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Automobile Industry in India: A Recent Study”

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ABSTRACT

The Indian Automobile Industry has made great strides over the past two decades, sufficient to be noticed at a global level and be counted as a major auto manufacturing hub. This paper gives a brief overview of Indian Automobile Industry over the last decade. The Automobile Sector is one of the core industries of the Indian economy and is playing the vital role in the growth of the Indian economy. India today is well known as a potential emerging automobile market and several foreign investments are pouring into Indian Automobile Industry. The increase in the demand for cars and other vehicles, powered by the increase in the income, a large young population, greater availability of credit and financing options, increasing demand for commercial vehicles due to high level of activity in infrastructure sector are the primary growth driver of the automobile industry in India. The Indian Automobile Industry has evolved into a massive market with lots of potential over the last decade. It has built strong market in terms of both, domestic demand and exports. India is the only country among top seven car markets globally to achieve double-digit growth rate of 11 per cent during January-May 2017. The paper attempts to study the automobile production trend, amount of Foreign Direct Investment (FDI) in automobile industry, correlation between FDI and automobile production, automobile export trend, automobile domestic sales trend, Gross turnover trends in Indian Automobile Industry over the last decade.

KEY WORDS: Automobile Industry, FDI, Export trends, Domestic sales

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1. INTRODUCTION

The Indian automobile industry is one of the largest globally, both in terms of sales volume and production. India is one of the fastest growing economies in the world and the automobile industry is one of the key drivers that boost the economic growth of the country. Demographically and economically, India's automobile industry is well-positioned for growth, servicing both growing domestic demand and export opportunities. The Indian automobile sector is compartmentalized in four different sectors which are as follows:

- Two wheelers (which comprise of mopeds, scooters, motorcycles and electric two-wheelers)
- Passenger vehicles (which include passenger cars, utility vehicles and multi-purpose vehicles)
- Commercial vehicles (comprised of light and medium-heavy vehicles)
- Three wheelers (which include passenger carriers and goods carriers)

As per the history of automobile companies in India, in the late 1980's Tata Motors launched its first truck in India. Though automobiles were introduced to India in the late 19th Century, it was only after the Indian independence in 1947 that India started manufacturing automobiles. Till 1930, India did not have any manufacturing facility and cars were imported directly from other countries. Since independence the Indian automobile industry faced several challenges and road blocks like manufacturing capability was restricted by the rule of license and could not increased. Since the de-licensing of the sector in 1991 and the subsequent opening up of 100 per cent FDI through automatic route, Indian automobile sector has come a long way. Today, almost every global auto major has set up facilities in the country. The liberalization policies of government have been one of the biggest factors behind the industry's rapid growth. Supportive policy measures like relaxation of foreign exchange and equity regulations, reduction tariffs on imports, and banking liberalization leading to a boom in financing driven purchases and convenient EMIs have contributed to the present success of the Indian automobile industry. The high growth in the Indian economy has resulted in all major international car manufacturers entering the Indian market. Indian auto industry has seen a phenomenal growth in the last 20 years.

According to a report published by India Brand Equity Foundation¹ (IBEF), the automobile industry in India is World's fourth largest, with the country currently being the World's fourth largest manufacturer of cars and seventh largest manufacturer of commercial vehicles in 2017. Indian passenger vehicles market, then, achieved a new feat by moving up to the fourth position in the world in terms of volume, beating Germany.

Currently, the automotive sector contributes more than 7 per cent to India's GDP, 49 per cent of the country's manufacturing gross domestic product (GDP) and 26 per cent of the industrial GDP². The Automotive Mission Plan 2016-26 aims to propel the Indian Automotive Industry to be the engine of the "Make in India" programme, as it is amongst the foremost drivers of the Manufacturing sector: Over the next decade, the Indian Automotive Sector is likely to contribute in excess of 12% of the country's GDP. The data obtained from Ministry of Commerce and Industry³, shows high growth obtained since 2001-02 in automobile production continuing in the first three quarters of the 2004-05. Annual growth of automobile production was 16.0 per cent in April-December, 2004 compared to the growth rate in 2004-05 that was 15.1 per cent.⁴

According to the report published by Ministry of Heavy Industries and Public Enterprises (Government of India), the Indian automotive industry has witnessed significant growth during FY 2006-11. During this period all vehicle segments registered a Compound Annual Growth Rate (CAGR) in excess of 10 per cent. The total production of vehicles has increased from 10.85 million in FY 2007-08 to 25.32 million in FY 2016-17 registering Annual Growth Rate of 14.78 per cent. The domestic sales of vehicles have increased from 9.65 million in FY 2007-08 to 21.86 million in FY 2016-17.⁵ Automobile export volume from India has increased from 1.23 million in FY 2007-08 to 3.47 in FY 2016-17. In order to keep up with the growing demand, several auto makers have started investing heavily in various segments of the industry. The industry has attracted Foreign Direct Investment (FDI) worth US\$ 19.29 billion during the period April 2000 to June 2018 (IBEF, 2018).

According to India Brand Equity Foundation, the two wheelers segment dominates the market in terms of volume owing to a growing middle class and a young population and made up 81 per cent share in the domestic automobile sales in FY 2018. During April-August 2018, highest year-on-year growth in domestic sales was recorded in three-wheelers segment at 44.27 per cent followed by 41.67 per cent year-on-year growth in the sales of commercial vehicles. The passenger vehicles sales in India crossed the 3.2 million units in FY 2018. Automobile exports grew 26.56 per cent during April-July 2018 and at that period automobile production also increased 16.69 per cent year-on-year to reach 10.88 million vehicle units. Employment in India's automobile sector offers an insight into the growth of this significant industrial sector of the country. The expansion of domestic and exports markets, the liberal policies of the government, the increase in foreign investment and the rise in production have opened up new avenues in the job sector of Indian automobile industry. Government had set a target that automotive industry will employ 35 million people, including direct and indirect jobs, by 2016. However, the industry could reach only 32 million jobs⁶.

Some of the early Automobile Companies in India are Hindustan Motors, Premier Automobiles, Tata Motors, Maruti Suzuki, Maruti Udyog. After the liberalization in 1991, India's Automobile Industry grew in leaps and bounds. With the growth in the Indian Economy, big international car manufacturers like General Motors, Ford, Toyota, Honda, Hyundai, Skoda and Volkswagen entered the Indian market and added to their investments in Indian auto industry. The other key international automobile companies like Volvo, Daimler Chrysler, Chevrolet, Nissan, Renault have their manufacturing bases in India. Even high end premium brands like Rolls Royce, Bentley, Aston Martin, Mercedes, BMW, Audi, Maybach and Porche have opened showrooms across cities in India. However, despite the presence of foreign Brands, the domestic companies like Tata Motors, Mahindra & Mahindra, Ashok Leyland, Maruti Suzuki share the top honours. Today Indian automotive is fully capable in producing various kinds of vehicles.

2. LITERATURE REVIEW

In our literature, it has attempted to examine the trends in the automobile industry in India and its impact on the economy in terms of GDP, exports, FDI, employment, production, domestic sales trend etc⁷. By using statistical tools, she found that all these factors are positively impacted by the growth of Indian automobile industry. Economists have focused on the domestic sales trend, market share of various segments of automobiles, performance of key players in Indian Automobile Sector⁸. They observed that “the four-wheeler passenger vehicle market has grown impressively at the hands of new middle-class, although market penetration remains low” which is quite true in FY 2018 also.

Existing literature⁹ helps us to know the actual position of the automobile industry in India. He analyzed the industry on various parameters by implementing fundamental and technical tools and recommended investing in four-wheeler industry is a good option as this industry is booming not only in India but also all around the world. Another great literature¹⁰ represents the figures of Indian Automobile Industry during the period 2005-2010. The study has been conducted to explain the present and future market trend. They founded that the Indian automobile industry has been able to sustain during the tough time of the recession and have had record breaking sales growth. They concluded, “The economic sustainability and increasing living standards and purchasing powers of the Indian customer's automobile sector has a bright coming future”

A number Studies have been made to give details on the FDI and in-relation to the development of production and export of automobiles in India for the period 2001-02 to 2011-12. From the existing literature¹¹, it was observed that there is a steady contribution of FDI in automobile sector growth and production, export, domestic sales of automobiles has also improved.

A study on growth and export potential of Indian automobile sector during the last three decades¹² revealed that output of automobile industry increased from 7 per cent in 1985-86 to 10.9 per cent in 2000-01 and then to 15.3 per cent in 2011-12 and export has also increased. Attempts have been made to study the fundamental analysis of Indian Automobile Industry. The major objectives of this study¹³ were to analyze the performance of selected companies of Indian automobile Industry and to estimate the intrinsic value of the stocks of those selected companies. It has also tried to assist the investors in making investment decisions in automobile industry. Our existing literature¹⁴ have also analyzed the impact of FDI in automobile in relation to the development of production and export of automobile industry in India and this study shows there is significant impact on automobile production and the development of Indian economy.

3. Data Sources and Methodology

To address the aforementioned objectives, present study collected data from various authentic and reliable sources like books, newspapers, and related websites. The study is conducted on the basis of secondary sources data and information published by Automobile Manufacturers Association of India, Society of Indian Automobile Manufacturer (SIAM), Department of Industrial Policy and Promotion (DIPP), India Brand Equity Foundation (IBEF), Klynveld Peat Marwick Goerdeler (KPMG). Further, annual reports as well as document on Automotive Mission Plan 2016-2026 released by Department of Heavy Industry (DHI), Ministry of Heavy Industries and Public Enterprises, Government of India was also used to collect relevant information.

Data can be analyzed with the help of statistical tools like Average, Percentage, Compound Annual Growth Rate (CAGR), Average Annual Growth Rate (AAGR), Correlation trend analysis. Besides, tables are used to present and analyze data. Calculation of Annual Growth Rate = [(Ending Value/ Beginning Value) – 1]. Calculation Average Annual Growth Rate (AAGR) is the sum of each year's growth rate divided by the number of years. Compound Annual Growth rate (CAGR) = [(Ending Value/ Beginning Value)^{1/no. of years}]- 1.

4. RESULTS AND ANALYSIS

This section contains the statistical data and its analysis about Indian Automobile Industry and this sector splits into four segments namely Passenger Vehicles, Commercial Vehicles, Three wheelers and Two- wheelers.

4.1 India's Automobile Production Trend

Automobile production in India increased significantly after the liberalization of the Indian economy. India is one of the largest producers of automobiles in India.

The Table 1 shows that the Indian Automobile Industry produced around 10.85 million vehicles in FY (Financial Year) 2007-08. During the FY 2017-18 this industry produced 29.07 million vehicles. The sector shows AAGR (Average Annual Growth Rate) of 10.7 per cent and CAGR (Compound Annual Growth Rate) of 10.35 per cent over FY 2007-18. Two-wheeler vehicle segment was the fastest growing segment, representing a CAGR of 11.17 per cent followed by passenger vehicle segment with a CAGR of 8.47 per cent between FY 2007-18. According to a report published by IBEF on January 2018, India is the 4th largest automobile industry in India and 7th largest manufacturer of commercial vehicles. During April-July 2018, automobile production in India increased 16.69 per cent year-on-year to reach 10.88 million vehicle units.

Table 1: Automobile Production Trends (No. Of Vehicles)

Year	Passenger Vehicles	Annual Growth Rate %	Commercial Vehicles	Annual Growth Rate %	Three Wheelers	Annual Growth Rate %	Two wheelers	Annual Growth Rate %	Grand Total	Annual Growth Rate %
2007-08	1777583	-	549006	-	500660	-	8026681	-	10853930	-
2008-09	1838593	3.43	416870	-24.06	497020	-0.72	8419792	4.89	11172275	2.93
2009-10	2357411	28.21	567556	36.14	619194	24.58	10512903	24.58	14057064	25.82
2010-11	2982772	26.52	760735	34.03	799553	29.12	13349349	26.98	17892409	27.28
2011-12	314069	5.47	929136	22.13	879289	9.97	15427532	15.56	20382026	13.91
2012-13	3231058	2.70	832649	-10.38	839748	-4.49	15744156	2.05	20647611	1.30
2013-14	3087973	-4.42	699035	-16.04	830108	-1.14	16883049	7.23	21500165	4.12
2014-15	3221419	4.28	698298	-0.10	949019	14.32	18489311	9.51	23358047	8.64
2015-16	3465045	7.56	786692	12.65	934104	-1.57	18830227	1.84	24016068	2.81
2016-17	3801670	9.71	810253	2.99	783721	-16.09	19933739	5.86	25329383	5.46
2017-18	4010373	5.48	894551	10.40	1021911	30.39	23147057	16.11	29073892	14.78
AAGR	8.89%		6.77%		8.43%		11.48%		10.70%	
CAGR	8.47%		5.00%		7.39%		11.17%		10.35%	

Source: Society of Indian Automobile Manufacturers (SIAM) ¹

4.2 FDI (Foreign Direct Investment) in India's Automobile Sector

Foreign Direct Investment (FDI) in automobile sector has made a significant contribution to the growth in this sector.

Table 2: FDI in Indian Automobile Industry

Year	Total FDI Inflow (Cr.)	FDI inflows in automobile sector (Cr.)	CAGR	Share of automobile FDI inflows in total FDI inflows %
2007-08	98642	2697	17.44%	2.7
2008-09	142829	5212		3.6
2009-10	123120	5609		4.5
2010-11	97320	5864		6.0
2011-12	165146	4347		2.6
2012-13	121907	8384		6.8
2013-14	147518	9027		6.1
2014-15	189107	15794		8.3
2015-16	262322	16437		6.2
2016-17	291696	10824		3.7
2017-18	288889	13461		4.6
TOTAL	1921296	97656		5.0

Source: Society of Indian Automobile Manufacturers (SIAM)

Table 2 shows, total FDI inflows received during 2007-18 were Rs. 1921296 Cr. Out of this the amount of FDI inflows in automobile industry during the same period is Rs. 97656 Cr. which is

5.0% of the total FDI inflows. During 2007-18 FDI inflows in automobile industry registered a CAGR of 17.44%.

4.3 Correlation analysis between FDI and Total Production of Automobiles

Table 3 shows the correlation analysis between FDI inflow in Indian automobile sector and the total production of automobiles in India.

Table 3: Correlation Analysis between FDI in automobile Industry and total output

Year	FDI inflows in Automobile Sector (Cr.) (X)	Total production of automobiles (Cr.) (Y)	Correlation Coefficient between X and Y
2007-08	2697	1085	$r = 0.79245$
2008-09	5212	1117	
2009-10	5609	1405	
2010-11	5864	1789	
2011-12	4347	2038	
2012-13	8384	2064	
2013-14	9027	2150	
2014-15	15794	2335	
2015-16	16437	2401	
2016-17	10824	2532	
2017-18	13461	2907	

Source: Society of Indian Automobile Manufacturers (SIAM)

The Table 3 shows correlation analysis between FDI inflows in automobile sector of India and total production of automobiles. Here, FDI inflows in automobile sector is taken as “X” and total production by automobile industry is taken as “Y” during 2007-18, “r” is the correlation coefficient between X and Y, which is 0.79. This shows a high degree of positive correlation between the FDI inflow and total production of automobile industry.

There was a lot of volatility in the annual FDI inflows in Automobile Industry during the period 2000-01 to 2016-17. The sector attracted \$17.9 billion FDI between April 2000 and September 2017; accounting for 5% of the total FDI inflows. The amount of FDI in Automobile industry was \$195.33 million in 2000-01 and it increased by \$40.43 million in 2001-02. The amount of FDI in automobile industry was \$193.93 million in 2005-06. It increased by \$17.96 million as compared to 2004-05. The maximum annual growth in FDI in automobile industry of \$ 151.65 million was recorded in the year 2007-08.

Table 4: Automobile export trends (no. of vehicles)

Year	Passenger vehicles	Annual Growth Rate %	Commercial vehicles	Annual Growth Rate %	Three wheelers	Annual Growth Rate %	Two wheelers	Annual Growth Rate %	Grand Total	Annual Growth Rate %
2007-08	218401	-	58994	-	141225	-	819713	-	1238333	-
2008-09	335729	53.72	42625	-27.74	148066	4.84	1004174	22.50	15305394	23.60
2009-10	446145	32.88	45009	5.59	173214	16.98	1140058	13.53	1804426	17.89
2010-11	444326	-0.40	74043	64.50	269968	55.85	1531619	34.34	2319956	28.57
2011-12	507414	14.19	92663	25.14	362876	34.41	1947198	27.13	2910151	25.43
2012-13	559414	10.24	80027	-13.63	303088	-16.47	1956378	0.47	2898907	-0.38
2013-14	596142	6.56	77050	-3.71	353392	16.59	2084000	6.52	3110584	7.30
2014-15	621341	4.22	86939	12.83	407600	15.33	2457466	17.92	3573346	14.87
2015-16	653053	5.10	103124	18.61	404441	-0.77	2482876	1.03	3643494	1.96
2016-17	758727	16.18	108271	4.99	271894	-32.77	2340277	-5.74	3479169	-4.51
2017-18	747287	-1.50	96867	-10.53	381002	40.12	2815016	20.28	4040172	16.12
AAGR	14.11%		7.60%		13.41%		13.79%		13.08%	
CAGR	13.08%		5.08%		10.43%		13.13%		12.55%	

Source: Society of Indian Automobile Manufacturers (SIAM)

4.4 Export by India's Automobile Sector

India is also a prominent auto exporter and has strong export growth expectations for the near future. This section deals with the statistical data and its analysis about the export by Indian Automobile sector.

Table 4 shows that the automobile export volume increased at a CAGR of 12.55% over FY 2007-18. Two wheeler segment reported the fastest growth (13.13%) followed by passenger vehicle (13.08%), commercial vehicle comprises of (5.08%) and three wheeler (10.43%). If we compare AAGR and CAGR of production and export during FY 2007-18 both are higher in case of exports; in April-March 2018, overall automobile exports increased by 16.12 per cent, according to the report published by SIAM.

4.5 Domestic Sales Trend in Automobile Sector in India

The Indian auto industry became the 4th largest in the world with sales increasing 9.5% year-on-year to 4.02 million units (Excluding two wheelers) in 2017.

Table 5: Automobile Domestic sales Trend (No. of vehicles)

Year	Passenger vehicle	Commercial Vehicle	Three wheelers	Two Wheelers
2007-08	1549882	490494	364781	7249278
2008-09	1552703	384194	349727	7437619
2009-10	1951333	532721	440392	9370951
2010-11	2501544	684905	526024	11768910
2011-12	2618072	809532	513251	13435769
2012-13	266515	793211	538290	13797185
2013-14	2503509	632851	480085	14806778
2014-15	2601236	614948	532626	15975561
2015-16	2789208	685704	538208	16455851
2016-17	3047582	714082	511879	175899738
2017-18	3287965	856453	635698	20192672

Source: Society of Indian Automobile Manufacturers (SIAM)

From the above table, we see, the sale of passenger vehicle was 1.5 million in FY 2007-08 and it increased to 3.2 million in FY 2017-18 as per SIAM. The sale of Commercial vehicles was 4.9 lakhs in FY 2007-08 and it increased to 8.5 lakhs in FY 2017-18. The sale of three-wheeler was 3.6 lakhs in FY 2007-08 and it increased to 6.3 lakhs in FY 2017-18. The sale of two-wheeler was 7.2 million in FY 2007-08 and it increased to 20.19 million in FY 2017-18.

4.6 Gross Turnover Trends in Automobile Sector in India

The gross turnover of the automobile manufacturers in India expended at a CAGR of 7.07 per cent with AAGR of 7.42 per cent over FY 2007-16.

Table 6: Gross Turnover Trends (In US\$ million)

Year	Gross Turnover	Annual Growth Rate %
2007-08	36612	-
2008-09	33250	-9.18
2009-10	43296	30.21
2010-11	58583	35.3
2011-12	66264	13.11
2012-13	67607	2.02
2013-14	55212	-18.33
2014-15	58909	6.69
2015-16	63866	8.41
2016-17	67724	5.98
AAGR		7.42%
CAGR		7.07%

Source: Society of Indian Automobile Manufacturers (SIAM)

The table 6 shows that gross turnover was recorded 36.6 million in 2007-08, by 2016-17 it increased to US\$ 67.7 million. Many fluctuations can be observed during 2007-16. It was low in 2008-09. However, industry turnover again picks up its growth again in 2014-15, with annual growth rate of 6.69 per cent.

5. CONCLUSION

The Indian Automobile Industry has made great strides over the past two decades, sufficient to be noticed at a global level and be counted as a major auto manufacturing hub. The automobile has come a long way since de-licensing. Today, numerous choices are available to the users in terms of type, capacity, brands, models etc. with regard to the automobiles. The Indian Automobile industry is now riding high on success, and the bright picture does tend to obscure the problems and challenges that lay on the track of its growth. Poor road conditions, heavy pollution and large scale traffic related accidents are serious impediments in the way of the industry's growth. However, steps are being initiated by the government to address these problems at various levels, and solutions are being worked out at a steady pace.

Government aims to develop India as a global manufacturing as well as a research and development (R&D) hub and several initiatives are taken in this regard, such as, 'Automotive Mission Plan' (AMP), 'Make in India', 'National electric Mobility Mission Plan' (NEMMP) etc.

It has set up National Automotive Testing and R&D Infrastructure Project (NATRiP) centres as well as a National Automotive Board to act as facilitator between the government and the industry. Under NATRiP, five testing and research centers have been established in the country since 2015.

The Indian Automobile Industry has evolved into a massive market with lots of potential over the last decade. It has built strong market in terms of both, domestic demand and exports. India is the only country among top seven car markets globally to achieve double-digit growth rate of 11 per cent during January-May 2017. Two-wheelers and passenger vehicles dominate the domestic demand. Two wheelers account for 80 per cent of domestic demand. Commercial vehicle segment expected to grow at 11.07 per cent during 2016-26. Domestic sales of passenger vehicles expected to increase at a CAGR of 12.87 per cent in 2017-26.

Although there is a still a long way to go before India becomes a leader in the manufacturing arena, companies in the automotive sector are embracing this opportunity to leverage India as a hub for low-cost, high-quality products. Over the past ten years, India has emerged as one of the most preferred locations in the world for manufacturing high quality automotive components and vehicles of all kinds, narrowing its gap over several established locations in the process. By 2026, the Indian Automotive Industry will be among the top three of the world in engineering, manufacture and export of vehicles and auto components. The rapid growth of Automobile industry will provide a strong fillip to the Micro & Small and Medium industries of the country across multiple sectors.

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APPENDIX

Calculation of Table 1:

For Passenger vehicle,

$$\text{AAGR} = (3.43+28.21+26.52+5.47+2.70+4.42+4.28+7.56+9.71+5.48) / 10 = 8.89\%$$

$$\text{CAGR} = (4010373 / 1777583)^{1/10} - 1 = 8.47\%$$

For Commercial vehicle,

$$\text{AAGR} = (-24.06+36.14+34.03+22.13-10.38-16.04-0.10+12.65+2.99+10.40) / 10 = 6.77\%$$

$$\text{CAGR} = (894551 / 549006)^{1/10} - 1 = 5.00\%$$

For Three wheelers,

$$\text{AAGR} = (-0.72+24.58+29.12+9.97-4.49-1.14+14.32-1.57-16.09+30.39) / 10 = 8.43\%$$

$$\text{CAGR} = (1021911 / 500660)^{1/10} - 1 = 7.39\%$$

For Two wheelers,

$$\text{AAGR} = (4.89+24.58+26.98+15.56+2.05+7.23+9.51+1.84+5.86+16.11) / 10 = 11.48\%$$

$$\text{CAGR} = (23147057 / 8026681)^{1/10} - 1 = 11.17\%$$

Calculation of Table 2:

FDI inflows registered,

$$\text{CAGR} = (13461 / 2697)^{1/10} - 1 = 17.44\%$$

Calculation of Table 3:

Correlation Analysis between FDI in automobile Industry and total output

Year	FDI in automobile industry (X _i)	Total production (Y _i)	X _i Y _i	X _i ²	Y _i ²
2007-08	2697	1085	2926245	7273809	1177225
2008-09	5212	1117	5821804	27164944	1247689
2009-10	5609	1405	7880645	31460881	1974025
2010-11	5864	1789	10490696	34386496	3200521
2011-12	4347	2038	8859186	18896409	4153444
2012-13	8384	2064	17304576	70291456	4260096
2013-14	9027	2150	19408050	81486729	4622500
2014-15	15794	2335	36878990	249450436	5452225
2015-16	16437	2401	39465237	270174969	5764801
2016-17	10824	2532	27406368	117158976	6411024
2017-18	13461	2907	39131127	181198521	8450649
Total	97656	21823	215572924	1088943626	46714199

$$\bar{X} = 97656 / 11 = 8877.81$$

$$\bar{Y} = 21823 / 11 = 1983.90$$

$$\text{Var}(X) = \sqrt{\frac{1088943626}{11} - (8877.81)^2} = 4492.14$$

$$\text{Var}(Y) = \sqrt{\frac{46714199}{11} - (1983.90)^2} = 557.57$$

$$r = \frac{(\sum_{i=1}^n \frac{X_i Y_i}{n}) - \bar{X}\bar{Y}}{\sqrt{\text{Var}(X)}\sqrt{\text{Var}(Y)}} = 0.79245$$

Calculation of Table 4:

For Passenger Vehicle,

$$\text{AAGR} = (53.72+32.88-0.40+14.19+10.24+6.56+4.22+5.10+16.18-1.50) / 10 = 14.11\%$$

$$\text{CAGR} = (747287 / 218401)^{1/10} - 1 = 13.08\%$$

For Commercial Vehicle,

$$\text{AAGR} = (-27.74+5.59+64.50+25.14-13.63-3.71+12.83+18.61+4.99-10.53) / 10 = 7.60\%$$

$$\text{CAGR} = (96867 / 58994)^{1/10} - 1 = 5.08\%$$

For Three wheelers,

$$\text{AAGR} = (4.84+16.98+55.85+34.41-16.47+16.59+15.33-0.7-32.77+40.12) / 10 = 13.41\%$$

$$\text{CAGR} = (381002 / 141225)^{1/10} - 1 = 10.43\%$$

For two wheelers,

$$\text{AAGR} = (22.50+13.53+34.34+27.13+0.47+6.52+17.92+1.03-5.74+20.28) / 10 = 13.79\%$$

$$\text{CAGR} = (2815016 / 819713)^{1/10} - 1 = 13.13\%$$

Calculation of Table 6:

Gross turnover,

$$\text{AAGR} = (-9.18+30.21+35.3+13.11+2.02-18.33+6.69+8.41+5.98) / 10 = 7.42\%$$

$$\text{CAGR} = (67724 / 36612)^{1/10} - 1 = 7.07\%$$