.05, null hypothesis is rejected at 5% level of significance and it is said that distribution is not normally distributed. In the present case, on the basis of

probability value, it is observed that Treasury Bills return series is normally distributed, followed by HDFC Ltd.

Through the present study, Beta, a measure of systematic risk has been calculated for all the concerned companies return with the help of following equation:

$$E(R_i) = R_f + \beta_i [(E(R_m) - R_f]$$

Where E (R_i) is expected return of any security R_f is the risk free rate of interest, β_i is systematic risk and [E(R_m) -R_f] is market risk premium.

Data has been analysed with the help of eviews 9. Classical Linear Regression has been applied on the data. Results are presented in Table 2

Table 2: Beta estimation of 10 top constituent companies of SENSEX and residual diagnostic

Company Name	Beta	Probability of Beta	Durbin Watson Stat	F stat for ARCH Test	Probability of F stat for ARCH Test
Axis Bank Ltd.	1.6156299	0	1.953925	0.034479	0.8530
HDFC Ltd.	1.097953	0	2.056099	0.978632	0.3244
HDFC Bank Ltd.	1.021747	0	1.959393	0.011552	0.9146
ICICI Bank Ltd.	1.654496	0	2.064415	0.007666	0.9304
Infosys Ltd.	0.863595	0	2.16085	0.293157	0.5891
ITC Ltd.	0.640404	0	2.254889	0.192754	0.6614
Kotak Mahindra Ltd.	1.005297	0	2.010622	0.052675	0.8188
Larson and Turbo	1.301883	0	1.786551	0.072997	0.7875
Reliance Industries Ltd.	1.111783	0	2.069504	0.194552	0.6599
TCS Ltd.	0.537576	0	2.675307	1.812089	0.1806
TCS Ltd. after adjusting for serial correlation	0.47806	0	2.070224	5.570939	0.0198
TCS Ltd. after applying HAC (Newey-west) covariance method	0.537576	0	2.675307	1.812089	0.1806

Source: Researchers own calculation with eviews 9

It is clear from the results presented in Table 2 that beta is positive and significant in all the cases but before interpreting the regression results presented in Table 2, we will discuss about the diagnostic statistics. For the regression results to be robust residuals should be checked. In the present study residuals have been checked for serial correlation and heteroskedasticity. Serial correlation is checked with the help of Durbin Watson stat. Durbin Watson stat checks for first order serial correlation. For the absence of first order serial correlation, Durbin Watson stat should be near to 2. In present study, for most of the companies, it is found to be near to 2, but for Infosys Ltd., ITC Ltd. and TCS, it is observed to be deviating from 2, so the serial correlation has been checked with the help of Correlogram Q-stat. In case of Infosys Ltd. and ITC Ltd. no serial correlation has been found but for TCS Ltd. presence of serial correlation is observed. Heteroskedasticity has been tested with the help of ARCH test. Null Hypothesis for ARCH test is that there is no heteroskedasticity in residuals. On the basis of probability value greater than 0.05, the null hypothesis cannot be rejected, i.e. no heteroskedasticity is found in residuals of 9 regression equations, out of the 10 analysed in present study. For TCS Ltd., it is not found in the first instance but when we tried to account for serial correlation by introducing ar(1) term in regression, serial correlation was adjusted, i.e. it was not observed in residuals but heteroskedasticity was now present in residuals, so the option with researchers was to change the covariance method to HAC(Newey-West). Presence of serial correlation and heteroskedasticity doesn't affect the coefficient values but standard errors, corresponding t-values and p values are not correct. HAC (Newey-West) covariance method calculates the robust standard errors by accounting for serial correlation and heteroskedasticity. In case of TCS Ltd., Beta is found to be significant before as well as after applying HAC (Newey-West) covariance method.

Let's now interpret Beta coefficients. Beta value equal to 1, indicates that volatility of that company return is exactly equal to the volatility of market return. Beta value less than 1 indicates that the return of that company is less volatile than the volatility of market return. Beta value greater than 1 is an indication of the company return being more volatile than the market return. 0 Beta value indicated that there is no correlation between the company retun and market return. Negative Beta return is an indication of negative correlation between company return and market return. In the present study, Beta is found to be positive for all the 10 companies considered in the present study. Highest Beta is for ICICI Bank Ltd. followed by Axis Bank Ltd, and Larson and Turbo. Lowest Beta is found to be for TCS Ltd. return. Beta is greater than 1 for 7 companies out of the 10 companies considered in present study. It indicates that these 7 companies return are more volatile that the market return. Three companies whose Beta coefficient is less than 1 are Infosys Ltd., ITC Ltd. and TCS Ltd.

Conclusion

Present study has been undertaken with the objective of estimating Betas of various companies listed at Bombay Stock Exchange. For the purpose, top ten constituent companies of SENSEX have been selected, SENSEX has been considered as benchmark index representing market. Monthly data for all the selected companies and SENSEX for 11 calendar years from January 2012 to December 2022 has been collected from official website of Bombay Stock Exchange. Prices are converted to simple return. For risk free return, return on 91 days treasury bills is considered and data for the same has been collected from the official website of Reserve Bank of India, weekly data for the same is available, which has been converted to monthly data. Popular Security Market Line is considered for estimating systematic risk. Results of regression equations have been tested for robustness. It is observed that Beta of 7 companies

out of 10 companies analysed, is greater than 1, indicating that these companies return is more volatile than market return.

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