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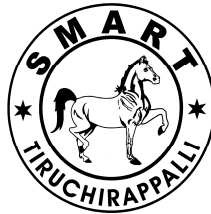
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PORTFOLIO EVALUATION USING CAPITAL ASSET PRICING MODEL

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Abstract

The Capital Asset Pricing Model (CAPM) is used to determine a theoretically appropriate, required rate of return for an asset, if that asset is to be added to an already well-diversified portfolio, given that assets have non-diversifiable risk. The model takes into account the asset's sensitivity to systematic risk, often represented by the quantity, beta, and the expected return of a theoretical risk-free asset. The CAPM says that the expected return of a security or a portfolio equals the rate on a risk-free security plus a risk premium. If this expected return does not meet or beat the required return, then the investment should not be undertaken. The security market line plots the results of the CAPM for all different risks (betas).

Keywords*: CAPM, Beta, Systematic Risk, Return, Security Analysis, Portfolio Management*

Introduction

CAPM (Capital Asset Pricing Model) is one of the most popular models in the finance industry. It is required to determine a theoretically estimated, required rate for return for an asset. The model takes into account the asset's sensitivity to non diversifiable risk (also known as systematic or market risk), often represented by the quantity, beta, in the financial industry as well as the expected rate of return of the market and expected return of a theoretically risk free asset.

This model was introduced by Treynor, Sharpe, Lintner and Mossin, independently building on the earlier work of Markowitz on diversification and modern portfolio theory. The model has contributed a lot to the development in the field of finance by providing the estimations of return of different assets based on statistical data and certain indicators.

Need of the Study

The investors of the secondary market were affected by the seasonal behaviour and high volatility of the secondary market. Any rational investor, if he knows how to price a security and the risk associated with the return, would be able to make fairly accurate purchase decisions. In a perfectly competitive market, the buyer has to be professional and hence this study was carried out to develop a simple procedure that will help an ordinary investor to price the shares in the secondary market.

Research on CAPM

One of the most well known models for asset pricing is Capital Asset Pricing Model (CAPM) developed by William Sharpe (1964), John Lintner (1965) and Jan Mossin (1966). The model relies on the covariance of assets return with "market return" to quantify asset risk. The market return is the return on all invested wealth, which in empirical studies, is often proxied by the return on diversified portfolio of common stocks. The CAPM is based on single period assumption although it is often assumed to hold inter-temporally.

Eugene F. Fama and James D MacBeth (1973) established that the intercept term is generally and substantially greater than risk free

rate of return and the beta coefficient is less than the market premium on market portfolio. Merton (1973) argued that the assumption that the CAPM holds inter-temporally was faulty when agents, instead of facing a constant investment opportunity set, faced a changing one.

Jack Clark Francis and Frank J. Fabozzi (1979) looked into the stability of the Single Index Market Model (SIMM). The inter-temporal instability in the betas, frequently observed, could be due to this business cycle economics. Litzenberger et al (1979) derived an after tax version of CAPM. The results of the study indicated that there is a strong positive relationship between before tax expected returns and dividend yields of common stocks.

Eugene F. Fama and Kenneth R. French (1992) tested CAPM using stock return data between 1963 and 1990 from NYSE, AMEX and NASDAQ. The results did not support the Sharpe-Lintner-Black CAPM model's positive relation between average stock return betas. The authors concluded that if asset pricing is rational, then size and book-to-market equity must be a proxy for risk.

A study conducted by Obaidullah (1994) suggested that CAPM, as a description of asset pricing in Indian markets, does not seem to rest on solid grounds. Huang (2000) found that the CAPM is stable in the low-risk state while it is violated in the high-risk state. Goetzmann and Masaa (2003) examined the relationship between daily index fund flows and asset prices. The result indicated a strong contemporaneous correlation between fund inflows and S&P market.

Robert S. Harris (2004) explained in his study how some of the most financially sophisticated companies and financial advisors estimate the cost of equity capital. Survey evidence shows that the Capital Asset Pricing Model (CAPM) is the most widely used model. Grigoris Michailidis et al. (2006) examined the Capital Asset Pricing Model (CAPM) for the Greek Stock Market. The findings of the study were not supportive of the theory's basic statement that higher risk (beta) is associated with higher levels of return.

Capital Asset Pricing Model for Finding Expected Rate of Return

For individual securities, we make use of the Security Market Line (SML) and its relation to expected return and systematic risk (beta) to show how the market must price individual securities in relation to their security risk class. The SML enables us to calculate the reward-to-risk ratio for any security in relation to that of the overall market. Therefore, when the expected rate of return for any security is deflated by its beta coefficient, the reward-to-risk ratio for any individual security in the market is equal to the market reward to- risk ratio, thus:

$$\frac{E(R_i) - Rf_f}{\beta_i} = E(R_m - R_f)$$

The market reward-to-risk ratio is effectively the market risk premium and by rearranging the above equation and solving for E(Ri), we obtain the Capital Asset Pricing Model (CAPM).

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

Where, $E(R_i)$ is the expected excess return on the capital asset

R_f is the risk free rate of interest

β_i is (the *beta coefficient*) is the sensitivity of the expected excess asset returns to the expected excess market returns

$E(R_m)$ is Expected excess return on market

DATA

This research was descriptive in nature. The study mainly depended on the secondary data of weekly closing prices list of 21 companies termed as the Group A Companies in NSE. This study covered a period from 1999-2010.

Analysis

Descriptive Statistics of Weekly Returns of Group A Companies

The Descriptive Statistic values of minimum, maximum, mean, standard deviation, skewness and kurtosis, based on weekly returns of 21 companies, operationally defined as Group A, were worked out for 611 weeks for the period from the first week of January 1998 to the first week of August 2010 and they are given in **Table- 1**

From **Table -1** it is inferred that out of 21 companies belonging to Group-A, the average returns turned out to be negative for all companies. The standard deviation was the highest (9.41 percent) for Seasagoa Limited, followed by Steel Authority of India Limited (8.39 percent). For the remaining 19 companies, it was ranging from 6 percent to 8 percent. The skewness values for Bharat Petroleum Corporation Limited (0.22), Oil and Natural Gas Commission (0.992), Tata Motors Limited (0.153), Reliance Infrastructure (0.378), Tata Power Limited (0.713), Steel Authority of India Limited (1.487) and Tata Steel Limited (0.020) turned out to be positive and indicated more number of positive returns over the period. It is also worthy of note that for Steel Authority of India Limited, the skewness coefficient was more than one and abnormal number of positive returns were recorded for this company. For all the other companies in Group-A, the skewness value turned out to be negative and led to the inference that there were more number of negative returns over the period.

Similarly kurtosis values of positively skewed companies were Bharat Petroleum Corporation Limited (4.929), Oil and Natural Gas Commission (7.896), Tata Motors Limited (2.418), Reliance Infrastructure (3.533), Tata Power Limited (4.101), Steel Authority of India Limited (7.932) and Tata Steel Limited (2.777). This led to the conclusion that even though Steel Authority of India Limited showed abnormal number of positive returns, the returns distribution showed leptokurtic pattern and it was followed by Oil and Natural Gas Commission in the second place. Hence the possibility of high risk was more for the two companies. Companies such as Bharat Petroleum Corporation Limited, Tata Power Limited showed mesokurtic pattern of return distribution and Tata Steel Limited, Tata Motors Limited and Reliance Infrastructure Limited showed approximately normal distribution pattern of returns.

In the case of negative skewness of returns, the kurtosis value for Hindustan Unilever Limited was the highest and stood at 79.437, followed by ITC Limited with 73.290, Hero Honda Ltd. With 52.135, Ambuja Cement Limited with 48.117, ACC Limited with 45.353 and the other companies in Group A followed this pattern of highly leptokurtic return distribution pattern ranging from 6 to 41. The above findings support the findings of Kraus and Litzenberg (1976) that the investors are willing to pay for positive skewness.

SML formulation based on weekly returns

Using Capital Asset Pricing Model, the characteristics and parameters of Security Market Line were calculated for 21 companies and they are presented in Table 2. The various characteristics of SML are coefficient of determination and F-value which explains the explanatory power of the excess return over market return in the prediction of expected rate of return and significance of the Security Market Line. The parameters of the equation are **â and constant** which forms the regression equation.

From **Table- 2** it is inferred that the Security Market Line equations were established for 21 companies of Group-A. The coefficients of determination R^2 were ranging from 0.0793 to 0.4661. The R^2 value was the least for Sun Pharmaceuticals Limited (0.0793) and the highest for Reliance Industries Limited (0.4661)

followed by Tata Steel Limited (0.4506), Tata Motors Limited (0.4192), Reliance Infrastructure Limited (0.4105) and others. The explanatory power of the equation is statistically significant since the F values were significant at 1% level for all the 21 companies.

The next parameter is β **values.** The **â** coefficients were more than one for 10 companies and for the remaining 11 companies they were less than one. This indicated that 10 companies were giving more than one unit contribution to expected return for every unit change in the market return. The β coefficient was the highest for Tata Steel Limited (1.290), followed by Steel Authority of India Limited (1.279), Reliance Infrastructure Limited (1.220), Tata Motors Limited (1.200), Seasagoa Limited (1.177), Mahindra and Mahindra Limited (1.174), Reliance Industries Limited (1.173), Bharat Heavy Electricals Limited (1.060), Tata Power Limited (1.009), ACC Limited (1.006) and for all the other companies they were less than one. The t values of **â** coefficients were all significant at 1% level. This indicated that the CAPM model was valid, with the basic assumptions.

Expected rate of return on weekly returns of Group A companies

The risk free rate of return was taken as 7.5 % and the average of (R_m - R_f) value was taken to calculate the expected rate of return of individual securities. The expected rate of return or the required rate of return for the individual investors were calculated for Group A companies based on weekly returns and they are presented in **Table- 3.**

From **Table- 3** it is observed that the minimum required rate of return for group A companies was found to be 13.92 percent for Reddys Lab Limited. It is also interesting to observe that the Tata Group of companies were stable and constantly took part in the calculation of S&P Nifty Index. These required rates of returns were used in further calculation of the intrinsic value of individual shares.

Estimation of Intrinsic Value Based on Weekly Returns

The values of the individual shares of the Group A companies were estimated using the concept of Alternative Growth Models suggested by Salomon (1963) and Miller and Modigliani (1961). The important parameters needed to calculate the value of the shares using long run growth model are mean return on equity, retention rate and relative return operator (the ratio of mean return on equity and expected rate of return). The present value of constant earnings and the present value of excess earnings growth investments were used to compute the value of the shares and they are presented in **Table-4.**

From **Table- 4** it is inferred that the values of the shares calculated for Group A companies were ranging from Rs 58.67 for Ambuja Cements Limited to Rs 1665.29 for Hero Honda Limited. The CAPM application resulted in the identification of properly valued shares for one firm, undervalued share for 11 firms and the shares were overvalued for nine firms among Group A companies.

Analysis of Effectiveness of the Estimation Process

The results of the valuation of the shares created interest in the comparison of the calculated intrinsic values of the shares with current market prices. The comparison of weekly closing prices of Group A companies' shares in National Stock Exchange was considered for a period of next three months. The calculated intrinsic values and the minimum and Maximum of the weekly closing prices from September 2010 to December 2010 are displayed in **Table-5.**

From **Table-5** it is gathered that the market prices were higher than the calculated intrinsic price for all companies. This was evidenced for Group A Companies through Mean Absolute Deviation (MAD) and Mean Absolute

Percentage Error (MAPE). The Mean Absolute Deviation was the highest for Bharat Heavy Electricals Limited (1991.84) in group A companies. Dr. Reddys Lab Limited (1210.87), Tata Power Limited (1191.68), Sun Pharmaceuticals Limited (1113.38), and Tata Motors Limited (1021.46) were the other companies, with Mean Absolute Deviation more than 1000 among Group A Companies. The Mean Absolute Percentage Error for group A companies ranged from 9.34 percentage to 120.32 percentage. The minimum MAPE occurred for Hero Honda Limited and the maximum value of 120.32 occurred for Ranbaxy Limited among group A companies.

Findings

Using the Capital Asset Pricing Model, the share prices of the selected companies were found out, based on weekly holding period returns.

The findings, based on weekly holding period returns, establish that market prices were higher than the calculated intrinsic price for all companies. This was evidenced for Group A Companies through Mean Absolute Deviation (MAD) which was 583.13 and Mean Absolute Percentage Error (MAPE) which was 265.35. Hence it can be concluded that the market prices were on an average 2.65 times more than the calculated intrinsic values for Group A Companies.

Even though CAPM model helped to understand the valuation status from the observation, the individual investor may get confused with the perceived true value and market value since the gap was more.

Conclusion

The analysis had been carried out from descriptive statistics to application of models to value the shares. The models had been constructed using weekly holding period return. The holding period returns were considered to observe whether the investment was made with the aim of investment rather than liquidity in order to realize stability in returns.

Many companies' shares returns were found to have abnormal skewness and kurtosis values which clearly indicated that those return distribution did not follow normal pattern exactly, irrespective of the holding periods. This behavior was supported by the measures of Mean Absolute Deviation and Mean Absolute Percentage Error. It also rendered evidence for mostly negative returns. Using the normal descriptive statistics, the investors cannot take firm decision because of the observation of evidences of random behavior of stock returns.

Hence it is concluded that variance modeling process can help the investors in short term prediction such as weekly price predictions. If the holding period increases, the CAPM model renders estimates of the prices reliable.

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Table -1

Respondents' Ranking on the Different Media for Advertisements

S. No	Sample Units	Min Return	Max Return	Mean Return	Standard Deviation	Skew ness	Kurtosis
1	ACC Limited	-1.05	0.1	-0.1403	0.07084	-3.38	45.353
2	Ambuja Cement Ltd	-1.01	0.21	-0.142	0.06736	-3.56	48.117
3	Bharat Heavy Electricals Ltd	-0.62	0.04	-0.1384	0.06419	-0.89	6.154
4	Siemens Ltd	-0.93	0.18	-0.1389	0.07277	-2.31	26.803
5	Bharat Petroleum Corporation Ltd	-0.62	0.2	-0.1394	0.07474	0.022	4.929
6	Reliance Industries Ltd.	-0.65	0.21	-0.1387	0.06349	-0.34	11.6
7	Oil and Natural Gas Commission	-0.46	0.28	-0.1393	0.06229	0.992	7.896
8	Cipla Ltd	-0.96	0.18	-0.1417	0.07497	-3.89	40.069
9	Dr. Reddy' s Lab Ltd	-0.63	0.09	-0.1405	0.06101	-1.4	13.581
10	Sun Pharmaceutical Ltd	-0.86	0.27	-0.1378	0.07336	-1.88	24.588
11	Ranbaxy Lab ltd	-0.69	0.15	-0.1407	0.06903	-1.07	10.502
12	Hero Honda Ltd	-0.95	0.13	-0.1396	0.06071	-3.58	52.135
13	Mahindra & Mahindra Ltd	-0.65	0.16	-0.139	0.07495	-1	8.774
14	Tata Motors Ltd	-0.48	0.16	-0.1389	0.06846	0.153	2.418
15	Hindustan Unilever Ltd	-1.05	0.11	-0.1437	0.06093	-5.11	79.437
16	ITC Ltd	-1.07	0.24	-0.1425	0.06555	-4.69	73.29
17	Reliance Infrastructure Ltd	-0.45	0.22	-0.1386	0.07033	0.378	3.533
18	Tata Power Ltd	-0.33	0.27	-0.1383	0.06083	0.713	4.101
19	Sesagoa Ltd	-1.09	0.32	-0.1357	0.09408	-1.46	19.156
20	Steel Authority of India Ltd	-0.41	0.49	-0.1352	0.08392	1.487	7.932
21	Tata Steel Ltd	-0.51	0.19	-0.1393	0.071	0.02	2.777

Source: computed

Table -2
Security Market Line Characteristics of Weekly Returns of Group A Companies

S.No	Company Name	R^2	F value	β Coefficient	t value	Constant	t value
1	ACC Limited	0.2751	229.95 ***	1.006	15.164***	0.001	0.117[NS]
2	Ambuja Cement Ltd	0.1926	144.57***	0.8	12.024***	-0.029	-3.045**
3	Bharat Heavy Electricals Ltd	0.372	358.91***	1.06	18.945***	0.011	1.305 [NS]
4	Siemens Ltd	0.1928	144.77***	0.865	12.032***	-0.017	-1.6538*
5	Bharat Petroleum Corporation Ltd	0.1717	125.66***	0.839	11.210***	-0.022	-1.984**
6	Reliance Industries Ltd.	0.4661	529.12***	1.173	23.003***	0.026	3.538***
7	Oil and Natural Gas Commission	0.2446	196.27***	0.834	14.010***	-0.022	-2.545**
8	Cipla Ltd	0.1663	120.85***	0.828	10.993***	-0.025	-2.320**
9	Dr. Reddy's Lab Ltd	0.1126	76.90***	0.554	8.769***	-0.063	-6.820***
10	Sun Pharmaceutical Ltd	0.0793	52.18***	0.559	7.223***	-0.059	-5.267***
11	Ranbaxy Lab ltd	0.1969	148.57***	0.829	12.189***	-0.024	-2.440**
12	Hero Honda Ltd	0.1179	81.03***	0.564	9.002***	-0.06	-6.615***
13	Mahindra&Mahindra Ltd	0.3347	304.84***	1.174	17.460***	0.026	2.659**
14	Tata Motors Ltd	0.4192	437.30***	1.2	20.912***	0.03	3.566***
15	Hindustan Unilever Ltd	0.1315	91.79***	0.598	9.581***	-0.06	-6.575***
16	ITC Ltd	0.154	110.32***	0.696	10.503***	-0.045	-4.628***
17	Reliance Infrastructure Ltd	0.4105	422.04***	1.22	20.544***	0.033	3.809***
18	Tata Power Ltd	0.3752	363.85***	1.009	19.075***	0.003	0.447[NS]
19	Sesagoa Ltd	0.2135	164.45***	1.177	12.824***	0.03	2.226**
20	Steel Authority of India Ltd	0.3171	281.41***	1.279	16.775***	0.045	4.026**
21	Tata Steel Ltd	0.4506	496.97***	1.29	22.293***	0.042	5.002**

Source : Computed

* 1% Significant level | ** 5% Significant level | * 10% Significant level | NS Not Significant

Table -3
Estimated Expected Rate of Return Based on Weekly Returns

S. No	Group A	Expected Rate of Return	
		Weekly	Annualised
1	ACC Limited	0.0037	0.1915
2	Ambuja Cement Limited	0.0032	0.1677
3	Bharat Heavy Electricals Ltd.	0.0038	0.1978
4	Siemens Limited	0.0034	0.1752
5	Bharat Petroleum Corporation Ltd.	0.0033	0.1721
6	Reliance Industries Limited.	0.0041	0.2109
7	Oil and Natural Gas Commission	0.0033	0.1716
8	Cipla Limited	0.0033	0.1709
9	Dr. Reddy's Lab Limited	0.0027	0.1392
10	Sun Pharmaceutical Limited	0.0027	0.1398
11	Ranbaxy Lab Limited	0.0033	0.1710
12	Hero Honda Limited	0.0027	0.1404
13	Mahindra and Mahindra Limited	0.0041	0.2110
14	Tata Motors Limited	0.0041	0.2140
15	Hindustan Unilever Limited	0.0028	0.1443
16	ITC Limited	0.0030	0.1557
17	Reliance Infrastructure Limited	0.0042	0.2163
18	Tata Power Limited	0.0037	0.1918
19	Sesagoa Limited	0.0041	0.2113
20	Steel Authority of India Limited	0.0043	0.2232
21	Tata Steel Limited	0.0043	0.2244

Source: computed

Table- 4

Intrinsic Value of Individual Shares of Group A Companies

S. No	Company Name	Mean Return on Equity	Mean Retention Rate	Expected Rate of Return	Relative Rate of Return Operator	Earnings Per Share (EPS)	Value of the Share
		(r)	(b)	(k)	(m)	(in Rs.)	(in Rs.)
1	ACC Limited	0.1913	0.5867	0.1915	1	85.58	446.62
2	Ambuja Cement Ltd	0.2284	0.6348	0.1677	1.36	8	58.67
3	Bharat Heavy Electricals Ltd	0.184	0.7462	0.1978	0.93	88.06	422.02
4	Siemens Ltd	0.2955	0.8113	0.1752	1.69	30.99	275.42
5	Bharat Petroleum Corporation Ltd	0.1632	0.6928	0.1721	0.95	42.53	238.27
6	Reliance Industries Ltd.	0.1615	0.8571	0.2109	0.77	49.64	188.12
7	Oil and Natural Gas Commission	0.232	0.6013	0.1716	1.35	78.39	553.5
8	Cipla Ltd	0.231	0.7977	0.1709	1.35	13.47	100.93
9	Dr. Reddy's Lab Ltd	0.1674	0.819	0.1392	1.2	50.11	419.71
10	Sun Pharmaceutical Ltd	0.2715	0.7522	0.1398	1.94	43.39	530.31
11	Ranbaxy Lab ltd	0.1507	0.4275	0.171	0.88	13.61	446.62
12	Hero Honda Ltd	0.506	0.4193	0.1404	3.6	111.77	1665.29
13	Mahindra & Mahindra Ltd	0.1957	0.663	0.211	0.93	36.89	166.43
14	Tata Motors Ltd	0.1091	0.5939	0.214	0.51	48.64	161.12
15	Hindustan Unilever Ltd	0.7504	0.2393	0.1443	5.2	10.09	140.21
16	ITC Ltd	0.2502	0.5891	0.1557	1.61	11.01	96
17	Reliance Infrastructure Ltd	0.0865	0.8007	0.2163	0.4	51	122.49
18	Tata Power Ltd	0.1075	0.7373	0.1918	0.56	39.93	140.72
19	Sesagoa Ltd	0.2568	0.7354	0.2113	1.22	25.49	139.74
20	Steel Authority of India Ltd	0.151	0.5576	0.2232	0.68	16.35	60.04
21	Tata Steel Ltd	0.2078	0.6327	0.2244	0.93	66.07	280.65

Source: Computed Value

Table- 5

Analysis of Effectiveness of Estimation Process of Group A Companies

S. No.	Company Name	Calculated Intrinsic Value (Rs.)	Minimum Market Price (Rs.)	Maximum Market Price (Rs.)	MAD	MAPE
1	ACC Ltd	446.62	885.35	1000.65	567.07	55.81
2	Ambuja Cement Ltd	58.67	124.2	143.9	83.4	58.58
3	Bharat Heavy Electricals Ltd	422.02	2197.75	2408.43	1991.84	82.47
4	Siemens Ltd	275.42	695.6	767.45	514.86	65.06
5	Bharat Petroleum Corporation Ltd	238.27	666.4	730.18	490.47	67.2
6	Reliance Industries Ltd.	188.12	936.2	1024.03	845.02	81.76
7	Oil and Natural Gas Corporation	553.5	1245.3	1351.6	788.07	58.68
8	Cipla Ltd	100.93	305.4	337.75	238.1	70.13
9	Dr. Reddy's Lab Ltd	419.71	1368.55	1593.98	1210.87	74.06
10	Sun Pharmaceutical Ltd	530.31	428.15	1367.25	1113.38	58.16
11	Ranbaxy Lab Ltd	446.62	616.4	498.5	446.62	120.32
12	Hero Honda Ltd	1665.29	1982.7	1708.85	174.5	9.34
13	Mahindar and Mahindra Ltd	166.43	799.95	629.25	564.28	77.1
14	Tata Motors Ltd	161.12	1357.85	1010.75	1021.46	86.27
15	Hindustan Unilever Ltd	140.21	308.85	266.55	155.07	52.44
16	ITC Ltd	96	178.4	163.15	75.19	43.9
17	Reliance Infrastructure Ltd	122.49	1096.7	780.15	862.84	87.38
18	Tata Power Ltd	140.72	1422.65	1239	1191.68	89.42
19	Sesagoa Ltd	139.74	372.4	298.1	190.09	57.47
20	Steel Authority of India Limited	60.04	226.15	176.5	137.82	69.46
21	Tata Steel Ltd	280.65	676.2	537.95	341.18	54.73

Source: computed