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CHALLENGES BEFORE THE CARHART MODEL

A Study of Indian Stock Market

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Abstract : The Carhart model is a well-known asset pricing model. This model helps in determining the expected rate of return from an asset. We discover from the existing literature that there is disagreement among scholars over the applicability of this model in Indian context and other economies. Furthermore, despite the fact that the Indian economy has undergone significant changes during the period April 2008 through March 2023 including the period of COVID-19, most existing studies belong to prior 2008. This paper finds that the model faces an empirical challenge from April 2008 to March 2023 in Indian context.

IndexTerms **– Asset pricing, CAPM, Fama-French Model, Carhart model.**

I. INTRODUCTION

The Carhart Model of Asset Pricing is a financial framework that extends the Capital Asset Pricing Model (CAPM) by incorporating additional factors to better explain the returns of investment assets, particularly in the context of equity markets. Developed by Mark Carhart in 1997, the model builds upon the idea that the risk and return of an asset can be understood by considering various factors beyond just the overall market risk, as proposed by the traditional CAPM. The Capital Asset Pricing Model (CAPM), introduced by William Sharpe, John Lintner, and Jan Mossin in the 1960s, suggests that an asset's expected return should be proportional to its beta, a measure of its systematic risk or sensitivity to market movements. However, the CAPM has faced criticism for its simplicity and inability to fully capture the complexities of real-world asset pricing. The Capital Asset Pricing Model (CAPM), introduced by William Sharpe, John Lintner, and Jan Mossin in the 1960s, suggests that an asset's expected return should be proportional to its beta, a measure of its systematic risk or sensitivity to market movements. However, the CAPM has faced criticism for its simplicity and inability to fully capture the complexities of real-world asset pricing. The Carhart Model adds three additional factors to the traditional CAPM model: Market Risk (RMRF): This is the same market risk as in the CAPM, which measures the sensitivity of an asset's returns to overall market movements. It is typically represented by the excess return of the market index over the risk-free rate. Size (SMB): This factor represents the size effect, which suggests that small-cap stocks tend to outperform large-cap stocks over time. It measures the difference in returns between small-cap and large-cap portfolios. Value (HML): This factor captures the value effect, indicating that value stocks (those with low price-to-book ratios) tend to outperform growth stocks (those with high price-to-book ratios). It measures the difference in returns between value and growth portfolios. Momentum (WML): In some versions of the Carhart Model, a fourth factor, momentum (WML for Winners Minus Losers), is added. This factor accounts for the tendency of stocks with recent positive performance to continue outperforming and those with recent negative performance to continue underperforming. The Carhart Model argues that these additional factors (SMB, HML, and WML) help explain the cross-sectional variation in stock returns and provide a more accurate framework for evaluating the risk and return of assets, especially in the context of diversified portfolios. Investors and financial analysts often use the Carhart Model to assess the performance of investment portfolios and evaluate the contribution of various factors to returns. It has become an essential tool for both academics and practitioners in the field of finance, offering a more comprehensive view of asset pricing than the traditional CAPM.

II. Literature Review

A few researches have been conducted to study the Carhart model in the context of Indian financial markets. Before 2016, Banerjee et al. (2014) found limited momentum factor impact on NIFTY returns, while Dash and Mahakud (2014) identified consistent momentum effects on NSE data. Bajpai (2016) suggested low significance of momentum in NSE 500 analysis, whereas Sehgal and Jain (2011) observed momentum effects in sectoral returns. Ansari and Khan (2012) favored the momentum effect in their study of BSE-listed stocks from 1994 to 2006. After 2016, Misra et al. (2019) noted the importance of co-skewness over co-kurtosis in explaining returns. Sharma et al. (2016) used quantile regression to find momentum as a significant factor in Indian firms' average returns. Das and Barai (2016) provided empirical support for the Carhart model in non-financial actively traded firms listed on the Bombay Stock Exchange from 1998 to 2013. However, it's worth noting that these studies primarily predate the events that occurred in 2016 and beyond.

III. RESEARCH METHODOLOGY

Sample size

We have studied the BSE Sensex, therefore, the sample size is 30 which are the companies listed on the BSE Sensex.

Data and Sources of Data

We required the following data sets – (a) the monthly adjusted returns of the stocks which are constituents of the Nifty (b) the risk-free return, and (c) the values of SMB, HML and WML. The monthly adjusted closing prices (from April 2008 to March 2023) have been obtained from the official website of the Bombay Stock Exchange and Risk-free rate data has been obtained from the website of the Reserve Bank of India. After that, the calculations of SMB, HML and WML were made.

Theoretical framework

The Carhart model is defined as follows: Carhart model is a widely used asset pricing model in finance that extends the original Capital Asset Pricing Model (CAPM) by including additional factors to explain the cross-section of stock returns. The model was developed by Mark Carhart in 1997 and is commonly known as the "Four-Factor Model" because it incorporates four factors. Indeed, the Carhart model extends the traditional CAPM by incorporating the size premium (SML), value premium (HML), and momentum premium (WML). Theoretically, these factors are considered to have significant explanatory power in describing the cross-section of stock returns beyond the market beta. The equation for the Carhart model can be expressed as follows:

$$R_i - R_f = \alpha_i + \beta_i(R_m - R_f) + \beta_i^S SMB + \beta_i^V HML + \beta_i^M WML + u_i \qquad (1)$$

Let us denote $R_{it} - R_{ft}$ by ER_i and $R_m - R_f$ by ER_m, therefore, the above equation is

$$ER_i = \alpha_i + \beta_i ER_m + \beta_i^S SMB + \beta_i^V HML + \beta_i^M WML + u_i \qquad (2)$$

We have used the Fama-MaBeth regression on the following data sets – (a) the monthly adjusted returns of the stocks which are constituents of the Sensex (b) the risk-free return, and (c) the values of SMB, HML and WML. The monthly adjusted closing prices (from April 2008 to March 2023) have been obtained from the official website of the Bombay Stock Exchange. Equation (3) has been used to get the monthly returns of asset i.

$$R_{it} = \left(\frac{P_t - P_{t-1}}{P_{t-1}}\right) \times 100 \qquad \ldots (3)$$

where Pt = Closing adjusted price at time t; P(t-1) = Closing adjusted price at one time lag i.e., t –1. Moreover, the values of SMB, HML, and MOM are not directly observable or available, but they have been calculated using equations (4), (5), and (6).

$$SMB = \frac{(SH + SM + SL)}{3} - \frac{(BH + BM + BL)}{3} \qquad \ldots (4)$$

$$HML = \frac{(SH + BH)}{2} - \frac{(SL + BL)}{2} \qquad \ldots (5)$$

$$WML = \frac{(SW_* + BW_*)}{2} - \frac{(SL_* + BL_*)}{2} \qquad \ldots (6)$$

where SH (Small-High), SM (Small - Medium), SL (Small - Low), BH (Big-High), BM (Big-Medium), BL (Big-Low), SW_* , BW_*, SL_* BL_* are the average returns of the portfolios.

3.4RESULTS

The following table shows the second pass results of the Fama-MacBeth regression. As per the table, R-squared value is 0.906970 (or 90.69 percent), but the adjusted R-squared has dropped to 0.534850 (53.48 percent), thus, the factors exposures jointly explain the average returns to the extent of 53.48 percent only. However, they do not explain the average returns significantly because the p-value 0.4433 (44.33%) of F-statistic is found to be exceeding the significance level of 5 percent. Thus, the degree of goodness of fit of the Carhart model is very much low. Moreover, none of the factor betas is significant because their individual p-value exceeds the significant level of 5 percent. Their individual relationships are shown in Figure -1, Figure-2, Figure-3, and Figure-4. In the figures, it can be easily noticed that the relationships are almost flatter or horizontal implying that there is no much impact of the factors**.**

Table-1: Fama-MacBeth Cross-Sectional Regression (or Second Pass Regression)

Variable	Coefficient	Std. Error*	t-Statistic	Prob.
γ_0^i (Constant)	-0.066866	0.044611	-1.498874	0.3746
β_1^i (Market beta)	0.022068	0.043578	0.506407	0.7016
β_2^i (SMB beta)	0.006910	0.004257	1.623377	0.3515
β_3^i (HML beta)	-0.004717	0.008119	-0.581037	0.6649
β_4^i (WML beta)	-0.008408	0.001258	-6.681327	0.0946

R-squared	0.906970	Mean dependent var	-0.044164
Adjusted R-squared	0.534850	S.D. dependent var	0.005115

S.E. of regression	0.003489	Akaike info criterion	-8.603628
Sum squared resid	1.22E-05	Schwarz criterion	-8.777162
Log likelihood	30.81088	Hannan-Quinn criter.	-9.298298
F-statistic	2.437306	Durbin-Watson stat	2.980347
Prob(F-statistic)	0.443325	Wald F-statistic	22.89880
Prob(Wald F-statistic)	0.155321		

Author's Note: *Standard errors are HAC standard errors i.e., Heterosdasticity and Autocorrelation consistent errors.

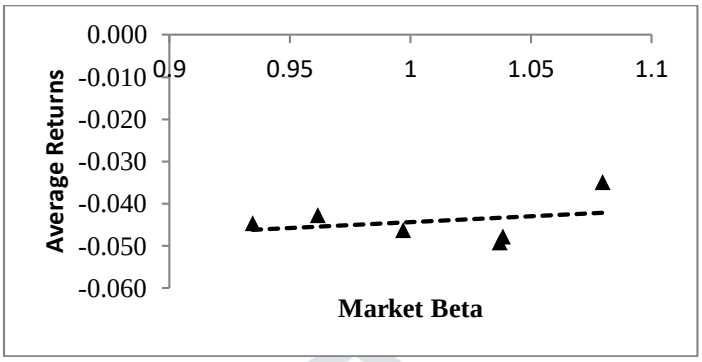

Figure -1: Relationship between average returns and market beta.

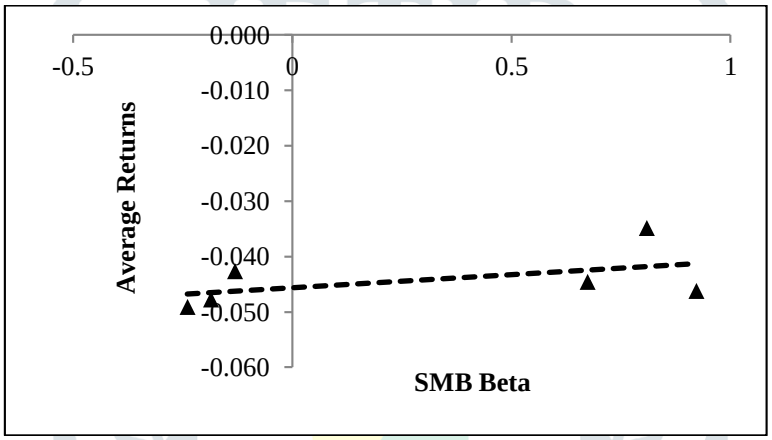

Figure -2: Relationship between average returns and *SMB* beta.

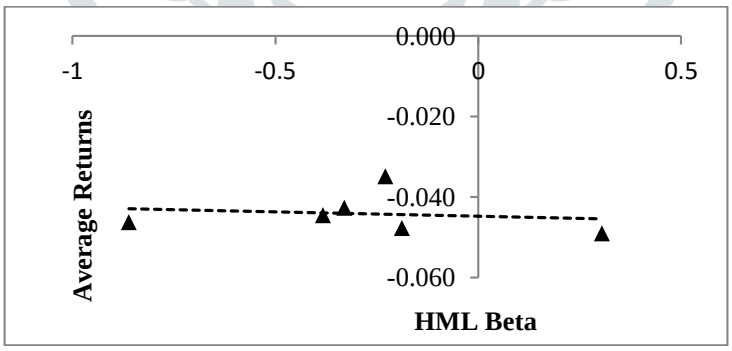

Figure -3: Relationship between average returns and *HML* beta.

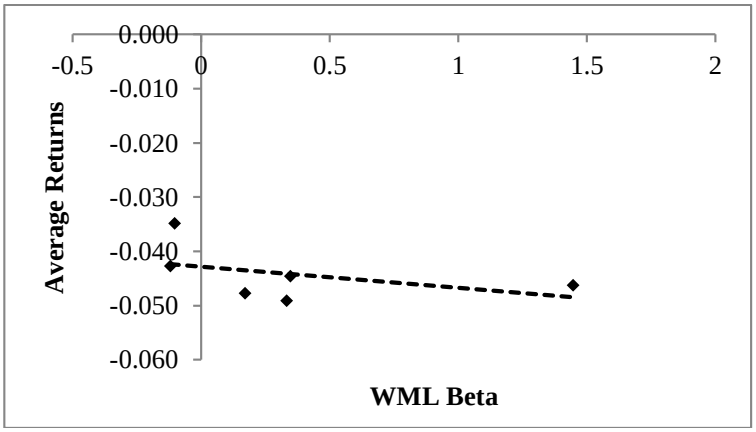

Figure -4: Relationship between average returns and WML beta.

IV. CONCLUSION

Based on the analysis of the BSE Sensex data for the period April 2008- March 2023, the empirical obstacles in the Carhart model have been examined in this research paper. the Carhart model exhibits a low degree of goodness of fit. The factors betas jointly explain only 53.48 percent of the average returns, which is not statistically significant. Furthermore, none of the factor betas are found to be significant individually.

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