Management Dynamics

Volume 21 | Number 2 Article 4

December 2021

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Recommended Citation

Yadav, Anuradha and Hegde, Pooja Srikanth (2021) "Arbitrage Pricing Theory and its relevance in modelling market," *Management Dynamics*: Vol. 21: No. 2, Article 4.
DOI: https://doi.org/10.57198/2583-4932.1044
Available at: https://managementdynamics.researchcommons.org/journal/vol21/iss2/4

ARBITRAGE PRICING THEORY AND ITS RELEVANCE IN MODELLING MARKET

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ABSTRACT

This research compares the Arbitrage Pricing Theory (APT) to the Capital Asset Pricing Theory (CAPT) by looking at numerous macroeconomic factors that affect market security prices and determining how APT explains the majority of the returns. The goal of this study was to look at the fundamental aspects (revenue, assets, liabilities, and growth potentials) in order to compute the intrinsic value based on the investor's risk tolerance. The BSE and NSE websites were used to get month-by-month secondary data over a period of ten years (2010–2020), which included the share price returns of TATA Motors and Eicher Motors as well as the BSE Auto Index. The statistics on GDP growth rate, inflation, and interest rates was obtained from the RBI's official website. The findings imply that the APT model accurately describes the majority of the company's share returns. Furthermore, it is clear that macroeconomic variables have a substantial impact on the risk of an asset over time and are one of the key inputs that financial analysts must consider when calculating expected returns. Furthermore, the sources of risk incorporated in a data set in an APT model inform the investor as to why certain stocks move in a particular direction.

Keywords: *APT, Modelling Market Efficiency, CAPM, Indian Stock Market, Indian Automobile Sector*

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1. INTRODUCTION

Arbitrage Pricing Theory (APT) is a "model of asset pricing that holds that an asset's return may be anticipated using a linear relationship between an assets's projected returns and some macroeconomic factors that affect the asset's risk" (Ross, 2013). The definition of an efficient market is one in which the securities in the market always represent all available information and adjust to new information. In fact, though, it is not the same. The securities will never reflect fair market value or will be mispriced. An arbitrager can profit from this mispricing of security by trading it. However, before the arbitrager decides to purchase or sell the security, he must be aware that it is mispriced and should also be aware of the security's fair market value. With the rise in stock market price volatility, this danger becomes even greater. As a result, Singh and Bhatia (2014) focused on investors' financial literacy of risk and return levels associated with various equities in order to arrive at a prudent risk-return trade investment decision. Researchers discovered that the majority of the swings in IT stocks were not due to market (index) fluctuations, whereas risk in banking stocks was spread evenly between systematic and unsystematic risk in the study confined to IT and Banking stocks. After accessing risk-returns analysis and leaving other parameters constant, the authors determined that a sensible investor would favor IT equities over banking stocks. Tripathi (2006) found good and substantial results in a study demonstrating that the longer the period to maturation, the larger the arbitrage gains. The author went on to say that far the month futures make more money than near the month futures. In addition, in compared to less liquid assets, high liquid assets will create more arbitrage benefit. The Derivative Market's entrance in the Indian Financial Sector pulled together three of the market's most important players: hedgers, speculators, and arbitrageurs. Arbitrageurs have been on the upswing among these three players, with their earnings increasing over time. By demonstrating the importance of arbitrageurs in the Indian stock market, the author attempted to learn how arbitrageurs make money. Therefore, we must employ the Arbitrage Pricing Theory in order to determine the security's intrinsic worth. It provides specialists and stockholders with a security model based on the relationship between expected financial asset returns and risk. Stephen Ross, an American economist, created APT (Ross, 2013). The Capital Asset Pricing Model (CAPM) is insufficient, according to Stephen Ross, because it states that different stocks will have varied sensitivities to various market variables, which could be radically different from the other stocks under consideration. APT, on the other hand, pinpoints the correct market price of an asset that has been incorrectly priced in the short run. It assumes that the market isn't totally efficient all of the time, which leads to asset mispricing, or overvaluation or undervaluation. However, market actions would gradually fix the situation and restore the prices to their true market worth.

Arbitrage in the APT:

Arbitrage is the technique of purchasing and selling an asset on multiple markets in order to profit from price variations and lock in a risk-free return on the trade. However, arbitrage is not a risk-free trade activity in APT, but it does offer a high probability of realization. It provides traders with a methodology for calculating an asset's theoretical fair market value. The decided value traders then hunt for little deviations from the fair-minded market value and engage in flinch trading. The following is a list of macroeconomic variables that influence stock prices:

Gross Domestic Product:

Gross Domestic Product (GDP) is defined by the Bureau of Economic Analysis (BEA) as "the value of the goods and services generated by the nation's economy less the value of the products and services consumed in production." Personal consumption expenditures, gross private domestic investment, net exports of goods and services, and government consumption expenditures and gross investment are all

included in GDP." It is the total monetary or market rate of all finished goods and services manufactured in a country during a given period of time. GDP includes the final price of the finished product, but not the pieces that went into it, which mitigates the effect of duplication. If the GDP growth rate accelerates, it could be an indication that the economy is thriving or reaching its peak, prompting the central bank to intervene and raise interest rates. When GDP shrinks, on the other hand, it indicates that the economy is entering a period of recession, and interest rates should be cut. Vassalou (2003) explains the cross-section of asset returns and demonstrates the significance of GDP news on asset price.

Inflation:

According to the Fisherian theory, "inflation should have no effect on real stock returns." It also suggests that the financial market/exchanges act as a "hedge" against inflation. This means that upturns in the overall price level are entirely compensated for by comparable upturns in the peppercorn share market takings, and therefore the real profits stay unaltered (Fisher 1930). Inflation reduces consumers' purchasing power over time for a given amount of money. It occurs as a result of a decrease in the value of a specific currency, resulting in an increase in the price of goods and services. It can be used on tangible assets like real estate or commodities. Businesses, as well as their profit margins, are affected by rising costs. Lower revenues and profits can have a control on the stock-prices of any given company. Therefore, inflation can affect the stock-exchanges as it comprises investors and their investment behavior.

Rates of Interest:

Sharma (2012) concluded in a thorough review study that various earlier research investigations have confirmed the negative association between inflation and stock prices, as well as the negative association between interest rates and stock prices. As high interest rates have a negative impact on the stock market, it restricts an organization's purchasing power and its capacity to grow internally. It also restricts investors' purchasing power because their mortgage interest payments may rise. Put another way, it can result in low demand for non-essential items and services, which can have an impact on the company and its stock values (Ferson, 1989; Assefa, et al., 2017).

2. Literature Review

Connor and Korajczyk (1995) made an early attempt to get economic insights into the components of a factor model and how to effectively analyze factor models using large cross-sectional data sets. Dhankar and Singh (2005) examined the Indian Stock Market for monthly and weekly returns from 1991 to 2002 and concluded that multiple factor based APT provides a better indication of asset risk and predicts the needed return than CAPM, which only considers 'beta' as a risk dimension. Sawyer and Gygax (2006) found the best evidence for arbitrage pricing in single factor models in a follow-up investigation of pricing errors in terms of orders of probability. Cetin et al. (2010) established an upright approximation for exceptionally liquid equities, despite the fact that it does not match well for outsized investors and/or transaction cost modelling. Polkovnichenko (2010) showed that pricing errors induced by ambiguity about the return generating process are quantitatively significant after accounting for the effects of learning in a detailed examination of a linear factor APT model that assumes agents are ambiguity averse with respect to the payoffs of arbitrage portfolios.

According to Agarwal et al. (2014), macroeconomic and foreign issues have a substantial impact on the CNX Nifty. Hasan (2010) investigated the link between expected returns and systematic risk

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https://www.bea.gov/data/gdp (accessed on 5.5.2021)

measurement in a series of studies. Holman and Ritter (2010), on the other hand, offered an explicit formula for mean-variance optimization in the context of the APT model, as well as associated generalizations with trading costs. Singh and Jotwani (2012) proposed a model indicating the effect of macroeconomic fundamentals on the share market directory in a study studying share price index as a replication of commercial activities in India.

Basu and Chawla (2012) used multi-factor arbitrage pricing theory to look at the relationship between portfolio yields and carefully picked macroeconomic indicators to see if the APT model was valid and reliable in emerging markets like India. Another study by Armstrong et al. (2012) revealed that currency swings have a significant impact on the marketplace 'betas' of a large percentage of stocks, while also confirming the global arbitrage pricing theory (Solnik, 1983).

Sakr et al. (2016) compared the APT multifactor model against other models in different marketplaces and found that it had less relative assumptions. The ideal number of elements (business cycle, economic growth rate, financial index, projected inflation rate, and government expenditure) ranged from four to five in different markets, with their identities altering. Furthermore, discovering provides valuable information for industry experts as well as academics who wish to learn more about a variety of factors. If and only if an equilibrium market is comprehensive, this is an adequate requirement for the APT equation to remain accurate in its exact form (Frahm, 2018). Furthermore, in a study of macroeconomic variables and their impact on stock returns, French (2017) discovered that risk premium and production were significant across the sample, but that these macroeconomic variables were not significant in determining native market return. Burzoni et al. (2019) established a structure for pricing and hedging derivative instruments in different stock exchange timelines in another important study.

In a recent development, Renault et al. (2019) developed an arbitrage theory framework extension to study the pricing of squared return/volatilities and discovered that the price of a particular discrepancy factor acknowledged by squared returns is minor compared to the price of market variance risk. Elshqirat (2019) investigated three factors [GDP, Exports, and Industrial Producers Price Index (IPPI)] to see if the APT could be used as a substitute for CAPM on the Jordanian Stock Exchange, and found that IPPI had a significant negative impact on the stock's rate of return. Rocciolo (2021) also demonstrated that the expected returns are linearly approximated by the factor loadings augmented by an idiosyncratic component in a large asset market under the conditions of uncertainty, in order to address the implications of arbitrage in a large asset market under the conditions of uncertainty. Pesaran and Smith (2021) recently linked variables from the statistical factor model to a set of academically trustworthy factors defined by their provisional covariation with the stochastic discount factor utilizing price securities in the Intertemporal Asset Pricing Model (IAPM). The risk premium is caused by non-zero correlation of observable factors, and pricing errors are caused by the correlation of errors in the statistical factor model, according to the findings.

3. Problem Statement

It is clear from the literature study that determining the intrinsic value using CAPM and APT allows investors to make investment decisions based on their risk tolerance. The literature study argues that the APT model is far superior to the CAPM because of its inherent factors such as economic fundamentals. As a result, the study looked at the inherent value of both CAPM and APT throughout pre- and post-pandemic periods.

4. Objective of the study

The study is aimed to verify the validity of the APT model in emerging markets like India.

Hypothesis Formulated:

H1: There is a significant impact of 'GDP' on 'stock returns'.

H2: There is a significant impact of "interest rates" on "stock returns".

H3: There is a significant impact of "inflation" on "stock returns"

5. Data Collection and Research Methodology

5.1 Data Collection

Secondary sources such as BSE and NSE, Yahoo Finance, Investopedia, and Trading Economics were used to collect data for a 10-year period beginning in 2010 and ending in 2020. Descriptive analysis, regression analysis, and one-way ANOVA were employed to examine the data in terms of tools and approaches. The study focused on Tata Motors and Eicher Motors, two significant vehicle manufacturers.

6. Data Analysis and Interpretation

6.1 Tata Motors Data Analysis

Table 1: Descriptive Analysis of TATA Motors

TATA MOTORS		**BSE AUTO INDEX**	
Mean	340.8206667	Mean	15759.42
Standard Error	11.48488087	Standard Error	579.5747439
Median	328.97	Median	15851.55
Mode	#N/A	Mode	#N/A
Standard Deviation	117.6850088	Standard Deviation	5938.873866
Sample Variance	13849.7613	Sample Variance	35270222.8
Kurtosis	-1.103187412	Kurtosis	-1.456794899
Skewness	0.161815211	Skewness	0.193080226
Range	432.06	Range	19051.26
Minimum	146.88	Minimum	7699.94
Maximum	578.94	Maximum	26751.2
Sum	35786.17	Sum	1654739.1
Count	105	Count	105

The descriptive analysis between the two variables, Tata Motors closing prices and the BSE Auto Index is shown in Table 1. The summarized result includes data from the previous ten years.

Interpretation

In compared to the BSE Auto Index, Tata Motors' average closing price for the last ten years has been 340.820. 117.685 is the standard deviation. The lowest closing price of Tata Motors shares in the last

ten years was 146.88, and the highest price was 578.94. The results assist us comprehend how much the Tata Motors share price fluctuates with the BSE Auto Index, as well as show the investor what the lowest and maximum share price returns are for the given time period.

Table 2: Regression Analysis and Anova for TATA Motors using CAPM Model

SUMMARY OUTPUT					
Regression Statistics					
Multiple R	0.778991538				
R Square	0.606827817				
Adjugted R Square	0.603408928				
Standard Error	7.733367282				
Observations	105				
ANOVA					
	df	**SS**	**MS**	**F**	**Significance F**
Regression	1	10614.9465	10614.9465	177.4927165	4.62649E-25
Residual	115	6877.571494	59.80496951		
Total	116	17492.518			
	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**
Intercept	-0.706349065	0.723013249	-0.976951758	0.330643688	-2.138499162
AUTO RETURNS	1.580152569	0.118606572	13.32263925	4.62649E-25	1.345215777

The findings of the regression analysis and ANOVA for Tata Motors utilizing the CAPM model are shown in Table 2. The data comprises 10 years of Tata Motors and BSE Auto Index performances. Regression research reveals how the Tata Motors share price is influenced by the BSE Auto Index. ANOVA, on the other hand, indicates how much variance there is between the two indices.

Interpretation:

The R Square is 0.606, which implies that the BSE Auto Index explains 60 per cent of Tata Motors' returns, and the systematic risk component is 1.58, which is beta, which means that if auto returns increase by 1 per cent, Tata Motors' returns vary by 1.580 per cent.

Table 3: Regression Analysis and ANOVA for TATA Motors using APT Model

SUMMARY OUTPUT					
Regression Statistics					
Multiple R	0.840828945				
R Square	0.706993314				
Adjusted R Square	0.69515466				

Standard Error	6.232025137				
Observations	105				
ANOVA					
	df	**SS**	**MS**	**F**	**Significance F**
Regression	4	9277.50857	2319.377143	59.71906232	l.46789E-25
Residual	99	3844.975594	38.83813731		
Total	103	13122.48416			
	Coefficients	**Standard Error**	**t Stat**	**P-value**	**Lower 95%**
Intercept	-10.85475926	6.897533903	-1.57371597	0.118743621	-24.54096296
AUTO RETURNS	1.584901769	0.104028459	15.23527101	l.05545E-27	1.378486737
INTEREST RATE	0.961138816	0.758847313	1.266577346	0.208278332	-0.544578886
INFLATION	0.355529739	0.231223059	1.537605027	0.127335298	-0.103266976
GDP	0.460050546	1.225903684	0.375274625	0.708259047	-1.972408325

Table 3 shows the regression results as well as the ANOVA test results using the APT model. The input variables include the stock returns of Tata Motors and the BSE Auto Index, as well as GDP growth, inflation, and 10-year interest rates. Regression analysis reveals how and to what extent the other four variables influence share returns.

Interpretation

R Square for the APT model is 0.706, indicating that the model can explain 70% of Tata Motors' returns. Auto Returns is 1.58, which means that if the market's beta improves by 1%, Tata Motors' returns will increase by 1.584 percent. Table 3 shows that the significance level (P Value) for all three variables is greater than 0.05, indicating that these factors have a significant impact on stock returns. Alternative hypotheses (H1, H2, and H3) are thus acceptable in the case of TATA Motors.

6.2 Eicher Motors

Table 4: Descriptive Analysis for Eicher Motors

EICHER.MOTORS LTD		**BSE AUTO INDEX**	
Mean	2036.314237	Mean	15997.85864
Standard Error	16.96853841	Standard Error	520.391711
Median	2114.735	Median	17568.99
Mode	2194.15	Mode	#NIA
Standard Deviation	184.325508	Standard Deviation	5652.900926
Sample Variance	33975.89289	Sample Variance	31955288.88
Kurtosis	-0.654296162	Kurtosis	-1.342636651
Skewness	-0.847757454	Skewness	0.080199399

Range	648.01	Range	19051.26
Minimmn	1621.69	Minimmn	7699.94
Maximum	2269.7	Maximum	26751.2
Sum	240285.08	Sum	1887747.32
Count	105	Count	105

The descriptive analysis between the two variables, Eicher Motors closing prices and the BSE Auto Index is shown in Table 4. The summarized result includes data from the previous ten years.

Interpretation:

When compared to the BSE Auto Index, the mean returns are 2036.31, according to Table 4. 184.325 is the standard deviation. Over the course of ten years, the maximum returns are 2269.7, while the minimum returns are 1621.69. It also tells us how the Eicher Motors share returns change in relation to the BSE Auto Index, and it displays the investor what the minimum and maximum share returns are for the chosen time period.

Table 5: Regression Analysis and ANOVA for Eicher Motors using CAPM Model

SUMMARY OUTPUT					
Regression Statistics					
Multiple R	0.138419908				
R Square	0.019160071				
Adjusted R Square	0.010704554				
Standard Error	2.114626793				
Observations	105				
ANOVA					
	df	**SS**	**MS**	**F**	**Significance F**
Regression	1	10.13268228	10.13238228	2.265984653	0.134960277
Residual	116	518.7109909	4.471646473		
Total	117	528.8436732			
	Coefficients	**Standard Error**	**T Stat**	**P-value**	**Lower 95%**
Intercept	0.330608188	0.194669399	1.698305893	0.092130905	-0.054959086
AUTO RETURNS	-0.026575157	0.017654172	-1.505318788	0.134960277	-0.061541469

The data in Table 5 shows the results of the regression analysis and ANOVA for Eicher Motors using the CAPM model. It contains 10-year results from Eicher Motors and the BSE Auto Index. The Eicher Motors share returns are dependent on the BSE Auto Index returns, as shown through regression analysis. ANOVA, on the other hand, illustrates how much variance there is between the two indexes.

Interpretation:

The CAPM model can explain 1.91 per cent of the company's profits, according to R Square of 0.0191. The auto returns are -0.026, meaning that if the systematic risk increases by 1 per cent, the company's returns will change by -0.026 per cent.

Table 6: Regression Analysis and ANOVA for Eicher Motors using APT Model

SUMMARY OUTPUT					
Regression Statistics					
Multiple R	0.149743089				
R Square	0.022422993				
Adjusted R Square	-0.017075068				
Standard Error	2.145179617				
Observations	105				
ANOVA					
	df	**SS**	**MS**	**F**	**Significance F**
Regression	4	10.44973105	2.612432763	0.567698567	0.68666222
Residual	99	455.5777633	4.601795589		
Total	103	466.0274944			
	Coefficients	**Standard Error**	**T Stat**	**P-value**	**Lower 95%**
Intercept	1.6992085	2.374260182	0.715679146	0.475874099	-3.0118388
AUTO RETURNS	-0.003766752	0.035808541	-0.105191443	0.916436735	-0.074818667
INTEREST RATE	-0.114697798	0.261209439	-0.439102806	0.66154394	-0.632993994
INFLATION	0.059585331	0.079591302	0.748641246	0.455848427	-0.098341079
GDP	-0.536862617	0.421978977	-1.272249676	0.206264594	-1.374160458

Table 6 shows the results of the APT model's regression analysis and ANOVA test for Eicher Motors. Eicher Motors share returns and BSE Auto Index returns, GDP growth rate, inflation rate, and 10-year interest rates are among the input factors. Regression analysis reveals how and to what extent the other four variables influence share returns.

Interpretation:

The R Square in this case is 0.022, indicating that the APT model can explain 2 per cent of the company's returns. Auto returns are -0.003, which implies that if the market's beta changes by 1 per cent, the company's returns will change by -0.003 percent. As can be seen in Table 6, the significance level (P Value) for all three variables is greater than 0.05, indicating that the factors have a substantial impact on stock returns. As a result, alternative hypotheses (H1, H2, and H3) are accepted by Eicher Motors.

7. Conclusion

The goal of the research was to look at the arbitrage pricing theory and how it might be used to predict

market efficiency in Indian stock markets. The study's data contains the closing prices of two vehicle firms (TATA Motors and Eicher Motors) for the last ten years, as well as GDP growth, inflation, and interest rates. Both the CAPM and APT models assist us in projecting market risk in an extremely complex Indian Stock Exchange by remaining static and relying on a small number of variables. The APT model, on the other hand, is designed for competency since it considers macroeconomic aspects while assessing risk for risky assets. The testing have demonstrated that the APT model is more efficient than the CAPM model, however similar results can be found in some cases. Stock returns are co-integrated with specific macro-economic variables, according to a regression model.

8. Limitations and Scope of Future Research:

There are certain limitations to the current study. First, the current study developed a multi-factor pricing model based on macroeconomic parameters such as inflation, interest rates, and GDP to forecast asset returns. Similarly, investors can evaluate the asset's returns using a variety of additional characteristics for future research. Second, data for the current study were collected over a ten-year period (2010-2020). As a result, it urged future academics to utilize this model to forecast the long-term returns of a specific asset. Finally, future research might be conducted to determine the linear relationship between asset expected yields and various economic conditions.

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