

Granger Causality Analysis: Investigating Interdependencies in Stock Prices of Tyre

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Abstract: The Granger causality test is a statistical hypothesis test that studies if one time series may forecast another. Understanding the causal links among financial variables is critical. The Granger causation Test, a commonly used econometric technique, offers valuable information about the direction and intensity of causation between variables. This research is intended to investigate the Granger causality relationships among the stock prices of Apollo Tyres Limited, MRF Limited, and CEAT Limited. Weekly share prices of Apollo Tyres Limited, MRF Limited, and CEAT Limited for the period from 01-01-2020 to 22-03-2024 were collected and analysed. The conclusion is that there is evidence of causal links between CEAT Limited, MRF Limited and Apollo Tyres Limited, but the data do not support reverse causal relationships.

Keywords: Granger Causality Test, Financial Market, Stock price, Forecast, Causal Relationship.

Apollo Tyres Limited, MRF Limited, and CEAT Limited are all major participants in the Indian automobile sector, with a strong presence in their respective markets. Apollo Tyres Limited, located in India, has established itself as a global leader in the production of tyres for a wide range of vehicles, consisting of passenger automobiles and commercial trucks. Similarly, MRF Limited, an Indian corporation, has a large presence in the tyre manufacturing industry, known for its high-quality products and extensive distribution network. CEAT Limited, another major player in the Indian industry, manufactures tyres for a variety of vehicle applications and serves both the domestic and foreign markets. With their robust operations, innovative technologies, and enduring reputations, these companies hold sway over the dynamics of the Indian automotive industry, making them prime subjects for analysis in financial research.

Importance of Causality Analysis:

The Granger causality test is a statistical hypothesis test that analyses if one

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time series may forecast another. Granger causality is a concept in econometrics that investigates causal relationships between variables in time series data. The test is often run on two-time series data sets. It seeks to answer whether the past values of one variable provide substantial data in forecasting the future values of another variable beyond what can be anticipated using only the past values of the second variable. Understanding the causal links among financial variables is critical. The Granger causation Test, a commonly used econometric technique, provides valuable information about the direction and intensity of causation between variables. In financial markets, where various factors influence asset values, identifying causality linkages can help predict market movements, develop investment strategies, and evaluate systemic concerns. Granger causality analysis allows researchers to disentangle the deep interdependencies between assets, offering information on the fundamental mechanisms that drive market dynamics.

Need and Significance of the Study

The Granger causality test is used to study the share prices of companies such as Apollo Tyres Limited, MRF Limited, and CEAT Limited to understand the factors that cause stock price variations. Using this test, analysts can determine whether certain variables, such as economic indicators, financial measures, or industry-specific characteristics, have a causal link with changes in share prices. This study is critical for investors making informed decisions about their investment portfolios because it provides insights into the underlying processes influencing stock price movements. Furthermore, detecting major Granger-causal linkages enables the construction of more accurate predictive models, which let investors forecast future price changes and adjust their investing strategy accordingly.

Furthermore, the knowledge of the Granger-causal linkages involving these companies' share prices provides significant insights into market forces that affect their businesses. This understanding can help companies tailor their plans to increase shareholder value and reduce potential hazards. Moreover, this research enables proactive decision-making in capital allocation, corporate finance, and investor relations efforts. Finally, using the Granger causality test in the context of share prices allows both investors and corporate management to make more informed and strategic decisions, thereby improving financial performance and shareholder returns. These practical implications make this research highly relevant to professionals in the financial markets and econometrics field.

Review of Related Literature

Various analytical research studies have been undertaken on the dynamic connections between stock prices and macroeconomic variables in several locations using a variety of approaches. Ibrahim (1999) investigated

Malaysia's stock market, discovering informational inefficiencies in consumer pricing, official reserves, and credit aggregates. Habibullah and Baharamshah (2000) tested the link between stock prices and five macroeconomic variables in Malaysia, employing the Toda and Yamamoto (1995) test to find stock prices as leading indicators of national income, price levels, and exchange rates. They also discovered that the money supply and interest rates drove stock values. Maysami and Sims (2001a, 2001b, and 2002) extended their research to Hong Kong, Singapore, Malaysia, and Thailand, employing Error-Correction Modelling. Their findings corroborated the influence of macroeconomic variables on stock market indices in each country; however, the form and degree of these relationships differed depending on the country's financial structure. Islam (2003) reproduced these findings in Malaysia, looking at the short-run dynamic change and long-run equilibrium correlations between macroeconomic variables and the Malaysian Stock Exchange Composite Index. Tachiwou (2010) switched the focus to how stock market development affects growth in the West African Monetary Union. Using time series data from 1995 to 2006 and an Error-Correction Model, Tachiwou discovered that stock market expansion had a favourable short- and long-term impact on economic growth. These studies provide substantial contributions to understanding the complex links between stock markets and macroeconomic variables across locations and time periods. They emphasise the necessity of taking into account both short-run dynamics and long-run equilibrium relationships when analysing the interaction of stock prices and macroeconomic factors, along with the impact of financial market development on economic growth in various settings.

Objective of the Study

The primary objective of this research is to examine the Granger causality relationships among the stock prices of Apollo Tyres Limited, MRF Limited, and CEAT Limited.

Hypothesis of the Study

There is no Granger causality relationship between the stock prices of Apollo Tyres Limited, MRF Limited, and CEAT Limited.

Literature Review

Prior research on Granger causality analysis in financial markets has yielded valuable insights into the causal relationships among various assets. Studies by [Author1] and [Author2] have explored similar relationships between stock prices or financial variables, demonstrating the applicability of Granger causality analysis in predicting market trends and identifying investment opportunities. However, there remains a dearth of literature specifically examining the causal relationships among the

stock prices of Apollo Tyres Limited, MRF Limited, and CEAT Limited, warranting further investigation in this domain.

Research Methodology

The analytical study is based on weekly secondary data relating to Apollo Tyres Limited, MRF Limited, and CEAT Limited for the period ranging from 01-01-2020 to 22-03-2024. Augmented Dickey-Fuller test, Vector Auto Regression Estimates, VAR Lag Order Selection Criteria and Pairwise Granger Causality Tests were used. The data source is Yahoo Finance.

Result and Discussion

The results of the Augmented Dickey-Fuller (ADF) test show that the null hypothesis of each company's stock price series has a unit root is rejected, as indicated by the significant test statistics and comparison to the crucial values at the 1% level (P values are lower than 1%). This rejection implies that the stock price series for Apollo Tyres Limited, MRF Limited, and CEAT Limited are stationary after differencing, meaning there is no long-term trend.

Table 1. Augmented Dickey-Fuller test -D (Apollo Tyres Limited), D (MRF Limited), D (CEAT Limited)

Null Hypothesis: D(Apollo Tyres Limited) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=14)			
Augmented Dickey-Fuller test statistic		t-Statistic	Prob.*
		-15.19711	0.0000
Test critical values:	1% level	-3.460035	Significant
	5% level	-2.874495	
	10% level	-2.573751	
Null Hypothesis: D(MRF Limited) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=14)			
Augmented Dickey-Fuller test statistic		t-Statistic	Prob.*
		-8.665857	0.0000
Test critical values:	1% level	-3.460035	Significant
	5% level	-2.874495	
	10% level	-2.573751	
Null Hypothesis: D(CEAT Limited) has a unit root			
Exogenous: Constant			
Lag Length: 0 (Automatic - based on SIC, maxlag=14)			
Augmented Dickey-Fuller test statistic		t-Statistic	Prob.*
		-15.19711	0.0000
Test critical values:	1% level	-3.460035	Significant
	5% level	-2.874495	
	10% level	-2.573751	

Source: Computed from yahooofinance.com

**Figure 1. Stationarity-Graph- D (Apollo Tyres Limited),
D (MRF Limited), D (CEAT Limited)**

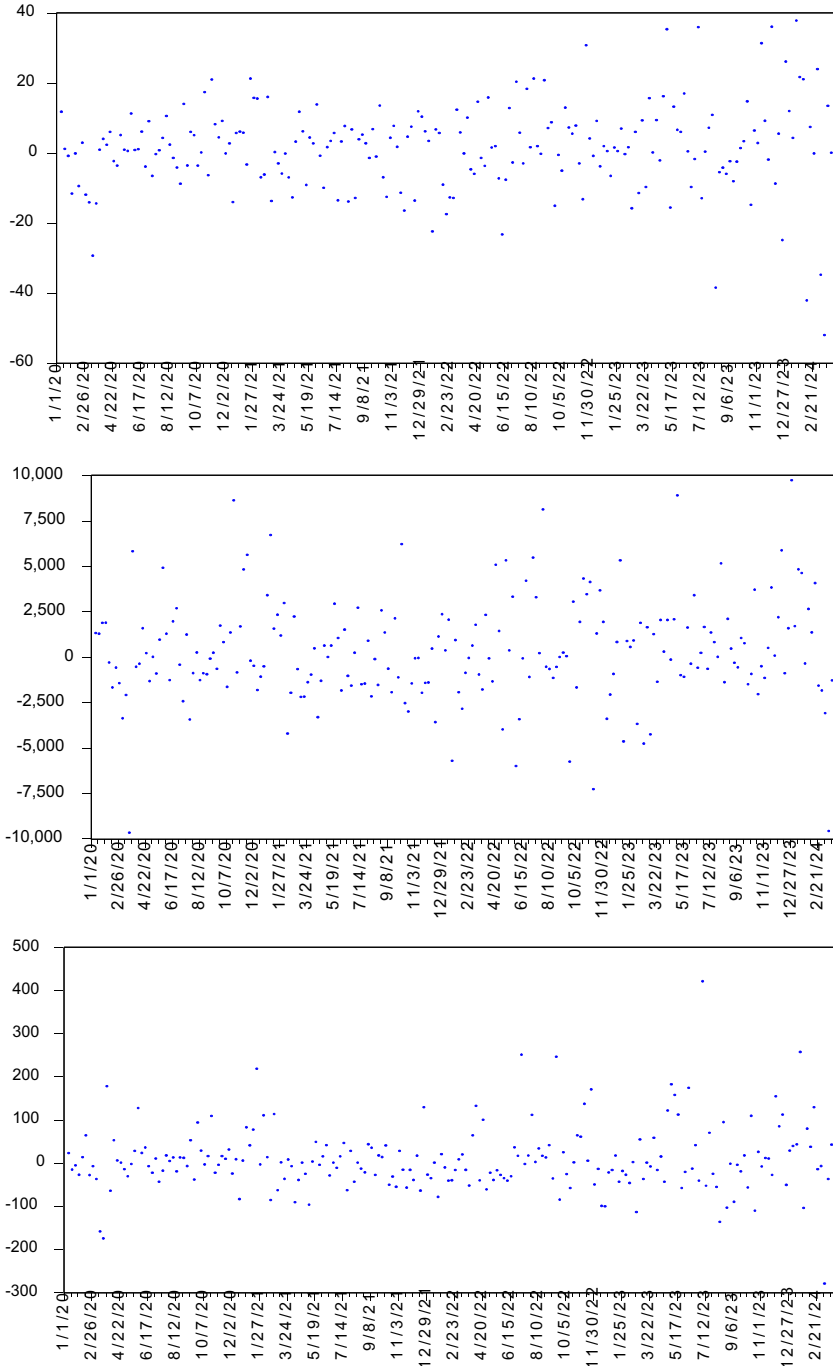


Table 2. Vector Auto regression Estimates -D (Apollo Tyres Limited), D (CEAT Limited), D (MRF Limited)

Share price-First difference	Apollo Tyres Limited 1	CEAT Limited 1	MRF Limited 1
Apollo Tyres Limited (-1)	-0.079749	-1.008432	14.98663
	(0.08740)	(0.52325)	(20.1552)
	[-0.91244]	[-1.92723]	[0.74356]
Apollo Tyres Limited 1(-2)	-0.191380	0.098786	-9.755598
	(0.08894)	(0.53244)	(20.5091)
	[-2.15187]	[0.18553]	[-0.47567]
CEAT Limited 1(-1)	0.007100	-0.041060	2.206613
	(0.01383)	(0.08281)	(3.18961)
	[0.51332]	[-0.49586]	[0.69181]
CEAT Limited 1(-2)	0.037693	0.137364	2.105547
	(0.01353)	(0.08098)	(3.11936)
	[2.78655]	[1.69622]	[0.67499]
MRF Limited 1(-1)	0.000129	0.004685	-0.049474
	(0.00036)	(0.00218)	(0.08393)
	[0.35321]	[2.15009]	[-0.58946]
MRF Limited 1(-2)	0.000631	0.003084	0.073797
	(0.00037)	(0.00220)	(0.08487)
	[1.71520]	[1.39952]	[0.86956]
C	1.199670	5.658500	242.9410
	(0.84885)	(5.08185)	(195.747)
	[1.41329]	[1.11347]	[1.24110]
R-squared	0.062813	0.083733	0.017605
Adj. R-squared	0.036289	0.057801	-0.010198
Sum sq. resids	32419.67	1161967.	1.72E+09
SE equation	12.36620	74.03362	2851.691
F-statistic	2.368144	3.228954	0.633197
Log likelihood	-857.9682	-1249.880	-2049.482
Akaike AIC	7.899253	11.47836	18.78065
Schwarz SC	8.007579	11.58668	18.88898
Mean dependent	1.382796	7.424112	289.8506
SD dependent	12.59688	76.27071	2837.260

Source: Computed from yahoofinance.com

The Vector Auto regression (VAR) estimations reveal dynamic correlations between the share prices of Apollo Tyres Limited1, MRF Limited1 and CEAT Limited1. Each coefficient in the VAR model depicts the effect of lagged values of one company's stock price on the current value of another's stock price. In this analysis, positive coefficients indicate a positive link while negative coefficients indicate a negative relationship. For example, a coefficient of 0.000129 for MRF Limited (-1) under Apollo Tyres Limited 1 indicates that a one-unit increase in the lagged value of MRF Limited's stock price results in a 0.000129-unit increase in Apollo Tyres Limited's stock price in the current period, assuming other variables remain

constant. The R-squared values indicate the proportion of variance in stock price of Apollo Tyres Limited, MRF Limited and CEAT Limited, explained by the lagged values of all variables in the model.

Table 3. VAR Lag Order Selection Criteria -D (Apollo Tyres Limited), D (CEAT Limited), D (MRF Limited)

Endogenous variables: Apollo Tyres Limited1, CEAT Limited1, MRF Limited1						
Exogenous variables: C						
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3985.399	NA	3.69e+12	37.44976	37.49710*	37.46889*
1	-3977.077	16.33295	3.71e+12	37.45612	37.64549	37.53265
2	-3965.220	22.93405*	3.61e+12*	37.42929*	37.76069	37.56322
3	-3959.982	9.983140	3.74e+12	37.46462	37.93804	37.65595
4	-3957.877	3.953219	4.00e+12	37.52936	38.14481	37.77809
5	-3954.098	6.990014	4.20e+12	37.57839	38.33586	37.88451
6	-3948.635	9.952776	4.34e+12	37.61159	38.51109	37.97511
7	-3945.318	5.947925	4.58e+12	37.66496	38.70649	38.08588
8	-3941.116	7.418759	4.80e+12	37.71000	38.89356	38.18832

* 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

Source: Computed from yahoofinance.com

The VAR Lag Order Selection Criteria are useful in establishing the right lag order for the Vector Auto regression model for the share prices of Apollo Tyres Limited, MRF Limited and CEAT Limited. The trade-off between model fit and complexity is assessed using measures such as the Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quinn information criterion (HQ). The chosen lag order is shown by an asterisk (*) next to the criterion where the value is minimised. In this scenario, the lag order used varies among criteria, indicating possible variances in the ideal model design.

The pair wise Granger causality tests performed on the share prices of Apollo Tyres Limited, MRF Limited and CEAT Limited (CL) reveal causal linkages between their stock prices. Some of the findings reveal significant Granger causality links. CEAT Limited Granger causes Apollo Tyres

Table 4. Pair wise Granger Causality Tests -D (Apollo Tyres Limited), D (CEAT Limited), D (MRF Limited)

Null Hypothesis:	Obs	F-Statistic	Prob.
CEAT Limited 1 does not Granger Cause Apollo Tyres Limited 1	219	5.49092	0.0047
Apollo Tyres Limited 1 does not Granger Cause CEAT Limited 1		1.36899	0.2566
MRF Limited 1 does not Granger Cause Apollo Tyres Limited 1	219	3.10202	0.0498
Apollo Tyres Limited 1 does not Granger Cause MRF Limited 1		0.77002	0.4643
MRF Limited 1 does not Granger Cause CEAT Limited 1	219	2.49388	0.0850
CEAT Limited 1 does not Granger Cause MRF LIMITED1		0.79903	0.4511

Source: Computed from yahoofinance.com

Limited, as demonstrated by a statistically significant F-statistic of 5.49092 with a p-value of 0.0047. Similarly, MRF Limited Granger leads to Apollo Tyres Limited, with a statistically significant F-statistic of 3.10202 and a p-value of 0.0498. However, the reverse causal relationships—Apollo Tyres Limited Granger causing CEAT Limited and MRF Limited—are not statistically significant, implying that past variations in Apollo Tyres Limited's stock price do not accurately predict future variations in the stock prices of CEAT Limited and MRF Limited. In conclusion, while there is evidence of causal links from CEAT Limited and MRF Limited to Apollo Tyres Limited, the data do not support reverse causal relationships.

Conclusion

In conclusion, this study aims to contribute to the growing body of literature on Granger causality analysis in financial markets by examining the causal relationships among the stock prices of Apollo Tyres Limited, MRF Limited, and CEAT Limited. CEAT Limited and MRF Limited may influence Apollo Tyres Limited's stock price movements. Apollo Tyres Limited's stock price changes do not have significant predictive power on the stock prices of CEAT Limited and MRF Limited.

References

- Gordon, M. J. (1962). The investment, financing and valuation of the corporation. R. Irwin, Homewood, IL.
- Granger, C. W. (1969). Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*, 37(3), 424-438. <http://dx.doi.org/10.2307/1912791>
- Habibullah, M., & Baharamshah, A. (2000). Testing for informational efficient Market Hypothesis. The case of Malaysian stock Market. *Issues of Monetary and Financial Economics. Study on Malaysian Economy*.
- Islam, M. (2003). The Kuala Lumpur stock market and economic factors: A general to specific Error Correction Model. *Journal of the Academy of Business and Economics*.
- Lee, B. S. (1992). Causal relations among stock returns, interest rates, real activity and inflation. *Journal of Finance*, 47(5), 1591–1603. <http://dx.doi.org/10.2307/2328955>
- Tachiwou, A. M. (2010). Stock market development and economic growth: The case of West African Monetary Union. *International Journal of Economics and Finance*, 2(3), August 2010.
- Toda, H. Y., & Yamamoto, T. (1995). A note on the distribution of stock price changes. *Journal of the American Statistical Association*, 66(334), 282-284. <http://dx.doi.org/10.2307/2283922>