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SYSTEMATIC RISK OF STOCKS: THE RETURN INTERVAL EFFECT ON BETA

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Abstract *Capital Asset Pricing Model (CAPM) and Market Model are the standard directives to describe the relationship between risk and return of investments. Both the models claim that the inherent risk of a security should be measured by beta. In India, leading stock exchanges disseminate beta values of prominent stocks by using daily paired observations of stock and key index returns. However, some other investment institutions and practitioners advocate weekly or monthly returns for beta estimations. This study aims to investigate the impact of return intervals on the estimation of beta. Beta coefficients of fifty most prominent stocks listed on National Stock Exchange (NSE) of India are estimated on the bases of daily, weekly, and monthly returns using S&P CNX Nifty as a proxy of the market. Results show that the return intervals have a significant impact on the estimation of beta.*

Keyword: *CAPM, Market Model, Beta, Return Interval, Systematic Risk, NSE*

INTRODUCTION

Every stock or portfolio comprises of two types of risks, systematic and unsystematic. The systematic risk, denoted by beta in the domain of finance, is the risk which is inherent in a stock and cannot be diversified away. Systematic risk, also known as market risk, cannot be reduced through diversification of stocks' portfolio. Investors are exposed to market risk even when they hold well diversified portfolio of securities. The non-systematic risk, on the other hand, can be diversified by holding enough stocks in portfolio. Elton *et al*. (2003) opine that "For very well diversified portfolios, non-systematic risk tends to go to zero and the only relevant risk is systematic risk measured by beta". Further, the capital asset pricing model (CAPM), one of the most recognised theorems in finance, is based on the assumption that a rational investor should not take on any non-systematic risk, and thus is rewarded for the systematic risk of a stock, or as per its beta value. Beta can also be interpreted as financial elasticity, or the sensitivity of the asset's returns to market returns. Further, the beta value also gives some idea on relative volatility of a stock. Sharpe, the originator of beta statistic in finance, *et al*. (1999, page183) mention, "Stocks with betas greater than one are more volatile than the market and are known as aggressive stocks. In contrast, stocks with betas less than one are less volatile than the market index and are known as defensive stocks."

By finance literature, beta can take the following values:

Negative: This means that the stock and the market returns move in opposite directions, which is theoretically possible, but may not observed in reality.

Zero: This signifies that in whichever direction the market moves, the stock value remains static. Practical examples of such stocks may be rare.

Between zero and one: Stocks with beta values of less than one are less volatile than the market and are known as defensive stocks. Many stocks can be expected to fall in this range.

One: Stocks having a beta of one move in tandem with the market. By definition, the market has a beta of one.

Greater than one: Stocks with betas greater than one are more volatile than the market and are known as aggressive stocks. In a stock market rally, such stocks prove to be very profitable. However, being volatile, they also take the maximum hit in the course of a market correction.

Index or Market model regresses returns of stock, the dependent variable, against returns of market index, the independent variable, for assessing systematic risk of stock by drawing a characteristic line. Since Index model is linear and envisage the premise of Simple Linear Regression Model (SLRM), we obtain:

$$R_{Si} = \alpha + \beta R_{Mi} + e_i \qquad (1)$$

Where R_S and R_M are return on the stock and the return on the market index respectively, α is intercept, *b*isslope of regression line and e_i is error term. Equation (1) signifies

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that return on any stock (R_S) depends on some constant (α), plus some coefficient (β), times the return on market index (R_M), plus a random component (e_i).

Since E(e_i) = 0 by assumption and if we take it to Equation (1) for estimating R_S (or, E(R_{Si})), we obtain following linear equation:

$$E(R_{Si}) = \alpha + \beta\,(R_{Mi}) \quad (2)$$

Index model signifies Equation (2) as Characteristic Line which is widely used to estimate forecast variable $R_S$on the basis of α & β, the parameters of the model, and known or given value of predictor variable R_M. Equation (2) requires the determination of two regression coefficients α (intercept) and β (slope). The most common approach to determineα and$b$is the method of least-squares. The resulting slope of equation (2) can be expressed as:

$$\beta = Covar_{S,M}/(\sigma_M)^2 \quad (3)$$

$$= s_S \sigma_M r_{SM}/(\sigma_M)^2 \quad (4)$$

$$= r_{SM} s_S / \sigma_M \quad (5)$$

and,

$$\alpha = \overline{R_S} - \beta \overline{R_M} \quad (6)$$

where $Covar_{S,M}$ is covariance of stock and market returns, s_S is standard deviation of stock returns, σ_M is standard deviation of market returns and r_{SM} is correlation coefficient between stock and market returns.The beta value of a stock is an important, but not decisive, factor to judge the course of investing. Investors often try to draw a parallel between the beta and their risk appetite, since beta is also a measure of systematic risk, or relative volatility of a stock. However, one can get a fair idea of the volatility of a stock from its beta value. Further, both CAPM and Market models provide no guidelines on what return interval, proxy for the market, and estimation period should be used for the estimation of beta.While testing for the stability of beta, it should be noted that there is probably no econometric test to determine whether a beta is stable or unstable in absolute terms. The results of any such test will greatly based upon the chosen sample time period and how that time period is classified.

LITERATURE REVIEW

Beta, emanating from the pioneering work of Sharpe (1964) and Lintner (1965), is a mile stone of modern finance theory and is a genesis of countless investment and financing decisions. Later studies focused on beta estimation issues in detail. Fabozzi & Francis (1978) suggest that beta coefficients of stocks move randomly through time rather than remain constant. Fabozzi & Francis, in their famous study, investigate around 700 stocks on the New York stock exchange and find that "many stocks' betas move randomly through time rather than remain stable as the ordinary least squares model presumes".Bollerslev *et al*. (1988) provide tests of the CAPM that imply time-varying beta values of stocks. Other researchers also have same opinions about betas to be time-varying in nature (Mandelker, 1974; Keim & Stambaugh, 1986; Ferson, 1989; Breen *et al*., 1989). Chawla (2001) also reviews the literature on beta stability and uses hypothesis tests to demonstrate instability of beta in Indian stock market.

Bos & Newbold (1984) report that the variation in the stock's beta may be due to the influence of either microeconomic factors, such as operational changes in the company or changes in the business environment peculiar to the company, and/or macroeconomic factors, such as the rate of inflation, general business environment and expectations about relevant future events. Roll & Ross (1994) claim that the choice of market index that is used to estimate beta may affect its value.Wang (2003) emphasizes the importance of having accurate beta forecasts.

Levhari & Levy (1977) claim that the beta estimates are biased if the analyst uses a time horizon shorter than the true one. Hawawini (1983) claims that a stock's beta may vary substantially depending upon whether it is estimated on the basis of daily, weekly, or monthly returns and proposes a model to overcome the interval effect in beta estimation. Cohen *et al*.(1986) and references therein also provide ample evidences that the beta estimates are sensitive to return intervals. Handa *et al*. (1989) propose that different beta estimates are possible for the same stock if different return intervals are considered. Daves *et al.* (2000) emphasize that daily return intervals should be used to estimate the beta as daily return intervals increases its precision. Gencay *et al*.(2003) report that the estimated beta becomes stronger with increased time intervals.

OBJECTIVES OF THE STUDY

This paper examines the impact of three return intervals i.e., daily, weekly, and monthly on the estimation of beta values of stocks. The study also evaluates the proposals of Gencay, Hawawini, and Handa in Indian context. Earlier, studies were conducted for the markets of developed countries. However, no such type of studies is available for Indian stock market. This paper aims to investigate the impact of the length of return intervals on stability of beta values of Indian stocks through empirical evidences from NSE, the leading stock exchange of India.

In this context, we test the following hypothesis:

Hypothesis 1:

Null hypothesis (Ho): $\mu(\beta_D - \beta_W) = 0$

Alternate hypothesis (H_1): $\mu(\beta_D - \beta_W) \neq 0$

where β_D is beta value of stock estimated on daily return basis and β_W is beta value of stock estimated on weekly return basis. $\mu(\beta_D - \beta_W)$ is population mean of the difference between paired beta values of stocks estimated on daily and weekly return intervals.

Hypothesis 2:

Null hypothesis (Ho): $\mu(\beta_D - \beta_M) = 0$

Alternate hypothesis (H_1): $\mu(\beta_D - \beta_M) \neq 0$

where β_M is beta value of stock estimated on monthly return basis. $\mu(\beta_D - \beta_M)$ is population mean of the difference between paired beta values of stocks estimated on daily and monthly return intervals.

Hypothesis 3:

Null hypothesis (Ho): $\mu(\beta_W - \beta_M) = 0$

Alternate hypothesis (H_1): $\mu(\beta_W - \beta_M) \neq 0$

where $\mu(\beta_W - \beta_M)$ is population mean of the difference between paired beta values of stocks estimated on weekly and monthly return intervals.

DATA COLLECTION AND METHODOLOGY

- A sample of fifty stocks of listed companies on NSE has been taken for this study. The sample of stocks has been selected from S & P CNX Nifty index of NSE.
- S&P CNX Nifty is a key index of NSE and represents well diversified portfolio of fifty stocks representing twenty three sectors of the economy. S & P CNX Nifty stocks represent about 65% of the free float market capitalisation and 45% of the traded volume of all stocks listed on NSE. Thus, returns of S&P CNX Nifty index are assumed to be the true proxies of stock market returns.
- Data of daily, weekly (weekend), and monthly (month-end) closing values of S&P CNX Nifty and selected fifty stocks from April 1, 2012 to March 31, 2013 have been compiled from official web site of NSE.
- Series of R_M and R_S (for each stock) are estimated through equations (7) and (8) respectively for the financial year 2012-13.

$$R_{M(i)} = (CV_{M(i)} / CV_{M(i-1)}) - 1 \quad (7)$$

and

$$R_{Si} = (CV_{S(i)} / CV_{S(i-1)}) - 1 \quad (8)$$

where $R_{M(i)}$ is return on market index, Nifty, of $(i)^{th}$ time period, $CV_{M(i)}$ is closing value of Nifty of $(i)^{th}$ time period and $CV_{M(i-1)}$ is closing value of Nifty of $(i-1)^{th}$ time period. Similarly, R_{Si} is stock's return of $(i)^{th}$ time period, $CV_{S(i)}$ is closing value of stock of $(i)^{th}$ time period and $CV_{S(i-1)}$ closing value of stock of $(i-1)^{th}$ time period. Time period may be daily, weekly, or monthly.

- The two leading stock exchanges of India National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) make use of Market Model for disseminating beta values of prominent stocks on their respective websites. We, therefore, applied Market Model mentioned in Equation (1) to estimate beta values of stocks.
- β_D , β_W and β_M of stocks are estimated as per Equation (5).
- β_D , β_W and β_M observations of stocks are compared with each other through paired *t* test to ascertain whether those are significantly different from their counterparts.

STATISTICAL ANALYSIS AND RESULTS

Using daily, weekly and monthly returns, we obtain β_D , β_W and β_M statistics of theeach of fifty sample stocks through Market Model which are summarized in table 1.

Testing of Hypothesis 1

As stated, Ho: $\mu(\beta_D - \beta_W) = 0$

H_1: $\mu(\beta_D - \beta_W) \neq 0$

As this is a case of taking 'repeated measurements' from same set of stocks (related populations), we test above mentioned hypothesis through paired *t* test. Table 2 displays the Microsoft Excel results of paired *t* test for this purpose.

Table 2 indicates that sample means of β_D and β_W are1.016 and 1.238, respectively. In the table, *t* test statistic is -10.9127. For Hypothesis 1, a two-tail test, upper and lower critical values from *t* distribution with 49 degrees of freedom and 0.05 level of significance are 2.0096 and -2.0096 respectively. Since $t = -10.9127 < t_{49} = -2.0096$ and p-value = 1.024E-14< 0.05, we reject null hypothesis. It, therefore, may be concluded that there is evidence of significant difference between the mean values of β_D and β_W. Result comes similar also at 0.01 level of significance as p-value is even lesser than to 0.01.

Testing of Hypothesis 2

Here, (Ho): $\mu(\beta_D - \beta_M) = 0$

(H_1): $\mu(\beta_D - \beta_M) \neq 0$

Table 3 displays the Microsoft Excel results of paired *t* test for this purpose.

From Table 3, sample means of β_D and β_M are 1.016 and

Table 1: β_D , β_W and β_M Statistics of Stocks as per Market Model

Sr. No.	Name of Stock	β_D	β_W	β_M
1	ACC Ltd.	0.78	0.98	0.85
2	Ambuja Cements Ltd.	0.94	1.27	1.47
3	Asian Paints Ltd.	0.65	0.81	0.63
4	Axis Bank Ltd.	1.52	1.82	2.30
5	Bajaj Auto Ltd.	0.63	0.55	0.99
6	Bank of Baroda	1.49	1.79	1.72
7	Bharti Airtel Ltd.	0.77	0.95	1.10
8	Bharat Heavy Electricals Ltd.	1.50	1.95	1.47
9	Bharat Petroleum Corporation Ltd.	0.67	0.96	1.13
10	Cairn India Ltd.	0.70	0.91	0.68
11	Cipla Ltd.	0.53	0.71	0.97
12	Coal India Ltd.	0.58	0.82	0.81
13	DLF Ltd.	1.68	1.99	2.35
14	Dr. Reddy’s Laboratories Ltd.	0.19	0.14	0.27
15	GAIL (India) Ltd.	0.71	0.89	0.85
16	Grasim Industries Ltd.	0.90	1.29	1.49
17	HCL Technologies Ltd.	0.78	0.97	0.95
18	Housing Development Finance Corporation Ltd.	0.94	1.23	1.55
19	HDFC Bank Ltd.	0.97	1.32	1.58
20	Hero MotoCorp Ltd.	0.73	0.88	0.71
21	Hindalco Industries Ltd.	1.63	1.96	2.06
22	Hindustan Unilever Ltd.	0.41	0.61	0.59
23	ICICI Bank Ltd.	1.68	2.02	2.46
24	IDFC Ltd.	1.79	2.18	2.50
25	Infosys Ltd.	0.77	0.92	0.86
26	I T C Ltd.	0.63	0.55	0.59
27	Jindal Steel & Power Ltd.	1.71	1.97	1.69
28	Jaiprakash Associates Ltd.	2.19	2.63	2.93
29	Kotak Mahindra Bank Ltd.	0.98	1.35	1.47
30	Larsen & Toubro Ltd.	1.56	1.87	1.98
31	Lupin Ltd.	0.17	0.14	0.38
32	Mahindra & Mahindra Ltd.	0.85	1.17	1.25
33	Maruti Suzuki India Ltd.	0.90	1.25	1.28
34	NTPC Ltd.	0.63	0.76	1.13
35	Oil & Natural Gas Corporation Ltd.	0.92	1.23	1.19
36	Punjab National Bank	1.47	1.76	1.98
37	Power Grid Corporation of India Ltd.	0.66	0.54	0.87
38	Ranbaxy Laboratories Ltd.	0.63	0.81	0.73
39	Reliance Industries Ltd.	0.95	1.24	1.17
40	Reliance Infrastructure Ltd.	2.19	2.42	2.76
41	State Bank of India	1.52	1.82	1.94
42	Sesa Goa Ltd.	1.67	1.98	2.35
43	Siemens Ltd.	1.06	1.27	1.68
44	Sun Pharmaceutical Industries Ltd.	0.44	0.35	0.70
45	Tata Motors Ltd.	1.58	1.90	2.28
46	Tata Power Co. Ltd.	1.16	1.52	1.63
47	Tata Steel Ltd.	1.46	1.68	1.98
48	Tata Consultancy Services Ltd.	0.48	0.62	0.78
49	Ultra Tech Cement Ltd.	0.40	0.35	0.69
50	Wipro Ltd.	0.66	0.79	0.95

Table 2:Paired *t* Test Results for Hypothesis 01

	β_D	β_W
Mean	1.016	1.238
Variance	0.2534	0.3695
Observations	50	50
Pearson Correlation	0.9842	
Hypothesized Mean Difference	0	
Df	49	
t Stat	-10.9127	
P(T<=t) one-tail	5.12E-15	
t Critical one-tail	1.6766	
P(T<=t) two-tail	1.024E-14	
t Critical two-tail	2.0096	

Table 3:Paired *t* Test Results for Hypothesis 02

	β_D	β_M
Mean	1.016	1.375
Variance	0.2534	0.4437
Observations	50	50
Pearson Correlation	0.9534	
Hypothesized Mean Difference	0	
Df	49	
t Stat	-10.5600	
P(T<=t) one-tail	1.599E-14	
t Critical one-tail	1.6766	
P(T<=t) two-tail	3.197E-14	
t Critical two-tail	2.0096	

1.375 respectively. The null hypothesis is rejected because $t = -10.56 < t_{49} = -2.0096$ and *p*-value = 3.197E-14 < 0.05. We, thus, conclude that there is significant difference between the mean values of β_D and β_M .

Testing of Hypothesis 3

As mentioned, (Ho): $\mu(\beta_W - \beta_M) = 0$

(H_1): $\mu(\beta_W - \beta_M) \neq 0$

Table 4 displays the Microsoft Excel results of paired *t* test for this purpose.

Table 4: Paired *t* Test Results for Hypothesis 03

	β_W	β_M
Mean	1.238	1.375
Variance	0.3695	0.4437
Observations	50	50
Pearson Correlation	0.9480	
Hypothesized Mean Difference	0	
Df	49	
t Stat	-4.5484	
P(T<=t) one-tail	1.78E-05	
t Critical one-tail	1.6766	
P(T<=t) two-tail	3.568E-05	
t Critical two-tail	2.0096	

From Table 4, sample means of β_W and β_M are 1.238 and 1.375 respectively. We reject the null hypothesis because $t = -4.5484 < t_{49} = -2.0096$ with *p*-value = 3.568E-05< 0.05 and conclude that there is significant difference between the mean values of β_W and β_M .

CONCLUSION

This study empirically assesses the impact of return interval on the estimation of beta. The above discussion proves thatβ_D,β_W and β_M of stocks are significantly different to each other.The results report significant change in beta values of stocks at different return intervals. It, therefore, becomes evident from this study that the beta estimates of Indian stocks are sensitive to return intervals.

REFERENCES

Bollerslev, T., Engle, R., & Wooldrige, J. (1988).A capital asset pricing model with time- varying covariances. *Journal of Political Economy*, 96, 116-131.

Bos, T., & Newbold, P. (1984). an empirical investigation of the possibility of stochastic systematic risk in the market model. *Journal of Business*, 57, 35-41.

Breen, W. J., Glosten, L. R., & Jagannathan, R. (1989). Economic significance of predictable variation in stock index returns. *Journal of Finance*, 44, 1177-1190.

Cohen, K., Hawawini, G., Mayer, S., Schwartz, R., & Whitcomb, D. (1986). *The microstructure of security Market*, Prentice-Hall, Sydney

Chawla, D. (2001). Testing stability of beta in the Indian stock market. *Decision*, 28(2),1-15.

Daves, P. R., Ehrhardt, M. C., & Kunkel, R. A. (2000). Estimating systematicrisk: The choice of return interval and estimation period. *Journal of Financial and Strategic Decisions*, 13(1) 7-13.

Elton, E. J., Gruber, M. J., Brown, S. J., & Goetzmann, W. N. (2003). *Modern portfolio theory and investment analysis*, 6th edition.Wiley, New York.

Ferson, W. E. (1989). Changes in expected security returns, risk and the level of interest rates. *Journal of Finance*, 44, 1191-1214.

Fabozzi, F., & Francis, J. (1978). Beta as a Random Coefficient. *Journal of Financial and Quantitative Analysis*, 13(1), 101-116.

Gencay. R., Selcuk, F., & Whitcher, B (2002). Systematic risk and time scales.*Quantitative Finance*,03, 108-116

Handa, P., Kothari,S.P., & Wasley, C. (1989). The relation between the return interval and betas: Implications for the size effect. *Journal of Financial Economics*, 23, 79-100.

Hawawini, G. (1983). Why beta shifts as the return interval changes. *Financial Analyst*, 39, 73-77.

Keim, D. B., & Stambaugh, R. F. (1986). Predicting returns in the stock and bond markets. *Journal of Financial Economics*, 17, 357-390.

Lintner, J. (1965). The valuation of risky assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics*, 47, 13-37.

Levhari, D., & Levy, H. (1977). The capital asset pricing model and the investment horizon. *Review of Economics and Statistics*, 59, 92-104.

Mandelker, G. (1974). Risk and return: The case of merging firms. *Journal of Financial Economics*, 4, 303-335.

Roll, R., & Stephen A. R. (1994). On the cross-sectional relation between expected returns and betas. *Journal of Finance*, 49, 101-122.

Sharpe, W. F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance*, 19, 425-442

Sharpe, W. F., Alexander, G. J., & Bailey, J. V. (1999). *Investments*, 6th edition, Prentice Hall, New Jersey.

Wang, K. Q. (2003). Asset pricing with conditioning information: A new test. *Journal ofFinance*, 58, 161-196.