

Time Series Analysis of Automobile Demand in India

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Abstract: The Indian automobile industry is growing remarkably after 1991 following India's growing openness, income of the people, the arrival of new and existing models, easy availability of finance at relatively low rate of interest, and price discounts offered by the dealers and manufacturers. Although the automobile demand depends on number factors, but this study endeavours to explore the interactions between India's automobile demand and the hike in Fuel and Power prices, Lending Rate, and Gross Domestic Savings and Unemployment. Hence this study has applied the techniques of Time Series Analysis. We found out that higher the GDS higher will be the volume of automobile sales. However, lending-rate, fuel and power price and Unemployment have a negative relationship with automobile demand

Keywords: Indian automobile sales, Gross Domestic Savings, Lending-rate, prices of fuel and power, Unemployment, Time Series Models, Granger Causality

I. INTRODUCTION

The prospects of growth of any economy are determined largely by its core industries. "In the recent decades, the automobile industries in many countries have proven to be one of the strongest drivers of technology, growth and employment" (Gottschalk and Kalmbach, 2007) and its holistic development is projected by the global competitiveness of major industrialised economies around the world. The automobile industry is gradually developing and it is because of this slowness that large amount of investments is essential in Research and Development and also in technology and is further seen as a pointer of the economic progress of a country. "An understanding of the automobile industry in the developed economy enables one to study the emerging trends in the developing countries like India" (Chaudhary and Goyal, 1997). Automobile industry in India is one of the core industries that has expanded rapidly over the reform periods and accounts for a large and increasing share of industrial production, output, exports, and employment and also has made its presence felt.

The Automotive sector is seen as a multiplier of industrial growth. Automotive sector in India is one of the main industries of Indian economy, whose prospect is an indication of the economic flexibility of the country. The economic contribution of automobile sector is immense, with significant linkages to the manufacturing and services sectors (Ministry of Heavy Industries and Public Enterprises, 2006). For most of its existence the automobile industry has been a model of industrial and social discipline and control. Many developing countries regard the automobile industry as an economically strategic sector "in the context of its contribution to national production, employment and technology, reinforced through magnitude of upstream and downstream activities (Audet and Vangrasstek, 1997). In 1991, Indian government deregularised the economy and began initiating a series of measures to shift the controlled and regulated economy to market oriented economy. Moreover, the liberalization steps like reduction of the foreign exchange and equity regulations, reduction of tariffs on imports, and restructuring the banking policies initiated by the Government of India, have played an important role in serving the Indian Automobile Industry reach greater heights. Automobile Industry in India is growing fast and seems to have a high correlation with liberalisation related to policies those influenced both domestic demand pattern as well foreign trade. Following India's growing openness, the arrival of new and existing models, easy availability of finance at relatively low rate of interest and price discounts offered by the dealers and manufacturers, all have contributed to the rise in demand for vehicles and also helped in attaining a strong growth. The growth of automobile demand in India has also been augmented by the government's tax policies that largely favoured automobile sector in India. Economic reforms and subsequent increase in disposable income have been associated with changing patterns of spending on goods and services and emergence of consumerism in India. This extraordinary growth that the Indian automobile industry has witnessed is a result of a major factor namely, the improvement in the living standard of the middle class and a rise in their disposable incomes. The convergence of government policies, economic growth, and rise in the people's purchasing power have all contributed to the phenomenal increase in demand of Indian auto industry. To facilitate this rising demand auto financing was initiated. After having recorded a strong volume growth over the last two decades, the automobile industry in India witnessed a slowdown during 2008-09 due to global economic crisis leading to moderation in growth contributed by firming up of commodity prices, rising fuel costs and interest rates. This slowdown of the automobile industry for two consecutive years has raised concerns on the long term demand prospects. Post June 2010, the cost of ownership has risen sharply on account of deregulation of petrol prices. The demand for vehicles was impacted due to macroeconomic factors such as uncertainty over income growth, increasing petrol prices, high interest rates and lower disposable income caused by high inflation. These factors are having a catastrophic impact on the Indian automotive industry and are resulting in

withdrawal, scaling down of capital investment which would hurt the objectives of the Automotive Mission Plan in the long run. With the allowance of 100% FDI and the roll-out of GST in April 2017 to simplify the tax structure and also the announcement of demonetisation and its effects in the Indian Automobile Industry. It is in this backdrop that there is a need to study the determinants of automobile sales in particular domestic sales and also to see the dynamic inter-relationship among these variables.

II.Literature Review

Carlson (1978) had formulated a multiple equation model to understand the demand of automobile in the United States using a quarterly data. He concluded after his analysis that the most prominent determinant of automobile demand in the United States is the disposable income. He further added that the insufficiency of oil and higher oil prices will lead to the fall in the demand of automobile. Duncan (1980) studied the relationship between automobile demand and gasoline price. The timeline the researcher used was the first quarter of 1970 to the second quarter of 1976. The researcher concluded that as the gasoline price increases the demand of automobile shifts from large to small automobile because of the rising cost of ownership. Carlson and Michael (1980) tried to forecast the demand of automobile of different variants and sizes. For their analysis they used quarterly data. They concluded that the disposable income has the most prominent impact on the future automobile demand. Danielson and Hilliard (1983) studied impact of Income and Oil Price on demand for new car sales in the USA. To validate this, they used Ordinary Least Square method and VAR. The concluded that increase in Oil price have a negative impact on the demand of automobile sales while an increase in Income will have a positive impact on the demand of automobile sales in USA. Hsiao and Taylor (1994) formulated a simple linear demand function by taking the data from the year 1969-1986 to estimate the demand of automobile in the United States. They finally came to the conclusion that income has the most impact on the automobile demand in the United States. Kang and Chen (1996) used the data of the determinants impelling Chinese automobile demand (1979-1993) to formulate a suitable forecasting model. The results showed that Chinese automobile demand is influenced only by national income. Mukherjee and Sastry (1996) focused on the of passenger vehicles in the rural areas is low. They further added that is the rural areas can be a place of new markets for automobile sales. They concluded that the demand of automobile in the rural areas is impacted by the prices of the automobile itself. Barber et al. (1999) tried to find out the relationship existent between fuel prices, exchange-rate and the automobile sales in the USA and Japan. He concluded that both the determinants have a notable effect on the automobile sales. He made a concluding remark saying that the fuel prices had a negative impact on the automobile sales in USA as compared to that of Japan. Dargay (2001) with the help of an expenditure survey in between 1970-95 tried to find out the relationship between automobile demand and income. He concluded that there is a very high correlation between automobile demand and income levels. Lee and Ni (2002) studied the impact of oil prices and automobile sales which involved 14 industrial countries. Researchers tried to analyse the influence of fuel prices by supply and demand mechanism. On the supply side; they concluded that the fuel based manufacturing industry have been affected by the rising oil prices as compared to other industries. On the demand side, rising fuel prices and their impact on production has resulted in inflation. This situation indirectly causes reduced consumer real income which will eventually reduce the demand for vehicle. Edrem and Saban (2011) studied the relationship between various macroeconomic variables and automobile demand in EU using the panel co-integration method. The timeline for their analysis was from January 1999 to August 2010. The concluded that there exist a long-run relationship between the macroeconomic variables and automobile demand. Cai and Chen (2012) studied the relationship between automobile demand and Urban Income using Granger Causality. The results obtained by them concluded that Urban Income Granger Causes automobile demand but automobile demand does not Granger Cause Income. They concluded as follows: according to the analysis of Granger causality, in a short period of time, lagged in three years, the income of urban residents in China has a significant impact on car sales. Muhammad et al. (2012) tried to study the relation between GDP and automobile sales. Various macroeconomic variables like GDP, Inflation, Unemployment rate and loan rate was taken into consideration for ASEAN region. He concluded that there was a long run relationship between the variables but the short-run relation was negative. Muhammad, Yahya, Hussin and Razak (2012) studied the relationship between macroeconomic variables and automobile demand in ASEAN region with the help of Pool Mean Group Analysis. The main objective of the researchers was to find out the impact of macroeconomic variables on the automobile sales of 5 ASEAN countries. The researchers concluded that the variables which had a significant impact were GDP, LR, Inflation and Unemployment-rate. They further added that unemployment and LR had a long run correlation with automobile demand. Nawi, et al. (2013) tried to find out the relationship between CPI (Inflation) and automobile sales. He concluded that inflation has an opposite relationship with automobile sales. Higher the inflation rate, lower will be the automobile sales. Nawi et al., (2013) also tried to find out the relationship between Interest-rates and automobile demand using the OLS regression. The researcher concluded that there was negative relationship between automobile demand and Interest-rates. Nawi, Ahmad, Mahmood, Nair and Hamid (2013) studied the determinants of automobile sales in Malaysia. The automobile demand in Malaysia particularly the passenger car segment is heavily influenced by various macroeconomic determinants like GDP, Interest- rates, Inflation (CPI), Exchange-rate and Unemployment. The time line chosen for the analysis was from the year 1981-2010. Joseph Chisasa and Winnie Dlamini (2013) studied the impact of interest-rates on the automobile demand. For their analysis, they used monthly data from January 1995-December 2011. They variables chosen by them were Income, Prices of the fuel, Interest-rates(Prime) and cost incurred by the producer. They concluded that there exists a negative but insignificant relationship between automobile sales and interest-rates in South Africa. Whereas the other variables have a positive and negative significant impact on the sales of automobile in South Africa. CRISIL (2013) discusses about the long term prospects of the automobile industry in India. They tried to find out the demand of automobile and the factors effecting the same. They concluded that income and car ownership due to the hike in fuel prices have the most significant impact.

Rabiul Islam, Ahmad Bashawir Abdul Ghani, Bobby Kusuma, Eric Teh Yew Hong (2014) tried to find out the major variables effecting the demand of automobile demand in Malaysia using various techniques like descriptive statistics, OLS and correlation. The researcher concluded that GDP has a positive impact on automobile demand in Malaysia whereas Interest-rates, Unemployment and CPI has a negative relationship with the automobile demand. Chifurira, Mudhombu, Chikobvu and Dubihela (2014) tried to understand the relation between Inflation and automobile demand in South Africa through the techniques of co-integration and causality analysis. For their analysis they opted for monthly data from 1960(January) to 2013 (September). They concluded that there exists a long-run relationship between Inflation and automobile sales and they also concluded that there exists a unidirectional causality at 5 percent level of significance. Rusli and Ali (2014) studied the relationship between Inflation rate, Fuel Price and GDP and the sale of Proton (name of a car model in Malaysia). To facilitate this process various econometric methods like co-integration test, error correction model, short-run granger causality, variance decomposition and impulse response function were used by them. The time frame chosen by them was the first quarter of 2000 till the fourth quarter of 2012. The estimation done by them indicate that there exists one co-integrating vector. Thus, it can be said that there exists a long run equilibrium relationship among the variables mentioned above. Copeland, Hall and Maccini (2015) studied the impact of Interest-Rates on the demand of New Light Vehicles. The time frame chosen by them is from February 1972 to December 2011. They studied the impact of interest rate variations on the demand as well as the supply of new light vehicles in a setting where consumers and manufacturers face their own interest rates. They concluded that higher will be the interest- lower will be the sales of automobile demand. Puja (2015) studies the relationship between various factors and demand of cars made by different automobile companies. The various factors that affect sales/demand includes income level of consumers, price of commodity, crude oil price, excise duty, bank interest rate, new launches etc. Although there are number of factors that can affect demand of car units but price is the most influential factor among them. Konstantakis, Milioti and Michaelides (2017) studied the relationship between various macroeconomic variables and automobile demand. They took into account the 2008 crisis as one of the variables. They used various econometrical techniques like VAR, Co-Integration, Granger Causality and also Impulse Response function. They concluded that oil Price granger causes automobile sales. They also found that there is no long run co-integrating relationships within the variables. The researcher concluded that along with various determinants it is also equally important to have financial and political stability. Patra and Rao (2017) studied the relationship between macroeconomic variables and automobile Demand. The timeline chosen by them were from 1991-2016. They used various econometric models like Ols, Co-integration and VECM models. The results showed a positive and long-run relationship between automobile sales and GDP per-capita and the other variables have the opposite relationship with automobile demand. We can clearly say, higher GDP will lead to higher volume of automobile sales. However, interest rate and fuel price have a negative relationship with both passenger as well commercial vehicles sales. Each of these factors play a crucial role in determining the level of automobile demand. The passenger and commercial vehicles demand model estimation through unit root test found that they have long-run positive equilibrium relationship with that of GDP per-capita. The error correction term is negative and statistically significant. This study may suggest that if the Government can lend a helping by mandating higher fuel efficiencies for vehicles and provide facilities for improving credit availability and reducing dependence on foreign oil that may prompt the demand for sales in Indian automobile industry

III.Data and Methodology

The study identifies the determinants of domestic automobile demand for the sample period of 1990-91 to 2015-16. The purpose of the study is to understand- what are the determinants that would impact domestic automobile demand and understand the causality among the macroeconomic variables. This section deals with the data and methodology.

The macroeconomic variable chosen for the study are Domestic Savings (GDS), Unemployment, Prices of Fuel and Power, Lending-rate, Personal Disposable Income (PDI), some series of dummy variables are also created in order to check the impact of outliers. All the variables are taken in the log form in order to normalise the scale of all the variables.

The datasets have been taken from Reserve Bank of India, Handbook of Statistics, SIAM (Society of Indian Automobile Manufactures). All the variables have been taken from secondary sources and are subject to all the limitations that apply to the secondary data. The following table gives the notation of the variables being used for the analysis.

Notation used:

AS	Automobile sales
GDS	Gross Domestic Savings
LR	Lending-Rate
UNEMP	Unemployment
PFP	Prices of fuel and Power

In order to ascertain whether India's automobile demand is linked to the macro-level variables or not. Since time-series macroeconomic variables are used, the augmented Dickey-Fuller (ADF) was used to test for stationarity of variables. To know the causality among the dependent and independent variables Granger Causality test was used.

The ADF test is most frequently used test for detecting the stationarity of the variable. So as to examine whether a series is stationary or not, first consider an AR (1) process:

$$Y_t = \alpha + \beta Y_{t-1} + vt, \text{-----} (1)$$

Where α and β are the parameters and vt is expected to be a white noise process. (Y) is a non-stationary series (a random walk with drift); if the process is started at some point, the variance of Y increases steadily with time and goes to infinity. If $|\beta| > 1$, then the series is explosive. Thus, the hypothesis that the series is stationary can be evaluated by testing whether the $|\beta|$ is strictly less than 1.

The ADF approach controls for higher-order correlation by adding lagged difference terms of the independent variable Y to the right hand side of the regression:

$$\Delta Y_t = \alpha + \delta Y_{t-1} + \theta_1 Y_{t-1} + \theta_2 Y_{t-2} + \dots + \theta_p \Delta Y_{t-p+1} + vt$$

This augmented specification is then used to test:

$$H_0: \delta = 0, H_1: \delta < 0.$$

For this study, multiple regression is used for the estimation, forecasting and hypothesis testing of the model.

Granger causality test performs pair wise granger causality tests between pairs of the listed series. The null hypothesis for testing the causality is that the variables X does not granger cause variable Y. If the result shows small probability, then this would lead to rejection of the null hypothesis that there is X does not granger cause variable Y. If the result shows a small probability then this would lead to rejection of the null hypothesis that there is X which does not granger cause variable Y which means that we accept the alternative hypothesis, which means that the variable X causes variable Y. For any given two variables granger causality test determines the direction of the causality between the two variables whether X Causes Y or Y Causes X. Therefore, it is important to note that the statement X Granger Cause Y does not imply that Y is the effect or the result of X. While doing the granger causality test we need to decide on the ideal number lags to be used. Engle granger causality model is used to test the causality between the two variables. The following is the model adopted in the study to empirically examine the hypothesis X is said to be granger cause Y if Y can be predicted with the granger accuracy by using past value of x.

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \beta_1 X_{t-1} + \epsilon_t$$

If $\beta_1 = 0$, X does not granger cause Y. On the other hand, if any of the β coefficients is non-zero then X does not granger cause Y. The null hypothesis that is $\beta = 0$ can be tested by using the standard F test of joint significance.

IV. Empirical Findings

Under this section, we provide the results of empirical analysis carried out in the study. The emphasis of this chapter is to see the impact of various macroeconomic variables on the automobile demand and also to find out the Granger Causality between the dependent and independent variables.

Results of Unit Root Test

Table 1: Results of Unit root test

Variables	Levels	1 st difference	Stationarity Indicated.
LNAS	-3.528505	-5.390094	1 st difference
LNGDS	-1.678629	-5.396357	1 st difference
LNPFP	-2.658962	-5.694589	1 st difference
LNLR	-2.621870	-4.895372	1 st difference
LNUNEMP	-3.519639	-6.535269	1 st difference

Sources- Author Calculation

A variable is said to be stationary when the estimated value is less than the critical value at various significance levels, i.e. at 1%, 5% and 10%. All the above mentioned variables are stationary at the first difference, i.e. integrated of the order I (1).

Estimation of Model

$$D(LNAS) = 0.008 + 0.863 * D(LNGDS) - 0.623 * D(LNPFP) - 0.067 * D(LNUNEMP) - 0.014 * D(LNLR) + 0.088 * DUM$$

(0.015) (4.089) (-2.697) (-3.212) (-3.145) (5.831)

- $R^2 = 0.803$
- D-W stat = 1.69
- F-Stat = 14.73
- Prob (F-Stat) = 0.0000

We can see from the value of R-squared = 0.803704 and from the value of Adjusted R-squared = 0.749177, that around 80 per cent variations in the dependent variable that is the Automobile Sales (AS) is explained by the explanatory variables. An Adjusted R-square of 0.749177 tells us that we need not worry about the loss of degrees of freedom and the model is a good fit. The over-all significance of the model is given by the F-statistic. The F-Statistic value of 14.73961 is significant which implies that the overall model is good and fits with the population of the sample data and we can reject the null hypothesis that all the coefficients of the explanatory variable are simultaneously zero. Since the Durbin-Watson stat is 1.69 which is closer to an ideal value of 2, we accept the model even though there is a presence of some autocorrelation in the model.

Now we look at the relationship between the individual variables. Going by the t-statistic value which is given in the parenthesis, we find that all the explanatory variables are individually significant in determining the dependent variable. Since, the model is in the log specification the value of the coefficients of the individual variable tells us what will be the change in the dependent variable (AS) for one percent change in explanatory variables. Coming to the estimated model we find that all the coefficients signs are according to the economic theory. Variables like GDS, PFP and UNEMP have positive and negative impact simultaneously with Automobile sales.

Gross Domestic Savings (GDS) has a positive coefficient of 0.863018, which means that for a given one percentage increase in GDS, the Automobile sales (AS) will increase by 0.863018% but Fuel and power, Unemployment and Lending- rate has a negative impact on Automobile sales. When Prices of Fuel and Power, unemployment and Lending-rate increases by one percent the automobile sales decreases by - 0.623078, - 0.067047 and -0.014692 respectively.

We have also added dummy variable in the model to account for the impact of various qualitative and structural changes and these needs to be explained as well. Positive dummy for the year 1999 is due to the Kargil War or Indo- Pak War.

We gave a negative dummy for the year 2007-08 as the famous subprime crisis took place which crippled the entire world economy including India.

We gave a positive dummy for the year 1996-97 as change of government took place from INC to BJP under the leadership of Atal Bihari Vajpayee. There was also the LOC tension with Pakistan

Table 2: Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
LNGDS does not Granger Cause LNAS	25	6.98866	0.0148
LNAS does not Granger Cause LNGDS		0.29279	0.5939
LNLR does not Granger Cause LNAS	25	0.76401	0.3915
LNAS does not Granger Cause LNLR		4.00398	0.0579
LNPFPP does not Granger Cause LNAS	25	4.63345	0.0426
LNAS does not Granger Cause LNPFPP		1.28755	0.2687
LNUNEMP does not Granger Cause LNAS	25	0.02183	0.8839
LNAS does not Granger Cause LNUNEMP		3.50516	0.0745

The results of the Granger causality presented in table 2 reveals that GDS, PFP granger causes AS at 5 percent significance level. So, there exists a unidirectional causality from GDS to AS whereas the AS is granger causing LR at 5 percent of significance level but AS is granger causing Unemp at 10 percent of significance level.

V.Conclusion

In this study we have used annual time series data from 1990-2016 to empirically analyse the dynamic relationship between automobile sales, GDS, LR, UNEMP and PFP. We have employed multiple OLS regression technique. From the empirical findings of the study we conclude that GDS has a significant positive impact on automobile sales where as LR, PFP and UNEMP has a negative impact on Automobile sales. The results show that GDS and PFP are the most significant variables that impact automobile sales. The

stability of the parameters is confirmed by the Recursive Residual Test which confirms the stability of the parameters over time. In order to see the causal linkage, Granger Causality technique was employed and the results showed the existence of unidirectional causality between the dependent and the independent variables. In a country like India where the per-capita income is very low, it is the savings that determines the demand of automobile. Increasing prices of fuel and lending rate have a negative relation with automobile demand and can lead to lesser automobile sales. Increase in savings has positive impact on sales while increasing fuel price causes automobile demand to fall. The demand also decreases due to the negative impact of petroleum prices and lending-rates. Automobile production has been growing wing to the growth of Indian economy. However, the negative association between petroleum price and automobile production can be a serious problem to the automobile Industry because higher petroleum prices causes prices of the fuel to rise which in turn leads to automobile demand and production to decrease. Looking at the India's automobile demand, the results find that the price of fuel along with lending rate are also another important factor in both PVs as well as in CVs in India. The various factors that affect sales/demand includes income level of consumers, Saving –rate, price of commodity, crude oil price, excise duty, bank interest rate, new launches etc. Although there are number of factors that can affect demand of automobiles but GDS is the most influential factor. All these factors considered for the analysis can have indirect impact on automobile production since it is directly reliant on consumption. Consequently, the GOI must attention to duck problems like automobile overproduction, air pollution, fuel shortages, traffic congestion, noise pollution and insufficient parking space. The explosion in commercial and passenger vehicles due to economic development in recent past advocates the rising demand for motor vehicles. Passenger vehicle (personal vehicles) – have displayed remarkable growth and the sale of these vehicles is on a rise. A long –run slowing industrial production can be threatening than the short-run problem of non-availability of credit. The commercial vehicle industry has a high degree of correlation with the GDP and IIP (Index of Industrial production) of the country. Although the slowdown of Indian economy affected automobile sector but when the economic situation improved and banks have started lending that led the automobile sector to grow well. This can be possible if the Government helps by mandating higher fuel efficiency vehicles and provide facilities for improving credit availability and reducing dependence on foreign oil. Rapid motorization in India has significant repercussions for energy security and climate change.

VI. References

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