PERFORMANCE EVALUATION ARBITRAGE PRICING THEORY: EVIDENCE FROM INDIA

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ABSTRACT

This research aims to assess the efficacy of the Arbitrage Pricing Theory in terms of predictability and forecasting for a given time horizon. The CNX Auto index and its constituents were chosen for this purpose using stratified random sampling from various NSE sectoral indices. Returns for the period of 2010-20 are computed from the index and constituents' weekly closing prices for the period under consideration are processed using a two stage multi regression model. The fitted APT model's predicting performance is supported by strong evidence.

KEYWORDS: Performance Evaluation, Arbitrage Pricing Theory.

1. INTRODUCTION

The present study aims to examine the efficiency of Arbitrage pricing theory to estimate the expected return from stocks of the select sectoral index of National stock exchange of India limited. But, the main problem in testing the APT is that the APT has been silent about which events and factors are likely to influence all assets. There is a rather gap between the theoretically exclusive importance of systematic "state variables" and our complete ignorance of their identity. This is, both, its strength and its weakness. It is strength in empirical work because it permits the researcher to select whatever factors provide the best explanation for the particular sample at hand, whereas it is the weakness in practical applications because, in contrast to the CAPM, it cannot explain variation in asset returns in terms of limited and easily identifiable factors. The arbitrage pricing theory and any other asset pricing model predecessor to this model do not provide the clear-cut mechanism to identify the set of macroeconomic forces that are related to stock returns which exert considerable influence on latter. It means that the casual relation between macroeconomic forces and stock returns. However, there are set of the variables that have been identified in the literature as important explanatory variables of stock returns and here this study shall examine this relation in detail with respect to select set of macroeconomic variables as follows. After going through literature thoroughly this study shortlisted eight macroeconomic variables for fitting the APT model which includes 1) Index of Industrial

Production, 2) Wholesale Price Index, 3) Call Money Rate 4) Exchange Rate, 5) Crude Oil Price, 6) Gold Prices, 7) NSE Nifty Index and 8) S& P 500 Index. All these factors are found to be priced in various studies and in varying context.

2. Literature Review

Richard Roll and Stephen A. Ross (1980) The empirical data support the APT against both unspecified alternative – a very weak test – and the specific alternative that own variance has an independent explanatory effect on excess returns. **Jay Shanken (1982)** concludes that the usual formulation of testable implications of the APT is shown to be inadequate, as it precludes the very expected return differentials which the theory attempts to explain. A recent competitive – equilibrium extension of the APT may be testable in principle. In order to implement such a test, however, observation of the return on the true market portfolio appears to be necessary. **Mustafa n. Gultekin et. al., (1987)** reveals that the most important implication of the findings in this paper is that the APT model can explain the risk-return relation mostly for January. **I. Virtanen (1992)** comes out with a research study titled "Some Empirical Tests of The Arbitrage Pricing Theory Using Transformational Analysis". This study concludes that the mean and variance of the returns were not fully time invariant. **Gregory connor et. al., (1993)** develops a test statistic to determine the number of factors in an approximate factor model of asset returns which does not require that diversifiable components of returns be uncorrelated across assets. This study finds evidence for one to six pervasive factors in the cross-section of New York Stock Exchange and American Stock Exchange stock returns. **Kai – Chun Chiu et. al., (2003)** investigated a generalised version of the APT model called macroeconomics modulated independent state space model in terms of model specification adequacy and its performance on prediction. Empirical results reveal that the model is not only well specified but also superior to the temporal factor analysis model in stock prices and index forecasting. **Javed Iqbal and Aziz Haider (2005)** examines the validity of the Arbitrage Pricing Theory (APT) model on returns from 24 actively trading stocks in Karachi Stock Exchange. Explanatory factor analysis approach indicates two factors governing stock return. The pre-specified macroeconomic approach identifies these two factors as the anticipated & unanticipated inflation and market index & dividend yield. **Shaojan Wang (2011)** re-modified Arbitrage Pricing Theory by adding basis skewness and kurtosis in addition to basis common factors and tested the predictive power of the modified model. The conclusion of the analysis is that model is valid and can be regarded as a natural generalisation of the classical APT model. **Dr. P.A. Isemila (2012)** examines the significance of money supply, exchange rate and inflation and oil prices in explaining stock returns in the Nigerian stock market. The findings reveal that money supply (M2) and exchange rate were appeared to be negative and also a significant determinant of stock returns both in the long-run and the short-run dynamic model for both one period and two period lags. The conclusion is that though the APT macroeconomic variables can explain stock returns, not all the variables are significant both in the long run and in the short run. **Yasmeen**

et. al., (2012) examined the validity of the CAPM in the capital markets of the Pakistan. The findings of the study are not in support of CAPM. The findings show that residual risk plays some role for pricing risky assets. The market risk alone does not explain the stocks excess returns and the unique risk also contributes towards the excess returns. **Bing Zhu (2012)** studied the impact of macroeconomic factors on the return of energy sector in Shanghai stock market (SEE), which are inflation rate, money supply (M2), exchange rate, industrial production, bond, exports, imports, foreign reserve and unemployment rate. The findings reveal that exchange rate, exports, foreign reserve and unemployment rate have effects on the stock return of energy sector in Shanghai stock market. **Muhammad Umar Faruque (2012)** investigated the explanatory power of Arbitrage pricing Theory from Frontier stock market perspective. The results confirm evidence of one significant macroeconomic factor in the Dhaka stock market - a frontier stock market of Bangladesh. **Florin Dan Pieleanu (2012)** reveals that the findings sustain APT only minimally for the 2 sub-periods, where only one priced factor was obtained, and stronger evidence was found for the entire period of time while 3 factors proved to be significant in influencing the returns of the selected assets. These results mainly those for the whole period of time resemble the conclusions of the majority of studies, who found in general 2-4 priced factors, regardless of which market was analysed. **Dr. Pooya Sabetfari and Dr. Cheng Fan Fah (2013)** made a study on "Test of Intertemporal Variability of APT in a Volatile Economy". In full period the sources of risk are the export of crude oil and interest rate proxy. In second sub-periods money supply (M2), money supply (M1), consumer price index and GDP are sources of risk. So that, the sources of systematic risks in TSE are dissimilar and not quantified. The important macroeconomic variables could be affected by stock returns changes during times. Therefore, it is hard to identify exactly which is the source of risk in TSE. **Khalafalla Ahmed Mohammed Arabi (2014)** Empirical results showed that volatility computed via TARCH indicates the impact of the bad news on the conditional is twice as good news; in addition to the preference of generalised least squares over covariate (fixed effects) model as an estimation technique. Results are against the CAPM because the CAPM's prediction that the intercept should equal zero has not been attained, and its main assumption i.e. the security market is efficient is violated. The APT showed no reaction to the news from macroeconomic variables. Nevertheless, APT out-performed Fama-French model and CAPM.

3. Research Gap

The literature review presented in the previous section reveals that there has been extensive literature and research works on as to testing the validity of arbitrage pricing theory with respect to various stock exchanges across the world. Studies aiming to test the explanatory power of arbitrage pricing theory were confined to other than Indian stock market. There are very few works aiming to test the explanatory power of asset pricing models in Indian stock market context. This work is a small endeavor to fill the research gap and focusing on the empirical validity of Arbitrage pricing theory with respect to Auto sectors in for the select time horizon.

4. Objectives

To examine the efficiency of Arbitrage Pricing Theory (APT) in estimation of expected return of stocks across the select sectoral indices of NSE.

5. Research Hypotheses

- H0: There is no difference between returns expected by APT and actual returns of selected set of stocks of various sectors.
- H0: There is no difference between returns expected by APT and actual returns of selected set of stocks over different time horizons.

6. Research Methodology

This part of the study deals with the detail presentation of the Research methodology followed to proceed with the work

6.1 Sampling Method

Stratified sampling method has been adopted to draw sample of stocks from universe where stocks are divided into various clusters such as sectoral indices which are being maintained by National stock exchange of Indian includes CNX Auto, CNX Bank, CNX Energy, CNX Finance, CNX FMCG, CNX IT, CNX Metal, CNX Pharma and CNX PSU Bank. One cluster, that is CNX Auto Index, is randomly selected for this study. All the stocks which are the constituents of sectoral indices are the sample of stocks for the study and sector indices as well. As observed from review of literature, most popularly used macroeconomic forces which have influence on stock market are selected, they are index of production (IIP), Money supply (M2), Mumbai interbank offer rate (MIBOR), Call money rate (CMR), NSE-NIFTY, USD-INR Exchange rate, Wholesale price index (WPI), Crude oil price and S&P index. Sample of the study is presented below.

6.2 Data Sources

Present study fully depends on the secondary data collected from various sources such as weekly index numbers of selected macroeconomic variables from Reserve bank of India monthly bulletin available at website. Data of few variables available at monthly frequency is converted into high frequency i.e., weekly frequency through e-views software. Weekly closing prices of crude oil are collected from MCX website. Weekly closing prices of all selected stocks are collected from an authorised website of National stock exchange of India.

6.3 Time Period of The Study

The time period of the study is of ten years starting from 1.04.2010 to 31.04.2020. The select asset

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pricing model is also evaluated for the whole period of ten years starting from 01.04.2010 to 31.03.2020 because during this period of ten years, many structural changes have been taken place in the financial system. It might have entailed regime switching in the behaviour of the economic variables. Considering entire ten years as one period may camouflage the impact of the regime switching on the results of the analysis.

6.4 Scope of the Study

The scope of the study is concerned, this study is confined to constituents of selected sectoral index being maintained by the National stock exchange of India, though, there are many sectoral and broad-based market indices. There are many asset pricing models available for pricing capital asset but, this study is limited to one asset pricing model such as Arbitrage pricing theory.

6.4 Analytical Framework of The Study

The analytical framework of the study is as follows:

$$E(R_i) = \lambda_0 + \lambda_1 b_{i1} + \lambda_2 b_{i2} + \ldots\ldots\ldots\ldots + \lambda_k b_{ik}$$

The analysis proceeds in the following stages:

1. To develop the APT model for Indian stock market, in a first step, weekly returns of the select sectoral indices and its constituents are regressed on the changes in select macroeconomic factors to compute respective betas for time period under consideration. This regression is known as first pass regression and it gets the following form;

   $R_{it} - R_f = \beta_1$ NSE Nifty $+ \beta_2$ IIP $+ \beta_3$ S&P 500 $+ \beta_4$ USD/INR $+ \beta_5$ WPI $+ \beta_6$ CMR $+ \beta_7$ Crude oil $+\beta_8$ Gold Price $+ \varepsilon_t$

2. In the second step, regression of the average holding period excess returns from the select sectoral indices and its constituents (dependent variable) on the beta coefficients of the select macroeconomic factors (independent variable), resulted from the first pass regression, is computed, this cross-sectional regression is known as second pass regression. This second pass regression gets the following form:

   $\overline{R}_i = \lambda_o + \lambda_{NSE\ Nifty}\tilde{b}_{iNSE\ Nifty} + \lambda_{IIP}\tilde{b}_{iIIP} + \lambda_{S\&P\ 500}\tilde{b}_{iS\&P\ 500} + \lambda_{USD/INR}\tilde{b}_{iUSD/INR} +$
   $\lambda_{WPI}\tilde{b}_{iWPI} + \lambda_{MMR}\tilde{b}_{iMMR} + \lambda_{Crude\ Oil}\tilde{b}_{iCrude\ Oil} + \lambda_{Gold\ Price}\tilde{b}_{iGold\ Price}$

3. Step 1 through 2 is repeated for all the periods under consideration.
   Expected returns calculated through APT model are compared with actual market returns of all sample stocks under consideration to find out the explanatory power of APT in Indian stock market context.

7. Empirical Testing of Arbitrage Pricing Theory

This section of the study deals with the empirical testing of the Arbitrage pricing theory in Indian context and this process go through five parts. First part of this section includes the presentation of relationship between select macroeconomic variables and studying the profile of returns from the same macroeconomic factors for the investment horizon under consideration separately. Second part of this section includes fitting of APT vis-a-vis each of the all select NSE sectoral index using multiple regression analysis as mentioned in the previous section. Resulted statistics of regression models such as beta values, standard error value and t-statistics pertaining to all the select macroeconomic factors will be well tabulated and interpreted. Third part deals with performance evaluation of the APT with respect to all the sectors for all the three time periods. This performance evaluation is discussed from three measures like F-statistic of the model representing the accuracy of the prediction, R-square value of the model representing the degree of predictability of the model and Mean absolute scaled error value (MASE) to evaluate the performance of the model in terms of its forecasting. Finally, fourth part of the section comprises of results from cross-sectional regression analysis.

7.1 Relationship between Select Macroeconomic Variables and Stock Returns

This part of the study provides the theoretical relationship between select macroeconomic forces with the characteristics of the returns from the select sectoral index and its constituents for the selected time period.

7.1.1 NSE Nifty Index

In an efficient market condition, Nifty index, being the barometer index, reflects all available price sensitive information in the market. Since it represents the present status of economy and price sensitive matter in the economic indicators, it is very much interested to all interesting parties of the stock market. Moreover it drives the sentiments of the interested parties towards the bullish or bearish trend of the stock market consequently modifying their portfolios and investment strategies. It means there is presence of relationship between movements of this index and expected returns from the individual stocks. But, degree of relationship varies from sector to sector and time to time depending on the price sensitive information that driving the market index, nature of the industry and unsystematic factors of the companies.

7.1.2 Index of Industrial Production (IIP)

Index of industrial production (IIP) is an index for India which is the barometer of growth of various sectors in an economy. The all India IIP is a composite index which gauges the short term changes in the volume of production of a basket of industrial production during a given period with respect to

that in a chosen base period. IIP, being a barometer of level of activity, is being compiled and published by Central Statistical Organisation in monthly intervals. Its rate of growth is always associated with economic growth. The growth rate of IIP is one of the most important indications of the performance of the economy. Upward movement in IIP is positive signal which installs confidence among prospective investors towards stock market. It means bullish trend in IIP is more favourable for the stock market. As long as IIP is growing, it is expected that industries and the firms should be faring well. Due to the expected positive impact of real economic activity on the firm's future profits and on its future dividends, IIP is expected to exert a positive impact on stock returns.

7.1.3 Wholesale Price Index (WPI)

The wholesale price index (WPI) is the price of representative basket of wholesale goods. Most of the countries use the changes in this index to measure inflation in their economies including India. The Indian WPI figure was released weekly on every Thursday until 2009. Since then till now, it has been made monthly. The wholesale price index focuses on the price of goods traded between corporations rather than goods bought by consumers. Relationship between stock market and inflation rate is of immense interest to the prospective investors to manage their interest in the stocks. Increasing WPI means increase in input rates leads to high production cost that shrinks margins of corporate companies. Shrinking margins creates negative impression among the investors towards future returns and probable dividend inflows. This negative impression results into bearish trend in stock market. In the light of inflationary trends, reserve bank also increases interest rate which, in turn, increases the cost of borrowing on the part of corporate companies. This action exerts pressure on returns prospects. But, influence of WPI varies from sector to sector in varying degrees.

7.1.4 Gold Prices

Gold is most prominent investment avenue among the commodities and also alternative to stock market. Gold prices and stock market always travels in reverse direction. When stock market facing hardships, investors shift their interest from stock market and diverts to gold market. Downfall in yellow metal price makes investors to shift over to stock market which adds fuel to stock market rally. Stocks, generally, gain in accessions following the plunge in gold in gold prices. This inverse relationship manifest at the global level as well as at particular economy level. Gold and stocks, generally, have long term inverse correlation. When prospective and existing investors lost their faith in shares, gold becomes a safer alternative. The reverse also holds true whenever there is an appetite for risk. Investors exit the gold market and shift their interest to stock market. Since, gold is a safe instrument, any sudden small fall in the prices of gold leads to risk aversion among investors, while there is no accurate theory that brings out a concrete correlation between the value of gold and performance of Indian stock market. Furthermore, this relation in degrees varies from sector to sector

and stock market as a whole depending on its growth prospects and fundamentals.

7.1.5 Crude Oil

India is the largest consumer of world crude oil market. Given India's heavy and increasing dependence on oil imports, it is exposed to trends in global oil market which in turn exert its effect on Indian stock market. When the oil prices go up because of supply side shock, the cost of doing business rises and stock prices factors that effect and take this into account for the drop in earnings. The reverse also holds true whenever this shock emanates from demand side factors. The sharp fall and rise in oil prices have different effect on different companies, while the oil companies take a hit, the user industries of oil products or linked product benefits immensely and it is reverse in latter situation subject to company specific fundamental factors. It means increased prices of oil in international market can have both positive and negative impact on Indian stock market. But when it is talked about India strictly; which fulfils the big part of its energy requirement from imported oil has always negative impact on stock exchange. Increase in oil prices adversely affects the stock market return. Contrary to this, upsurge in oil prices in global market driven by demand creates sense of growth in world economic activity which is boost the positive sentiments of the investors towards future. This, in turn, has positive impact on Indian stock market at level its integration with world stock market. When it is discussed in the Indian context, it is independent of the fluctuations in global crude oil prices because of regularised pricing mechanism and levies of additional taxes.

7.1.6 Exchange Rate

Exchange rate variations are caused various state factors like interest rate differentials between two countries, inflationary trends, balance of trade, speculative trading in the forex market. These exchange rate fluctuations have the significant impact on the overall economy at the macro level and at the micro level; it affects the competitiveness of the firms. Rupee appreciation indicates strengthening of the Indian economy that installs positive signal in the stock market making investors bullish towards future stock returns vice-a-versa. Flow-oriented models of exchange rate also known as goods market approach proposed by Dornbusch and Fisher (1980) suggest that change rate affects the value of the earnings and cost of the funds where companies borrow in foreign currencies to fund their operations. Depreciation of local currency makes the exporting attractive that leads to an increase in foreign demand for goods, revenue of the firms, value of the firm and stock prices. However, the sensitivity of the value of an importing firm to exchange rate is just opposite to that of an exporting firm. But on the macro basis, the impact of exchange rate variation on stock market seems to depend on the both importance of country international trade and the degree of trade balances.

7.1.7 Call Money Rate

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Vol. 4, No. 03 May-June; 2022 Page. No. 83-97

The money market is the part of the financial market where banks and other financial intermediaries trade in short-term financial instruments. This hub is usually interbank market where banks deal with each other to meet their reserve requirements and long-term obligations to finance loans and investments. Being a part of the financial sector, rates and yields in the money market are related other leg of financial sector i.e. is capital market operations where long-term instruments and stocks are traded. A fall in the short-term interest rates in the money market shows a condition of cheap credit which is likely to be followed by more moderate fall in the long-term interest rates in the capital market. The moderate shift in long-term interest rate driven by a change in call Money Rate has impact on stock returns in two ways. One is, changes can impact by affecting the rate at which the firms expected future cash flows will be capitalized and expectations about future cash flows. It means increase in long term long term interest rates backed by increase in many market rate causes stocks to decline and decline in interest rates causes stock prices to decline suggesting an inverse relationship. On the other hand, downward movement in money market set the bank lending rate down. This causes more demand for funds for funding the investment and expenditure. This leads to increase in economic activity, more demand for services and products, stock returns and dividends suggesting again an inverse relationship.

7.1.8   Model Specification

This model will examine how the selected macroeconomic forces would influence on selected stock excess return over risk-free rate using weekly log return.

$$R_{it} - R_f = \beta_1 \text{ NSE Nifty} + \beta_2 \text{ IIP} + \beta_3 \text{ S\&P 500} + \beta_4 \text{ USD/INR} + \beta_5 \text{ WPI} + \beta_6 \text{ CMR} + \beta_7 \text{ Crude oil} + \beta_8 \text{ Gold Price} + \varepsilon_t$$

Where,

$R_{it} - R_f$ stands for excess return from security i over risk-free return, β_1 to β_8 stands for sensitivity factors, NSE Nifty is change in market index, IIP is change in manufacturing activity, S&P 500 stands for change in standard & poor index, USD/INR stands for exchange rate change, CMR is change in call Money Rate, Crude oil stands for change in crude oil price while Gold price stands for change crude oil price.

8   Prediction of Expected Return from Auto Index & Constituents Through APT

This section presents the results of regression analysis done to predict the expected return from NSE auto index and its constituents by regressing them on select macroeconomic factors. The results of the analysis are presented for each of three-time horizons separately.

Table 1: Prediction of Expected Return from Auto Index and Its Constituents Through APT (2010-2020)

Company/ Index	Parameter	NSE Nifty	IIP	S&P 500	USD/ INR	WPI	CMR	Crude Oil	Gold Price
NSE Auto Index	Beta	0.059	0.789	-0.026	0.017	-0.041	-0.141	0.008	0.062
	S.E	0.961	22.981	1.045	0.456	29.820	0.478	0.674	1.117
	t-stat	28.299[a]	0.774	-0.929	0.274	-0.363	-4.98[a]	0.279	2.256[b]
Amtek Auto	Beta	-0.078	0.317	0.025	-0.149	0.200	-0.080	0.023	-0.033
	S.E	1.309	31.296	1.423	0.621	40.610	0.652	0.918	1.522
	t-stat	7.368[a]	-0.661	0.575	-1.519	1.142	-1.84[b]	0.538	-0.791
Apollo Tyres	Beta	-0.123	0.398	0.006	-0.163	0.202	-0.141	0.098	-0.025
	S.E	1.213	29.013	1.319	0.575	37.646	0.604	0.851	1.411
	t-stat	9.681[a]	-1.092	0.134	-1.74[c]	1.206	-3.37[a]	2.440[a]	-0.612
Ashok Leyland	Beta	0.165	0.378	-0.061	0.197	-0.242	-0.102	-0.074	0.049
	S.E	1.169	27.952	1.271	0.554	36.270	0.582	0.820	1.359
	t-stat	8.980[a]	1.437	-1.411	2.053[b]	-1.411	-2.39[a]	-1.80[c]	1.193
Bharat Forge	Beta	0.047	0.502	-0.020	0.078	-0.079	-0.076	0.020	0.056
	S.E	1.061	25.371	1.153	0.503	32.922	0.528	0.744	1.234
	t-stat	12.683[a]	0.432	-0.489	0.863	-0.488	-1.9[b]	0.524	1.442
Eicher Motors	Beta	-0.171	0.348	-0.008	-0.057	0.290	-0.196	-0.009	-0.034
	S.E	1.256	30.040	1.366	0.596	38.979	0.625	0.881	1.461
	t-stat	8.261[a]	-1.487	-0.191	-0.593	1.696[c]	-4.59[a]	-0.223	-0.813
Exide Industries	Beta	0.031	0.386	-0.047	0.022	-0.085	-0.106	0.063	-0.101
	S.E	1.086	25.973	1.181	0.515	33.702	0.541	0.762	1.263
	t-stat	9.206[a]	0.268	-1.096	0.233	-0.500	-2.48[a]	1.540	-2.45[a]
Hero MotoCorp	Beta	0.042	0.416	-0.019	0.073	-0.141	-0.086	-0.055	0.063
	S.E	0.867	20.731	0.942	0.411	26.900	0.432	0.608	1.008
	t-stat	10.088[a]	0.376	-0.448	0.770	-0.837	-2.04[b]	-1.368	1.562
MRF	Beta	-0.075	0.414	0.019	0.014	0.104	-0.137	-0.065	0.018
	S.E	1.027	24.545	1.116	0.487	31.850	0.511	0.720	1.193
	t-stat	10.093[a]	-0.664	0.459	0.147	0.623	-3.29[a]	-1.623	0.448
Mahindra&mahindra	Beta	-0.106	0.606	-0.050	-0.099	0.182	-0.104	0.037	0.100
	S.E	0.917	21.928	0.997	0.435	28.453	0.457	0.643	1.066
	t-stat	16.801[a]	-1.075	-1.352	-1.204	1.240	-2.82[a]	1.036	2.829[a]
Maruti	Beta	0.008	0.568	-0.018	0.025	0.022	-0.116	-0.010	0.065

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Vol. 4, No. 03 May-June; 2022 Page. No. 83-97

Suzuki	S.E	0.804	19.233	0.874	0.381	24.957	0.400	0.564	0.935
India	t-stat	15.138ᵃ	0.077	-0.481	0.290	0.147	-3.06ᵃ	-0.272	1.767ᶜ
Mothers	Beta	-0.216	0.262	-0.037	-0.113	0.374	-0.028	0.025	0.028
on Sumi	S.E	1.014	24.247	1.102	0.481	31.463	0.505	0.711	1.179
Systems	t-stat	5.959ᵃ	-1.795ᶜ	-0.818	-1.128	2.092ᵇ	-0.631	0.588	0.661
	Beta	0.088	0.601	-0.008	0.028	-0.062	-0.150	0.000	0.031
Tata	S.E	1.062	25.403	1.155	0.504	32.963	0.529	0.745	1.235
Motors	t-stat	16.599ᵃ	0.887	-0.210	0.343	-0.417	-4.08ᵃ	0.012	0.863
ᵃ significant at 1%, **ᵇ** significant at 5% and **ᶜ** significant at 10%									

Source: Compiled from computations

The above table 1 presents the regression statistics of returns from NSE Auto index and it's 12 constituents when these are regressed on select macroeconomic factors. NSE Nifty index reported significant positive and negative influence on the auto index and on its constituents as well in varying degrees. Highest positive influence is on Ashok Leyland and lowest positive influence is recorded on Maruthi Suzuki while highest negative influence is on Motherson Sumi Systems and lowest negative influence is recorded on MRF. Highest positive influence of IIP is reported on NSE Auto index while it lowest positive in case of Mothersonsumi Systems. As t-statistics confirms, impact of IIP is insignificant in case of all constituents except Mothersonsumi Systems and NSE Auto index. Influence of S&P 500 index on Amtek auto is high in its magnitude while it is lowest on Apollo tyres and highest negative impact is recorded on Ashok Leyland while lowest negative impact is recorded on Eicher Motors. No single constituents and NSE Auto index are significantly influenced as stated by t-statistics. As far as influence of the USD/INR exchange rate is concerned, it is highest positive on Ashok Leyland, highest negative on Apollo Tyres, lowest positive on MRF and Lowest negative on Eicher motors. As t-statistics highlights, NSE Auto index and all the constituents except Apollo tyres and Ashok Leyland are insignificantly influenced. Influence of the WPI is insignificant except Mothersonsumi Systems and Eicher motors. Highest positive impact of WPI, highest negative impact of WPI, lowest positive impact of WPI and lowest negative impact of WPI is on Mothersonsumi systems, Ashok Leyland, Maruthi Suzuki and NSE Auto index respectively. Highest impinge of CMR is on Eicher motors and lowest impinge of CMR is on Motherson sumi systems. Influence of CMR is significant in the case of NSE Auto index and all the constituent companies except in the case of Mothersonsumi Systems. As t-statistics highlights, impact of crude oil price is significant on Apollo tyres and Ashok Leyland. Conversely, it is insignificant in case of rest of the companies and index. Highest positive influence of crude oil prices on Apollo tyres, highest negative influence is on Ashok Leyland, lowest positive influence is on Tata motors and lowest negative influence is recorded on Eicher motors. Influence of gold price is significant in the case of NSE auto index, Exide industries, Mahindra & Mahindra and Maruthi Suzuki. The impact of gold price is high and positive in case of

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Vol. 4, No. 03 May-June; 2022 Page. No. 83-97

Mahindra & Mahindra while it is lowest and positive in case of MRF. Highest negative influence is recorded on Exide industry while lowest negative influence is recorded on Apollo tyres.

9 Performance Evaluation of Arbitrage Pricing Theory

This part of the thesis deals with the performance evaluation of the Arbitrage pricing theory. For evaluating the model performance three criterions are considered here. One is the accuracy of the model in predictions of returns second is the degree of predictability of model and the third one is forecasting ability of the model. Three values are furnished here such as F –statistic of the model representing the accuracy of the prediction, R-square value of the model representing the degree of predictability of the model and Mean absolute scaled error value (MASE) to evaluate the performance of the model in terms of its forecasting. This analysis is done sector wise and over three peri

Performance Evaluation of APT - NSE Auto Index and Its Constituents
This part of the section deals with the performance evaluation of the CAPM in respect of NSE Auto index and its constituents under consideration separately.

Table 2: Forecasting Performance Evaluation of APT - NSE Auto Index and Its Constituents (2010 – 2020)

Company/Index	F-STAT	R^2	MASE
CNX Auto Index	49.465	0.436	0.426
Amtek Auto Ltd.	8.415	0.116	0.642
Apollo Tyres Ltd.	15.546	0.195	0.608
Ashok Leyland Ltd.	11.736	0.155	0.650
Bharat Forge Ltd.	21.729	0.253	0.614
Eicher Motors Ltd.	11.694	0.154	0.611
Exide Industries Ltd.	12.486	0.163	0.611
Hero MotoCorp Ltd.	14.736	0.187	0.632
MRF Ltd.	15.581	0.196	0.627
Mahindra & Mahindra Ltd.	39.092	0.379	0.509
Maruti Suzuki India Ltd.	31.437	0.329	0.583
Motherson Sumi Systems Ltd.	5.546	0.080	0.671
Tata Motors Ltd.	38.313	0.374	0.550

Source: Compiled from Computations

Regression statistics like F-statistics and R-square values and Mean absolute scaled error values pertaining to NSE CNX Auto index and its constituents are tabulated above 4.33. The highest level of

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F-statistic, highest R-square value and lowest value of MASE is reported by NSE CNX Auto index while lowest level of F-statistic, R-square value and highest value of MASE is reported by Mothersonsumi Systems limited. Highest MASE value reported for the above mentioned company is lower than 1 which is considered as the cut-off rate.

10 Findings

1. A macroeconomic model of APT fitted to estimate the required rate of return from the NSE Auto index and its constituents highlights that fitted model is significant for all the three periods for highest and lowest standard error of estimates of 46.64 and 12.02. The regression model provided comparatively highest R-square in the measurement of required return from sectoral index comparatively with that of individual scrips in the index in all the periods. As far as macroeconomic forces in the model are concerned, following findings can be drawn.

   a. Influence of the market index is significantly positive on the auto index and its constituents for the first sub-period of 2005-2010 while responsiveness of these constituents and auto index to the market index is mixed for the whole period and second sub-period of 2010 – 2015.

   b. Index of industrial production reported significantly negative influence on Maruti Suzuki India Ltd during first sub-period while it is significantly positive on Motherson Sumi systems Ltd during the whole period.

   c. Responsiveness of the auto index and its constituents, during three investment horizons, to changes in the S & P 500 index is insignificant.

   d. Variation in the value of Indian rupee against US dollars has the significantly positive influence on the Ashok Leyland Ltd and significantly negative on the returns from Apollo tyres Ltd.

   e. Inflation rate reported significantly positive influence on the returns from Eicher motors Ltd and Mothersonsumi systems Ltd.

   f. Influence of the call money rate on the NSE Auto index and its constituents is significantly negative except on the Motherson Sumi systems Ltd.

   g. Responsiveness of the returns from Apollo tyres to the changes in the prices of crude oil is significantly positive while it is significantly negative as to returns from the Ashok Leyland Ltd.

   h. Returns from the NSE auto index, Mahindra & Mahindra Ltd and Maruti Suzuki Ltd are positively influenced by the gold prices while returns from Exide industries Ltd are negatively influenced.

The efficiency of arbitrage pricing model can be tested based on three factors such as the significance of the model, the degree of predictive ability of the model and forecasting performance of the model. The significance of the model is measured by F-statistic of the regression model, the R-square value of the model accounts for the degree of variation accounted by the model while forecasting performance of the model can be judged by mean absolute scaled error. Based on these three statistics of model with respect to all the sectors for three periods under consideration, following findings can

be drawn.

1. The significance of the arbitrage pricing model with respect to all the sector indices for all the three periods is better than that of constituents of the indices.
2. Predictive ability of the arbitrage pricing model as indicated by R-square values also strong and it is found that degree of predictive ability is higher in the case of sector indices comparatively with that of it constituents for all the three periods.
3. Forecasting performance of the arbitrage pricing model in the case of all the sectoral indices and constituents of the same indices is strong for all periods.

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