Asset Pricing Models In Indian Capital Markets

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INTRODUCTION

Asset pricing theory is a framework designed to identify and measure risk, as well as to assign rewards for bearing risk. Asset pricing models help assess the *"fair"* rate of return for a particular asset, which is critical for the investment decision facing both corporations evaluating projects and investors forming portfolios. In the corporate setting, the theory helps characterize the risk of a particular project or acquisition and assigns a discount rate that reflects the risk. In the portfolio investment setting, the theory helps identify overvalued and undervalued assets. Asset pricing theory is also an input in establishing a framework to help the investor understand the risk that he faces with a particular portfolio.

The fundamental model in asset pricing was the Capital Asset Pricing Model (CAPM) of Sharpe (1964), Lintner (1965), and Mossin (1966). The CAPM explains the returns of stocks/portfolio of stocks in terms of their systematic risk. However, there is a general contention that the simple CAPM does not adequately describe stock return behavior. Other factors such as the earning to price ratio, market capitalization (size) and book to market ratio have also been found to affect the returns of stocks (Fama and French, 1992, 1995). At the same time, asset prices are commonly believed to react sensitively to macro-economic factors. Ross (1976) proposed the Arbitrage Pricing Model (APM), extending the CAPM to include other macro-economic factors in explaining asset returns.

LITERATURE REVIEW

The roots of asset pricing theory can be traced back to Markowitz's Theory (Markowitz; 1952, 1959). The Markowitz Model is a single-period model, where an investor forms a portfolio at the beginning of the period, with the objective to maximize the portfolio's expected return, subject to an acceptable level of risk (or minimize risk, subject to an acceptable expected return). The Capital Asset Pricing Model (CAPM) was developed by Sharpe (1964), Lintner (1965) and Mossin (1966) on the Markowitz framework. They showed that, assuming that investors use Markowitz theory in forming portfolios, in the presence of a risk-free asset, investors would choose a portfolio with a combination of the risk-free assets and a market portfolio, tangent to efficient frontier; this would result in a linear relationship between the systematic risk (beta) of an asset and its return. Unfortunately, the CAPM is restricted by some of its unrealistic assumptions. Ross (1976) proposed the Arbitrage Pricing Model (APM), which is based on the premise that arbitrage opportunities should not exist in efficient financial markets. The APM assumes that there are a set of factors, which cause asset returns to systematically deviate from their expected values, and shows that an asset's expected return must be a linear function of its sensitivity to the common factors. However, the theory does not specify how many factors should be taken, nor does it identify the factors.

Basu (1977) contradicted the predictions of the CAPM. He showed that stocks with high earnings/price ratios (or low price/earnings ratios) earned significantly higher returns than stocks with low earnings/price ratios (i.e. an "E/P effect"), and that differences in beta could not explain these return differences.

Bhandari (1988) studied the relation between leverage and asset returns. He found that stock returns were positively related to the debt-equity ratio, controlling for the beta and firm size, and controlling for the January effect.

Fama and French (1992) studied the influence of size, leverage, earnings/price ratio, book-to-market-value, and beta on asset returns. They found out that book-to-market-value and firm size had significant influence on assets returns, whereas beta did not.

Soufian (2001) studied the impact of macro-economic factors on asset returns. She found that the influence of the

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market portfolio diminishes when macro-economic variables are introduced into the model. She also found that several factors, including risk premium, term structure, changes in expected inflation, unexpected inflation and changes in yearly industrial production are statistically significant in explaining the variation of average returns.

Dhankar and Singh (2005) studied asset pricing models in Indian capital markets, viz. the National Stock Exchange (NSE) and the Bombay Stock Exchange (BSE). Their results suggested that the APM may lead to better estimates of expected rate of return than the CAPM. They suggested that the APM explains the return generation process, and forecasts return better than the CAPM.

Many studies have investigated the influence of different factors on asset returns. There is a wide consensus that the APM is a better model than the CAPM, but very few studies test the difference between them. The present study tests the difference between the CAPM and the APM in Indian capital markets, specifically, the National Stock Exchange (NSE).

DATA AND METHODOLOGY

The data for the study was collected from a sample of fifty companies listed in S&P 500 on the National Stock Exchange belonging to the eight most flourishing industries in the Indian economy, viz. cement, textiles, pharmaceuticals, telecom, software, entertainment/media, construction/infrastructure, and finance/banking. The data used in the study consisted of weekly average closing prices of the sample scrips, weekly average closing S&P 500 index values, weekly average INR/USD exchange rates, weekly average MIBOR rates, weekly average oil prices, and weekly average inflation rates. The study period was 1-January-2005 to 31 December-2007. The data was collected from NSE[1], RBI[2], and other financial websites[3].

The study uses the standard two-step regression method to estimate the CAPM and the APM using the sample scrips. For the CAPM, the first step of the analysis involved computations of the betas of each of the sample scrips. This involved the first pass regression for each scrip, i.e. $r_{it} = \alpha_i + \beta_i r_{Mt}$. The next step involved the second pass regression, i.e. $Er_i = a + b\beta_i$. For the APM, the first step involved residual analysis in order to justify the selection of macro-economic variables for the analysis. The SML residuals were computed as $\hat{\epsilon}_i = Er_i - [\hat{a} + \hat{b}\beta_i]$. The first pass regressions were performed once again in order to compute the betas of each of the sample scrips with respect to each macro-economic variable. The residuals from the SML regression were then regressed on each of these betas. Once the macro-economic variables were selected for the analysis, factor analysis was performed to identify the factor structure of the macro-economic variables. The factors were then used in the first pass regression for each scrip:

$$r_{it} = \alpha + \Sigma_i \beta_{i,j} F_{j,t}$$

The factor betas were then used in the second pass regression (the APM): $E_{ri} = r_f + \Sigma_j \lambda_j \beta_{i,j}$

To test for the significance of the difference between the CAPM and the APM, the F-test was employed, i.e. $F_{cal} = \dfrac{(SSE_R - SSE_U)/k}{MSE_U}$, with $df_1 = k$, the number of additional variables in the APM, and $df_2 = n\text{-}k\text{-}1$, the degree of freedom of MSE in the APM. The difference is significant if F_{cal} is significant.

THE CAPM REGRESSION

The results of the CAPM regression are shown in the Table1 . Comparing the results of the regression with the CAPM model, $Er = r_f + [Er_M - r_f]\beta$, the risk-free rate is estimated to be $\alpha = 6.85\%$, and the market risk premium is estimated to be $\beta = 16.975\%$. The model fit was low, with $R^2 = 16.4\%$.

THE APM REGRESSION

The macro-economic variables considered in constructing the APM were the following: MIBOR (i.e. interest rates), oil prices, exchange rates, and inflation rates. The values of the macro-economic variables are plotted in Figures 1 - 4.

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[1] www.nse-india.com

[2] www.rbi.org

[3] www.capitalmarket.com

Table 1: SML Regression					
Regression Statistics					
Multiple R	0.4050				
R Square	0.1640				
Adjusted R Square	0.1470				
Standard Error	0.0058				
ANOVA					
df	**SS**	**MS**	F	**p-value**	
Regression	1	0.000059	0.000059	9.415	0.000415
Residual	48	0.000310	0.000006		
Total	**49**	**0.000369**			
	Coefficients	**Standard Error**	**t Stat**	**p-value**	
Intercept	0.06850	0.06200	1.1048	0.1374	
Beta	0.16975	0.06125	2.7714	0.0040	

Table 2: Regression Of SML Residuals On MIBOR Betas					
Regression Statistics					
Multiple R	0.1459				
R Square	0.0213				
Adjusted R Square	0.0173				
Standard Error	0.0011				
ANOVA					
	df	SS	MS	F	**p-value**
Regression	1	0.000042	0.000042	7.47128	0.00673
Residual	48	0.000268	0.000006		
Total	**49**	**0.000310**			
	Coefficients	**Standard Error**	**t Stat**	**p-value**	
Intercept	-0.0001	0.0001	-1.2855	0.1998	
MIBOR_Beta	0.1985	0.0863	2.2997	0.0223	

Table 3: Regression Of SML Residuals On Oil Price Betas					
Regression Statistics					
Multiple R	0.17271				
R Square	0.029829				
Adjusted R Square	0.025836				
Standard Error	0.001112				
ANOVA					
df	**SS**	**MS**	F	**p-value**	
Regression	1	0.000052	0.000052	9.72910	0.003065
Residual	48	0.000258	0.000005		
Total	**49**	**0.000310**			
	Coefficients	**Standard .Error**	**t Stat**	**p- value**	
Intercept	0.0000	0.0001	0.5979	0.5504	
Oil Price_Beta	2.4798	0.9072	2.7334	0.0067	

Table 4: Regression Of SML Residuals On Exchange Rate Betas					
Regression Statistics					
Multiple R	0.260761				
R Square	0.067996				
Adjusted R Square	0.064161				
Standard Error	0.00109				
ANOVA					
	df	**SS**	**MS**	**F**	**p-value**
Regression	1	0.000082	0.000082	17.72859	0.000036
Residual	48	0.000228	0.000005		
Total	**49**	**0.000310**			
	Coefficients	**Standard Error**	**t Stat**	**p- value**	
Intercept	-0.00009	0.000073	-1.2967	0.195960	
Exchange Rate_Beta	0.31490	0.074800	-4.2105	0.000036	

Table 5: Regression Of SML Residuals On Inflation Betas					
Regression Statistics					
Multiple R	0.192229				
R Square	0.036952				
Adjusted R Square	0.032989				
Standard Error	0.001108				
ANOVA					
	df	**SS**	**MS**	**F**	**p-value**
Regression	1	0.000050	0.000050	9.323888	0.002514
Residual	48	0.000260	0.000005		
Total	**49**	**0.000310**			
	Coefficients	**Standard Error**	**t Stat**	**p- value**	
Intercept	0.0000776	0.0000752	1.03134	0.303407	
Inflation_Beta	0.2663200	0.0872170	-3.0535	0.002514	

The results of the residual regressions variables on the macro-economic variables are shown in Tables 2,3,4 and 5. The results of the regressions are given in Tables 2,3,4 and 5, and indicate that each of the variables considered should be introduced into the SML regression to improve its explanatory power.

Table 6: Correlation Between The Macro-Economic Variables

		MIBOR	INFLATION RATE	OIL PRICE	EXCHANGE RATE	S&P 500
MIBOR	Pearson Correlation	1.000	-.071	-.126	.019	-.005
	Sig. (1-tailed)		.239	.103	.424	.480
INFLATION RATE	Pearson Correlation	-.071	1.000	-.042	.036	.045
	Sig. (1-tailed)	.239		.339	.360	.326
OIL PRICE	Pearson Correlation	-.126	-.042	1.000	.157	-.058
	Sig. (1-tailed)	.103	.339		.056	.280
EXCHANGE RATE	Pearson Correlation	.019	.036	.157	1.000	-.438(**)
	Sig. (1-tailed)	.424	.360	.056		.000
S&P 500	Pearson Correlation	-.005	.045	-.058	-.438(**)	1.000
	Sig. (1-tailed)	.480	.326	.280	.000	

** Correlation is significant at the 0.01 level (1-tailed).

Table 7: Factor Analysis: Rotated Component Matrix			
	Component		
	1	2	3
MIBOR		-.758	
INFLATION RATE			.944
OIL PRICE		.739	
EXCHANGE RATE	.849		
S&P 500	-.831		
% variance explained	29.208%	22.566%	20.732%
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.			

The next step was factor construction. The correlations between the macro-economic variables are shown in Table 6, and the results of factor analysis are shown in Table 7. As shown in Table 7, three factors were identified: a market factor, comprising of the S&P 500 index and the (INR/USD) exchange rate, a MIBOR factor, comprising of the MIBOR and (crude) oil prices, and an inflation factor, comprising the inflation rate on its own.

The factors were then used in the first-pass regression for each stock, i.e.

$$r_{it} = \alpha + \beta_{i,market} F_{market,t} + \beta_{i,MIBOR} F_{MIBOR,t} + \beta_{i,inflation} F_{inflation,t.}$$

The factor betas were then used in the second pass regression (i.e. the APM):

$$Er_i = r_f + \lambda_{market} \beta_{i,market} + \lambda_{MIBOR} \beta_{i,MIBOR} + \lambda_{inflation} \beta_{i,inflation.}$$

The results of the APM regression are shown in Table 8.

Table 8: APM Regression					
Regression Statistics					
Multiple R	0.4630				
R Square	0.2140				
Adjusted R Square	0.1900				
Standard Error	0.0787				
ANOVA					
	df	**SS**	**MS**	**F**	**p-value**
Regression	3	0.000077	0.000026	4.17727	0.01069
Residual	46	0.000292	0.000006		
Total	**49**	**0.000369**			
	Coefficients	**Standard Error**	**t Stat**	**beta**	**p-value**
Intercept	0.00227	0.001712	1.32768		0.0954
Beta_market factor	0.31538	0.070383	4.48093	0.56194	0.0000
Beta_MIBOR factor	0.419087	0.189134	2.21582	0.27835	0.0158
Beta_inflation factor	0.016225	0.171092	0.09483	0.01157	0.4624

The results of the APM regression indicate that two of the factors are significant: the market factor and the MIBOR factor. In particular, the market factor has more than two times an impact on expected returns as the MIBOR factor. The model fit was moderate/low, with $R^2 = 21.4\%$.

Finally, to test for the significance of the difference between the CAPM and the APM, the F-statistic is computed, with $SSE_R = 0.000310$ (from Table 1), $SSE_U = 0.000292$, and $MSE_U = 0.000006$ (from Table 8), yielding $F_{cal} = 1.5000$ (with $df_1 = 2, df_2 = 46$), which is clearly not significant at 5% level of significance.

DISCUSSION

The results of the study show that the APM does not have significant better explanatory power over the CAPM for Indian capital markets. Apart from the market factor, the APM suggests that interest rates (the MIBOR factor) have a significant role to play in influencing asset returns; but the market factor was found to be the most influential of the factors, more than twice as important as interest rates. There are several limitations inherent in the study. The sample size used for the study was quite limited. The models applied were very static in nature. Furthermore, they did not take into account company factors such as size (market capitalization) and book-to-market-value and qualitative factors such as government policies, industry lifecycle, political risk, and so on, which have an impact on asset returns. The results of the study could also depend on the nature of capital markets in the study period, which was a boom period, and may not be generalisable to other periods. There is a vast scope for further research in the field of asset pricing, bringing in a wider range of macro-economic, industry-related, and company-specific variables in order to explain asset returns. More detailed studies, taking different periods and controlling for more factors would give better insight into the nature of asset returns.

Figure 1: Weekly Average MIBOR Rates For The Study Period

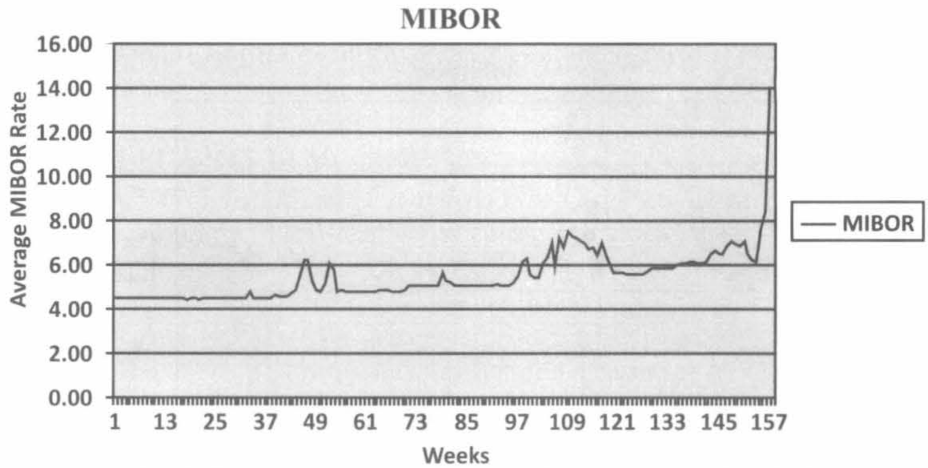


Figure 2: Weekly Average Oil Prices For The Study Period

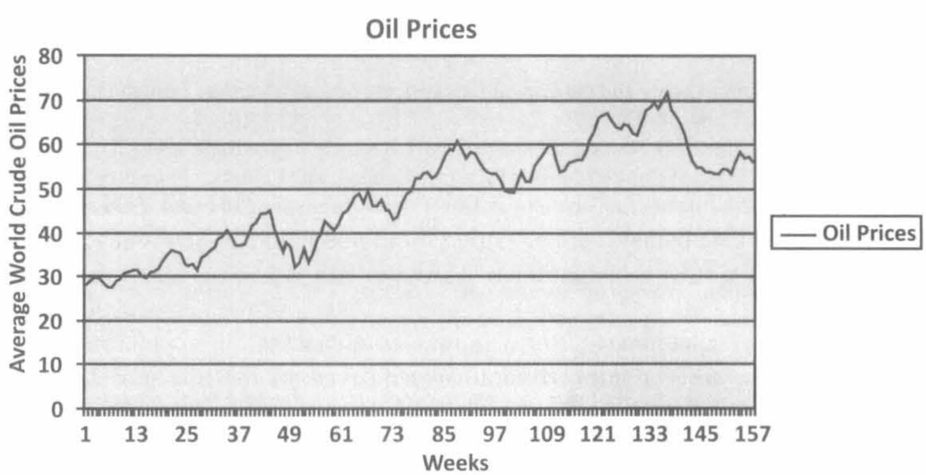


Figure 3: Weekly Average USD/INR Exchange Rate For The Study Period

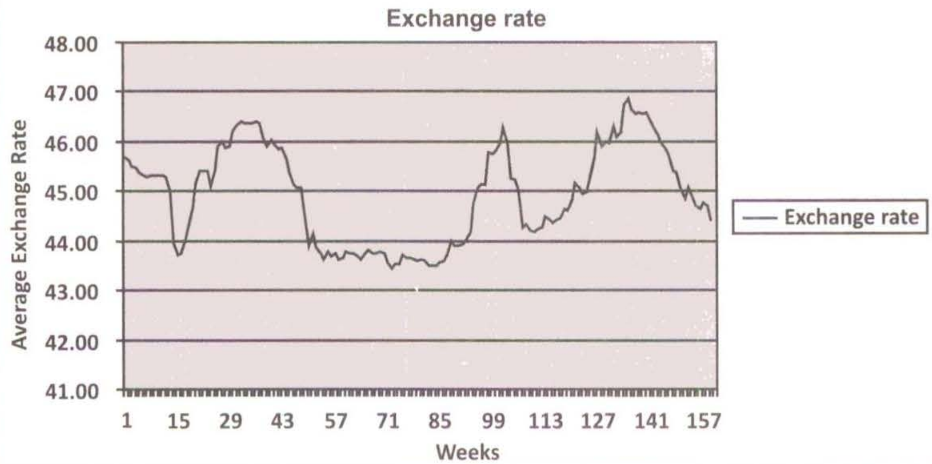
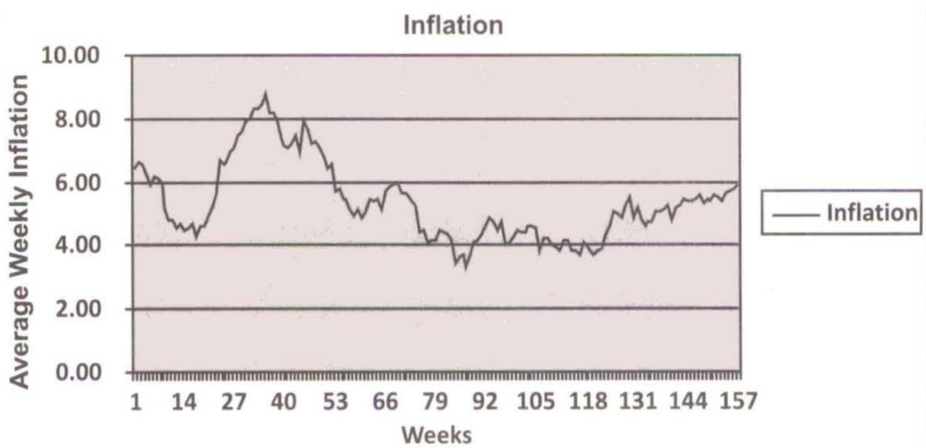


Figure 4: Weekly Average Inflation Rates For The Study Period



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