iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** X **Month of publication:** October 2021

DOI: https://doi.org/10.22214/ijraset.2021.38623

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue X Oct 2021- Available at www.ijraset.com

How do Capital Goods Index, Metal Index and Oil and Gas Index explain the rising Auto Index?

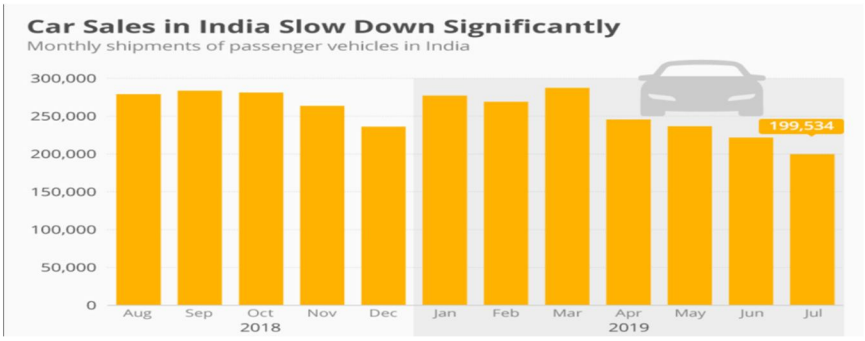
Kanika Gupta
B.A. (Hons.) Economics – 3A, Lady Shri Ram College for Women, New Delhi

Abstract: ***The automobile sector holds a noteworthy position in the Indian economy. Resurgence of the sector from the short-term slump it experienced in 2019 and the advent of electronic vehicle revolution is certain to bring about remarkable changes in the industry. Additionally, sector's image as a bellwether of economic conditions makes it an all the more intriguing sphere to study. The paper examines the relationship between auto index, capital goods index, metal index and oil and gas index. All the indices have followed an upward trajectory in the past years. The aim is to study if these movements are related to each other through tools of Johansen Tests of Cointegration and Vector Error Correction Model (VECM). The result confirms a long-run direct relationship between the auto index and capital goods index. However, such a relationship of the auto index with the other two indices in the study remains uncertain. The data does not clearly support a conclusion in their case.***
Keywords: Automobile sector, Indian economy, auto index, capital goods index, metal index, oil and gas index, VECM

I. INTRODUCTION

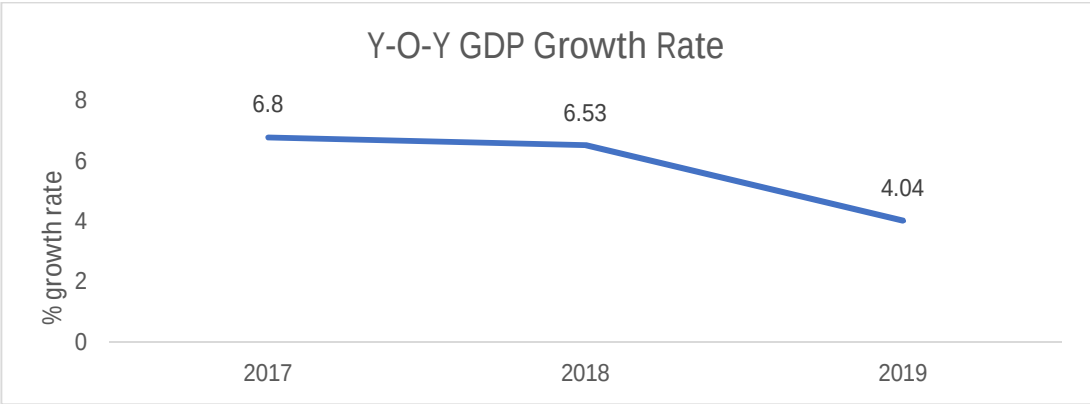
Interestingly, the automobile sector serves as an indicator of the economy's health. A fall in the sales of commercial vehicles was a foreboding for the impending challenges in the years 2012 and 2019. Perhaps, it was one of the first sectors to indicate that the country might be moving towards a recessionary phase. The two graphs below verify this conjecture. Similarly, an increase in two-wheelers and passenger vehicles sales was indicative of economic prosperity enjoyed in 2010.

Chart 1. Car Sales in India in FY 2018-19



Source – Statista

Chart 2. Y-O-Y GDP Growth in FY 2018-19



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Liquidity crunch, higher acquisition costs and weaker customer sentiment led to slowing down of the industry in the third quarter of FY 2018. The pandemic and the concomitant lockdown worsened the woes. In the months of April and May of FY 2020, the y-o-y sale for all the segments plummeted down by more than 90%.

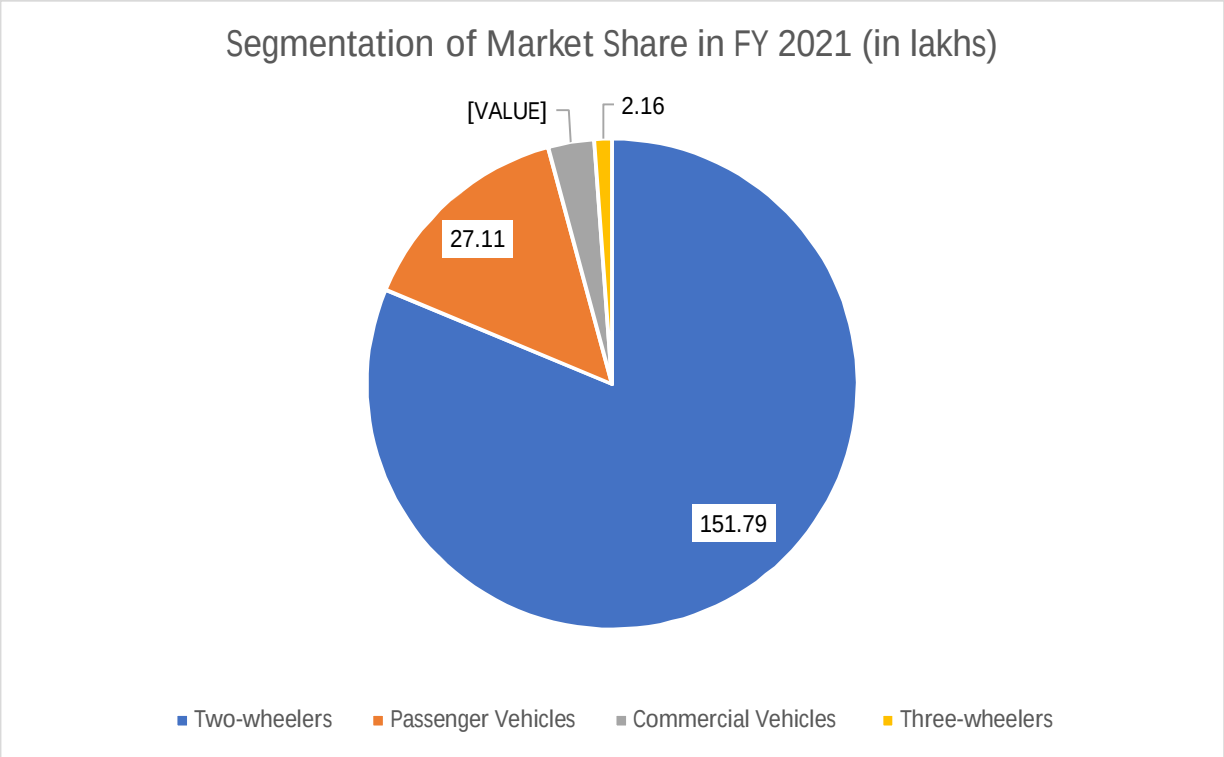
However, in the late 2020, eased travel restrictions and a festival season worked as an antidote which stimulated the demand and the two segments of two-wheelers and passenger vehicles saw an increase in m-o-m demand. These early signs of recovery were evident by the end of 2020. Therefore, it might be safe to conclude that the industry was resilient to the short-term challenges and is now changing gears to move into the phase of resurgent. The following sub-sections aim to illustrate the present and expected trends in the sector.

A. A Snapshot

The automobile sector in India was the fifth largest in the world in the year 2020 with 3.49 million units combined sold in the passenger and commercial vehicle category. The industry contributes 6.4% to the nation's GDP and 35% to the manufacturing GDP. Furthermore, it buttresses over 38 million jobs both directly and through the value chain. Tata Motors, Hindustan Motors Limited, Ashoke Leyland, Maruti Suzuki India Limited, Hyundai Motor India Limited and Bajaj Auto have emerged as the market leaders in the past years and hold the majority of the market share.

The CAGR of around 8% during FY 2009-20 shows a promising picture for India's technological and economic advancements. The two wheeler segment dominates the sector because of factors like large domestic market, growing middle class and an increasing young population. The chart below represents the statistics of FY 2021.

Chart 3. Automobile market segmentation in FY 2021

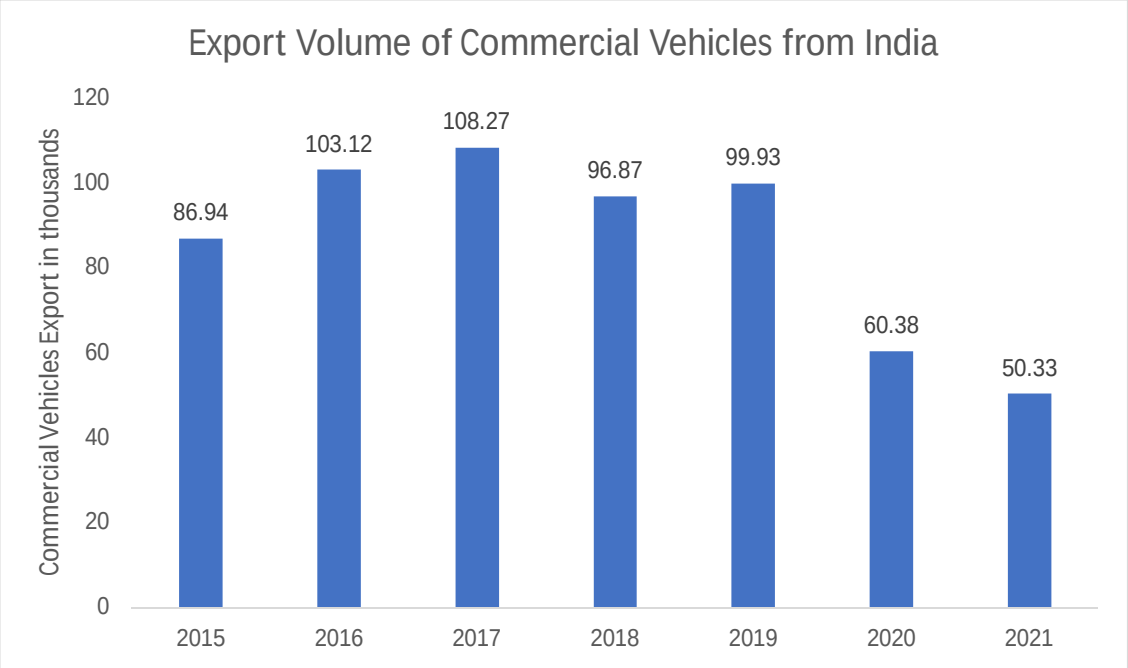


The two-wheelers composed of more than 80% of the total sales followed by passenger vehicles. Along with a lucrative domestic market, the industry is a profound exporter. The automobile export proliferated at a CAGR of 6.94% during FY 2016-20. To put things in perspective, the industry exported 4.77 million vehicles in FY 2020 alone.

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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
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Chart 4. Export volume of CV from FY 2015-21



Tesla's interest in opening a unit in India gave the Electronics Vehicles (EV) segment the much needed breakthrough. In 2020, the sales of electronic two-wheelers experienced an increase of 20% to reach 1.56 lakh units. A report by the NITI Aayog and Rocky Mountain Institute suggests that India's EV finance industry will value at around US$ 50 billion by 2030. Owing to this auspiciousness, the EV industry is expected to create 5 crore job opportunities by 2030. However, a cumulative investment of US$ 180 billion in infrastructure and production is a pre-requisite to meet India's EV aspiration. Favorable expectations from the sector has led to a cumulative FDI inflow of about US$ 25.85 billion between April 2000 and March 2021. The government predicts that the sector will enjoy additional investments of US$ 8 – 10 billion by 2023 in local and foreign investments. The Government of India has allowed for 100% FDI in the sector. Furthermore, the country inaugurated Asia's longest high-speed track for automotive testing in July 2021. Measures like FAME, NATRiP and regular budget allocations by the government pave way for the upcoming success the sector is likely to enjoy.

While we talk of economic development, MSME's role stays prevalent as an employment generator and growth driver. MSME hold 35% of the share of value-addition to a car. While an official estimate is missing, an estimate projects around 25000-35000 MSMEs to be engaged in the auto value chain.

Technological advancements, availability of labor at low costs, increasing demand, low-cost steel production coupled with government's monetary and fiscal support is crucial to sector's predicted growth in the upcoming years.

B. Objective

A lucrative automobile sector would indubitably lead to higher stock values of the companies in the industry. An accompanying outcome would be a proportional increase in the value of stocks of the allied industries – capital goods, metal, oil and gas. In other words, an increase in the valuation of stocks of automobile companies would act as a harbinger for these other complementary sectors. Manufacturing of automobile goods requires heavy machinery thus, the capital goods industry is relevant to the case. Metal, again, is a pivotal component in the manufacturing of all automobiles. A high valuation of auto indices should be accompanied by a proportional increase in value of metal indices and vice versa. Oil and gas indices, however, primarily come into play once the automobile is operational. A higher demand for automobiles naturally results in higher demand for oil and gas. Thus, the index would prove helpful in understanding the auto sector dynamics.

The paper aims to understand the nature and magnitude of relationship between auto index, capital goods index, metal index and oil and gas index in terms that how the last three indices tend to affect the former. For the purpose at hand, the following four variables have been used – S&P BSE Auto Index, S&P BSE Capital Goods Index, S&P BSE Metal Index, S&P BSE Oil and Gas Index.

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II. REVIEW OF LITERATURE

Dr. Atul A Agwan in the paper 'Empirical Analysis of the Impact of Capital Structure on the Profitability of Automobile Industry' posits that there exists a positive relationship between the capital structure and financial performance of firms in the automobile industry.

Another paper 'Oil and Cars: The Impact of Crude Oil Prices on the Stock Returns of Automotive Companies' tests if the impact of oil prices is different on the overall market and automotive companies using data from US, German, and Japan car manufacturers. A relationship between oil prices and the share prices of car-producing companies is absent. Additionally, evidence refutes the claim that car companies' stock prices are inversely related to oil prices.

A Business Standard article studies the effects of rising metal prices on the automotive industry. Needless to say, an increase in metal prices raises production costs for car manufacturers. It further establishes that in April 2021, the auto index was down nearly 12% from its 52 weeks high, against a 5% decline in BSE Sensex from the highs.

The paper 'Relationship between Crude Oil prices and stock performance of European Automobile Manufacturers' by Peter de Goeij examines the relationship by adding an oil factor to the three-factor Fama-french model and carrying out regression by using the OLS method. The results indicate that crude oil prices generally have no major impact on the stock performance of European auto manufacturers. However, for most of the years studied, crude oil prices have negligible effects on stock performance. It is notable that the relationship turned negative in the years of the credit crisis but this was a result of economic and financial turmoil more than anything else.

III. HYPOTHESIS

The upward trends in S&P BSE Auto Index are primarily explained by S&P BSE Capital Goods Index, S&P BSE Metal Index and S&P BSE Oil and Gas Index.

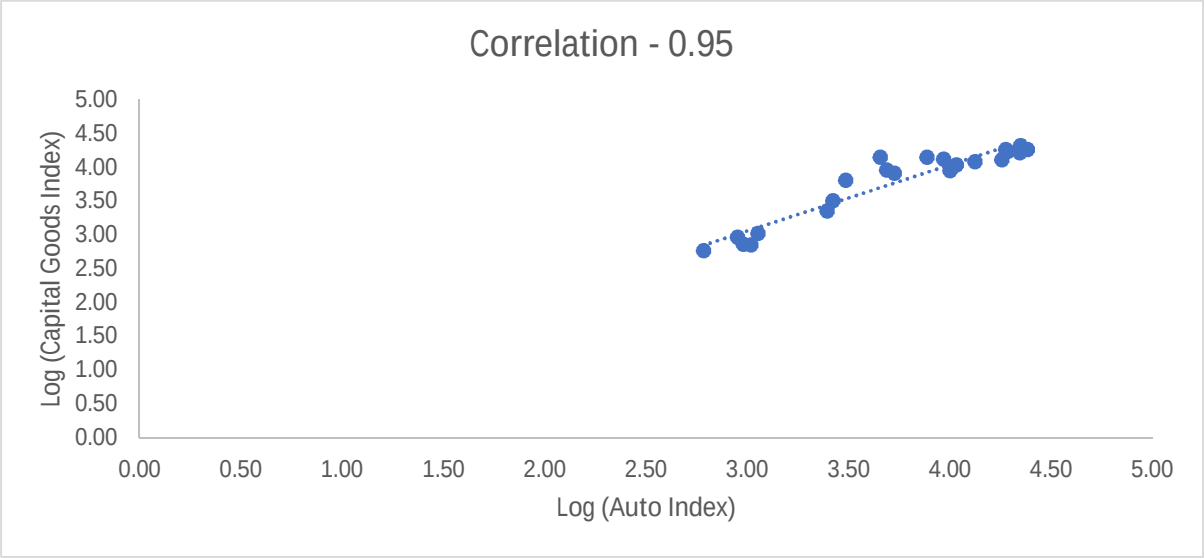
IV. METHODOLOGY AND RESULTS

A. Variables in the Study

Let's take a moment to understand and analyse the variables at length. All the four variables - S&P BSE Auto Index, S&P BSE Capital Goods Index, S&P BSE Metal Index, S&P BSE Oil and Gas Index, have been taken in the log form for the years 1999 – 2021 (23 years). The data has been sourced from the Economic Outlook, CMIE Database. For the ease of understanding, the variables will here fore be referred as Auto Index, Capital Goods Index, Metal Index and Oil and Gas Index.

The following graphs reflect the mutual correlation between S&P BSE Auto Index with S&P BSE Capital Goods Index, S&P BSE Metal Index, S&P BSE Oil and Gas Index respectively.

Chart 5. Correlation between Auto Index and Capital Goods Index



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Chart 6. Correlation between Auto Index and Metal Index

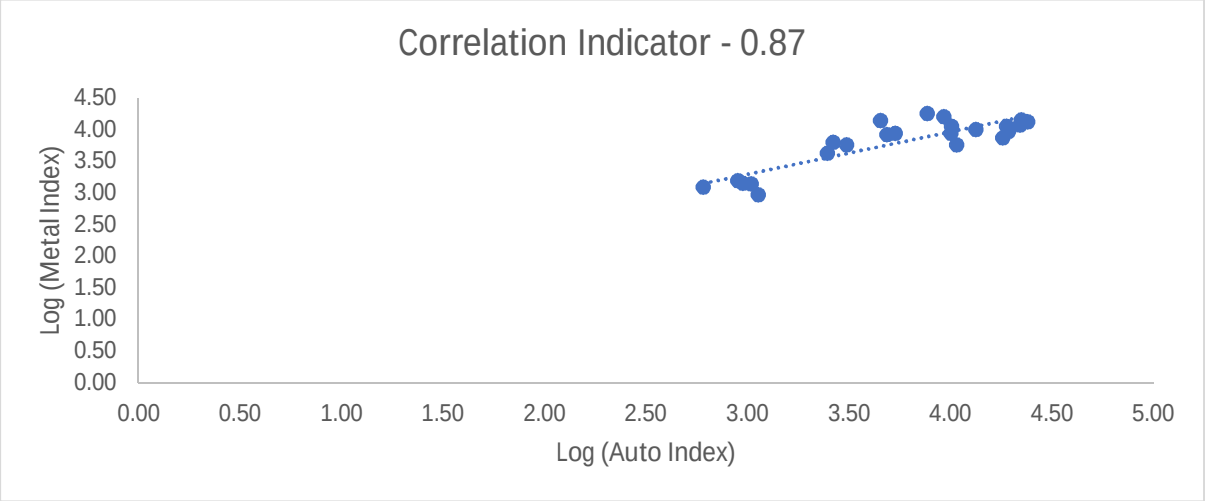


Chart 7. Correlation between Auto Index and Oil and Gas Index

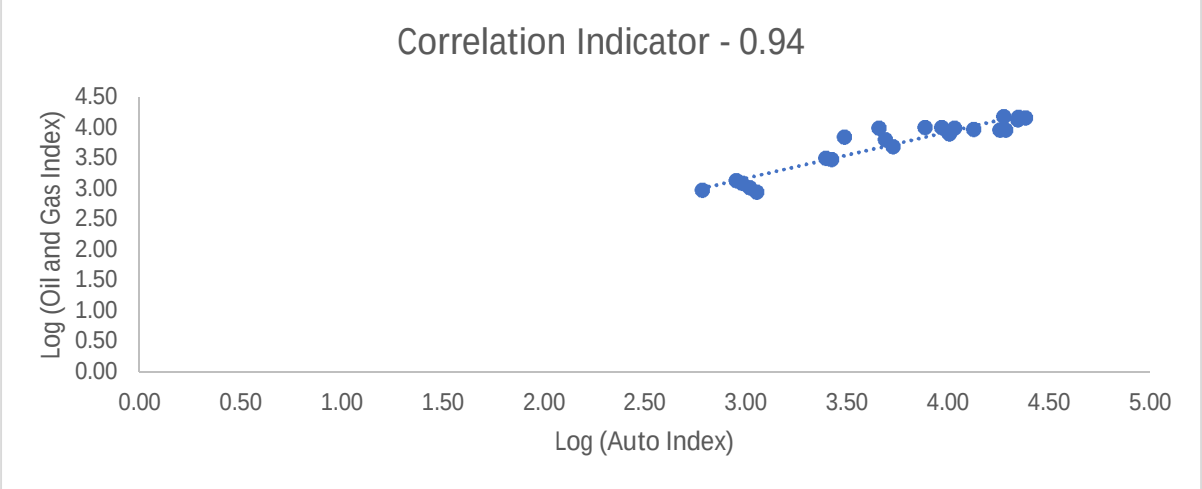
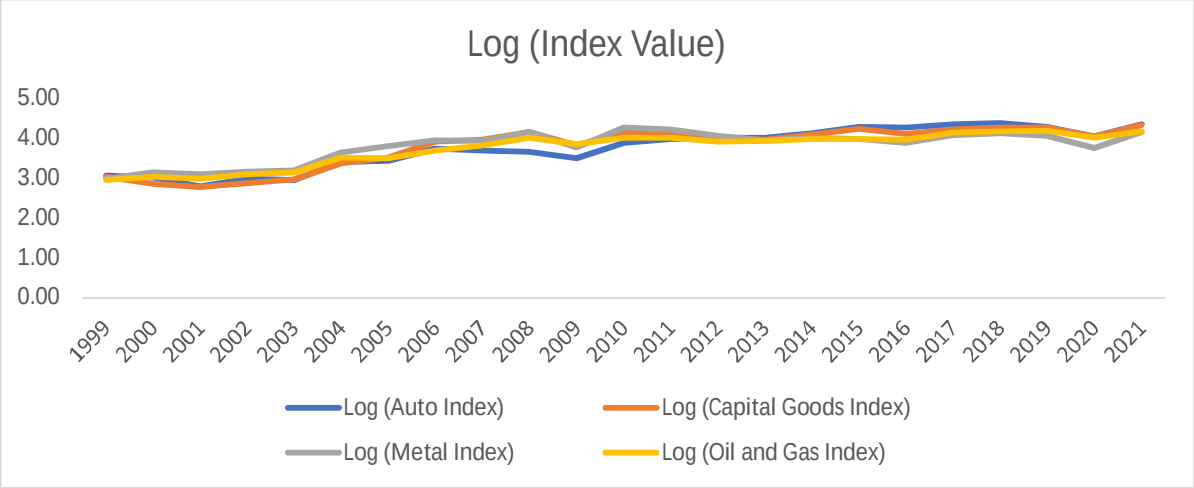


Chart 8. Trends of Auto Index, Capital Goods Index, Metal Index and Oil and Gas Index



The above graphs support a previously made claim that the four variables move in close sync with each other. On calculating correlation of Auto Index with each of the other three indices separately, the value range in between 0.87 to 0.95 indicating a fairly strong positive relationship.

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B. Approach and Statistical Tests Employed

To begin with, the data is tested for stationarity using the Phillips-Perron Test for Unit Root. Next, a classical multivariate linear regression model suffers from high degree of multicollinearity, autocorrelation and non-normality of error terms that results in anomalous outputs. As a result, a reliable linear relationship between the dependent and the explanatory variables cannot be found. Therefore, the Johansen Tests for Cointegration and Vector Error Correction Model have been put to use to derive the relationship among the variables.

Furthermore, the model has been tested for stability conditions and autocorrelation among the variables. All the tests in the study have been performed on Stata econometrics software.

C. Phillips-Perron Test for Unit Root

The test helps us to understand the nature of the variables i.e. whether a given time series is stationary. To check formally, a general multivariable log regression was performed and the results are as follows:

Table 1. Results of general regression model and Durbin – Watson statistic

Log (Auto Index)	Coefficient	Standard Error	t – statistic	Probability
Log (Capital Goods Index)	0.9237209	0.3706773	2.49	0.022
Log (Metal Index)	-0.5803912	0.2768636	-2.10	0.050
Log (Oil and Gas Index)	0.5370922	0.4532882	1.18	0.251
Constant	0.4443163	0.4818155	0.92	0.368
R – squared	0.9218			
Adjusted R – squared	0.9095			
F statistic	74.67			
Probability	0.0000			
Durbin – Watson statistic	0.752857			
Number of observations	23			

As shown in the table, R – squared > Durbin – Watson statistic. It implies that the outcome of regression is unstable and coefficients change sign on underfitting or overfitting and hence the model is non stationary. It cannot be used for prediction and forecasting.

More often than not, the data is non-stationary in nature at level. To further analyze the data, it is essential to convert it into stationary form i.e. to ensure the data does not have unit roots. On testing through the Phillips – Perron Test, it is found that the variables are non-stationary at the level. However, at the first difference, the data is stationary and hence is fit for further analysis. The results of the test are summarized in the table below.

Table 2. Results of Phillips – Perron Test for Unit Root

Variables	Level		First Difference	
	Test Statistic	5% Critical Value	Test Statistic	5% Critical Value
Log (Auto Index)	-0.874	-3.00	-5.508	-3.00
Log (Capital Goods)	-1.146	-3.00	-5.138	-3.00
Log (Metal Index)	-2.092	-3.00	-6.023	-3.00
Log (Oil and Gas Index)	-1.807	-3.00	-5.651	-3.00

H_0 : Variable is non stationary

For each variable, at level, absolute value of test statistic < absolute critical value at 5% significance level. Hence, the null hypothesis cannot be rejected. On taking the first difference, absolute value of test statistic > absolute respective critical value for all the variables and hence we reject the null hypothesis. Thus, the model is stationary at the first difference and the variables at the first difference will be employed in further analysis.

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D. Johansen Tests for Cointegration

Cointegration, an econometric property of time series variables, is a precondition for the existence of a long run econometric relationship between two or more variables having unit roots, integrated of order one. The Johansen approach shows that two or more random variables are cointegrated if each of the series is themselves non-stationary, and they have a long-run equilibrium relationship among the variables. The precondition for applying Johansen Cointegration test is that the variables must be non-stationary at level but stationary at the first difference.

The multivariate cointegration model can be expressed as:

$$\Delta y_t = \alpha_0 + \pi y_{t-1} + \sum_{i \stackrel{\text{def}}{=} 1}^{p-1} r_i \Delta y_{t-i} + \varepsilon_t$$

where π and r_i are coefficient matrices, p is the lag order based of AIC and Δ is the symbol of difference operator. Specifically, the maximum eigenvalue test and trace test are used to test for the number of co-integrating vectors which can be computed respectively as:

$$T(r) = -T \sum_{i=r_{+1}}^{n} ln(1 - \hat{\lambda}_i)$$

$$\lambda max(r, r+1) = -T\, ln(1 - \hat{\lambda}_{r+1})$$

where $\hat{\lambda}_i$ is the expected eigenvalue of the characteristic roots and T is the sample size.

The null hypothesis of the Maximum Eigenvalue test investigates the number of r cointegrating vectors against the alternative of r+1 cointegrating vectors.

H_0 = There is no cointegration (r = 0)

H_1 = There is cointegration among variables

The results are as follows:

Table 3. Results of Johansen Tests for Cointegration

Cointegrating Regressors	Null Hypothesis	Alternative Hypothesis	Max Statistic	5% critical value	Null Hypothesis
Log of auto index = F (log of capital goods index, log of auto index, log of oil and gas index)	r = 0	r = 1	47.25	47.21	Reject
	r <= 1	r = 2	27.64	29.68	Accept

Since the critical value is lesser than Max-L statistic at r = 0 we reject the null hypothesis. It is at rank 1 that Max-L statistic is lower than the critical value at the 5% significance level, thus we do not reject the null and so there exists no cointegration among all variables. Since the variables are co-integrated, there exists a long-run relationship among them which is now further examined using the VECM test.

E. Vector Error Correction Model

Vector Autoregressive (VAR) model is one of the special forms of system simultaneous equations. Model VAR can be applied only if the variables are not cointegrated. But since the variables taken here are both non stationary and not cointegrated, VECM is used. It is a VAR model which has been designed for non-stationary data having cointegrating relationship. It is one of the time series models which can directly estimate the level to which a variable can be brought back to equilibrium condition after a shock in other variables. VECM is proves handy to estimate both the short-term effects and the long-run effects of the time series data. A Vector Error Correction Model (VECM), which can be derived from the long-run cointegrating vectors, can be used to determine the direction of this causality. In the short term, we have

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$\Delta dlogauto_t = 0.004931 - 0.2304314\Delta dlogauto_{t-1} + 0.2982034\Delta dlogcapitalgoods_{t-1} - 0.0926687\Delta dlogmetal_{t-1} - 1.135334\Delta dlogoilgas_{t-1} - 0.0838551ECT_{t-1}$

Table 4. Results of VEC Model

Log (Auto Index)	Coefficient	Standard Error	Z Statistic	Probability
Log (Capital goods Index)	8.56713	1.97427	4.34	0.00
Log (Metal Index)	-4.818718	2.582361	-1.87	0.062
Log (Oil and Gas Index)	-7.191027	3.984757	-1.80	0.071

The long-run equilibrium can be expressed as:

$ECT_t = 1.000dlogauto_t + 8.56713dlogcapitalgoods_t - 4.818718dlogmetal_t - 7.191027dlogoilgas_t - 0.1013235$

F. Interpretation

Here,

dlogauto – Log (Auto Index) taken at first difference

dlogcapitalgoods – Log (Capital goods Index) taken at first difference

dlogmetal – Log (Metal Index) taken at first difference

dlogoilgas – Log (Oil and Gas Index) taken at first difference

The long-run relationship can be understood using elasticities since the model is a log-log model.

A percentage increase in the value of capital goods index leads to around 8.6% increase in the value of auto index. When the metal index and oil and gas indices rise by a percent, the auto index falls by around 4.8% and 7.2% respectively.

Note that the coefficients are significant at 10% critical level. At 5% critical level, only the relationship derived between Auto Index and Capital goods Index stands significant.

V. CONCLUSION

The automotive industry is one of the most dynamic yet important industries in the country. Its trends have often been an indication of economy's health and the sector occupies an essential position in terms of contribution towards GDP and employment generation. Estimates predict the industry to move up to the third position in the world by 2026 from the present fifth. This is the motivation behind studying the sector further. The S&P BSE Auto Index serves as a fair yardstick of any sector's performance. Since automobile is closely related to capital goods, metal, oil and gas; analysis could help explain the influence of these indices on the auto index. More specifically, a percentage increase in the value of capital goods index leads to around 8.6% increase in the value of auto index which conforms to the hypothesis. However, the results for Metal index and Oil and Gas index are insignificant at 5% critical level. Therefore, not much can be said about the relationship of the Auto Index with these two indices and there might be some other factors which play a key role in the index's performance over the years.

VI. SCOPE FOR FURTHER RESEARCH

Although the paper attempts to cover significant ground yet there remain areas which can be explored further. The research takes into account only three allied sectors of capital goods, metal and oil and gas. However, other related sectors could be included to get a more holistic view of the factors influencing the auto index. Secondly, increasing penetration of EVs (electronic vehicles) might distort the present relation between these variables. It is thus essential to incorporate the electronics vehicle sector while talking about automobile. Further nuances could be explored by examining the effects of EV on traditional automotive vehicles. Lastly, recent developments like shutting down of Ford's units in the country and interest shown by EV tycoons like Elon Musk in the country will further determine India's automobile future.

The author declares no conflict of interests.

VII. LIST OF ABBREVIATIONS

1) *VECM:* Vector Error Correction Model
2) *Dlogauto:* Log (Auto Index) taken at first difference
3) *Dlogcapitalgoods:* Log (Capital goods Index) taken at first difference
4) *Dlogmetal:* Log (Metal Index) taken at first difference
5) *Dlogoilgas:* Log (Oil and Gas Index) taken at first difference
6) *OLS:* Ordinary Least Squares
7) *BLUE:* Best Linear and Unbiased Estimator

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APPENDIX

A. LM Test for Autocorrelation

Serial correlation or autocorrelation occurs when the error terms in the model are related. When autocorrelation is present, the OLS procedure still produces unbiased estimates but increases the variances hence the OLS estimators ceases to be BLUE.

Using the Lagrange-multiplier test:

Table 5. Results of Lagrange-multiplier test

Lags	Chi-squared	Probability
1	8.4234	0.93525
2	15.0789	0.51887

H_0 – no autocorrelation at lag order

Since p value is more than 0.05, we cannot reject the null hypothesis and hence the model does not suffer from the problem of autocorrelation.

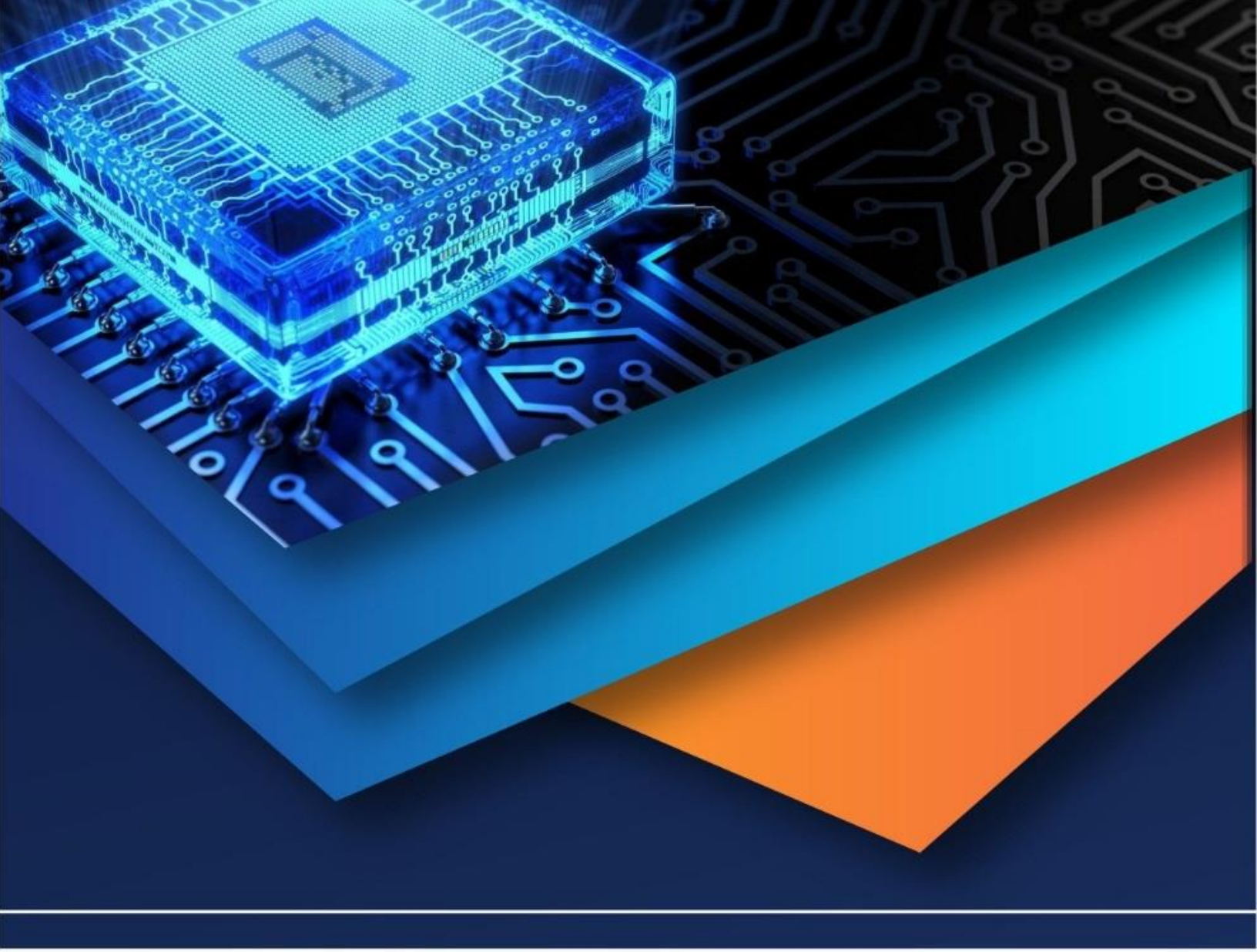
B. Eigenvalue Stability Condition

Table 6. Results of Eigenvalue Stability Condition

Eigenvalue	Modulus
1	1
1	1
1	1
-0.7972161	0.797216
0.0504945 + 0.5503161i	0.552628
0.0504945 - 0.5503161i	0.552628
-.5014146 + .2162223i	.546048
-.5014146 - .2162223i	.546048

The VECM specification imposes 3 unit moduli.

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