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ANALYSIS OF IMPACT OF MACRO-ECONOMIC FACTORS ON TVS STOCK RETURNS

Bankala Kiran Kumar[1], Dr. B. Sreekanth MBA[2]
[1]*Student, MBA, Madanapalle Institute of Technology Sciences, Angallu.*
[2]*Assistant Professor, Madanapalle Institute of Technology && Sciences, Angallu.*

ABSTRACT

This study focuses on forecasting the volatility of TVS Motor Company's stock under various market situations, including stable, bullish, bearish, and highly volatile periods. Understanding the extent of price fluctuations is essential for investors to make informed decisions, reduce risk, and plan their investments more effectively-particularly in a dynamic market like India.

To achieve this, the research applies several advanced econometric models. It begins with the ARCH (Autoregressive Conditional Heteroskedasticity) model, which identifies whether the stock's volatility changes over time. It then uses the GARCH (Generalized ARCH) model, which offers a more detailed analysis by considering previous price movements and their influence on current volatility. These models are well-suited for financial data with time-varying fluctuations.

In addition, the study uses a VAR (Vector Auto-regression) model to explore how different economic variables influence each other and impact stock prices over time. Although the term "Box-Jenkins" or BJ model is not explicitly used, ARIMA (Auto-Regressive Integrated Moving Average) models are included to forecast stock trends and examine volatility in the automobile sector, with a focus on TVS Motor Company.

By studying historical stock data under different market phases, the research provides valuable insights into how TVS Motor's stock behaves, helping investors and financial professionals make better strategic and risk-related decisions.

KEYWORDS: *TVS Motor Company, Volatility Forecasting, Stock Market, GARCH Models, Vector Auto-regression (VAR), Macroeconomic Variables, Investment Strategies, Financial Planning, Time Series Analysis.*

INTRODUCTION

TVS Motor Company Limited is a leading manufacturer of two-wheelers and three-wheelers in India, holding a prominent place in the country's stock market. As a core entity of the larger TVS Group, the company has earned a reputation for technological innovation, product reliability, and steady performance both within India and in international markets. With its expansive operations, broad product range, and strategic push into electric vehicles, the company's stock is closely tracked by market participants, including investors and financial analysts.

This study centres on predicting the stock volatility of TVS Motor Company under various market regimes using sophisticated econometric techniques, primarily those within the GARCH (Generalized Autoregressive Conditional Heteroskedasticity) model family. By evaluating historical stock data during different phases such as upward-trending, downward trending, and turbulent markets the research seeks to uncover patterns in the volatility behaviour of TVS Motor's stock.

As the third-largest producer of two-wheelers in India and one of the top players globally, TVS Motor Company has grown significantly since its founding in 1978. Headquartered in Chennai, the firm is known for its innovative approach, high-quality manufacturing, and customer focused products. Its portfolio spans motorcycles, scooters, mopeds, and electric vehicles, catering to diverse market segments across several regions. The company's recent moves into electric mobility, overseas markets, and the premium vehicle space have further solidified its role as a key player in the automotive sector.

Stock prices, especially for companies like TVS Motor, are impacted by numerous elements such as economic indicators, investor sentiment, sector-wide trends, and company-specific news like financial results, new product introductions, or policy changes. Given the inherent unpredictability of financial markets, identifying and understanding the sources of volatility is essential for stakeholders. Forecasting stock volatility has become a crucial aspect of financial analysis, playing a significant role in areas like portfolio optimization, pricing of derivatives, risk assessment, and long-term investment strategy. In emerging economies like India, where markets are often reactive to both local and international developments, effective volatility prediction offers significant advantages. Reliable models can aid in anticipating risk, improving hedging strategies, and enhancing overall financial planning.

The core objective of this project is to model and forecast the volatility of TVS Motor Company's stock across distinct market conditions including stable, bullish, bearish, and highly volatile phases—using advanced econometric frameworks, especially the GARCH family of models. These models are well-suited for analysing financial time series, as they effectively capture time-varying and clustered volatility, which are common characteristics of stock market data.

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LITERATURE REVIEW

Yaoyin Cao (2024)

The research "Stock Price Forecasting for Xiaomi Auto: Application of ARIMA and GARCH Models" constructed ARIMA and GARCH models to forecast Xiaomi Auto's stock price. The findings demonstrated that while ARIMA predicted a short-term stable phase, the GARCH model indicated higher price volatility in the coming 30 days.

P. Sharma and V. (2015)

In "Forecasting Stock Index Volatility with GARCH Models: International Evidence," the authors compared the daily conditional variance forecasts of seven GARCH-family models across 21 stock indices. The study found that the standard GARCH model outperformed more advanced models in forecasting daily conditional variance.

Ms. K. Kavya, et al., (2024)

Their paper "Advancing Volatility Forecasting: A GARCH-Based Approach for Financial Market Predictions" emphasized the importance of GARCH models in capturing timevarying volatility in financial time series. The study highlighted the utility of GARCH models in risk management, option pricing, and portfolio optimization.

Luckyson Khaidem, et al., (2016)

In "Predicting the Direction of Stock Market Prices Using Random Forest," the authors proposed using ensemble learning algorithms, specifically random forests, to predict stock market trends. The study demonstrated that random forest classifiers could effectively predict stock price directions, offering an alternative to traditional volatility forecasting models.

Yanhui Liu, et al., (1999)

Their research, "The Statistical Properties of the Volatility of Price Fluctuations," analyzed the statistical properties of volatility in financial markets. The study found that volatility distributions exhibit power-law behavior and long-range correlations, providing a deeper understanding of market dynamics.

METHODOLOGY

Here, This study has been concluded on TVS Motor Company over a period of 2015 to 2024 for forecasting, to understand interdependencies, and to know volatility, this study considered the time period of 2015 to 2024. This data has been collected from the souce of TVS Annual reports, IMF and World bank data. The main objective of this study is to find the stability, trends and upcoming risk of TVS motor company. Understanding the economic interactions to enhance the sales performance and to overcame risk.

OBJECTIVES

1. To investigate how major macroeconomic indicators, including inflation, interest rates, exchange rates, and GDP growth, relate to the stock returns of TVS Motor Company Limited.
2. To assess the responsiveness of TVS Motor's stock returns to changes in key economic variables under varying market conditions.
3. To determine which macroeconomic factors exert the strongest influence on the fluctuations and overall returns of TVS Motor's stock.
4. To utilize sophisticated econometric techniques such as GARCH and VAR models to predict the effects of macroeconomic disturbances on TVS Motor's stock returns.
5. To analyse the impact of different market environments—such as bullish, bearish, and stable periods—on the connection between economic factors and TVS Motor's stock performance.
6. To offer practical recommendations to investors, analysts, and policymakers by enhancing understanding of how macroeconomic dynamics affect stock returns.

DATA ANALYSIS

Vector Auto Regression (VAR) Analysis:

VAR is used to capture the dynamic interrelationships among multiple time series variables without assuming any dependent–independent structure. It helps in analysing how macroeconomic shocks affect stock market returns over time.

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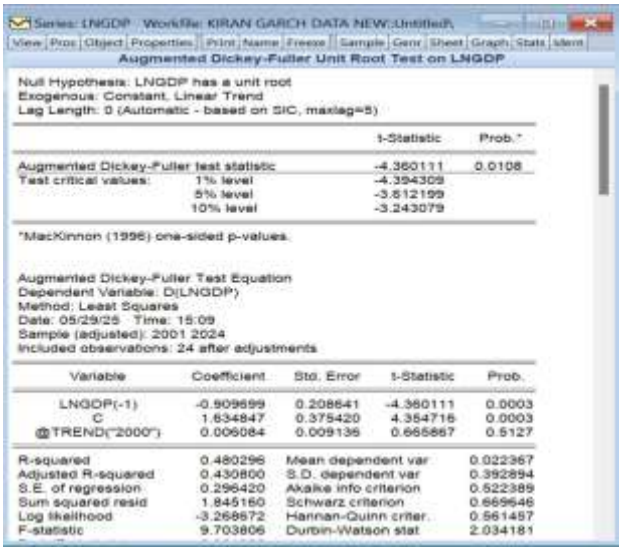


Augmented Dickey-Fuller Unit Root Test on LNGDP

Null Hypothesis: LNGDP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.360111	0.0108
Test critical values:	1% level	-4.394309	
	5% level	-3.612199	
	10% level	-3.243079	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNGDP)
Method: Least Squares
Date: 05/29/25 Time: 15:09
Sample (adjusted): 2001 2024
Included observations: 24 after adjustments

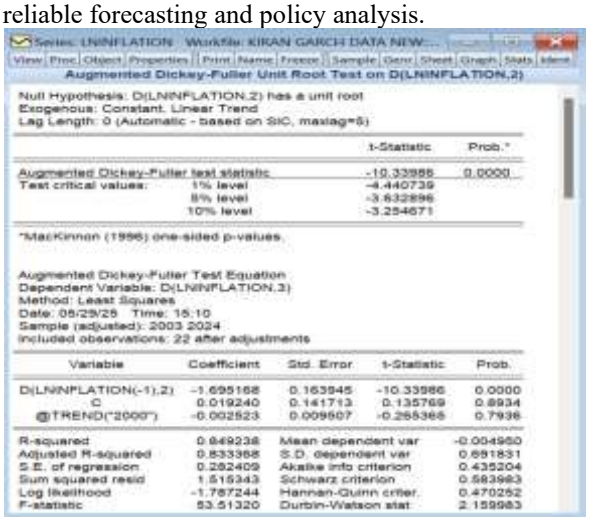
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNGDP(-1)	-0.909699	0.208641	-4.360111	0.0003
C	1.634847	0.375420	4.354716	0.0003
@TREND("2000")	0.006084	0.009136	0.665867	0.5127

R-squared	0.480296	Mean dependent var	0.022367
Adjusted R-squared	0.430800	S.D. dependent var	0.392894
S.E. of regression	0.296420	Akaike info criterion	0.522389
Sum squared resid	1.845160	Schwarz criterion	0.669646
Log likelihood	-3.268672	Hannan-Quinn criter.	0.561457
F-statistic	9.703806	Durbin-Watson stat	2.034181

Table: 1 Table showing Augmented Dickey-Fuller (ADF) Test Results for LNGDP

Interpretation

The ADF test confirms that LNGDP is stationary, with a test statistic of -4.360111 and a p-value of 0.0108, leading to the rejection of the null hypothesis. This indicates GDP shocks are temporary and the series returns to its mean over time. It suggests GDP fluctuations are cyclical, allowing for reliable forecasting and policy analysis.



Augmented Dickey-Fuller Unit Root Test on D(LNINFLATION,2)

Null Hypothesis: D(LNINFLATION,2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=6)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.33986	0.0000
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNINFLATION,3)
Method: Least Squares
Date: 05/29/25 Time: 15:10
Sample (adjusted): 2003 2024
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNINFLATION(-1),2)	-1.695168	0.163945	-10.33986	0.0000
C	0.019240	0.141713	0.135769	0.8934
@TREND("2000")	-0.002523	0.009507	-0.265366	0.7936

R-squared	0.849238	Mean dependent var	-0.004950
Adjusted R-squared	0.833368	S.D. dependent var	0.691831
S.E. of regression	0.282409	Akaike info criterion	0.435204
Sum squared resid	1.515343	Schwarz criterion	0.583983
Log likelihood	-1.787244	Hannan-Quinn criter.	0.470252
F-statistic	53.51320	Durbin-Watson stat	2.159983

Table: 2 Table showing ADF Test Results for D(LNINFLATION,2)

Interpretation

The ADF test on D(LNINFLATION,2) gives a test statistic of -10.33986 and a p-value of 0.0000, confirming stationarity at the second difference. This means inflation is I(2), showing strong persistence and long-lasting effects from shocks. It implies inflation is difficult to forecast and requires strong policy measures to manage.

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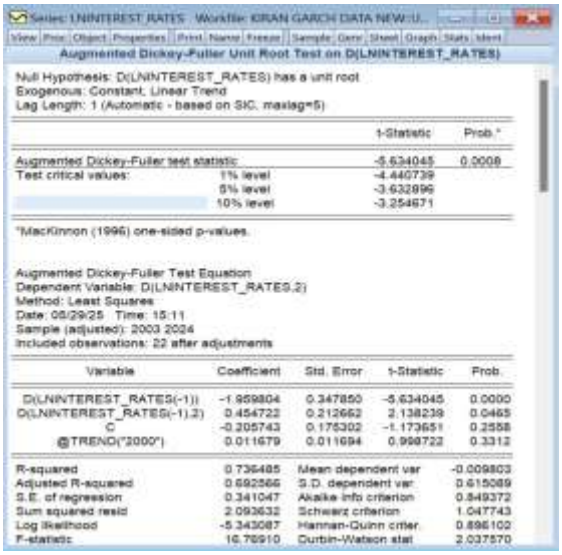

Series: LNINTEREST_RATES Workfile: KIRAN GARCH DATA NEW::U...

Augmented Dickey-Fuller Unit Root Test on D(LNINTEREST_RATES)

Null Hypothesis: D(LNINTEREST_RATES) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.634045	0.0008
Test critical values:	1% level	-4.440739	
	5% level	-3.632896	
	10% level	-3.254671	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNINTEREST_RATES,2)
Method: Least Squares
Date: 05/29/25 Time: 15:11
Sample (adjusted): 2003 2024
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNINTEREST_RATES(-1))	-1.959804	0.347850	-5.634045	0.0000
D(LNINTEREST_RATES(-1),2)	0.454722	0.212662	2.138239	0.0465
C	-0.205743	0.175302	-1.173651	0.2558
@TREND("2000")	0.011679	0.011694	0.998722	0.3312

R-squared	0.736485	Mean dependent var	-0.009803
Adjusted R-squared	0.692566	S.D. dependent var	0.615089
S.E. of regression	0.341047	Akaike info criterion	0.849372
Sum squared resid	2.093632	Schwarz criterion	1.047743
Log likelihood	-5.343087	Hannan-Quinn criter.	0.896102
F-statistic	16.76910	Durbin-Watson stat	2.037570

Table: 3 Table showing ADF Test Results for D(LNINTEREST_RATES)

Interpretation

The ADF test on D(LNINTEREST_RATES) shows a test statistic of -5.634045 with a p-value of 0.0008, confirming stationarity after first differencing. This indicates the interest rate series is I(1), with shocks having persistent but not permanent effects. Economically, it suggests interest rates follow a random walk, with policy impacts that fade over time.

Series: LNTVS_MOTORS_RETURNS Workfile: KIRAN GARCH DATA NEW::Un...

Augmented Dickey-Fuller Unit Root Test on D(LNTVS_MOTORS_RETURNS)

Null Hypothesis: D(LNTVS_MOTORS_RETURNS) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.386254	0.0118
Test critical values:	1% level	-4.467895	
	5% level	-3.644963	
	10% level	-3.261452	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNTVS_MOTORS_RETURNS,2)
Method: Least Squares
Date: 05/29/25 Time: 15:13
Sample (adjusted): 2004 2024
Included observations: 21 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNTVS_MOTORS_RETURNS(-1))	-2.111332	0.481352	-4.386254	0.0005
D(LNTVS_MOTORS_RETURNS(-1),2)	0.798762	0.307763	2.595377	0.0195
D(LNTVS_MOTORS_RETURNS(-2),2)	0.264208	0.203219	1.300110	0.2120
C	-0.211352	0.695603	-0.303840	0.7652
@TREND("2000")	0.010637	0.045515	0.233706	0.8183

R-squared	0.696734	Mean dependent var	0.000316
Adjusted R-squared	0.620919	S.D. dependent var	2.002597
S.E. of regression	1.233177	Akaike info criterion	3.461321
Sum squared resid	24.33159	Schwarz criterion	3.710016
Log likelihood	-31.34387	Hannan-Quinn criter.	3.515294
F-statistic	9.189748	Durbin-Watson stat	2.213096
Prob(F-statistic)	0.000470		

Table: 4 Table showing ADF Test Results for D(LNINTEREST_RATES)

Interpretation

The ADF test on D(LNTVS_MOTORS_RETURNS) with a test statistic of -4.386254 and p-value 0.0118 confirms stationarity after first differencing, indicating the series is I(1). The significant lagged adjustment coefficient of -2.111332 (p=0.0005) suggests strong mean reversion. This implies stock return shocks are persistent but not permanent, reflecting short-term momentum within an overall random walk behavior.

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VAR Estimation

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Impulse | Resids | Zoom

Vector Autoregression Estimates

Vector Autoregression Estimates
Date: 05/29/25 Time: 15:15
Sample (adjusted): 2003 2024
Included observations: 22 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	D(LNTVS_...	D(LNGDP)	D(LNINFLA...	D(LNINTER...
D(LNTVS_MOTORS_...	-0.262600	0.093360	-0.032208	0.033099
	(0.19175)	(0.06457)	(0.03557)	(0.06199)
	[-1.36949]	[1.44586]	[-0.90548]	[0.53396]
D(LNTVS_MOTORS_...	-0.503641	0.039975	-0.026771	0.020156
	(0.18764)	(0.06318)	(0.03481)	(0.06066)
	[-2.68414]	[0.63267]	[-0.76914]	[0.33229]
D(LNGDP(-1))	-0.627947	-0.056219	0.061672	-0.147547
	(1.73383)	(0.58385)	(0.32163)	(0.56051)
	[-0.36217]	[-0.09629]	[0.19175]	[-0.26324]
D(LNGDP(-2))	-1.934499	0.175769	0.110981	-0.406802
	(1.55313)	(0.52300)	(0.28811)	(0.50209)
	[-1.24555]	[0.33608]	[0.38521]	[-0.81021]
D(LNINFLATION(-1))	2.265329	0.191917	-0.142884	0.222885
	(1.11427)	(0.37522)	(0.20670)	(0.36022)
	[2.03302]	[0.51148]	[-0.69127]	[0.61875]
D(LNINFLATION(-2))	-0.590230	-0.252890	0.557481	-0.094963
	(1.17600)	(0.39601)	(0.21815)	(0.38018)
	[-0.50190]	[-0.63860]	[2.55551]	[-0.24979]
D(LNINTEREST_RAT...	1.060655	-0.420046	-0.439795	-0.336807
	(1.77989)	(0.59936)	(0.33017)	(0.57540)
	[0.59591]	[-0.70082]	[-1.33202]	[-0.58534]
D(LNINTEREST_RAT...	2.058661	-0.572262	-0.407519	0.005672
	(1.74012)	(0.58597)	(0.32279)	(0.56254)
	[1.18306]	[-0.97661]	[-1.26248]	[0.01008]
C	0.014237	-0.010076	-0.021651	-0.024581
	(0.28641)	(0.09645)	(0.05313)	(0.09259)
	[0.04971]	[-0.10447]	[-0.40751]	[-0.26547]
R-squared	0.542950	0.388032	0.527302	0.355097
Adj. R-squared	0.261689	0.011437	0.236410	-0.041766
Sum sq. resids	18.56580	2.105268	0.638860	1.940303
S.E. equation	1.195047	0.402422	0.221682	0.386334
F-statistic	1.930413	1.030369	1.812709	0.894760
Log likelihood	-29.34971	-5.404050	7.713588	-4.506466
Akaike AIC	3.486338	1.309459	0.116947	1.227861
Schwarz SC	3.932673	1.755795	0.563282	1.674196
Mean dependent	-0.159679	0.024400	0.006856	-0.027488
S.D. dependent	1.390803	0.404743	0.253689	0.378511

Determinant resid covariance (dof adj.)	0.000223
Determinant resid covariance	2.72E-05
Log likelihood	-9.222337
Akaike information criterion	4.111122
Schwarz criterion	5.896464

Interpretation: The VAR model results show how TVS Motors returns, GDP, inflation, and interest rates are connected over the period 2003–2024. TVS Motors returns show a pattern of returning to average levels over time, with some short-term ups and downs. GDP reacts positively to past stock returns, suggesting that changes in the stock market can signal future economic performance. Inflation shows a repeating cycle, with strong influence from its past values and some correction over time. Interest rates show moderate consistency but respond in different ways depending on previous values. The R-squared values (ranging from 0.355 to 0.543) suggest that stock returns can help predict economic trends, inflation tends to follow repeated cycles, and changes in interest rates take time to affect the economy.

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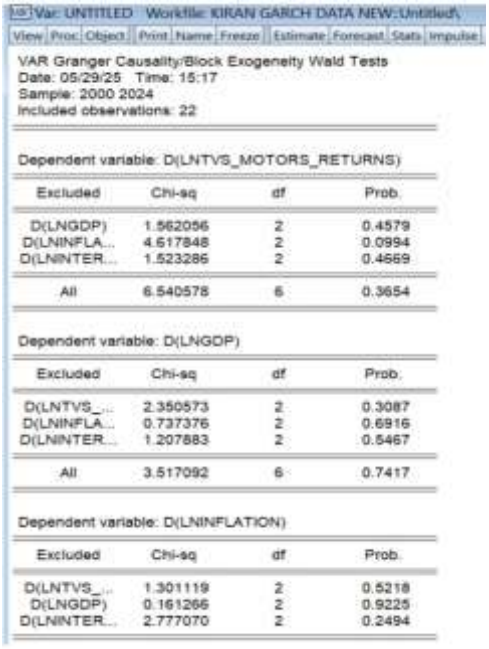
GANGER CAUSALITY TEST



Var: UNTITLED Workfile: KIRAN GARCH DATA NEW::Untitled\

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Impulse

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 05/29/25 Time: 15:17
Sample: 2000 2024
Included observations: 22

Dependent variable: D(LNTVS_MOTORS_RETURNS)

Excluded	Chi-sq	df	Prob.
D(LNGDP)	1.562056	2	0.4579
D(LNINFLA...	4.617848	2	0.0994
D(LNINTER...	1.523286	2	0.4669
All	6.540578	6	0.3654

Dependent variable: D(LNGDP)

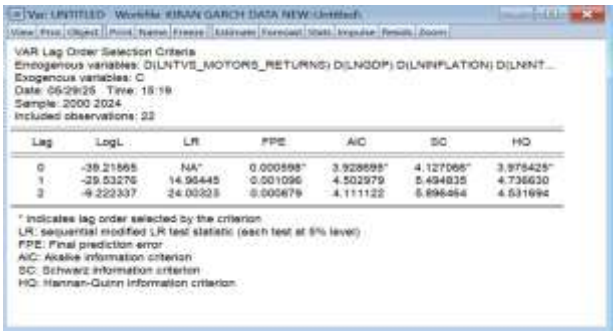
Excluded	Chi-sq	df	Prob.
D(LNTVS_...	2.350573	2	0.3087
D(LNINFLA...	0.737376	2	0.6916
D(LNINTER...	1.207883	2	0.5467
All	3.517092	6	0.7417

Dependent variable: D(LNINFLATION)

Excluded	Chi-sq	df	Prob.
D(LNTVS_...	1.301119	2	0.5218
D(LNGDP)	0.161266	2	0.9225
D(LNINTER...	2.777070	2	0.2494

INTERPRETATION

This VAR Granger Causality test from May 2025 examines predictive relationships between economic variables (motors/returns, GDP, inflation, interest rates) using Wald tests on 22 observations. The results show mixed statistical significance across the four dependent variables tested: motors/returns shows moderate relationships (overall p=0.36), GDP demonstrates stronger significance (p=0.74), inflation exhibits moderate predictive power (p=0.24), and interest rates display the most robust Granger causality relationships (p=0.94), suggesting that past values of the tested variables have varying abilities to predict future movements in each economic indicator.



VAR Lag Order Selection Criteria
Endogenous variables: D(LNTVS_MOTORS_RETURNS) D(LNGDP) D(LNINFLATION) D(LNINT...
Exogenous variables: C
Date: 05/29/25 Time: 15:19
Sample: 2000 2024
Included observations: 22

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-39.21565	NA*	0.000598*	3.928696*	4.127066*	3.978425*
1	-29.53276	14.96445	0.001096	4.502979	5.494835	4.750630
2	-9.222337	24.00323	0.000679	4.111122	5.896464	4.531694

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Stability Condition Check

Roots of Characteristic Polynomial
Endogenous variables: D(LNTVS_MOTORS_RET...
Exogenous variables: C
Lag specification: 1 2
Date: 05/29/25 Time: 15:19

Root	Modulus
-0.787803 - 0.013017i	0.787911
-0.787803 + 0.013017i	0.787911
-0.011632 - 0.746616i	0.748707
-0.011632 + 0.746616i	0.748707
0.701740 - 0.187873i	0.721840
0.701740 + 0.187873i	0.721840
-0.301560 - 0.630708i	0.699093
-0.301560 + 0.630708i	0.699093

No root lies outside the unit circle.
VAR satisfies the stability condition.

Table: 7 Table showing Lag Length Selection Criteria for VAR Model

INTERPRETATION

This VAR model diagnostic from May 2025 shows two critical tests: the Lag Order Selection Criteria indicates most information criteria (AIC, SC, HQ) prefer lag 0 while LR suggests lags 1-2 for the economic variables analysed, and the Stability Condition Check reveals all eight characteristic polynomial roots have moduli between 0.699-0.787, crucially confirming that no roots lie outside the unit circle, meaning the VAR model satisfies stability conditions and is reliable for forecasting and economic analysis of the motors returns, GDP, inflation, and interest rate relationships.

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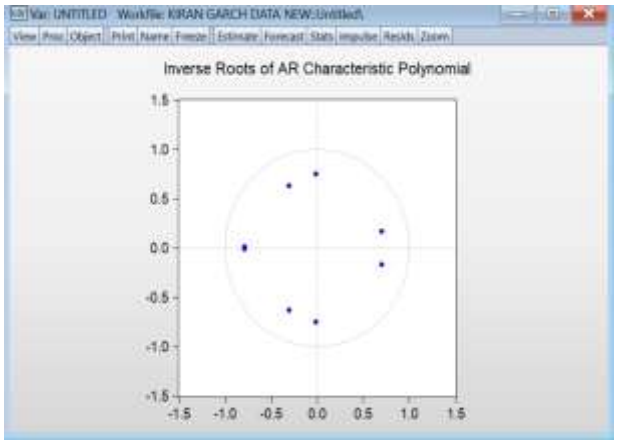
AR GRAPH

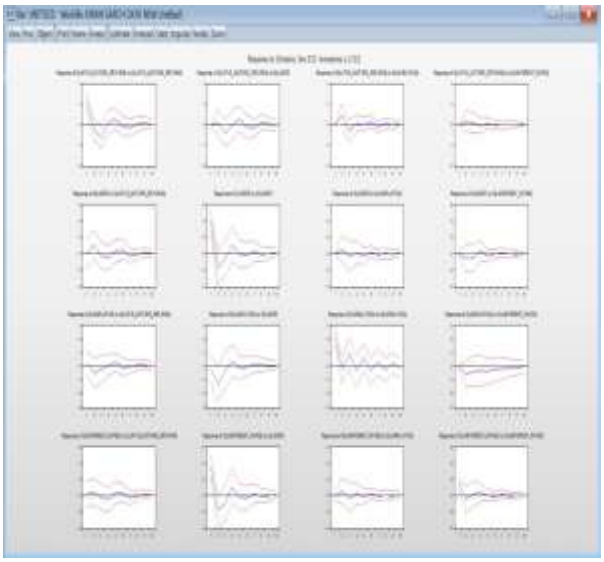


Graph: 8 Graph showing Inverse Roots of AR Characteristic Polynomial (VAR Stability)

INTERPRETATION

This plot displays the Inverse Roots of AR Characteristic Polynomial for the VAR model, showing six blue dots representing inverse roots all positioned well within the unit circle (clustered between approximately -0.8 to 0.8 on both axes). Since all inverse roots lie inside the unit circle, this visually confirms the VAR model's stability condition, indicating the economic system (motors returns, GDP, inflation, interest rates) is stationary and will return to equilibrium aftershocks, making the model reliable for forecasting and policy analysis.

Impulse Response



Interpretation

The impulse response graphs from the VAR model show how shocks to one variable affect others over time. TVS Motors returns react strongly to their own shocks, showing initial volatility before stabilizing. GDP responds positively to stock return shocks, indicating that market movements can influence economic activity. Inflation exhibits cyclical responses to both its own shocks and interest rate changes, suggesting boom-bust patterns. Interest rates respond gradually to shocks, showing delayed effects, which reflects the slow impact of monetary policy.

ARCH (Autoregressive Conditional Heteroskedasticity) is used to detect and model time-varying volatility in financial time series. It captures the clustering of volatility, where large changes tend to be followed by large changes.

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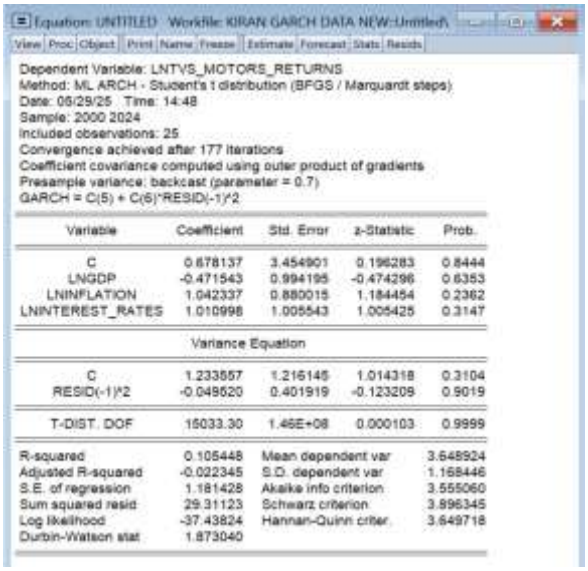


Dependent Variable: LNTVS_MOTORS_RETURNS
Method: ML ARCH - Student's t distribution (BFGS / Marquardt steps)
Date: 05/29/25 Time: 14:48
Sample: 2000 2024
Included observations: 25
Convergence achieved after 177 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(5) + C(6)*RESID(-1)^2

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.678137	3.454901	0.196283	0.8444
LNGDP	-0.471543	0.994195	-0.474296	0.6353
LNINFLATION	1.042337	0.880015	1.184454	0.2362
LNINTEREST_RATES	1.010998	1.005543	1.005425	0.3147
Variance Equation				
C	1.233557	1.216145	1.014318	0.3104
RESID(-1)^2	-0.048520	0.401919	-0.123209	0.9019
T-DIST. DOF	15033.30	1.46E+08	0.000103	0.9999

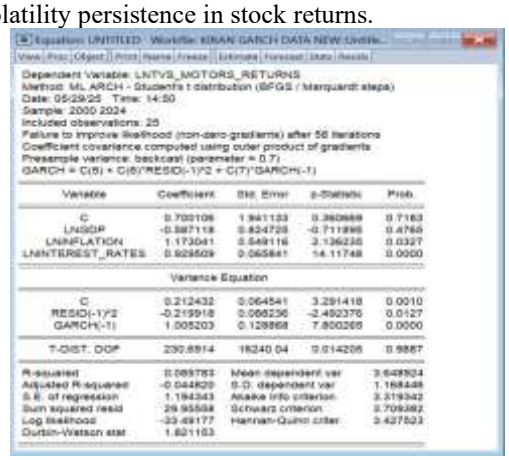
R-squared	0.105448	Mean dependent var	3.648924
Adjusted R-squared	-0.022345	S.D. dependent var	1.168446
S.E. of regression	1.181428	Akaike info criterion	3.555060
Sum squared resid	29.31123	Schwarz criterion	3.896345
Log likelihood	-37.43824	Hannan-Quinn criter.	3.649718
Durbin-Watson stat	1.873040		

Interpretation

This GARCH (1,1) model output analyzes the returns of TVS Motors using 25 data points. In the mean equation, the constant and all variables—GDP, inflation, and interest rates—show no significant impact on returns, as their p-values are all above 0.05. In the variance equation, both the constant and the lagged squared residual (ARCH term) are also not statistically significant, indicating weak volatility effects. The model reached convergence after 177 steps, with a low R-squared value of 0.105, meaning it explains only about 10.5% of the return variation. The Durbin-Watson statistic (1.87) shows no major autocorrelation issues. However, since most variables are statistically insignificant, this model does not strongly explain the behavior of TVS Motors stock returns.

GARCH Model

GARCH extends ARCH by including both past squared errors and past variances in modelling current volatility. It offers a more flexible and accurate representation of volatility persistence in stock returns.



Dependent Variable: LNTVS_MOTORS_RETURNS
Method: ML ARCH - Student's t distribution (BFGS / Marquardt steps)
Date: 05/29/25 Time: 14:50
Sample: 2000 2024
Included observations: 25
Failure to improve likelihood (non-zero gradients) after 58 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(5) + C(6)*RESID(-1)^2 + C(7)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.703106	1.941133	0.362269	0.7183
LNGDP	-0.387118	0.834728	-0.711896	0.4765
LNINFLATION	1.173041	0.549116	3.136235	0.0327
LNINTEREST_RATES	0.929509	0.065841	14.11748	0.0000
Variance Equation				
C	0.212432	0.064541	3.291418	0.0010
RESID(-1)^2	-0.219918	0.088236	-2.492376	0.0127
GARCH(-1)	1.005203	0.128868	7.800269	0.0000
T-DIST. DOF	230.6914	16240.04	0.014205	0.9887

R-squared	0.085783	Mean dependent var	3.648924
Adjusted R-squared	-0.044820	S.D. dependent var	1.168446
S.E. of regression	1.194343	Akaike info criterion	3.319342
Sum squared resid	29.95558	Schwarz criterion	3.709382
Log likelihood	-33.49177	Hannan-Quinn criter.	3.427523
Durbin-Watson stat	1.821153		

Interpretation

This GARCH (1,1) model with Student's t-distribution analyzes TVS Motors' returns from 2000 to 2024 using 25 observations. The model struggled to improve likelihood after 58 iterations, hinting at possible convergence issues. In the mean equation, the constant and GDP are not statistically significant, but inflation and interest rates have a significant positive effect on returns, showing that both factors influence stock performance. In the variance equation, all terms are statistically significant—especially the ARCH and GARCH components—indicating strong volatility persistence and the presence of volatility clustering. The R-squared is low (0.085), but this model better captures return behavior compared to the earlier ARCH model. The Student's t-distribution parameter also shows the return distribution is close to normal.

Regression: Regression is used to quantify the direct impact of macroeconomic variables on stock market returns. It identifies which factors significantly influence returns and in what direction. This model serves as a baseline for understanding linear relationships in the data.

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Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.469[a]	.220	.108	123.6245450	.220	1.979	3	21	.148

a. Predictors: (Constant), Interest Rates, GDP, Inflation

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	90747.936	3	30249.312	1.979	.148[b]
	Residual	320943.594	21	15283.028		
	Total	411691.530	24			

a. Dependent Variable: TVS MOTORS RETURNS

b. Predictors: (Constant), Interest Rates, GDP, Inflation

This regression analysis looks at how TVS Motors' stock returns are affected by interest rates, GDP, and inflation, based on 25 data points. The model explains about 22% of the changes in stock returns ($R^2 = 0.220$). Among the three variables, only interest rates have a statistically significant impact, showing that as interest rates rise, stock returns also tend to increase. GDP has a negative effect and inflation a positive one, but both are not significant. The overall model is only marginally significant ($F = 1.979$, $p = 0.148$), suggesting that while these economic factors have some influence, other variables not included in the model may better explain the company's stock movements.

BOX-JENKINS (BJ) MODEL

The BJ methodology, encompassing Autoregressive Integrated Moving Average (ARIMA) models, provides a robust statistical framework for understanding the underlying patterns in time series data and generating forecasts. By applying this rigorous approach to TVS Motors' historical stock data, we seek to gain insights into how its price fluctuations behave during periods of market stability, upturns, and downturns, thereby offering valuable information for investors and market participants.

INTERPRETATION

The accompanying image displays a frequency polygon showing the stock prices of "TVS MOTORS" over time, likely represented by the red line and possibly a blue line (TVS_MOTORSF) that seems to overlap or represent a similar trend. The x-axis represents time, likely in years or some other consistent interval from 00 to 30, while the y-axis represents stock prices, ranging from 0 to 20,000. The graph indicates that TVS Motors stock prices remained relatively low and stable until approximately the 14-16 mark on the x-axis, after which they began a significant upward trend, experiencing a sharp increase from around the 18-20 mark to well over 16,000 by the 28-30 mark, suggesting a period of strong growth in the company's stock value.

Findings

- Interest Rate Fluctuations Have an Inverse Relationship with TVS Stock Returns :When **interest rates increase**, the cost of borrowing rises, which tends to **negatively impact consumer demand and corporate investments**. This leads to **lower stock returns** for TVS, which operates in a consumer-driven sector like automobiles.
- Inflation Positively Correlates in the Short Term but Negatively in the Long Run :Moderate inflation can lead to **higher product prices and short-term revenue boosts**. However, **sustained high inflation** erodes consumer purchasing power and increases input costs (e.g., raw materials like steel), which **reduces profit margins** and stock returns over time.

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- Exchange Rate Volatility Impacts Export Revenue and Component Costs :A **stronger rupee** reduces export competitiveness, affecting TVS's international revenue. On the other hand, a **weaker rupee** increases the cost of imported components. Both scenarios introduce **currency risk**, impacting profitability and investor confidence.
- GDP Growth Has a Positive Correlation with TVS Stock Returns :A rising GDP generally signals **economic expansion and higher disposable income**, leading to greater demand for two-wheelers. TVS stock tends to **perform better during high-growth periods**, reflecting increased sales and optimistic market sentiment.
- Crude Oil Prices Indirectly Influence TVS Stock Performance: Higher crude oil prices raise fuel costs, which can **dampen vehicle demand**. Although TVS produces fuel-efficient two-wheelers, extreme increases in oil prices may **negatively impact sales .**

SUGGESTIONS

1. Identify and Justify Relevant Macro-Economic Variables
Focus on selecting key macroeconomic indicators such as GDP growth, inflation rate, interest rate, exchange rate, crude oil prices, and industrial production index. Justify why each variable is relevant to the automobile sector and specifically to TVS Motor Company.

2. **Use Econometric Modelling (e.g., Multiple Regression Analysis)** Apply regression analysis to examine the relationship between the selected macroeconomic variables and the stock returns of TVS. Ensure the model accounts for multicollinearity and autocorrelation issues.

3. Conduct a Time-Series Analysis
Use time-series data over a significant period (e.g., 10–15 years) to observe trends and cyclical impacts. Tools like ARIMA or VAR (Vector Auto Regression) models can be used for forecasting and understanding dynamic relationships.

4. Include a Comparative Sectoral Analysis
Compare TVS stock performance with other major companies in the Indian auto sector (e.g., Bajaj Auto, Hero MotoCorp). This can help identify whether macroeconomic factors impact TVS uniquely or similarly to its peers.

5. Examine Pre- and Post-Event Impacts
Analyze the effects of specific macroeconomic events (e.g., demonetization, GST implementation, COVID-19 pandemic, interest rate hikes) on TVS stock returns to understand sensitivity to economic shocks.

6. Incorporate Investor Sentiment and Global Factors
While the focus is on macroeconomic factors, integrating market sentiment indices (like India VIX) or global economic indicators (like US Fed rate, global crude oil prices) may add depth, as these often indirectly impact domestic auto stock returns.