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Econometric Analysis Of Natural Rubber Prices In Kerala

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Abstract: -
To facilitate informed and timely decision-making, volatility models offer investors, traders, and policymakers crucial insights by enabling accurate price forecasts. This study explores the volatility behaviour of Natural Rubber prices RSS 4 and RSS 5 in Kerala. It utilises secondary time series data from the Historical Data of the Statistics & Planning Department, Rubber Board, Kerala. The analysis employs a combination of Time Series Plot, Unit Root Test, GARCH (1,1) and GARCH (2,1) models to assess volatility from April 2016 to April 2025. Key findings reveal stationarity in the Natural Rubber prices RSS 4 and RSS 5 in Kerala. However, the GARCH (1,1) and GARCH (2,1) models indicate the absence of volatility in Natural Rubber prices RSS 4 and RSS 5 during the study period.
Keywords: - *Natural Rubber, RSS 4, RSS 5 Unit Root Test, Stationarity, Volatility, GARCH*

INTRODUCTION: -

Kerala, India's leading producer of natural rubber, has experienced significant price instability over the past few decades. These fluctuations impact various stakeholders, including farmers, traders, and policymakers. Several factors, including global demand and supply, exchange rate fluctuations, government policies, weather conditions, and crude oil prices, influence the price of natural rubber. By employing advanced forecasting models, stakeholders can better anticipate price variations and adopt measures to reduce adverse impacts. Implementing targeted policies can further enhance market stability and ensure sustainable livelihoods for rubber growers in Kerala. This article examines the fluctuations in natural rubber prices of RSS 4 and RSS 5 using econometric analysis to identify the key determinants and trends influencing the rubber market in Kerala.

REVIEW OF LITERATURE

- Reddeppa Reddy et al. (2021), in their study published in IJFANS, analysed time series forecasting models for rubber production in Kerala. They compared the ARIMA and SARIMA models and found that both models effectively predict future rubber output, with SARIMA better suited for capturing seasonal variations. Accurate forecasting is critical for policy planning and resource allocation in the rubber sector, especially considering price volatility and climatic influences.
- Ajayan (2020), in his article on the Growth and Trends in Production and Marketing of Natural Rubber in Kerala, noted that Kerala contributes 90% of India's natural rubber production. He examined long-term trends using CAGR and found fluctuations in area, productivity, and export patterns due to domestic and global market conditions.
- Karunakaran (2017) emphasised the economic vulnerability of small growers in Kerala due to declining rubber prices. His study found that the average farm-gate price of rubber fell sharply from ₹245 per kg in 2011 to ₹102 per kg in 2016. This decline and increasing input costs made rubber cultivation economically unsustainable for many farmers.
- Ali and Manoj (2017) investigated the causes and consequences of price instability in their article Price Volatility and Its Impact on Rubber Cultivation in India. They attributed price volatility to international demand-supply mismatches, synthetic rubber alternatives, crude oil prices, and trade liberalisation under the WTO. The study concluded that persistent price volatility discourages rubber investment and threatens smallholders' livelihoods.
- Shyju Mathew (2021) used a seasonality index to study the periodic nature of price fluctuations. He identified that prices tend to be low during peak production months (October–January), worsening

income instability for growers. He stressed that import dumping and lack of protective policy interventions are key factors behind the declining price trend.

- Pradeep and Jacob (2021), using satellite data, demonstrated that despite a sharp fall in rubber prices post-2012, total area under rubber in Kerala continued to grow in certain districts. This suggested a strong attachment of local growers to rubber, especially those whose livelihoods heavily depended on the crop. However, the study also identified challenges like ageing plantations and rising costs.
- The JETIR (2019) study on Attingal Municipality highlighted the declining interest among smallholders due to unremunerative prices and labour shortages. Farmers who once saw rubber as a daily income source were increasingly forced to leave plantations untapped. The study also documented structural issues, such as wage demands and insufficient government support.
- Mathew (2019) examined the effectiveness of Rubber Producers' Societies (RPS) in Kerala. His study found that most RPSs underperformed due to poor management, lack of customer-centric service, and inadequate infrastructure. Price manipulation by tyre companies and exploitation by mediators further weakened the growers' bargaining power.
- Lekshmi et al. (1996) analysed long-term price trends in India's rubber market. Their study concluded that production levels were the most significant determinant of rubber prices. Import and world prices had less statistical significance, indicating a semi-insulated market. However, the authors cautioned that empirical models alone may not sufficiently capture real-world price behaviour due to several non-quantifiable factors.

Objectives

The main objectives of the study are: -

- To study the stationarity of the Natural Rubber prices RSS 4 and RSS 5 in Kerala
- To analyse the volatility of Natural Rubber prices RSS 4 and RSS 5 in Kerala using the GARCH method.

Hypotheses Of The Study

- H_0: There is no stationarity or unit root in Natural Rubber prices RSS 4 and RSS 5
- H_o: There is no volatility in Natural Rubber prices RSS 4 and RSS 5

METHODOLOGY OF THE STUDY

The sample selected for the study is Natural Rubber prices in Kerala (Rupees per 100 Kg) traded in the domestic market in Kerala. The analysis is based on time series data of monthly Natural Rubber prices RSS 4 and RSS 5 in Kerala (Rupees per 100 Kg) from April 2016 to April 2025, which is collected from the Historical Data of Statistics & Planning Department, Rubber Board, Kerala. The study uses some econometric methods to carry out the empirical analysis. Time Series Plot, Unit Root Test, GARCH (1, 1) and GARCH (2, 1) models are used to analyse the present data.

DATA ANALYSIS AND DISCUSSION

Econometrics methods were used to analyse the data using the software EViews. The study employs a Time Series Plot to check the Random Walk Pattern of the series, and a Unit Root Test was employed to test the stationarity of the series. GARCH (1, 1) and GARCH (2, 1) models were used to obtain the Volatility of Natural Rubber prices RSS 4 and RSS 5 in Kerala (Rupees per 100 Kg).

A. Time Series Plot of Natural Rubber prices RSS 4 and RSS 5 in Kerala

Time series plot of Natural Rubber prices RSS 4 and RSS 5 in Kerala is examined to check the series' trend. Figures 1 and 2 portray the actual framework of the series and describe whether the series is stationary or not. From the graphs below, the Natural Rubber prices RSS 4 and RSS 5 in Kerala do not exhibit a Random Walk Pattern. If the series does not follow a random walk, the series is stationary.

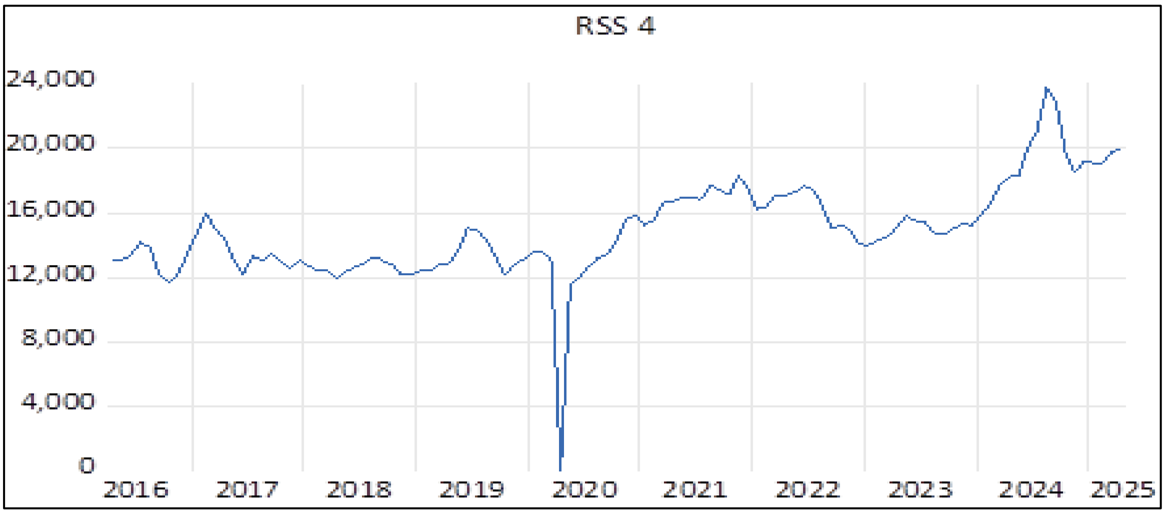


Figure: 1 .Time Series Plot of RSS 4

The time series analysis of RSS 4 prices from 2016 to 2025 reveals a market narrative marked by growth, disruption, recovery, and stabilisation cycles. From 2016 to 2018, there was a gradual upward trend, suggesting consistent demand and a relatively stable economic environment. However, a sharp downturn occurred between 2019 and 2020, likely due to global disruptions such as the economic slowdown triggered by the COVID-19 pandemic. This period of volatility gave way to a strong recovery starting in 2021, with prices climbing steadily and peaking around 2024, possibly reflecting renewed industrial demand or supply shortages that pushed prices higher. By 2025, the trend appears to flatten, hinting at a market correction or stabilisation as supply and demand rebalance. This analysis underscores the importance of understanding external shocks and their ripple effects on commodity markets. It offers insight for policymakers, investors, and industry stakeholders as they navigate future market movements.

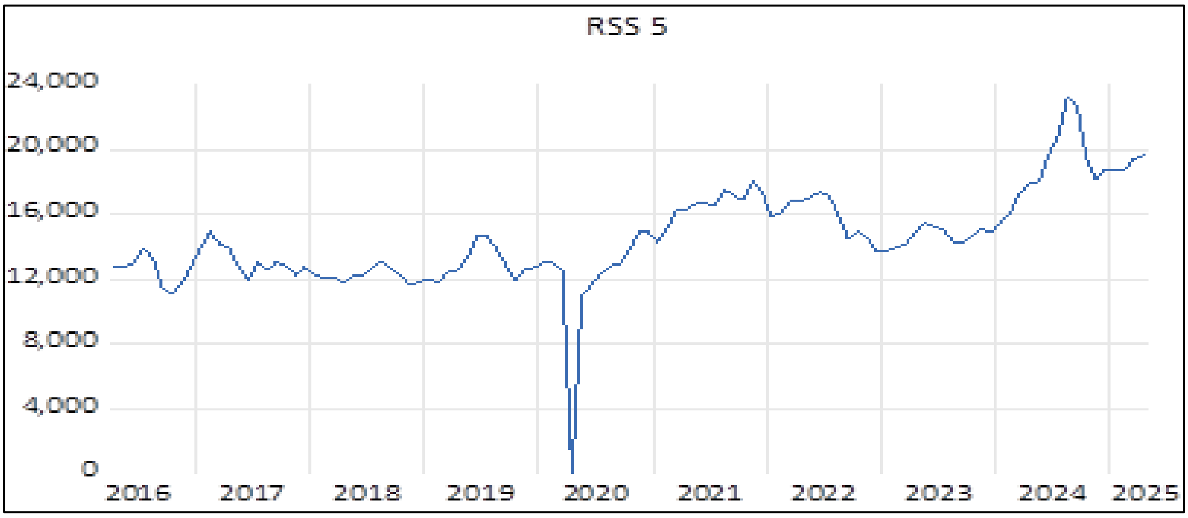


Figure: 2 .Time Series Plot of RSS 5

The time series graph for RSS 5 from 2016 to 2025 highlights a dynamic market journey, reflecting fluctuations shaped by external shocks and subsequent adjustments. In the initial years, from 2016 to 2019, the trend appears relatively stable with mild variations, suggesting a period of steady supply and demand. However, a significant downturn occurs around 2020, aligning with global economic disruptions such as the COVID-19 pandemic, which may have caused sharp contractions in industrial activity and international trade. This is followed by a dramatic rebound from 2021 onward, with values rising steeply and reaching a peak around 2022. This sharp recovery likely reflects restored demand, production normalisation, or price surges due to constrained supply chains. After peaking, the graph shows a soft decline and then a plateauing trend through 2024 and 2025, indicating that the market may be stabilising after a period of volatility. Overall, the series narrates a cycle of shock, adaptation, and eventual equilibrium, offering key insights into market resilience and the influence of global events on commodity pricing.

B. Stationarity of Natural Rubber prices RSS 4 and RSS 5 in Kerala

To test the stationarity of the time series, the Augmented Dickey Fuller test has been applied for each of the Natural Rubber prices RSS 4 and RSS 5 in Kerala. The null hypothesis of the Unit Root Test is as follows:-

TESTING OF HYPOTHESIS:-1

H_0: There is no stationarity or unit root in Natural Rubber prices RSS 4 and RSS 5 in Kerala

Table 1. Results of Unit Root Test.

Unit Root Test at Original Time Series			
	RSS 4 With constant	**RSS 5** With constant	Remarks
ADF Test Statistics	-2.279645	-2.184748	
p-value	0.1804	0.2131	Non-Stationary
Unit Root Test at First Order Difference			
	RSS 4 With constant	**RSS 5** With constant	Remarks
ADF Test Statistics	-9.646081	-9.575316	
p-value	0.0000	0.0000	Stationary

The unit root test results for RSS 4 and RSS 5 indicate that both time series are non-stationary at their original levels, as reflected by the relatively high p-values of 0.1804 for RSS 4 and 0.2131 for RSS 5. These values exceed the typical significance threshold (usually 0.05), meaning we cannot reject the null hypothesis of a unit root. Thus, the series exhibits persistent trends or structural shifts over time. However, after first differencing, the Augmented Dickey-Fuller (ADF) test statistics drop significantly to -9.646081 for RSS 4 and -9.575316 for RSS 5, with associated p-values of 0.0000 for both. This suggests that the differenced series are stationary, as we can now reject the null hypothesis. Therefore, RSS 4 and RSS 5 are integrated of order one, I(1), indicating that time series modelling methods are appropriate for capturing their dynamics. These results highlight the importance of transforming the data before building reliable forecasting models or conducting further econometric analysis.

The test equations for Natural Rubber prices RSS 4 and RSS 5 are as follows:-

RSS 4: $\Delta R_t = \alpha_0 + \alpha_1 t + u_t$

RSS 5: $\Delta S_t = \alpha_0 + \alpha_1 t + u_t$

Where, R_t and S_t are Natural Rubber prices RSS 4 and RSS 5 respectively at time 't', α_0 is the constant, $\alpha_1 t$ is the coefficient of the trend series, and u_t is the error term.

TESTING OF HYPOTHESIS:-2

H_o: There is no volatility in Natural Rubber prices RSS 4 and RSS 5

Table No: 2. Result of GARCH (1, 1) Model- RSS 4 Prices

Variable	**Coefficient**	**Std. Error**	**Prob.**
C	97656.64	57218.09	0.0879
RESID(-1)^2	5.853298	0.589761	0.0000
GARCH(-1)	-0.009494	0.013718	0.4889
R-squared	-0.150353	S.D. dependent var	1867.751
Adjusted R-squared	-0.161308	AIC	17.09289

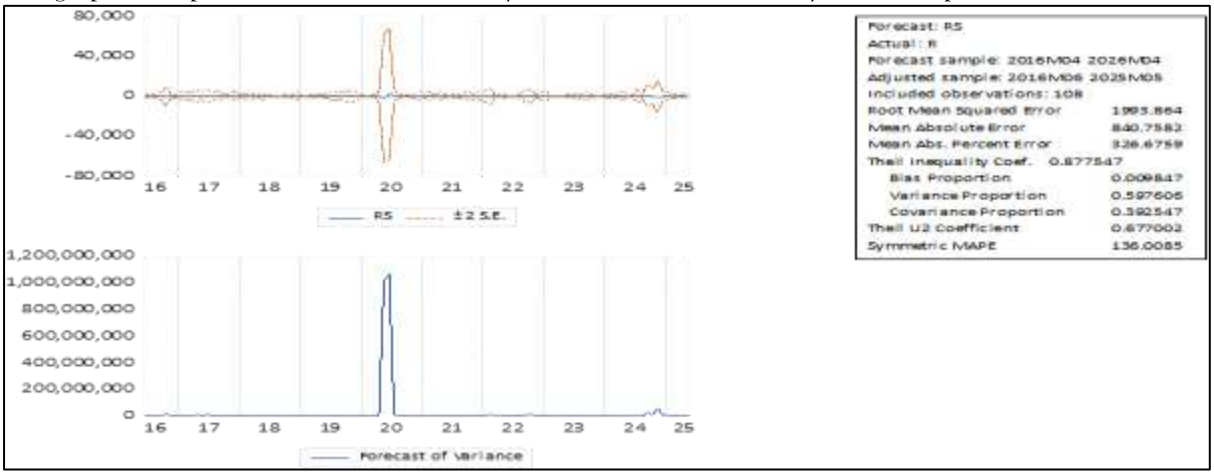
The results are from a GARCH (1,1) (Generalised Autoregressive Conditional Heteroskedasticity) model, commonly used to model volatility in time series data. The constant term (C) is estimated at 97,656.64 and is marginally insignificant at the 10% level (p = 0.0879), suggesting a relatively high baseline variance in the model. The coefficient for the lagged squared residual term, RESID(-1)^2, is highly significant (p = 0.0000), indicating that past shocks or innovations have a substantial impact on current volatility. This supports the presence of ARCH effects, where previous periods' errors affect current variability. In contrast, the GARCH(-1) term, which captures the persistence of volatility over time, is not statistically significant (p = 0.4889), implying that the volatility of RSS 4 Prices does not carry forward strongly from one period to the next. The negative R-squared and adjusted R-squared values indicate poor explanatory power of the model for the mean equation, possibly due to the model being focused more on variance than on predicting the actual level of the dependent variable. The AIC (Akaike Information Criterion) value of 17.09289 can be used for model comparison; lower values generally indicate a better-fitting model. While the model detects significant volatility clustering, it may require refinement or additional terms to better capture persistence in variance and improve overall fit.

The GARCH (1,1) equation for RSS 4 Prices is as follows:

$\sigma_t^2 = 97656.64 + 5.853298\, u^2_{t-1} - 0.009494\sigma^2_{t-1}$

Volatility Forecast of RSS 4 Prices

The graphical representation of the volatility of RSS 4 Prices from May 2025 to April 2026.



The data visualisation of RSS 4 provides a snapshot of economic or financial behaviour over time, showcasing a sequence of values that reflect fluctuations, trends, and potential turning points. Interpreting the visible patterns suggests phases of steady movement followed by pronounced dips and eventual recoveries, which could be attributed to cyclical market forces or external disruptions. If the graph includes fitted or predicted values (like a forecast model), it demonstrates how historical behaviour informs future expectations, highlighting periods of volatility and stabilisation. Overall, such an analysis helps identify structural changes and model accuracy and potentially guides strategic or investment decisions based on observed and projected trends.

Table No: 3. Result of GARCH (2, 1) Model- RSS 5 Prices

Variable	Coefficient	Std. Error	Prob.
C	1502651	502083.0	0.0028
RESID(-1)^2	0.141533	0.049442	0.0042
GARCH(-1)	0.391556	0.566939	0.4898
GARCH(-2)	-0.153080	0.318303	0.6306
R-squared	-0.149295	S.D. dependent var	1800.200
Adjusted R-squared	-0.160240	AIC	17.48303

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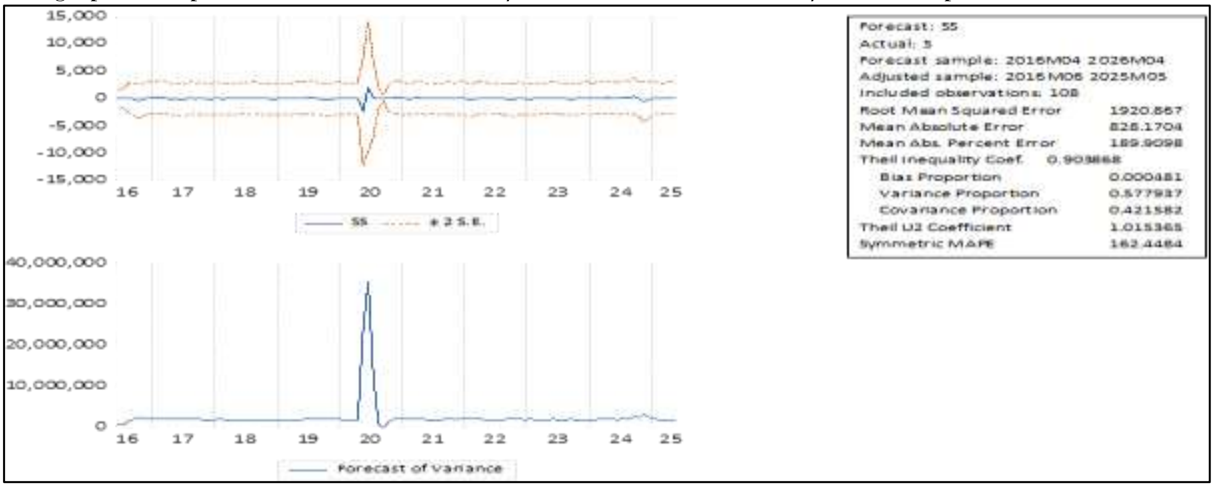
The results obtained from a GARCH (2,1) model that aims to capture the volatility patterns within the dataset, likely related to a financial or commodity time series such as RSS 5 prices. The constant term (C) is statistically significant (p = 0.0028), implying a strong baseline variance in the model. The squared residual term from the previous period, RESID(-1)^2, is also significant (p = 0.0042), which confirms the presence of ARCH effects, indicating that recent shocks or innovations play an important role in influencing current volatility levels. However, both GARCH terms, GARCH(-1) and GARCH(-2), are statistically insignificant (p-values of 0.4898 and 0.6306, respectively), suggesting that the persistence of volatility RSS 5 over time is weak or not well captured by these lagged variance components. The model's explanatory power is limited, as negative R-squared and adjusted R-squared values indicate. Nevertheless, the Akaike Information Criterion (AIC) of 17.48303 can be helpful when comparing this specification with alternative GARCH models. While the model captures short-term volatility spikes effectively, it may require refinement, such as adjusting lag structures or model order to better reflect long-run volatility dynamics.

The GARCH (2,1) equation for RSS 5 Prices is as follows:

$\sigma_t^2 = 1502651 + 0.141533\, u^2_{t-1} + 0.391556 u^2_{t-2} - 0.153080\, \sigma^2_{t-1}$

Volatility Forecast of RSS 5 Prices

The graphical representation of the volatility of RSS 5 Prices from May 2025 to April 2026.



The forecast analysis reveals important insights into the accuracy and variability of the predicted values from 2016 to 2025. The sharp spike observed around the 2020 mark in the forecasted series and the variance graph suggests a significant anomaly or structural shock, possibly reflecting a market disturbance or external event that introduced considerable uncertainty. The widening of the ±2 standard error bands during this period underscores the elevated volatility and reduced confidence in forecast precision. The statistical summary further informs us that while the model attempts to capture the data's behaviour, its forecasting accuracy is moderate. Metrics such as the Root Mean Squared Error (1920.87) and Mean Absolute Percentage Error (189.91%) point toward substantial prediction errors. A Theil U2 coefficient slightly above 1 (1.015) suggests the model performs only marginally better than a naïve forecast. The Bias Proportion is nearly zero, which is positive, indicating minimal systematic forecast bias, but the high Variance and Covariance Proportions suggest that mismatches in variation and pattern alignment between predicted and actual values contribute significantly to the forecast error. Overall, this analysis implies that while the model detects potential turning points and volatilities, further refinement may be necessary for improved forecast reliability.

CONCLUSION

Bringing together the entire analysis, the data reveals a compelling narrative of volatility, structural change, and adaptive recovery within the RSS price series across the years 2016 to 2025. Initial time series trends show signs of non-stationarity, but first differencing establishes stationarity, validating the suitability of models like GARCH. GARCH modelling captures significant short-term volatility via ARCH effects, though persistent variance over time remains weakly expressed, signalling room for model refinement. Forecast diagnostics indicate that while predictive patterns are roughly aligned with real fluctuations, high forecast errors and sensitivity to variance suggest limited reliability under turbulent market conditions. Nonetheless, the overarching findings provide valuable insight into market dynamics, response to shocks, and the modelling challenges posed by real-world financial or commodity time series, offering a springboard for more robust econometric modelling and informed policy or investment strategies.

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