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Skewed Passenger Car Market in Uttar Pradesh: An Exploration

Dripto Mukhopadhyay[1]

and

Tuhin Das[2]

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Ascension Centre for Research and Analytics (ACRA)

Registered Office

A/3, 5/1, Sector – 5, Rajendra Nagar, Sahibabad, Ghaziabad, UP - 201005

[1] Founder and Lead of Ascension Centre for Research and Analytics (ACRA). Contactdripto@ascension.org.in for any query on the paper.
[2] Analyst at Ascension Centre for Research and Analytics (ACRA)

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Skewed Passenger Car Market in Uttar Pradesh

An Exploration

1. Background

Uttar Pradesh seems to have performed much below its actual potential in terms of economic activities. Though it is the largest state in India, in terms of economy it is the third largest in the country with a GDP of Rs. 20.48 lakh crore. Though the population share of Uttar Pradesh was 16.5% the share of GDP of the state to India's GDP in 2022-23 is about 7.50%. Uttar Pradesh has an urban population of about 22.76% which is again much lower compared to India's average. A NITI Aayog report[4] based on NFHS-4 (2015–16) stated that 37.79% of the population of Uttar Pradesh was found to be poor in terms of household income.

Passenger car market penetration is one of the key indicators that show the frontiers of economic development over space. The Indian Car market has seen rapid growth in the recent years, both in terms of manufacturing as well as exports. As per invest India, the $222 Bn Indian automobile industry is expected to reach $300 Bn by 2026, of which passenger cars account for 17.4%.Uttar Pradesh which contributes to about 7.5% of India's GDP should have a strong foothold in the automobile sector. Strategically located in the upcoming Golden Quadrilateral and the existing plethora of expressways, the state has huge potential to capitalize on the country's largest consumer base. However, it is also important to see how the demand for cars has been shaped across the districts.

However, studies showthat higher inequality exists in the state when it comes to different facets of human development, especially regarding household income and consumption expenditure. A study by Bajapi portrayed how consumption expenditure, education and, employment vary across different regions of the state (Bajpai, 2020). Another study (Nagalia, 2018) has shown the levels of economic disparities in land and asset ownership across rural Uttar Pradesh. With this background, this paper explores the disparities that exist at micro-level with the help of economic activities and high-end asset ownership such as passenger car to reflect a pattern of household income distribution at the district level.

[3] According to Census of India 2011
[4] "National Multidimensional Poverty Index Baseline Report Based on NFHS-4 (2015-16)", NITI Aayog. 20 September 2021.

2. Objectives

The purpose of this study is to evaluate the distribution pattern of economic activity and passenger car sales across the 75 districts of Uttar Pradesh and to compare the findings with that of the year 2014 using scientific methods. This will help us quantify the economic disparity that exists across different regions and districts of Uttar Pradesh.

The following research questions have been addressed in this study:

- Examine the levels of disparity between various regions and districts;
- Quantify how well certain districts outperform other districts;
- Identifying clusters in terms of household income distribution.

3. Data and Methodology

The study explored economic activity in terms of district domestic product and car sales[5]. The car sales have been considered in terms of absolute value as well as per capita. As well understood, a completely different picture may emerge in certain cases when these two variables are used. Therefore, this paper presents both scenarios of car sales so that it can easily decipher the usage pattern of passenger cars in Uttar Pradesh. Data used for the study was collected from different authentic government sources. This paper used car sales data for 2014 and 2022 so that changes over time can also be captured. Since we have not used any household income distribution of the districts to explain the car sales pattern across Uttar Pradesh, we have used district domesticproduct (DDP) data to explore how domestic product is associated with the car sales. Due to non-availability of 2021-22 district domestic product data for Uttar Pradesh, the data for 2020-21 has been used. Since the economic pattern of activities in any region does not change drastically within one year, our assumption was that the relationship would show more or less similar scenario. Apart from these, we calculated the Gini Coefficient to examine the extent of inequality across districts in terms of car sales and population data. The coefficient varies between 0 and 1, with 0 representing perfect equality and 1 perfect inequality.

While the car sales data could be obtained in actual numbers, the district-wise population for 2014 and 2022 are not available in any government data source. Therefore, this paper estimated the population for 2014 and 2022.

[5] Registration data was used as a proxy to sales.

population data for the districts of Uttar Pradesh. However, these estimates are relatively crude since the latest Census of India data is available only till 2011. To overcome this constraint , the paper used data presented by the National Health Mission (NHM) for Uttar Pradesh from 2011 to 2036. In absence of any other database, the population distribution of the census 2011 was used to estimate the population of the districts for 2014 and 2022. Although the per capita numbers are not robust, it still provides us a sense of direction about the inequality that exists across the districts and the changesexperienced over time. The graphs for number of car sales and car sales per lakh population are presented in index form. To convert the actual data into index form, we used 2014 as base year with the maximum value assumed as 100. Rest of the data for 2014 and 2022 has been calibrated accordingly.This helps in clearly understanding the changes that happened over time.

Identifying Clusters

The associations obtained through data analysis and graphical representations suggested that certain patterns should emerge in terms of similarities across districts based on car sales, car sales per lakh population and district domestic product. To explore this, we examined clustering through various clustering techniques, viz., K-Means, Gaussian Mixture Modelling (GMM) and DB Scan clustering techniques using car sales and domestic products data. Though we presented results of all three clustering methodologies, we found that the clusters obtained by K Means clustering is most robust and shows similar clusters as seen visually through graphs. We used the silhouette score analysis to decide the most suitable value of k for clustering since it combines the two factorsof cohesion and resolution (Shahapure and Nicholas, 2020). From the table given below, it is worth noticing that silhouette scores gradually decrease as the number of clusters increase.

4. Results

This section discusses the patterns that emerge from economic activities as well as distribution of high- income households, as proxied through car sales in Uttar Pradesh. District-wise domestic product including Gross Value Added for primary, secondary and tertiary sectors and the total are given in Appendix. It is quite evident from the table that the spatial distribution of the district domestic product is more skewed towards the western region compared other regions in the state. Prominent districts apart from Gautam Buddha Nagar, which is the largest contributor to the state's GDP, are the districts of Ghaziabad, Agra, and Meerut, which are located within the western part of the state. Lucknow, Kanpur Nagar, Allahabad are few such districts which lie

outside the western Uttar Pradesh having dominance in the market share.

Household income is directly proportional to economic activity. As expected from the pattern of district domestic product, population with higher affordability should have more concentration in the districts that are identified with higher GDP. The number of towns, especially large towns, are more concentrated in the districts where manufacturing and services sector activities are higher. This is reflected in the car sales in both years under consideration, i.e., 2014 and 2022. The index of car sales is presented in Figure 1 and 2 below and the changes over two years can be seen and compared clearly. The graphs suggest that the highest car sales were recorded in Lucknow in 2014followed by Ghaziabad, Gautam Buddha Nagar (NOIDA), Kanpur Nagar and Agra as the top 5 districts in terms of car sales. During the eight years, car sales in Lucknow almost doubled, while for both Ghaziabad and Noida, the sales were more than double. But the changes recorded in Kanpur Nagar and Agra were much lower compared to the above three districts. It was interesting to observe that the order of index in 2022 remained the same.

A similar picture of concentration can be seen in Figure 3 and 4 when visualizing car sales per lakh population for 2014 and 2022 respectively. However, a few notable changes in the order of top-ranking districts are worth mentioning. Although Lucknow was leading in terms of absolute car sales in 2014 and 2022, it was overtaken by Noidawhen we look into the numbers for per lakh population basis.. Another interesting point is that car sales per lakh populationin Hapur was higher than Ghaziabad. . The growth rate of car sales per lakh population between 2014 to 2022in Noida, Lucknow and Hapur was significantly higher compared to all other districts of the states except those with small base value. The average annual growth rate numbers between 2014 and 2022 are presented in Table 1.

Fig 1: Index of Car Sales in 2014

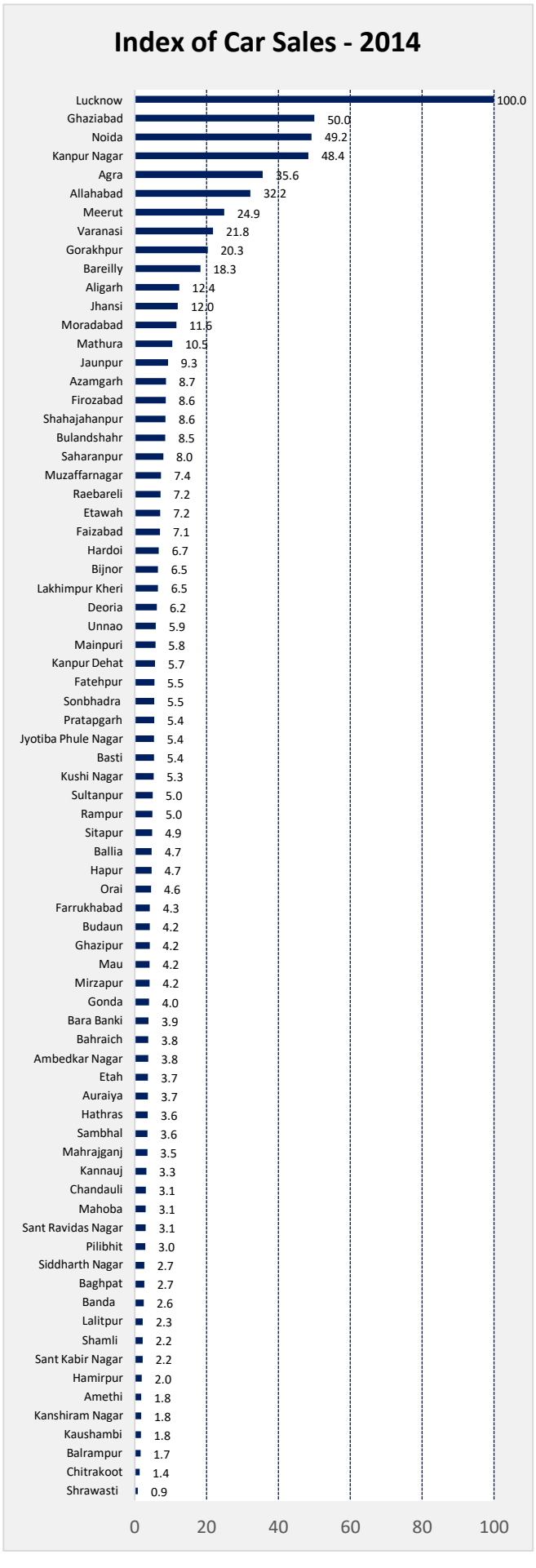


Fig 2: Index of Car Sales in 2022

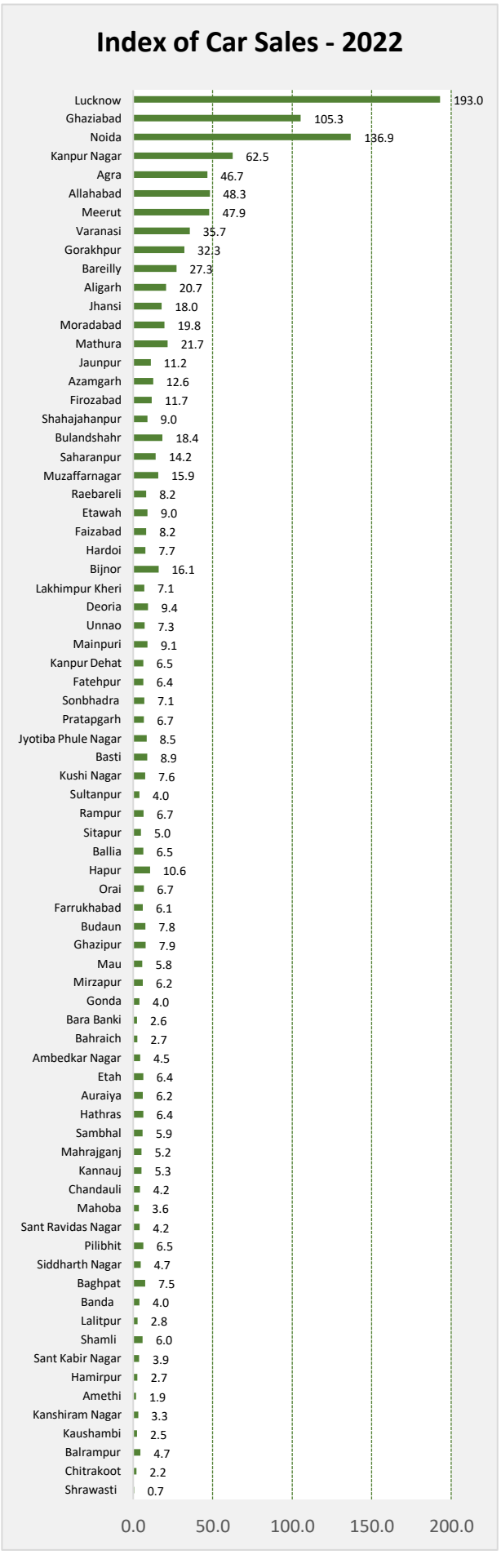


Fig 3: Index of Car Sales Per Lakh Pop in 2014

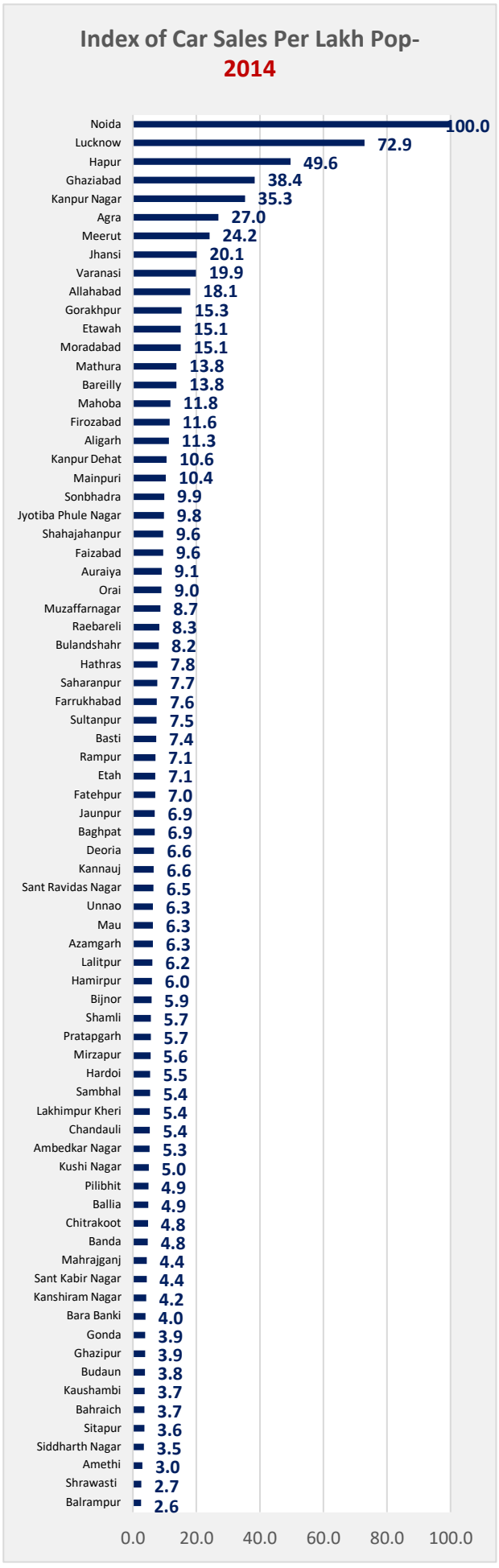


Fig 4: Index of Car Sales Per Lakh Pop in 2022

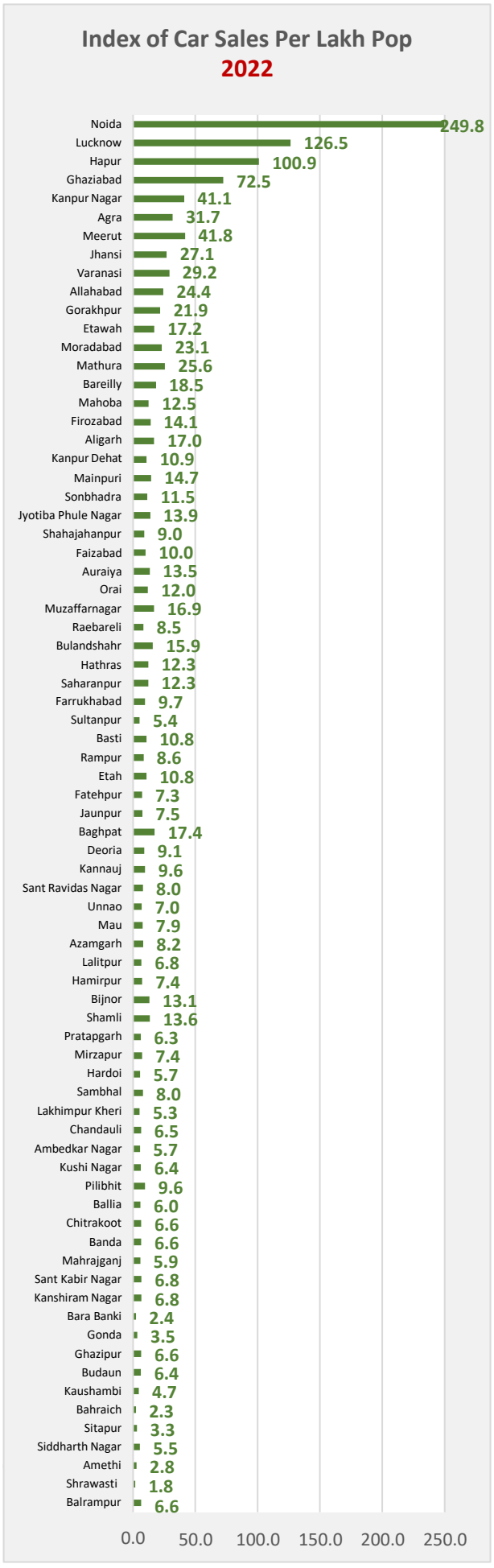
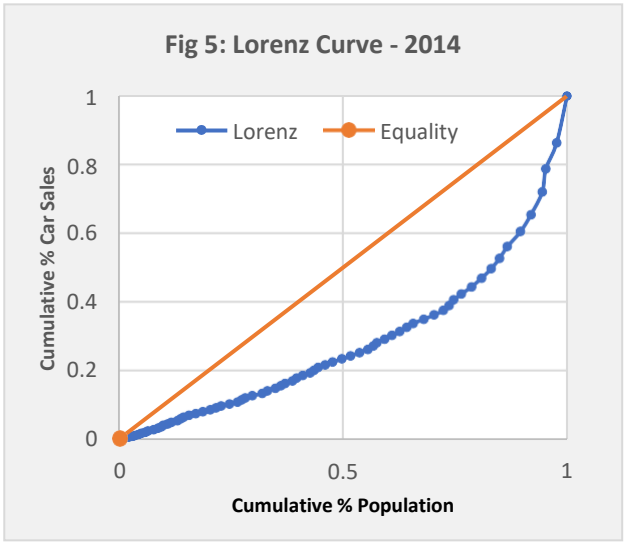
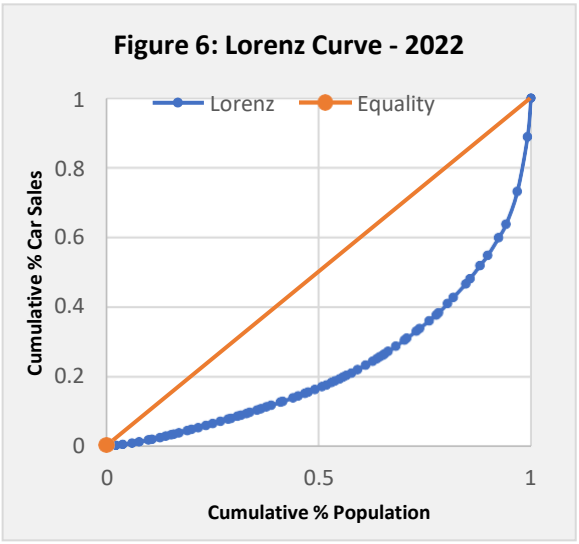


Table 1: Average Annual Growth of Car Sales and Per Lakh Population Car Sales (from 2014 to 2022)

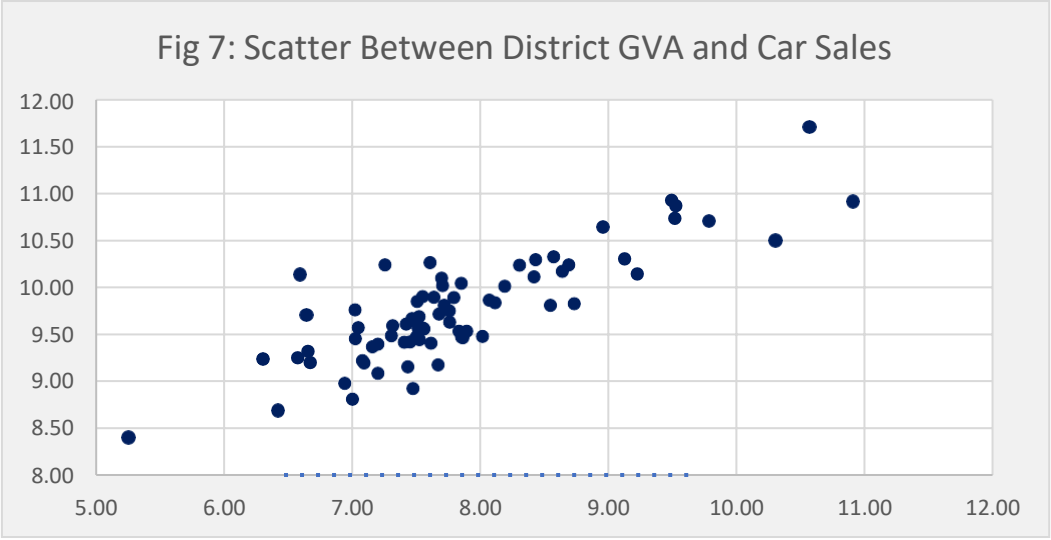
District	Average Growth rate during 2014-22- Absolute sales	Average Growth rate during 2014-22- Per capita sales	District	Average Growth rate during 2014-22- Absolute sales	Average Growth rate during 2014-22- Per capita sales
Balrampur	22.69	19.14	Mahrajganj	5.98	4.09
Baghpat	22.65	19.08	Orai	5.98	4.10
Noida	22.26	18.72	Azamgarh	5.61	3.78
Shamli	20.69	17.31	Farrukhabad	5.29	3.47
Bijnor	18.45	15.30	Kushi Nagar	5.28	3.48
Hapur	15.80	12.92	Kaushambi	5.22	3.41
Pilibhit	14.68	11.87	Mau	4.81	3.04
Bulandshahr	14.48	11.76	Hamirpur	4.68	2.93
Muzaffarnagar	14.41	11.69	Ballia	4.62	2.89
Ghaziabad	13.80	11.13	Sant Ravidas Nagar	4.47	2.74
Mathura	13.37	10.75	Firozabad	4.45	2.73
Lucknow	11.63	9.17	Chandauli	4.42	2.70
Meerut	11.50	9.06	Rampur	4.27	2.55
Ghazipur	11.03	8.68	Agra	3.88	2.21
Budaun	10.64	8.31	Sonbhadra	3.71	2.05
Kanshiram Nagar	9.87	7.63	Kanpur Nagar	3.67	2.02
Saharanpur	9.68	7.43	Etawah	3.29	1.69
Siddharth Nagar	9.53	7.26	Unnao	2.94	1.39
Hathras	9.40	7.17	Pratapgarh	2.89	1.33
Sant Kabir Nagar	9.17	6.98	Lalitpur	2.79	1.24
Etah	8.79	6.62	Jaunpur	2.56	1.02
Moradabad	8.75	6.59	Ambedkar Nagar	2.36	0.84
Aligarh	8.36	6.24	Mahoba	2.20	0.70
Auraiya	8.23	6.11	Faizabad	2.07	0.60
Sambhal	8.08	5.99	Fatehpur	1.94	0.48
Varanasi	7.97	5.89	Hardoi	1.93	0.48
Basti	7.96	5.87	Kanpur Dehat	1.77	0.32
Kannauj	7.82	5.78	Raebareli	1.69	0.26
Gorakhpur	7.36	5.34	Lakhimpur Kheri	1.16	-0.23
Mainpuri	7.21	5.20	Shahajahanpur	0.60	-0.73
Jyotiba Phule Nagar	7.13	5.14	Amethi	0.52	-0.77
Banda	6.86	4.90	Sitapur	0.31	-1.02
Chitrakoot	6.67	4.70	Gonda	-0.20	-1.46
Deoria	6.60	4.67	Sultanpur	-2.47	-3.50
Allahabad	6.25	4.34	Shrawasti	-3.10	-4.09
Jhansi	6.25	4.34	Bahraich	-3.68	-4.55
Bareilly	6.19	4.29	Bara Banki	-4.26	-5.11
Mirzapur	5.99	4.09			

To show the existing inequalities, Lorenz curves based on car sales and population are presented as Fig 5 and Fig 6 below. It is evident from the above figures that the level of inequality has worsenedas we move from 2014 to 2022. The Gini Coefficient was measured as 0.54 and 0.60 for 2014 and 2022 respectively. This shows that over the period considered in this study, inequality has increased in Uttar Pradesh at least in terms of car sales. Since car sales is one of the important indicators to reflect household income, one can suggest that perhaps the same is also true in case of household income. We can see high association between car sales and district domestic product as presented through a scatter plot in Fig 7. This depicts that as the district domestic product increases, so does the affordability of the population to purchase high valued assets like passenger cars.





Note: The area between the line of equality (in orange) and Lorenz curve (in blue) gives the measure of inequality



Identifying Clusters

As discussed in the methodology section of this paper, we explored different clustering models to identify districts with similar characteristics. The data of car sales and district domestic product are used for clustering purposes. Based on the silhouette score analysis, we found that the data is most suited for four clear clusters. The results from K Means, GMM and DB Scan clustering models are presented in Table 2. The table mentions the specific cluster in which each of the district fall. One can clearly seethat the clustering obtained from K Means and GMM matches to a considerable extent, except a handful districts. However, DB Scan clustering model was a bit different from the other two. From the data also, we found that the clusters obtained from K Means clustering is more accurate.

We have presented the clusters in Fig 8. The map provides a clear picture of a lopsided car market across the districts of Uttar Pradesh. It is worth noticing that high sales clusters are forming around the satellite districts of Delhi NCT. From the figure, we can also see that excluding Gorakhpur and Varanasi, the rest of Purvanchal and the entirety of Bundelkhand falls under the category of very poor household income cluster. However there has been some improvements between 2014 and 2022 in terms of car sales per capita. New players such as Jhansi (Bundelkhand), Mathura and Moradabad (Western UP) have shown signs of improvement.

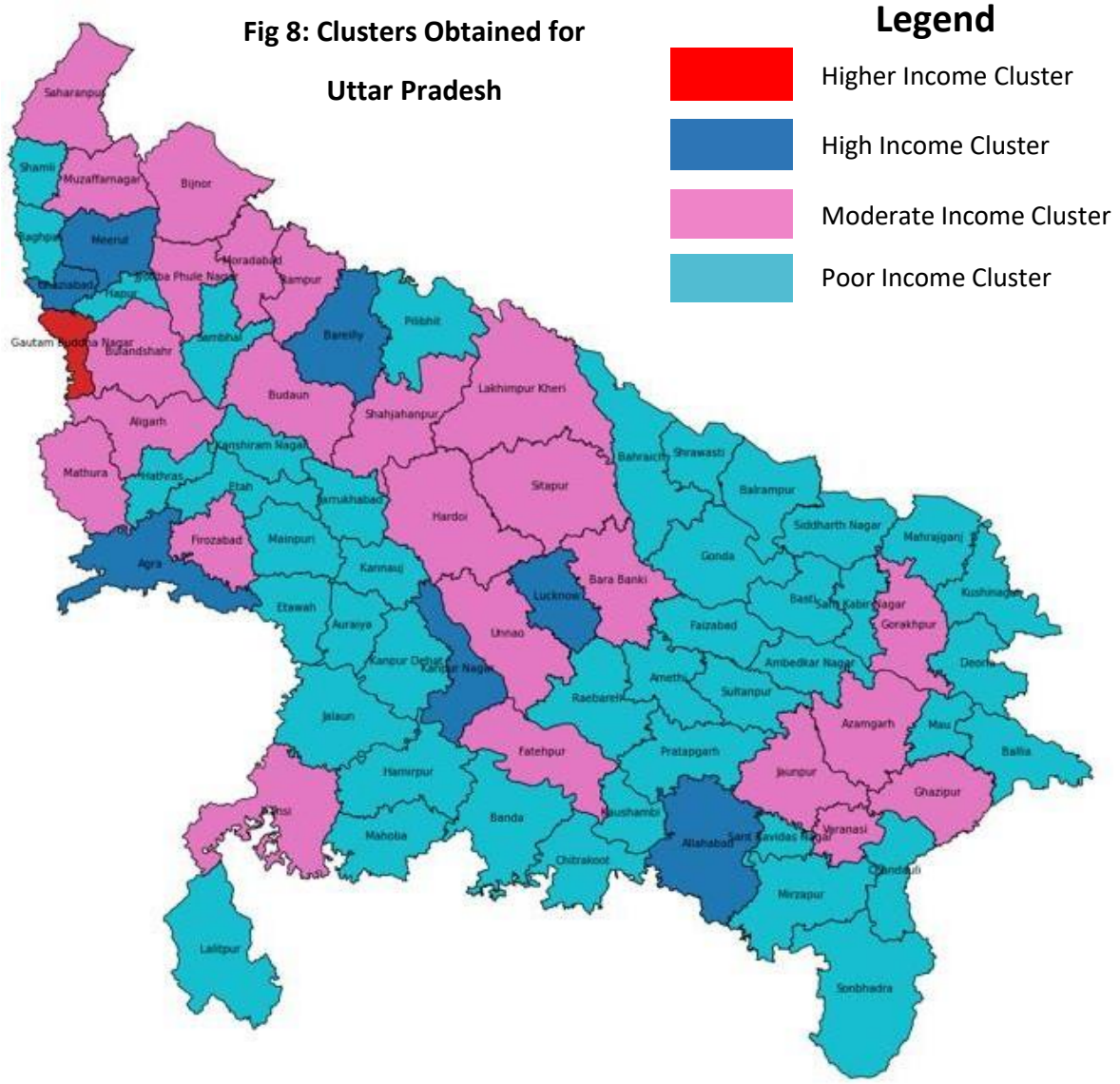
Table 2: Clusters based on Car Sales and District Domestic Product

District	Car Sales index 2022	GDP Index 2020-21	K Means 4 cluster	GMM 4 cluster	DB Scan 4 cluster
Gautam Buddha Nagar	70.9	100.00	1	1	1
Agra	24.2	45.84	**2**	**2**	**2**
Allahabad	25.0	43.22	2	2	2
Bareilly	14.2	34.50	2	2	1
Ghaziabad	54.5	29.88	2	2	1
Kanpur Nagar	32.4	36.73	2	2	3
Lucknow	100.0	45.22	2	2	1
Meerut	24.8	37.84	2	2	3
Aligarh	10.7	22.85	3	3	4
Azamgarh	6.5	18.25	3	3	4
Bara Banki	1.3	20.81	3	3	4
Bijnor	8.3	24.15	3	3	4
Budaun	4.0	18.36	3	4	4
Bulandshahr	9.6	24.90	3	3	4

Fatehpur	3.3	15.53	3	4	4
Firozabad	6.1	15.30	3	4	4
Ghazipur	4.1	14.92	3	4	4
Gorakhpur	16.7	24.55	3	3	4
Hardoi	4.0	19.84	3	3	4
Jaunpur	5.8	15.73	3	4	4
Jhansi	9.3	14.93	3	3	4
Jyotiba Phule Nagar	4.4	16.18	3	4	4
Lakhimpur Kheri	3.7	23.42	3	3	4
Mathura	11.2	15.19	3	3	4
Moradabad	10.2	21.33	3	3	4
Muzaffarnagar	8.2	20.14	3	3	4
Rampur	3.5	16.32	3	4	4
Saharanpur	7.3	22.76	3	3	4
Shahjahanpur	4.7	18.82	3	4	4
Sitapur	2.6	22.84	3	3	4
Unnao	3.8	16.22	3	4	4
Varanasi	18.5	20.92	3	3	4
Ambedkar Nagar	2.3	9.62	4	4	4
Amethi	1.0	8.42	4	4	4
Auraiya	3.2	6.21	4	4	4
Ayodhya	4.3	12.47	4	4	4
Baghpat	3.9	7.96	4	4	4
Bahraich	1.4	13.49	4	4	4
Ballia	3.3	11.71	4	4	4
Balrampur	2.4	7.29	4	4	4
Banda	2.1	10.49	4	4	4
Basti	4.6	11.34	4	4	4
Chitrakoot	1.1	4.89	4	4	4
Deoria	4.9	11.33	4	4	4
Etah	3.3	10.70	4	4	4
Etawah	4.7	10.66	4	4	4
Farukhabad	3.1	10.15	4	4	4
Gonda	2.0	14.19	4	4	4
Hamirpur	1.4	9.14	4	4	4
Hapur	5.5	10.74	4	4	4
Hathras	3.3	12.53	4	4	4
Jalaun	3.5	11.63	4	4	4
Kannauj	2.7	12.01	4	4	4
Kanpur Dehat	3.4	10.37	4	4	4
Kasganj	2.2	8.30	4	4	4
Kaushambi	1.3	8.55	4	4	4
Kushi Nagar	3.9	13.59	4	4	4
Lalitpur	1.4	8.12	4	4	4
Mahoba	1.9	6.54	4	4	4
Mahrajganj	2.7	10.80	4	4	4

Mainpuri	4.7	10.60	4	4	4
Mau	3.0	10.09	4	4	4
Mirzapur	3.2	12.95	4	4	4
Pilibhit	3.4	13.21	4	4	4
Pratapgarh	3.5	11.69	4	4	4
Rae bareli	4.3	14.09	4	4	4
Sambhal	3.0	12.21	4	4	4
Sant Kabir Nagar	2.0	5.55	4	4	4
Shamli	3.1	7.78	4	4	4
Shrawasti	0.3	3.65	4	4	4
Siddharth Nagar	2.4	9.90	4	4	4
Sonbhadra	3.7	9.99	4	4	4
Sultanpur	2.1	11.77	4	4	4

Fig 8: Clusters Obtained for Uttar Pradesh



5. Concluding Remarks

This paper conclusively shows disparate development in Uttar Pradesh in terms of economic activities and as a consequence a skewed household income distribution. Large proportion car sales is concentrated only in a few districts suggesting lesser affordability towards purchasing high valued asset for those.

Table 3: Disparities across Districts of Uttar Pradesh

Cluster	No. of Districts	Share in Car Sales (in %)	Share of DDP in UP's GSDP
Cluster 1	1	11.20	7.97
Cluster 2	**7**	43.44	21.78
Cluster 3	24	26.51	37.01
Cluster 4	43	18.89	33.22
Total	**75**	**100**	**100**

As shown in Table 3, the topmost district Gautam Buddha Nagar solely accounts for more than 11% of the total car sales in the state, while 7 districts account for more than 43% of the market share. The total share of these 8 districts is more than 55% of the total car sales in state in 2022, while rest of the 67 districts account for only 45% of the car sales. It is important that policies need to be thought of to reduce such lopsided development. With recent infrastructure development, especially with enhanced connectivity through newly built expressways like Delhi-Mumbai, Poorvanchal, Bundelkhand as well as the link roads that connect various regions of the state to different parts of the country will be able to produce positive impacts on economic activities.

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Appendix

A 1: District Domestic Products - 2020-21

District	Primary	Secondary	Tertiary	Gross Value Added (Base Price)	Gross Domestic Product (at Market Price)
Agra	9199.79	23772.98	22823.14	55795.92	62025.23
Aligarh	8683.57	6124.82	13002.41	27810.81	30915.73
Allahabad	9091.69	14102.45	29421.21	52615.36	58489.58
Ambedkar Nagar	3578.23	1491.68	6643.02	11712.93	13020.62
Amethi	3564.78	1777.12	4908.95	10250.86	11395.31
Amroha	4970.46	7402.09	7328.41	19700.96	21900.46
Auraiya	3137.24	857.16	3567.58	7561.99	8406.24
Ayodhya	4256.62	1741.56	9176.13	15174.31	16868.44
Azamgarh	6426.10	3142.05	12652.92	22221.07	24701.93
Baghpat	4409.47	1162.34	4122.82	9694.63	10776.98
Bahraich	6776.93	1035.37	8613.32	16425.61	18259.44
Ballia	4064.22	1639.43	8548.50	14252.15	15843.32
Balrampur	3813.34	770.54	4292.39	8876.28	9867.26
Banda	5973.48	839.22	5953.28	12765.99	14191.24
Bara Banki	12394.32	2242.80	10690.82	25327.93	28155.66
Bareilly	8739.38	11748.33	21505.12	41992.84	46681.11
Basti	3725.90	1657.22	8424.41	13807.53	15349.06
Bhadohi	1348.85	2697.73	4299.06	8345.63	9277.37
Bijnor	9995.19	5645.10	13752.09	29392.38	32673.88
Budaun	8690.25	3664.02	9992.20	22346.46	24841.32
Bulandshahr	10867.67	6961.33	12483.18	30312.17	33696.36
Chandauli	3324.41	1650.72	4914.11	9889.24	10993.32
Chitrakoot	2997.74	323.97	2631.78	5953.49	6618.16
Deoria	3142.12	1248.17	9407.69	13797.98	15338.45
Etah	5755.89	739.84	6527.56	13023.29	14477.27
Etawah	4148.08	1694.32	7131.80	12974.20	14422.69
Farukkhabad	4660.72	1410.43	6283.10	12354.25	13733.54
Fatehpur	7210.46	2629.24	9064.83	18904.53	21015.12
Firozabad	5707.43	3930.24	8987.27	18624.94	20704.31
Gautam Buddha Nagar	2208.43	77004.27	42517.59	121730.29	135320.81
Ghaziabad	2801.96	14762.83	18807.28	36372.06	40432.81
Ghazipur	4988.62	1855.76	11312.44	18156.82	20183.94
Gonda	6420.08	1991.52	8866.64	17278.23	19207.25
Gorakhpur	6920.15	4969.50	17998.21	29887.86	33224.67
Hamirpur	6069.06	719.08	4340.43	11128.57	12371.02
Hapur	3522.12	3392.12	6160.37	13074.61	14534.32
Hardoi	8746.19	3541.33	11862.31	24149.83	26846.03

Hathras	6423.13	2215.14	6611.65	15249.93	16952.50
Jalaun	6595.31	1532.01	6028.36	14155.69	15736.09
Jaunpur	4952.11	2857.05	11337.00	19146.16	21283.72
Jhansi	5904.78	2037.72	10227.64	18170.14	20198.73
Kannauj	4480.53	2929.37	7214.74	14624.64	16257.40
Kanpur Dehat	4554.68	1936.67	6136.19	12627.54	14037.34
Kanpur Nagar	4415.29	14882.88	25410.95	44709.12	49700.65
Kasganj	4313.64	1935.85	3857.92	10107.41	11235.84
Kaushambi	3448.08	2821.08	4136.89	10406.05	11567.83
Kushi Nagar	5847.73	2235.97	8462.99	16546.70	18394.05
Lakhimpur Kheri	13569.67	2919.74	12023.83	28513.24	31696.59
Lalitpur	4556.59	800.34	4531.22	9888.15	10992.11
Lucknow	5312.58	17001.57	32733.69	55047.84	61193.63
Mahoba	3891.29	635.89	3433.32	7960.50	8849.25
Mahrajganj	4045.28	1537.80	7566.77	13149.86	14617.97
Mainpuri	5680.99	672.42	6549.48	12902.89	14343.43
Mathura	5464.55	3485.98	9538.03	18488.56	20552.71
Mau	2046.79	3222.13	7010.75	12279.67	13650.63
Meerut	8773.86	16827.37	20467.32	46068.56	51211.86
Mirzapur	4562.74	2905.68	8292.82	15761.24	17520.89
Moradabad	5179.94	8082.30	12703.17	25965.41	28864.31
Muzaffarnagar	8884.06	3989.73	11642.86	24516.64	27253.79
Pilibhit	5009.49	2962.33	8111.55	16083.37	17878.99
Pratapgarh	4106.11	1552.76	8570.80	14229.68	15818.34
Rae Bareli	4198.45	2953.96	9993.79	17146.20	19060.48
Rampur	4988.76	6570.26	8312.26	19871.29	22089.81
Saharanpur	10118.67	4231.83	13359.85	27710.34	30804.05
Sambhal	5745.19	3035.45	6085.88	14866.52	16526.29
Sant Kabir Nagar	2626.47	703.86	3420.66	6750.99	7504.70
Shahjahanpur	8186.61	3561.92	11155.98	22904.51	25461.68
Shamli	4235.74	1512.57	3726.61	9474.92	10532.74
Shrawasti	1736.14	433.92	2274.57	4444.63	4940.85
Siddharth Nagar	4096.70	1781.98	6172.77	12051.45	13396.93
Sitapur	9663.75	3376.19	14768.55	27808.49	30913.16
Sonbhadra	3847.58	2639.22	5676.20	12163.00	13520.94
Sultanpur	3822.03	2607.88	7903.67	14333.58	15933.85
Unnao	7137.79	3143.59	9460.25	19741.62	21945.67
Varanasi	2981.59	6858.67	15622.36	25462.62	28305.38