

YEAR WISE TREND ANALYSIS OF CONSUMER PRICE INDEX DATA (2013-2022)

PROJECT REPORT

**MASTER OF SCIENCE
IN
COMPUTER SCIENCE**

SUBMITTED BY

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**UNDER THE SUPERVISION OF
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**DEPARTMENT OF COMPUTER SCIENCE
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ACKNOWLEDGEMENT

On the very outset of this report, we would like to extend our sincere and heartfelt obligation towards all the people who have helped us in this endeavour.

We are ineffably indebted to **Dr. Vasudha Bhatnagar** for her conscientious guidance, exceptional mentoring and constant monitoring to accomplish this assignment. We would also like to extend our sincere gratitude to the **Department of Computer Science**, for giving us the opportunity to execute this project, which is an integral part of the curriculum in MSc program at Delhi University.

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ABOUT THE DATA

What is Consumer Price Index (CPI)?

- A Consumer Price Index (CPI) is designed to measure the changes over time in general level of retail prices of selected goods and services that households purchase for the purpose of consumption.
- Such changes affect the real purchasing power of consumers' income and their welfare.
- The CPI measures price changes by comparing, through time, the cost of a fixed basket of commodities.
- The basket is based on the expenditures of a target population in a certain reference period. Since the basket contains commodities of unchanging or equivalent quantity and quality, the index reflects only pure price.
- Traditionally, CPI numbers were originally introduced to provide a measure of changes in the living costs of workers, so that their wages could be compensated to the changing level of prices.
- However, over the years, CPIs have been widely used as a macroeconomic indicator of inflation, and also as a tool by Government and Central Bank for targeting inflation and monitoring price stability.
- CPI is also used as deflators in the National Accounts. Therefore, CPI is considered as one of the most important economic indicators.

What is the CPI formula?

When calculating the consumer price index, the final consumer price index result represents the average change in prices that consumers will spend on a basket of goods and services over time. This is how economic and financial professionals identify and determine inflation. They can then use CPI to determine the economy's aggregate price levels to measure the purchasing price of an entire country or a specific area.

1. The consumer price index formula is:

$$CPI_t = \frac{C_t}{C_0} * 100$$

where,
CPI_t = Consumer price index in current year
C_t = Cost of products or services in current year
C₀ = Cost of products or services in base year

2. CPI of rate of inflation from base year = CPI of current year – 100
3. Rate of inflation of given period of Year A to Year B (B>A) is given by

$$CPI_{AB} = \frac{CPI_B - CPI_A}{CPI_A} * 100$$

NOTE: RBI maintains the rate of inflation between 2% to 6%

Structure of CPI:

Table 2: All India Sub-group/Group Weights

Group Code	Sub-group Code	Description	Rural	Urban	Combined
	1.1.01	Cereals and products	12.35	6.59	9.67
	1.1.02	Meat and fish	4.38	2.73	3.61
	1.1.03	Egg	0.49	0.36	0.43
	1.1.04	Milk and products	7.72	5.33	6.61
	1.1.05	Oils and fats	4.21	2.81	3.56
	1.1.06	Fruits	2.88	2.90	2.89
	1.1.07	Vegetables	7.46	4.41	6.04
	1.1.08	Pulses and products	2.95	1.73	2.38
	1.1.09	Sugar and Confectionery	1.70	0.97	1.36
	1.1.10	Spices	3.11	1.79	2.50
	1.2.11	Non-alcoholic beverages	1.37	1.13	1.26
	1.1.12	Prepared meals, snacks, sweets etc.	5.56	5.54	5.55
1		Food and beverages	54.18	36.29	45.86
2		Pan, tobacco and intoxicants	3.26	1.36	2.38
	3.1.01	Clothing	6.32	4.72	5.58
	3.1.02	Footwear	1.04	0.85	0.95
3		Clothing and footwear	7.36	5.57	6.53
4		Housing	—	21.67	10.07
5		Fuel and light	7.94	5.58	6.84
	6.1.01	Household goods and services	3.75	3.87	3.80
	6.1.02	Health	6.83	4.81	5.89
	6.1.03	Transport and communication	7.60	9.73	8.59
	6.1.04	Recreation and amusement	1.37	2.04	1.68
	6.1.05	Education	3.46	5.62	4.46
	6.1.06	Personal care and effects	4.25	3.47	3.89
6		Miscellaneous	27.26	29.53	28.32
		All Groups	100.00	100.00	100.00

Structure of CPI raw data:

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POSSIBLE DATA LOSSSome features might be lost if you save this workbook in the comma-delimited (.csv) format. To preserve these features, save it in an Excel file format.

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1SectorYearMonthCereals and Meat and EggsMilk and P. Oils and FruitsVegetable: Pulses and Sugar and SpicesNon-alcohol Prepared r Food and I Pan, tobacClothingFootwearClothing and HousingFuel and li Household He

1	Rural	2013	January	107.5	106.3	108.1	104.9	106.1	103.9	101.9	106.1	106.8	103.1	104.8	106.7	105.5	105.1	106.5	105.8	106.4	NA	105.5	104.8
2	Urban	2013	January	110.5	109.1	113	103.6	103.4	102.3	102.9	105.8	105.1	101.8	105.1	107.9	105.9	105.2	105.9	105	105.8	100.3	105.4	104.8
3	Rural+Urb	2013	January	108.4	107.3	110	104.4	105.1	103.2	102.2	106	106.2	102.7	104.9	107.3	105.6	105.1	106.3	105.5	106.2	100.3	105.5	104.8
4	Rural	2013	February	109.2	108.7	110.2	105.4	106.7	104	102.4	105.9	105.7	103.1	105.1	107.7	106.3	105.6	107.1	106.3	107 NA	106.2	105.2	
5	Urban	2013	February	112.9	112.9	116.9	104	103.5	103.1	104.9	104.1	103.8	102.3	106	109	107.2	106	106.6	105.5	106.4	100.4	105.7	105.2
6	Rural+Urb	2013	February	110.4	110.2	112.8	104.9	105.5	103.6	103.2	105.3	105.1	102.8	105.5	108.3	106.6	105.7	106.9	106	106.8	100.4	106	105.2
7	Rural	2013	March	110.2	108.8	109.9	105.6	106.2	105.7	101.4	105.7	105	103.3	105.6	108.2	106.6	106.5	107.6	106.8	107.5 NA	106.1	105.6	
8	Urban	2013	March	113.9	111.4	113.2	104.3	102.7	104.9	103.8	103.5	102.6	102.4	107	109.8	107.3	106.8	107.2	106	107	100.4	106	105.7
9	Rural+Urb	2013	March	111.4	109.7	111.2	105.1	104.9	105.3	102.2	105	104.2	103	106.2	108.9	106.9	106.6	107.4	106.5	107.3	100.4	106.1	105.6
10	Rural	2013	April	110.2	109.5	106.9	106.3	105.7	108.3	103.4	105.7	104.2	103.2	106.5	108.8	107.1	107.1	108.1	107.4	108 NA	106.5	106.1	
11	Urban	2013	April	114.6	113.4	106	104.7	102.1	109.5	109.7	104.6	102	103.5	108.2	110.6	108.8	108.5	107.9	106.4	107.7	100.5	106.4	106.5
12	Rural+Urb	2013	April	111.6	110.9	106.6	105.7	104.4	108.9	105.5	105.3	103.5	103.3	107.2	109.6	107.7	107.5	108	107	107.9	100.5	106.5	106.3
13	Rural	2013	May	110.9	109.8	105.9	107.5	105.3	108.1	107.3	106.1	103.7	104	107.4	109.9	108.1	108.1	108.8	107.9	108.6 NA	107.5	106.8	
14	Urban	2013	May	115.4	114.2	102.7	105.5	101.5	110.6	123.7	105.2	101.9	105	109.1	111.3	111.1	109.8	108.5	106.7	108.3	100.5	107.2	107.1
15	Rural+Urb	2013	May	112.3	111.3	104.7	106.8	103.9	109.3	112.9	105.8	103.1	104.3	108.1	110.5	109.2	108.6	108.7	107.4	108.5	100.5	107.4	106.9
16	Rural	2013	June	112.3	112.1	108.1	108.3	105.9	109.2	118	106.8	104.1	105.4	108.2	111	110.6	109	109.7	108.8	109.5 NA	108.5	107.5	
17	Urban	2013	June	117	120.1	112.5	107.3	101.3	112.4	143.6	105.4	101.4	106.4	110	112.2	115	110.9	109.2	107.2	108.9	106.6	108	107.6
18	Rural+Urb	2013	June	113.8	114.9	109.8	107.9	104.2	110.7	126.7	106.3	103.2	105.7	109	111.6	112.2	109.5	109.5	108.1	109.3	106.6	108.3	107.6
19	Rural	2013	July	113.4	114.9	110.5	109.3	106.2	110.3	129.2	107.1	104.3	106.4	109.1	112.1	113.1	109.8	110.5	109.5	110.3 NA	109.5	108.3	
20	Urban	2013	July	117.8	119.2	114	108.3	101.1	113.2	160.9	105.1	101.3	107.5	110.4	113.1	117.5	111.7	109.8	107.8	109.5	107.7	108.6	108.1
21	Rural+Urb	2013	July	114.8	116.4	111.9	108.9	104.3	111.7	140	106.4	103.3	106.8	109.6	112.6	114.7	110.3	110.2	108.8	110	107.7	109.2	108.2
22	Rural	2013	August	114.3	115.4	111.1	110	106.4	110.8	138.9	107.4	104.1	106.9	109.7	112.6	114.9	110.7	111.3	110.2	111.1 NA	109.9	108.7	
23	Urban	2013	August	118.3	120.4	112.7	108.9	101.1	108.7	177	104.7	101	108.5	110.9	114.3	119.6	112.4	110.6	108.3	110.2	108.9	109.3	108.7
24	Rural+Urb	2013	August	115.6	117.2	111.7	109.6	104.5	109.8	151.8	106.5	103.1	107.4	110.2	113.4	116.6	111.2	111	109.4	110.7	108.9	109.7	108.7
25	Rural	2013	September	115.4	115.7	111.7	111	107.4	110.9	154	108.1	104.2	107.9	110.4	114	117.8	111.7	112.7	111.4	112.5 NA	111.1	109.6	
26	Urban	2013	September	118.6	119.1	113.2	109.6	101.7	103.2	174.3	105.1	100.8	109.1	111.1	115.4	119.2	112.9	111.4	109	111.1	109.7	109.5	109.6
27	Rural+Urb	2013	September	116.4	116.9	112.3	110.5	105.3	107.3	160.9	107.1	103.1	108.3	110.7	114.6	118.3	112	112.2	110.4	111.9	109.7	110.5	109.6
28	Rural	2013	October	116.3	115.4	112.6	111.7	107.7	113.2	164.9	108.3	103.9	108.2	111.1	114.9	119.8	112.2	113.6	112.3	113.4 NA	111.6	110.4	
29	Urban	2013	October	118.9	118.1	114.5	110.4	102.3	106.2	183.5	105.3	100.2	109.6	111.4	116	120.8	113.5	112.5	109.7	112	110.5	109.7	110.2

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Attributes of the CPI data:

- **Sector:** It denotes whether the data point captured belongs to rural, urban or combined sector. It is string datatype.
- **Year:** It denotes the year in which the data point was captured.
- **Month:** It denotes the month in which the data point was captured.

***Note:** All the remaining attributes are groups and subgroups of the CPI table and are in integer format. Also, during the data pre-processing stage, housing attribute has been dropped because of non-availability of data in majority of rows. Furthermore, all the records having NA as value in any column of the table has been dropped accordingly. Since, this report will focus majorly on year wise analysis, April has been selected as the month which represents the year, as the financial year of India starts from 1st April of the given year and ends on 31st March of next year.*

QUESTIONS

We will be focusing on 3 main questions while exploring the dataset:

- 1. How volatile is price of each commodity across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)? What is the correlation between price of each commodity in urban and rural sector?**
- 2. How volatile are the prices of all commodities in each sector? What is the correlation among prices of commodities in a given sector?**
- 3. How volatile is the CPI index in general across the 3 sectors?**

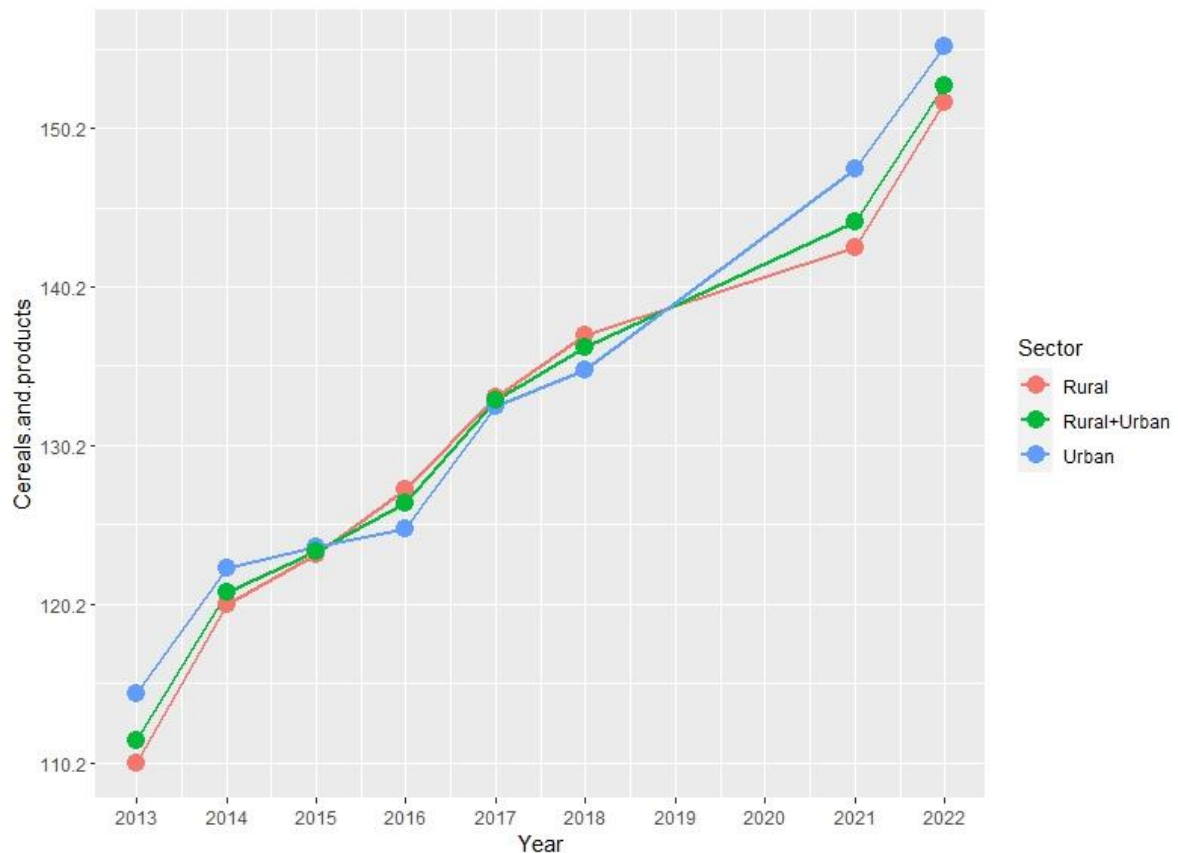
QUESTION 1

How volatile is price of each commodity across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)? What is the correlation between price of each commodity in urban and rural sector?

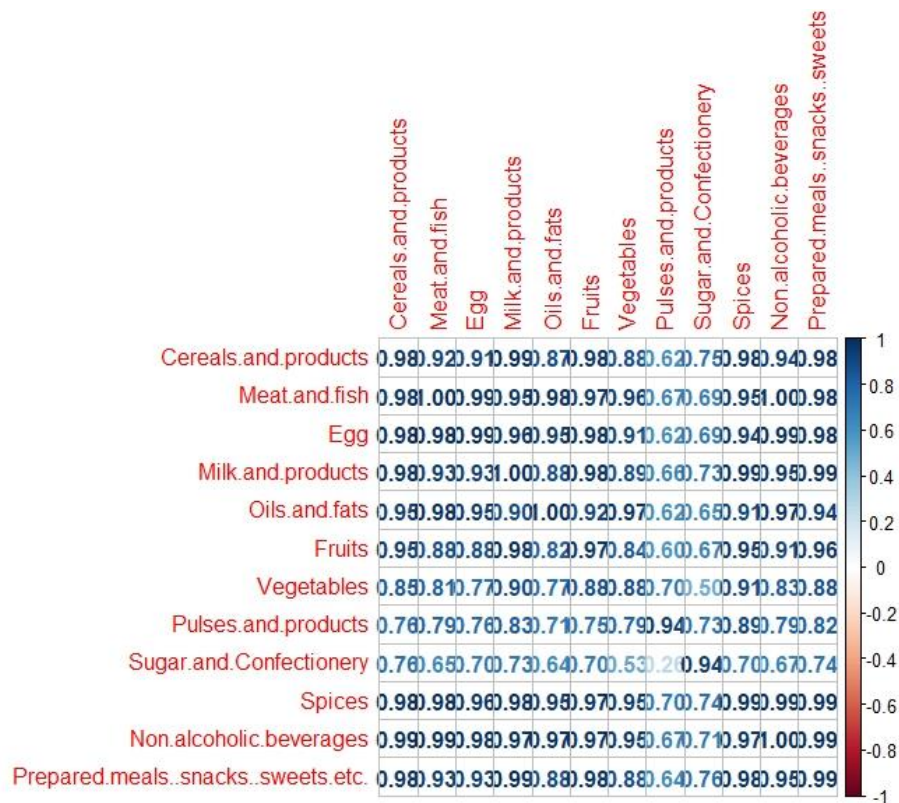
- To answer the first part of the question, we will perform trend analysis on price of each commodity and also group of commodities over the years across the 3 sectors by visualizing the data in form of line charts and note down (if any) interesting patterns formed in it.
- For the second part of the question, we will visualize the data in form of correlation heatmap and note down (if any) interesting patterns formed in it.

GROUP 1 COMMODITY 1: CEREALS AND PRODUCTS

- Rate of inflation of Rural Sector is 37.74%, of Urban Sector is 35.60% and combined is 37.01%.
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.



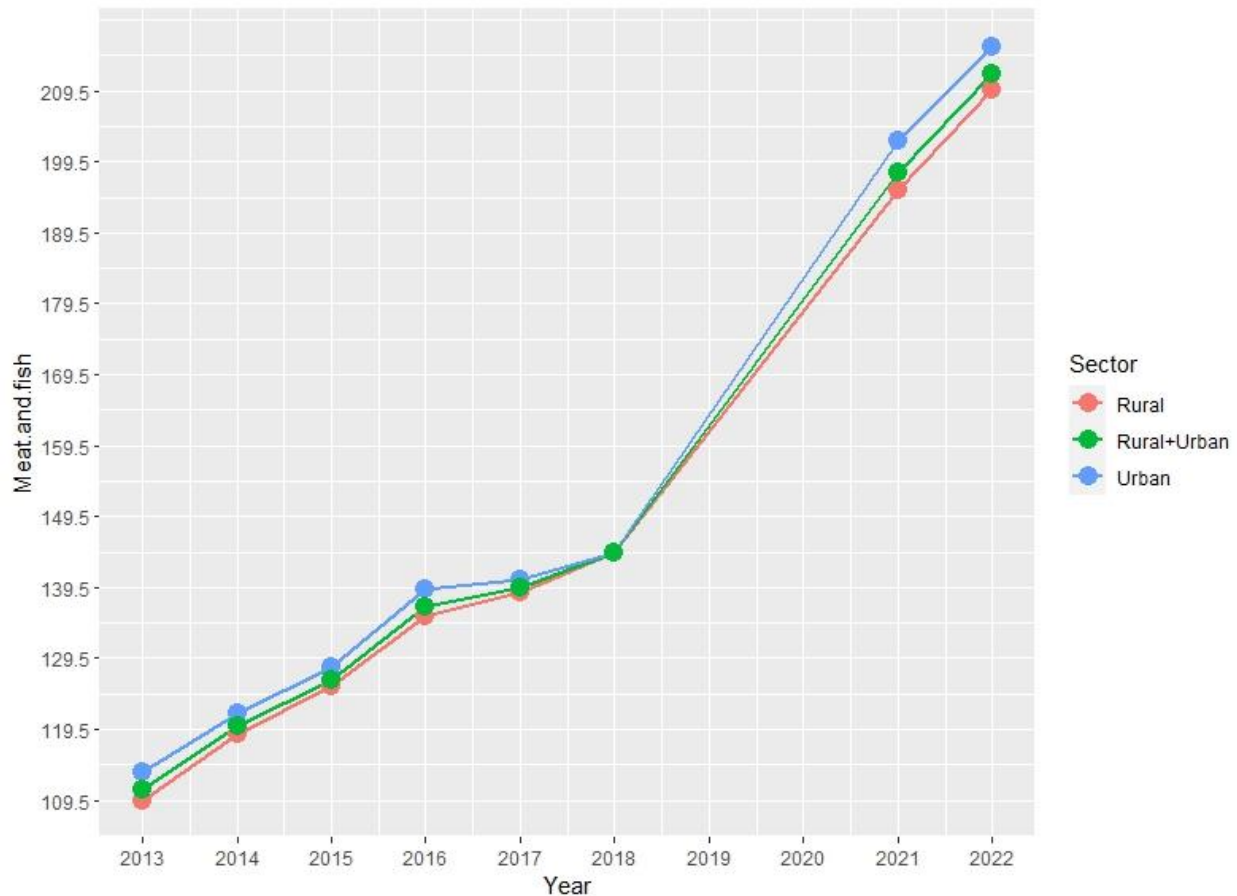
- **How volatile is price of ‘cereals and products’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across the three sectors, indicating the consistent increase in price of cereals and its products over the span of 10 years.
 - Since, the line graphs for Rural and Urban are similar to each other. There has not been a significant difference in the prices of cereals and its products across the various sectors.



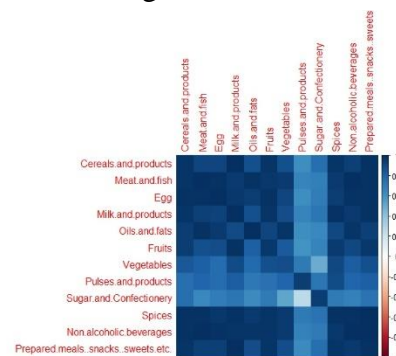
- Since, price of all the commodities in both sectors have grown over the years, there's positive correlation between commodities of both sectors.
- Not all the commodities have correlation coefficient $> +0.95$ among their prices in urban and rural sector.
- Sugar and Pulses have very weak correlation with all the other commodities, hence their prices can either be more or less volatile compared to others.

GROUP 1 COMMODITY 2: MEAT AND FISH

- Rate of inflation of Rural Sector is 91.50%, of Urban Sector is 90.22% and combined is 90.29%.
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

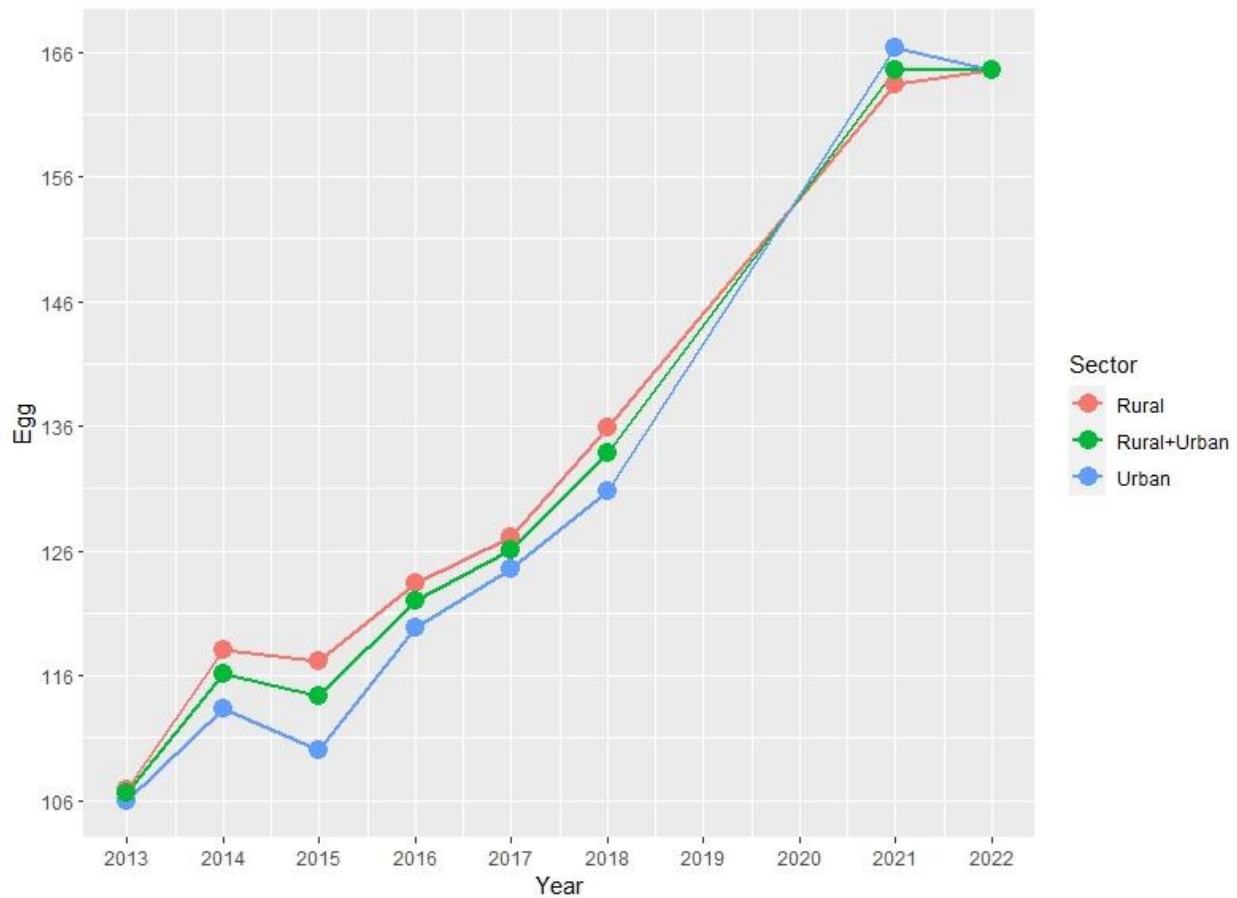


- **How volatile is price of ‘meat and fish’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across the three sectors, indicating the consistent increase in price of meat and fish over the span of 10 years.
 - The line graphs for Rural and Urban are identical to each other. There has not been a significant difference in the prices of meat and fish across the various sectors.

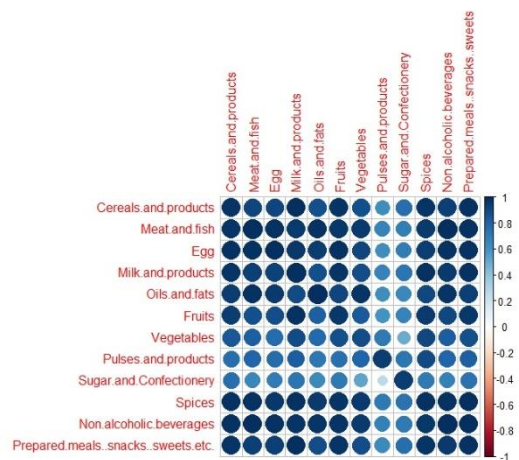


GROUP 1 COMMODITY 3: EGG

- Rate of inflation of Rural Sector is 53.88%, of Urban Sector is 55.28% and combined is 54.31%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

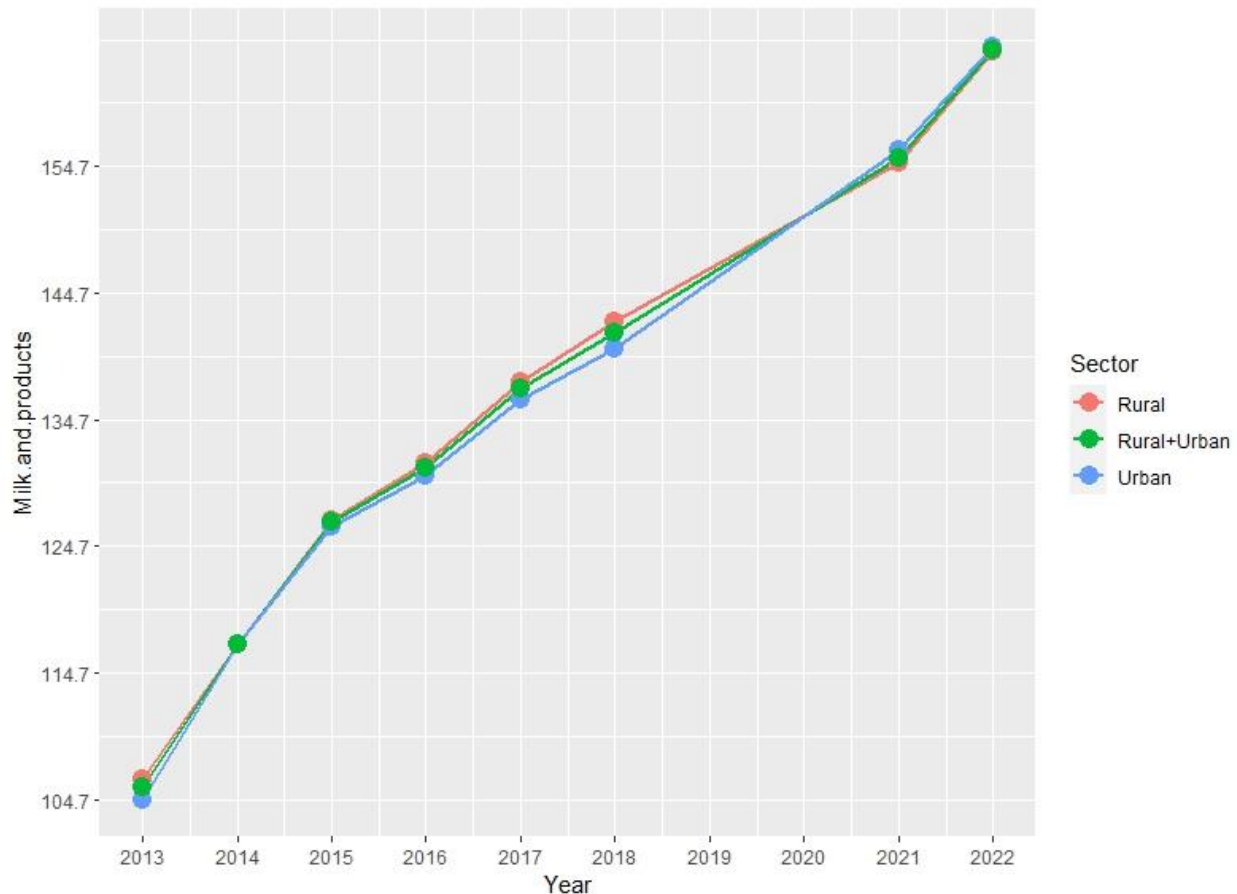


- **How volatile is price of 'egg' across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of egg over the span of 10 years.
 - The line graphs for Rural and Urban are almost identical to each other. There has not been a significant difference in the prices of eggs across the various sectors.

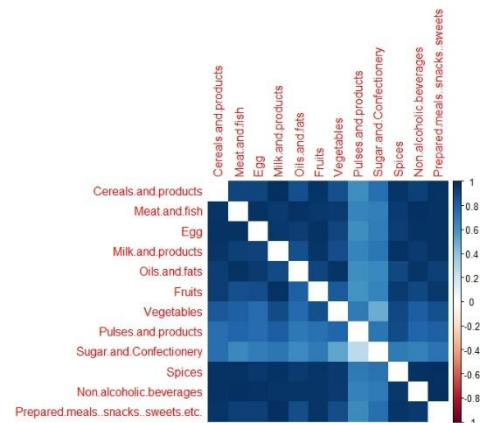


GROUP 1 COMMODITY 4: MILK AND PRODUCTS

- Rate of inflation of Rural Sector is 54.09%, of Urban Sector is 56.82% and combined is 55.06%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

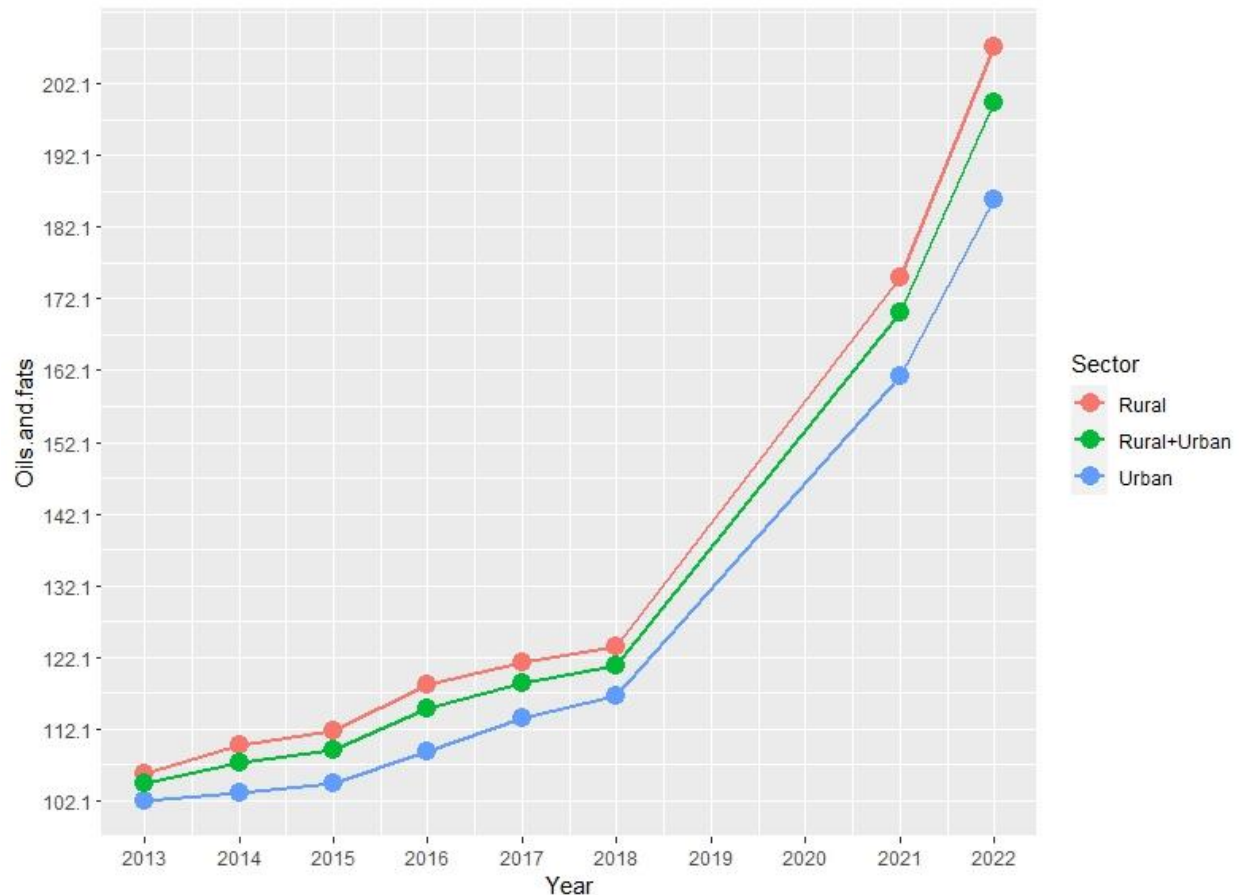


- **How volatile is price of 'milk and products' across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of milk and its products over the span of 10 years.
 - The line graphs for Rural and Urban are coinciding and identical to each other. There has not been a significant difference in the prices of milks and its products across the various sectors.

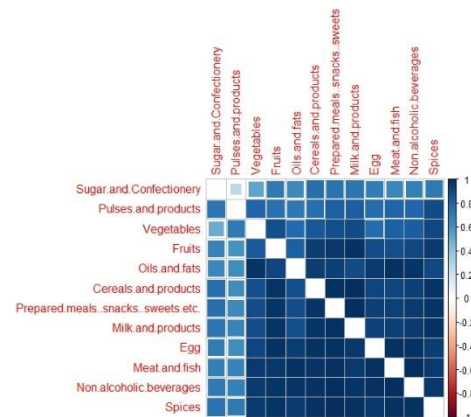


GROUP 1 COMMODITY 5: OILS AND FATS

- Rate of inflation of Rural Sector is 96.09%, of Urban Sector is 82.17% and combined is 91.09%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

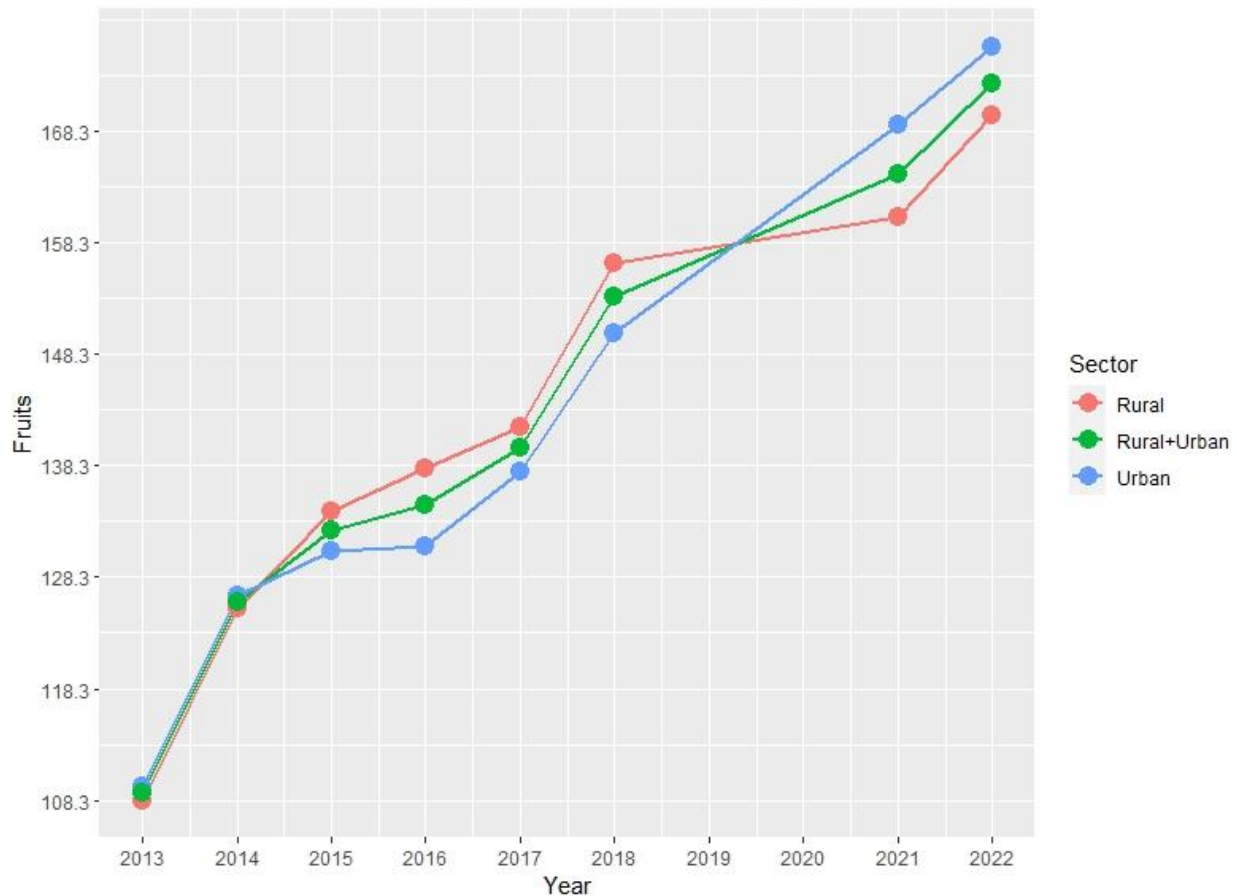


- **How volatile is price of ‘oils and fats’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of oils and fats over the span of 10 years.
 - The line graphs for Urban always stays below Rural, indicating that price of oils and fats in Rural has been consistently costlier than Urban.

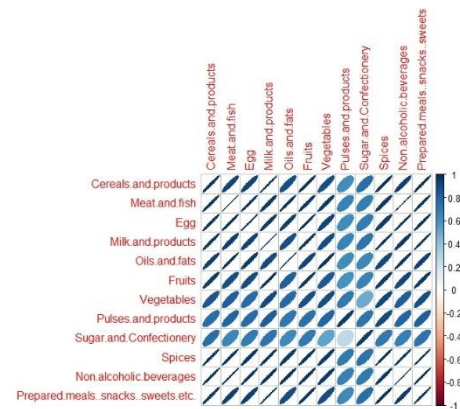


GROUP 1 COMMODITY 6: FRUITS

- Rate of inflation of Rural Sector is 56.69%, of Urban Sector is 60.63% and combined is 58.49%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

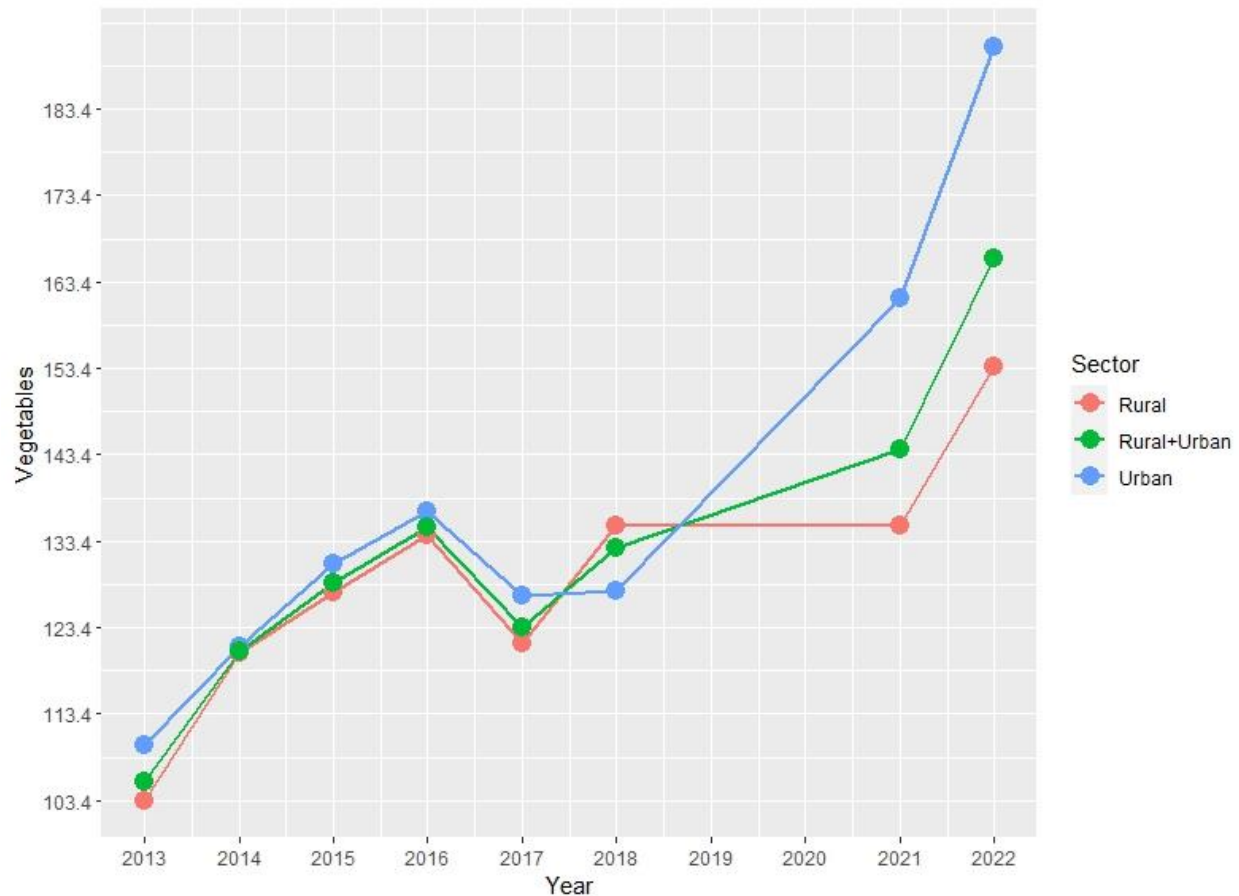


- **How volatile is price of 'fruits' across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of fruits over the span of 10 years.
 - Initially, prices for Rural and Urban are identical to each other. The graph diverges at 2015, 2016 to indicate significant difference between the two.
 - In 2018-2022, the price of Urban sector crosses that of Rural sector indicating the fluctuating prices.

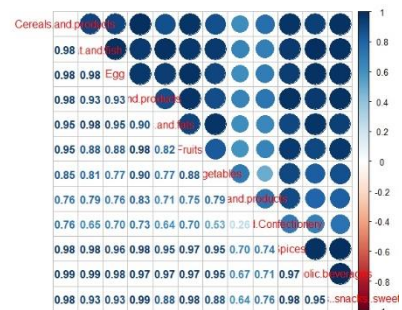


GROUP 1 COMMODITY 7: VEGETABLES

- Rate of inflation of Rural Sector is 48.54%, of Urban Sector is 73.83% and combined is 57.53%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

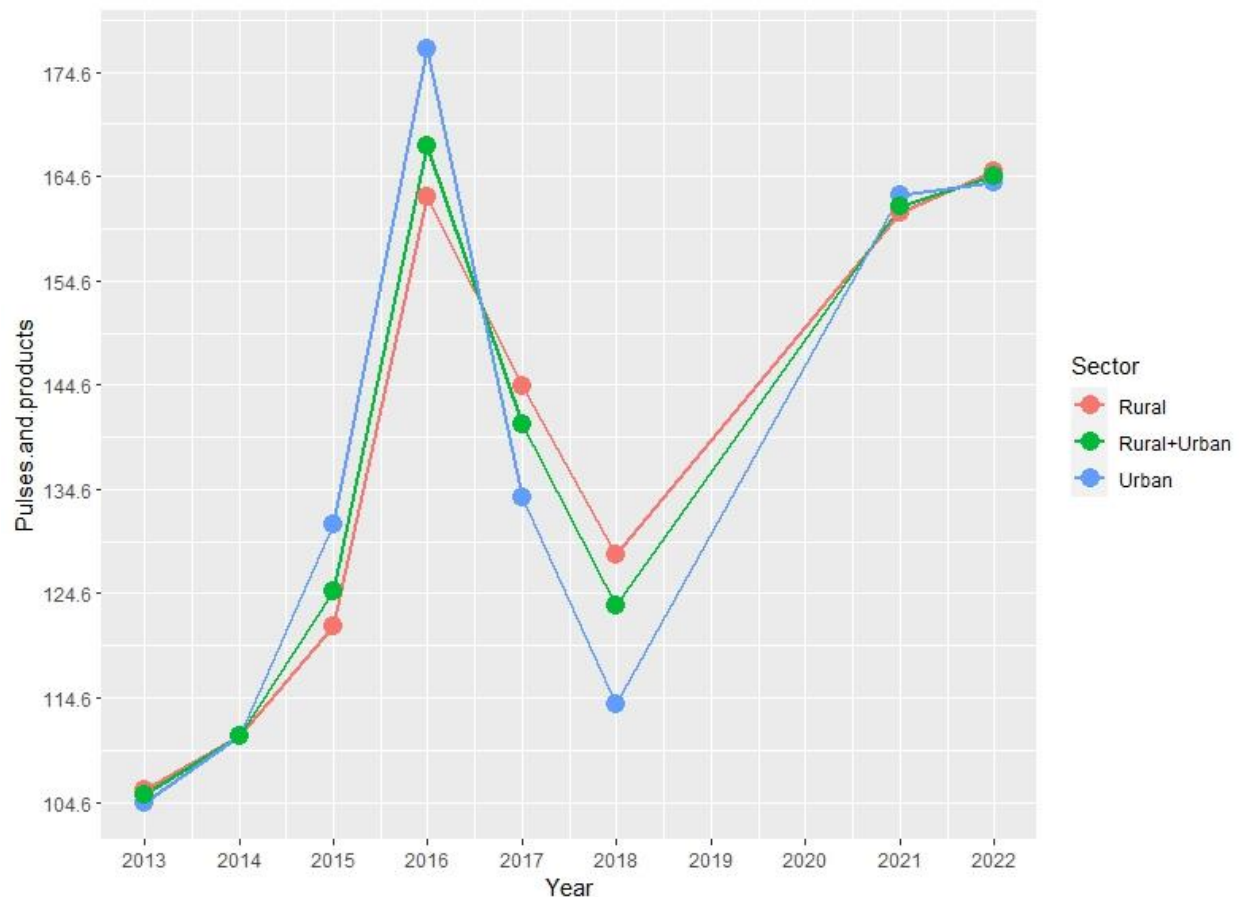


- How volatile is price of ‘vegetables’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?
 - The graph rises steadily across sectors, indicating the consistent increase in price of egg over the span of 10 years.
 - Initially, prices for Rural and Urban are identical to each other.
 - The dip at 2017 is followed by fluctuation in 2018-2022, as the price of Urban sector crosses that of Rural sector. In 2022, prices of vegetables are much higher than Rural.

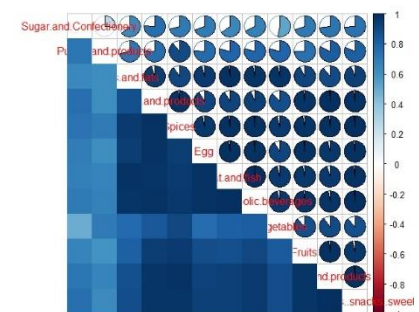


GROUP 1 COMMODITY 8: PULSES AND PRODUCTS

- Rate of inflation of Rural Sector is 56.19%, of Urban Sector is 56.78% and combined is 56.41%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

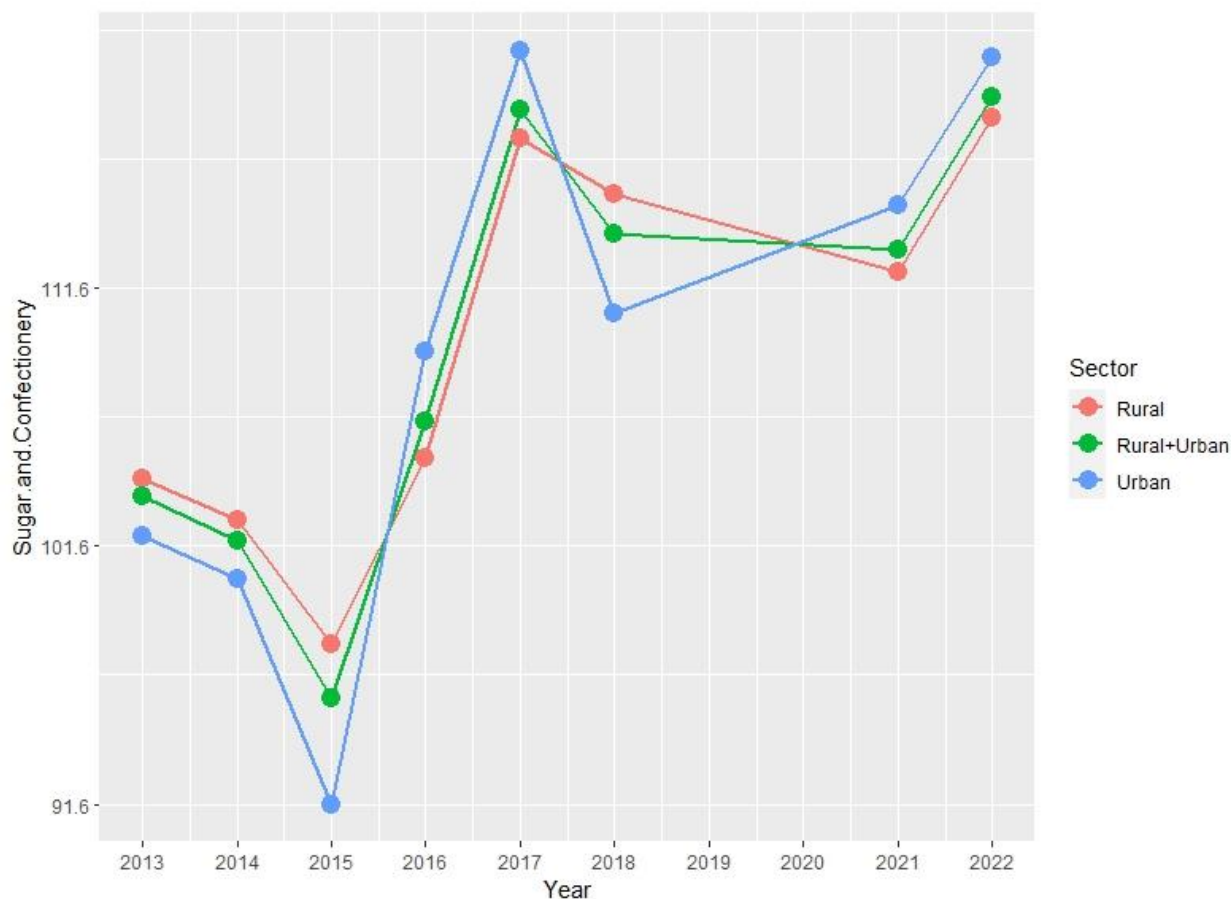


- **How volatile is price of ‘pulses and products’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - There is a sharp rise at 2016 across sectors. Interestingly, the year 2016 was declared as the Year of Pulses by United Nations to position pulses as a primary source of protein and other essential nutrients.
 - In 2017-2018, the prices for pulses and its products were controlled. The later years have experienced a steady growth in prices.

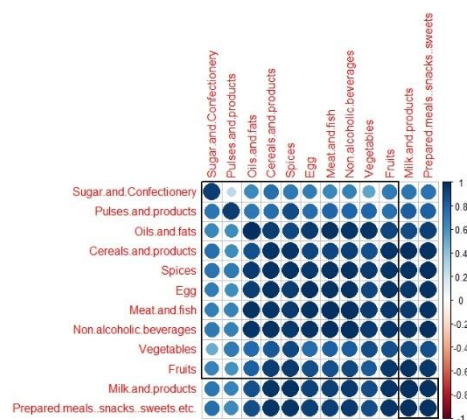


GROUP 1 COMMODITY 9: SUGAR AND CONFECTIONERY

- Rate of inflation of Rural Sector is 13.43%, of Urban Sector is 18.13% and combined is 14.97%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

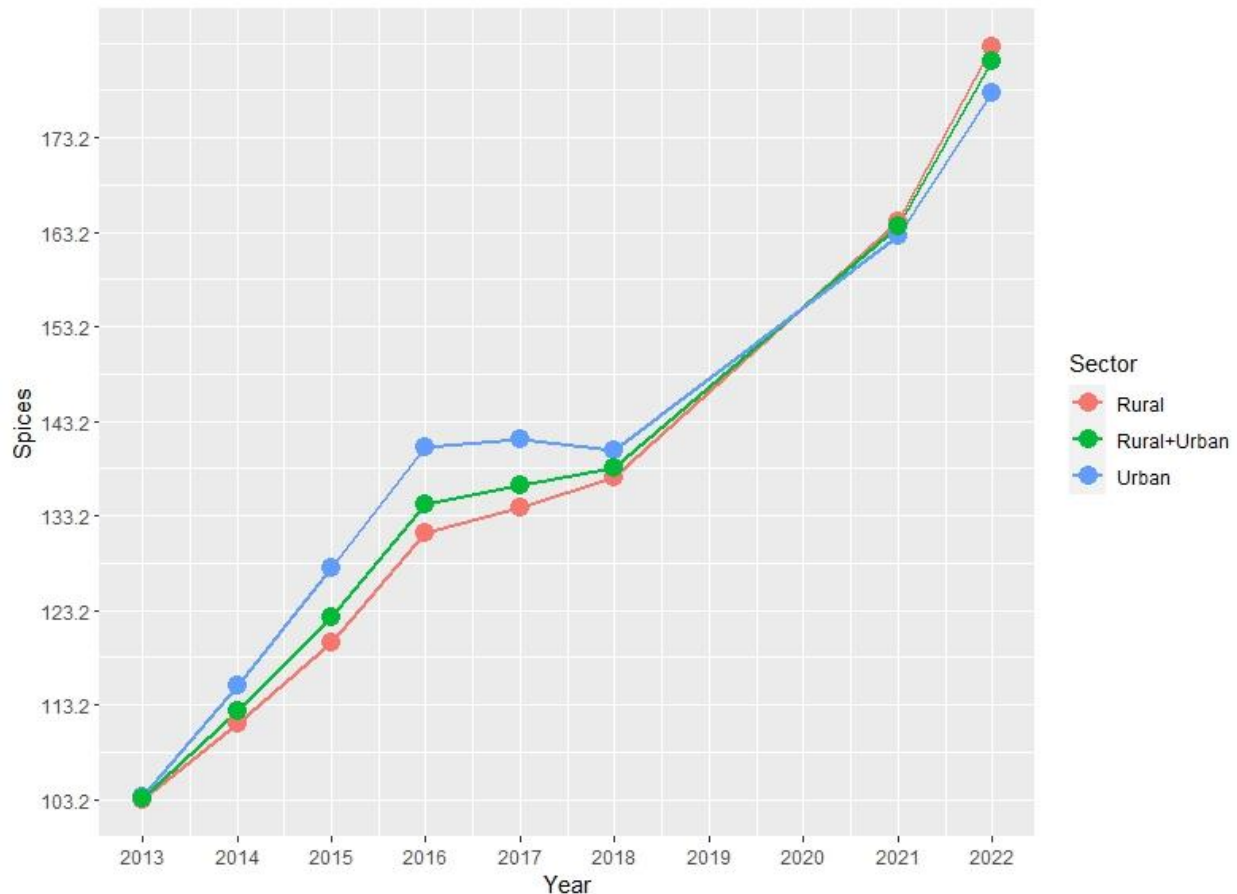


- **How volatile is price of ‘sugar and confectionary’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The significant dip 2015 is followed by a sharp rise at 2016-17 across sectors. This drop in price was a result of falling global prices and ample domestic output.
 - In 2015-2017, the prices for sugar and confectionaries spike rapidly, which is later brought under control to some extent.
 - Years 2020-2022 have experienced a steady growth in prices.

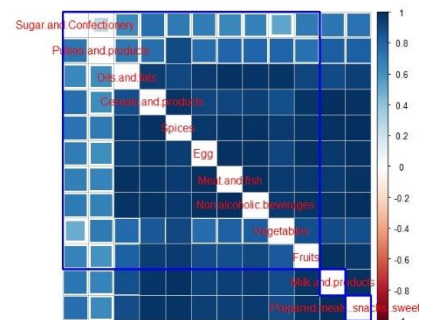


GROUP 1 COMMODITY 10: SPICES

- Rate of inflation of Rural Sector is 77.22%, of Urban Sector is 71.98% and combined is 75.50%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

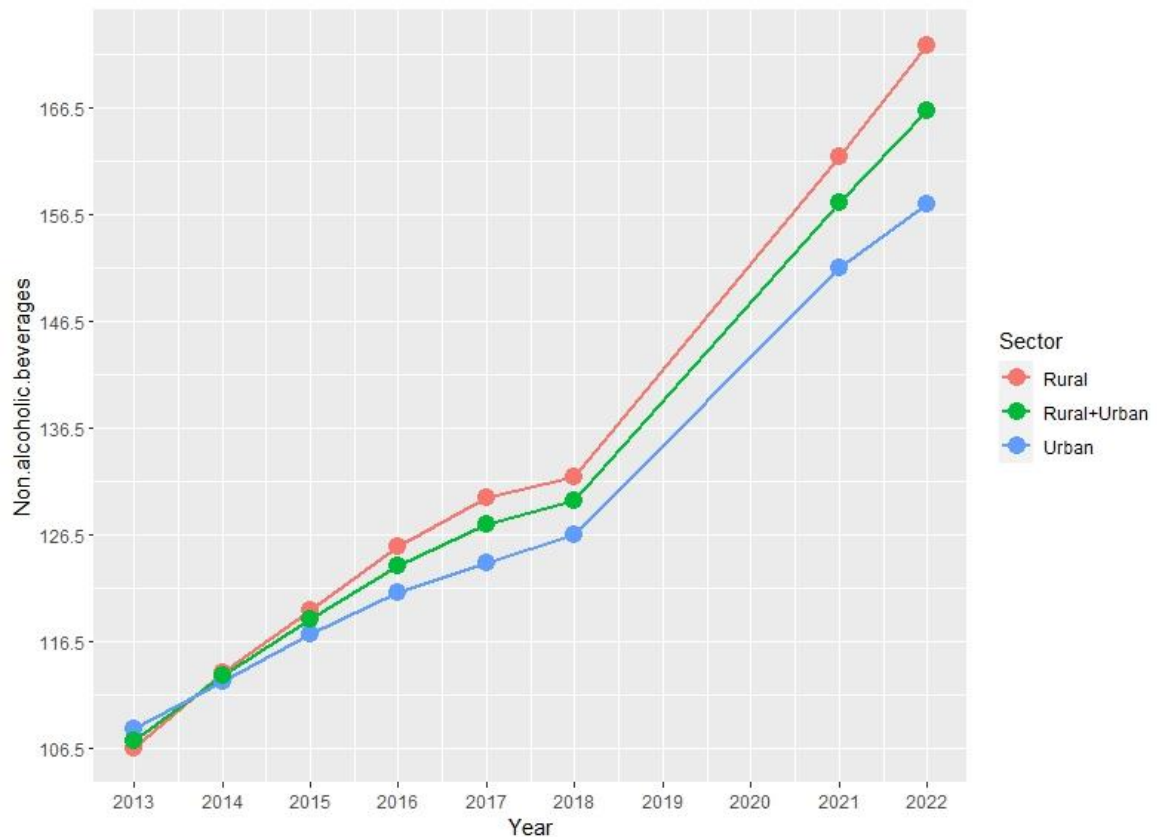


- **How volatile is price of 'spices' across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of spices over the span of 10 years.
 - The line graphs for Rural and Urban are almost identical to each other. There has not been a significant difference in the prices of spices across the various sectors.

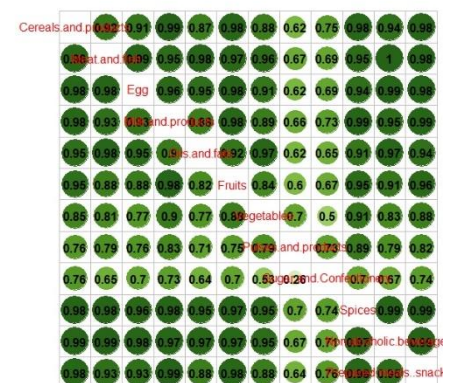


GROUP 1 COMMODITY 11: NON-ALCOHOLIC BEVERAGES

- Rate of inflation of Rural Sector is 61.87%, of Urban Sector is 45.56% and combined is 55.03%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

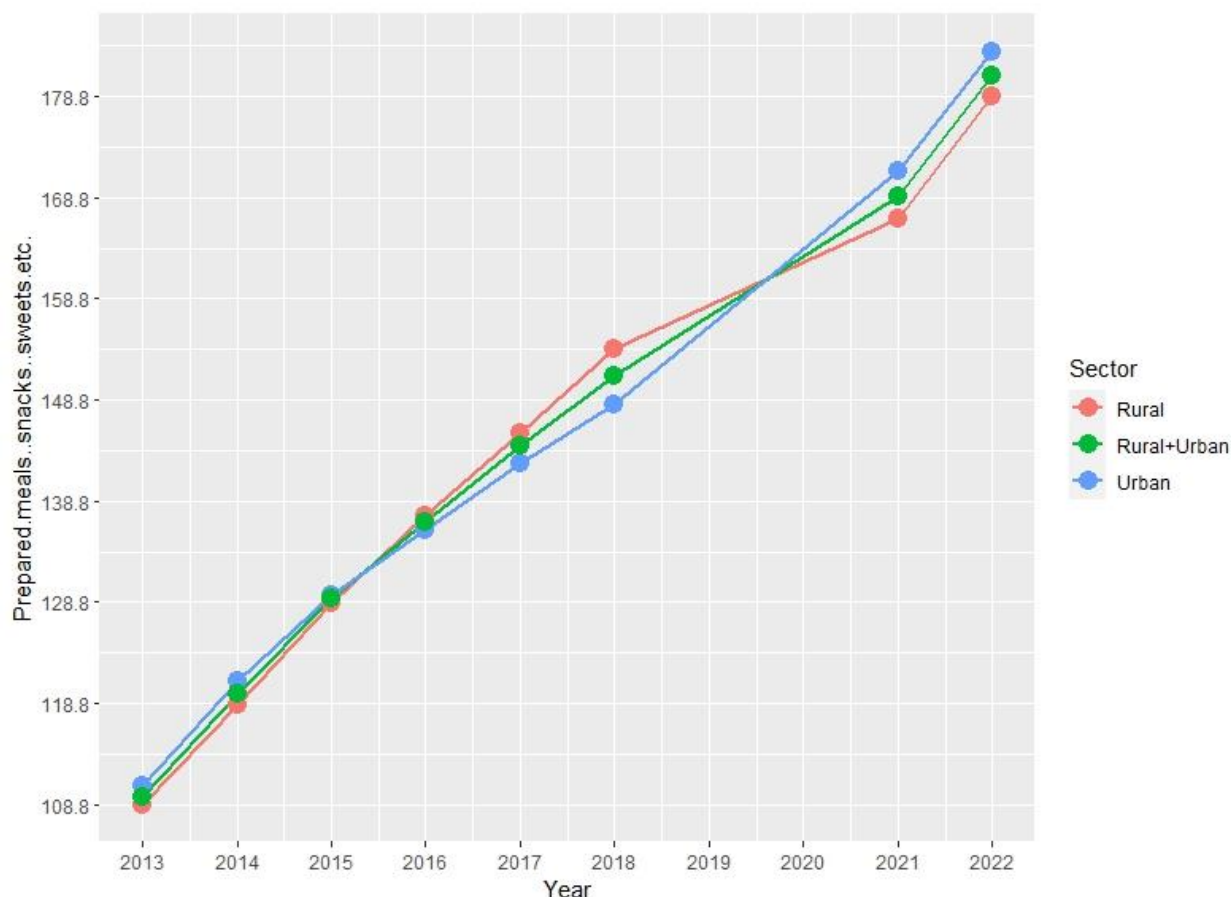


- How volatile is price of 'non-alcoholic beverages' across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?
 - The graph rises steadily across sectors, indicating the consistent increase in price of non-alcoholic beverages over the span of 10 years.
 - Initially, the line graphs for Rural and Urban are almost identical to each other. There has been a significant difference in the prices of non-alcoholic beverages after 2016. The commodity has been costlier in Rural sector as compared to the Urban sector.



GROUP 1 COMMODITY 12: PREPARED MEALS, SNACKS, SWEETS ETC

- Rate of inflation of Rural Sector is 64.43%, of Urban Sector is 65.73% and combined is 65.05%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

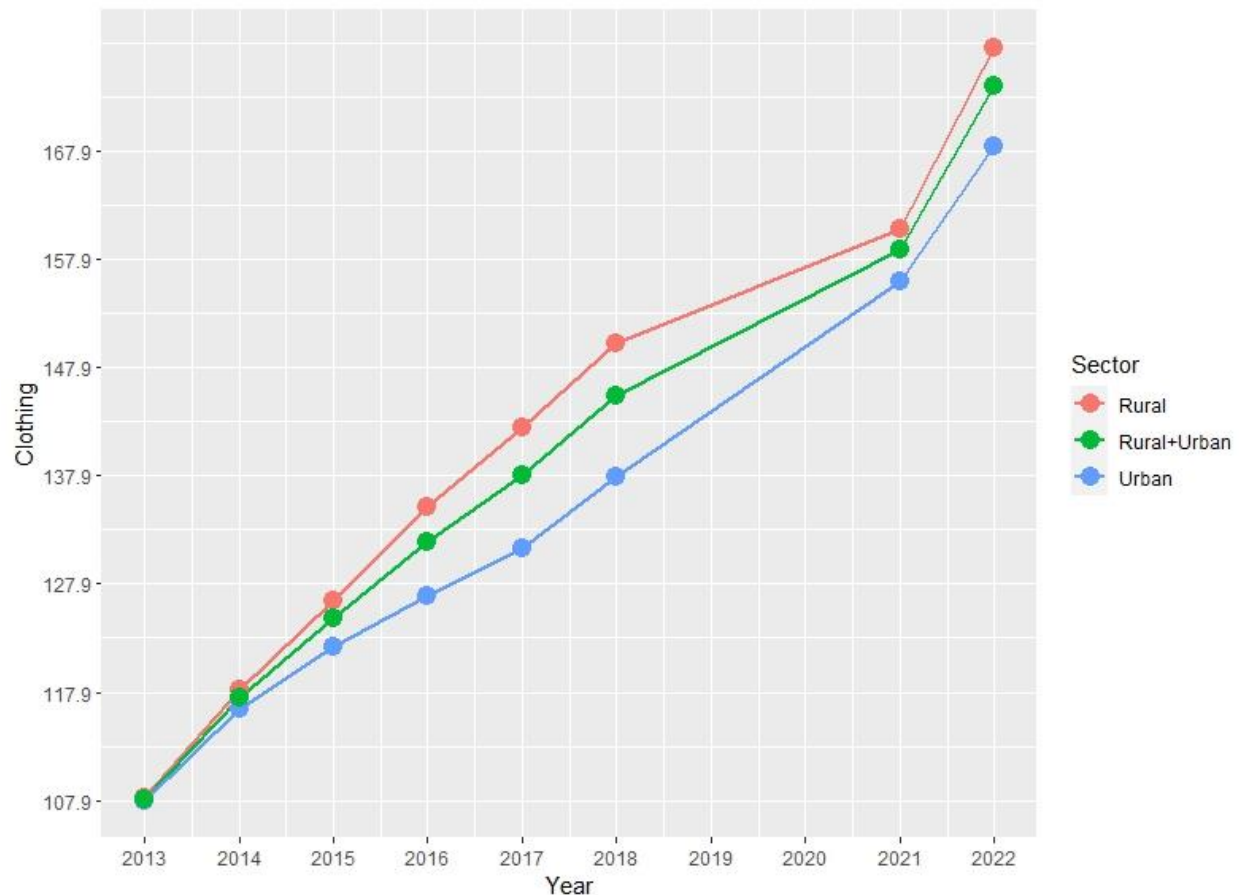


- **How volatile is price of ‘prepared meals, snacks and sweets’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of prepared meals, snacks and sweet over the span of 10 years.
 - The line graphs for Rural and Urban are almost identical to each other. There has not been a significant difference in the prices of this commodity across the various sectors.

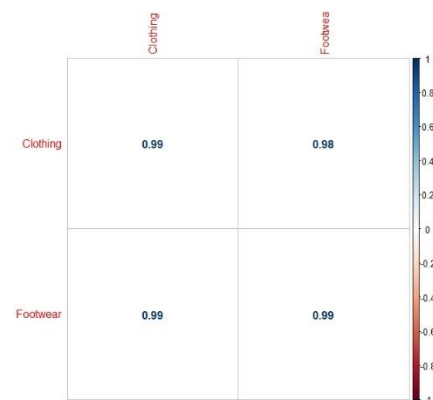
Cereals and products	0.91	0.95	0.87	0.98	0.88	0.62	0.75	0.98	0.94	0.95
Meat and fish	0.95	0.98	0.97	0.96	0.67	0.69	0.95	1	0.98	
Egg	0.95	0.95	0.98	0.91	0.62	0.69	0.94	0.95	0.95	
Milk and products	0.98	0.91	0.98	0.98	0.66	0.73	0.99	0.95	0.95	
Oils and fats	0.95	0.98	0.94	0.92	0.97	0.62	0.65	0.91	0.97	0.94
Fruits	0.95	0.88	0.88	0.98	0.82	0.84	0.6	0.67	0.95	0.91
Vegetables	0.95	0.91	0.77	0.9	0.77	0.85	0.7	0.5	0.91	0.83
Spices and products	0.76	0.70	0.76	0.83	0.71	0.75	0.72	0.73	0.89	0.79
Condiments	0.70	0.65	0.7	0.73	0.64	0.7	0.63	0.62	0.67	0.74
Spices	0.98	0.98	0.98	0.98	0.95	0.97	0.95	0.7	0.74	0.95
Alcoholic beverages	0.95	0.95	0.98	0.97	0.97	0.97	0.95	0.67	0.71	0.95
Non-alcoholic beverages	0.98	0.93	0.93	0.99	0.88	0.98	0.88	0.64	0.76	0.95

GROUP 3 COMMODITY 1: CLOTHING

- Rate of inflation of Rural Sector is 63.98%, of Urban Sector is 54.41% and combined is 60.14%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

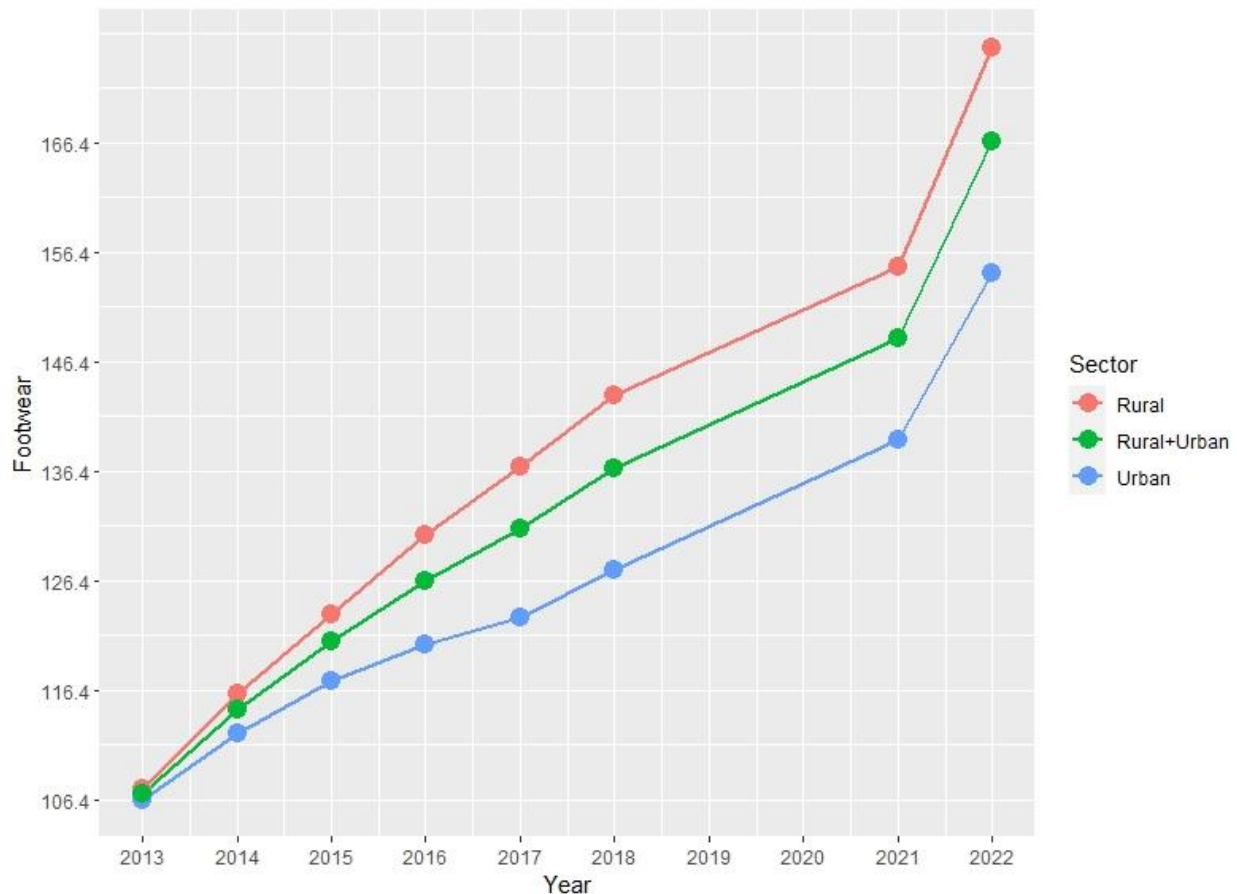


- **How volatile is price of ‘clothing’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of clothing over the span of 10 years.
 - Initially, the line graphs for Rural and Urban are almost identical to each other. There has been a significant difference in the prices of clothing after 2016. The commodity has been costlier in Rural sector as compared to the Urban sector

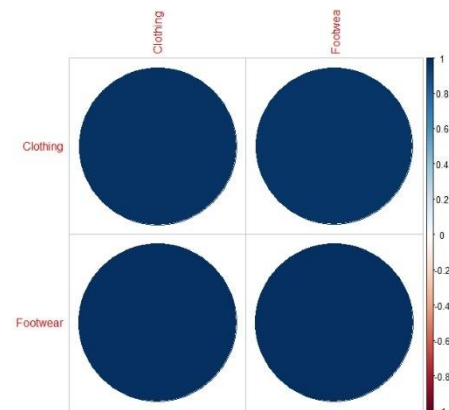


GROUP 3 COMMODITY 2: FOOTWEAR

- Rate of inflation of Rural Sector is 64.19%, of Urban Sector is 56.07% and combined is 61.01%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

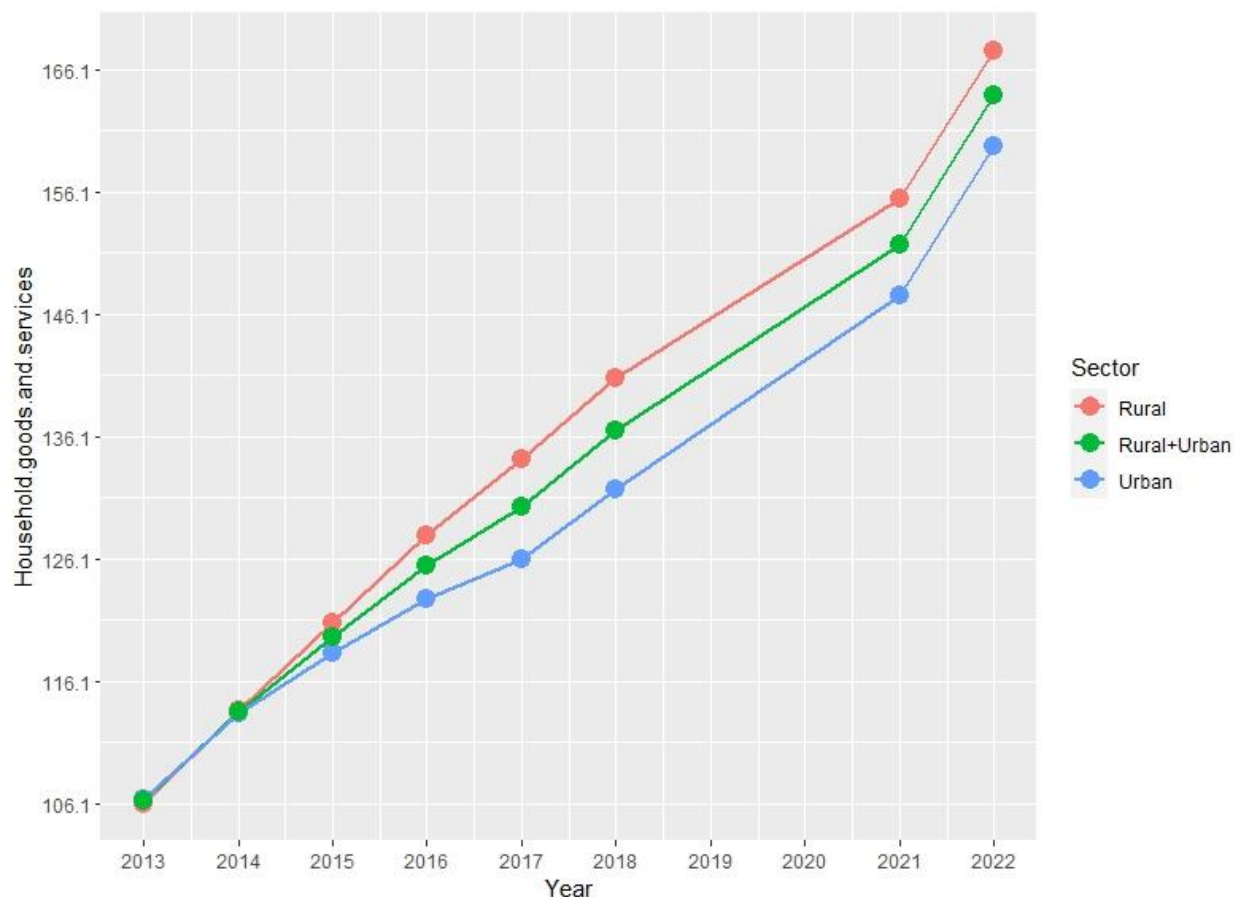


- **How volatile is price of 'footwear' across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of footwear over the span of 10 years.
 - The line graphs for Rural and Urban have an identical slope but there has been a noticeable difference in the prices of footwear in recent years with Rural sector prices being higher than urban

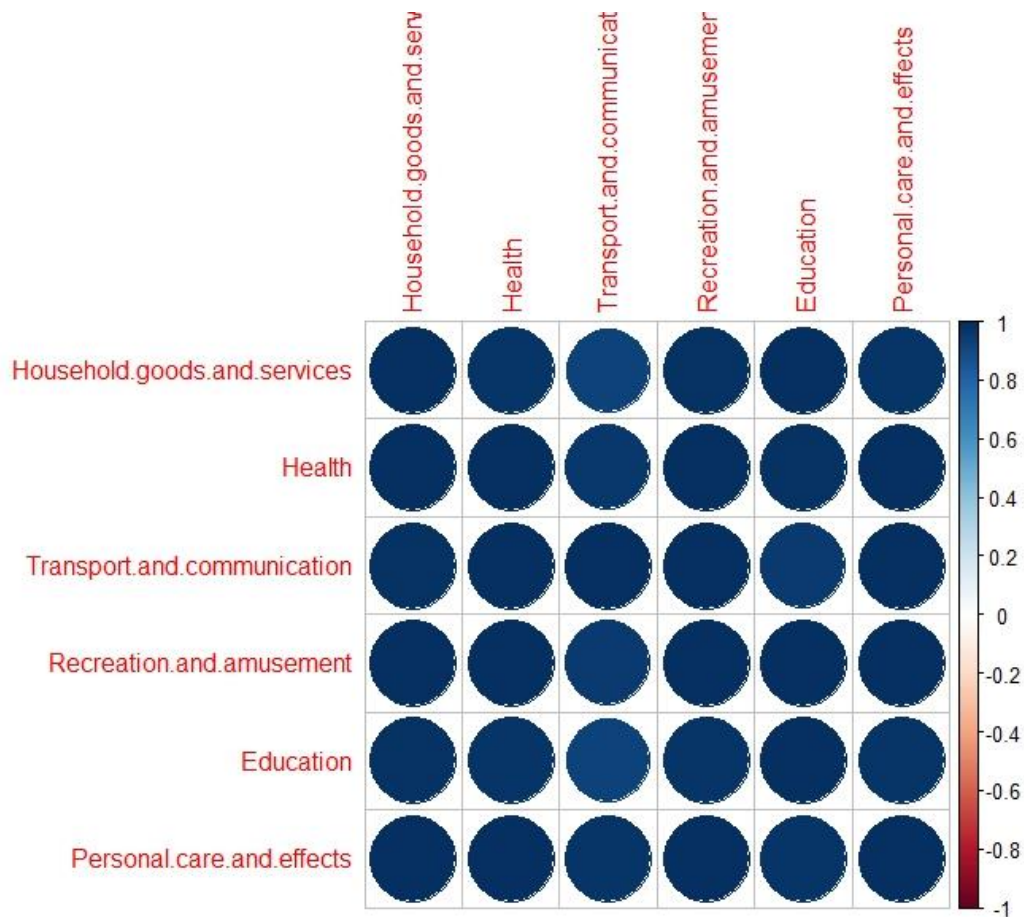


GROUP 5 COMMODITY 1: HOUSEHOLD GOODS AND SERVICES

- Rate of inflation of Rural Sector is 58.05%, of Urban Sector is 50.04% and combined is 54.28%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.



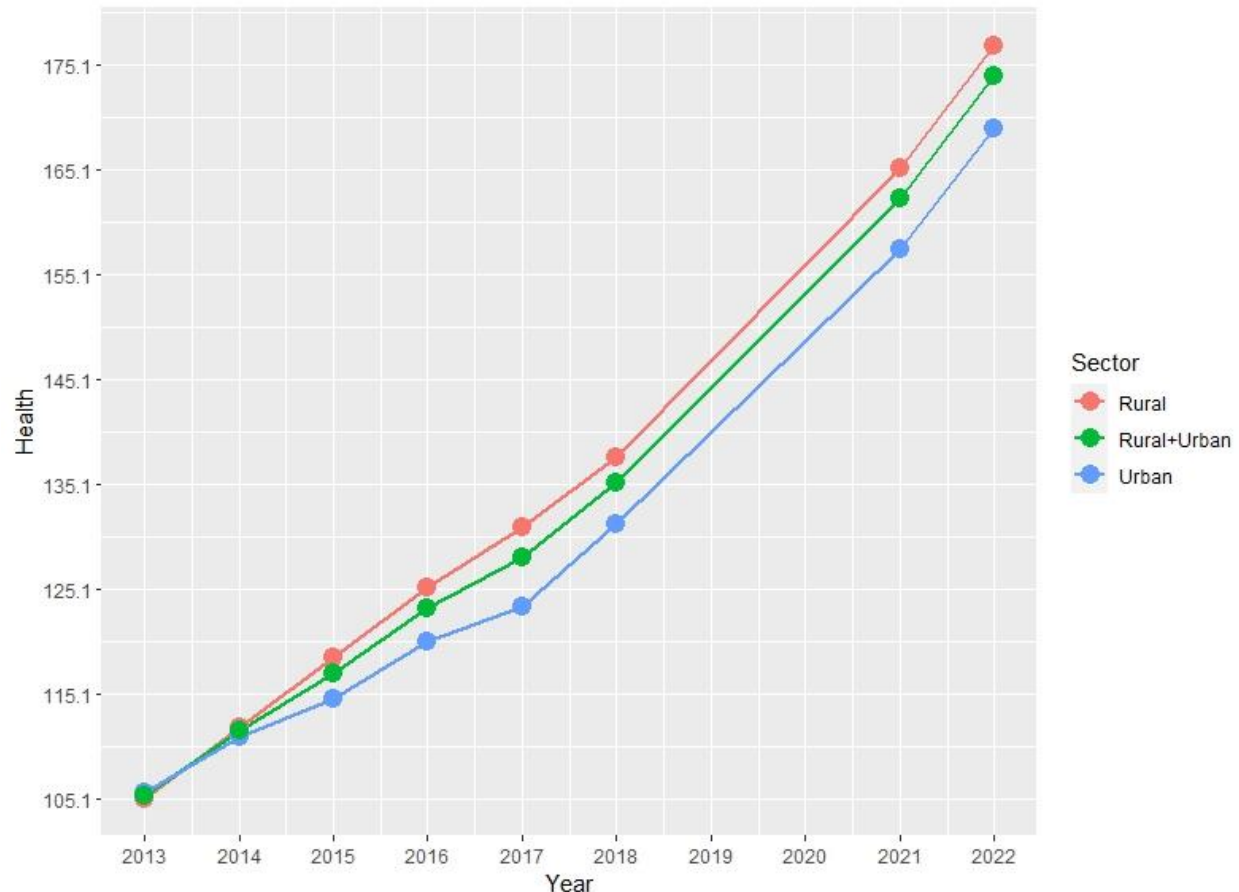
- **How volatile is price of 'household goods and services' across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of household goods and services over the span of 10 years.
 - Initially, the line graphs for Rural and Urban are almost identical to each other. There has been a significant difference in the prices of household goods and services after 2016. The commodity has been costlier in Rural sector as compared to the Urban sector



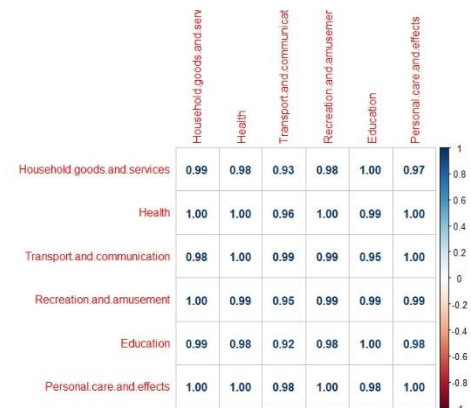
- There is very strong positive correlation among the prices of this group of commodities across the sectors.
- All the correlation coefficient values are $>+0.9$ in this group of commodities.

GROUP 5 COMMODITY 2: HEALTH

- Rate of inflation of Rural Sector is 68.41%, of Urban Sector is 59.88% and combined is 65.24%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

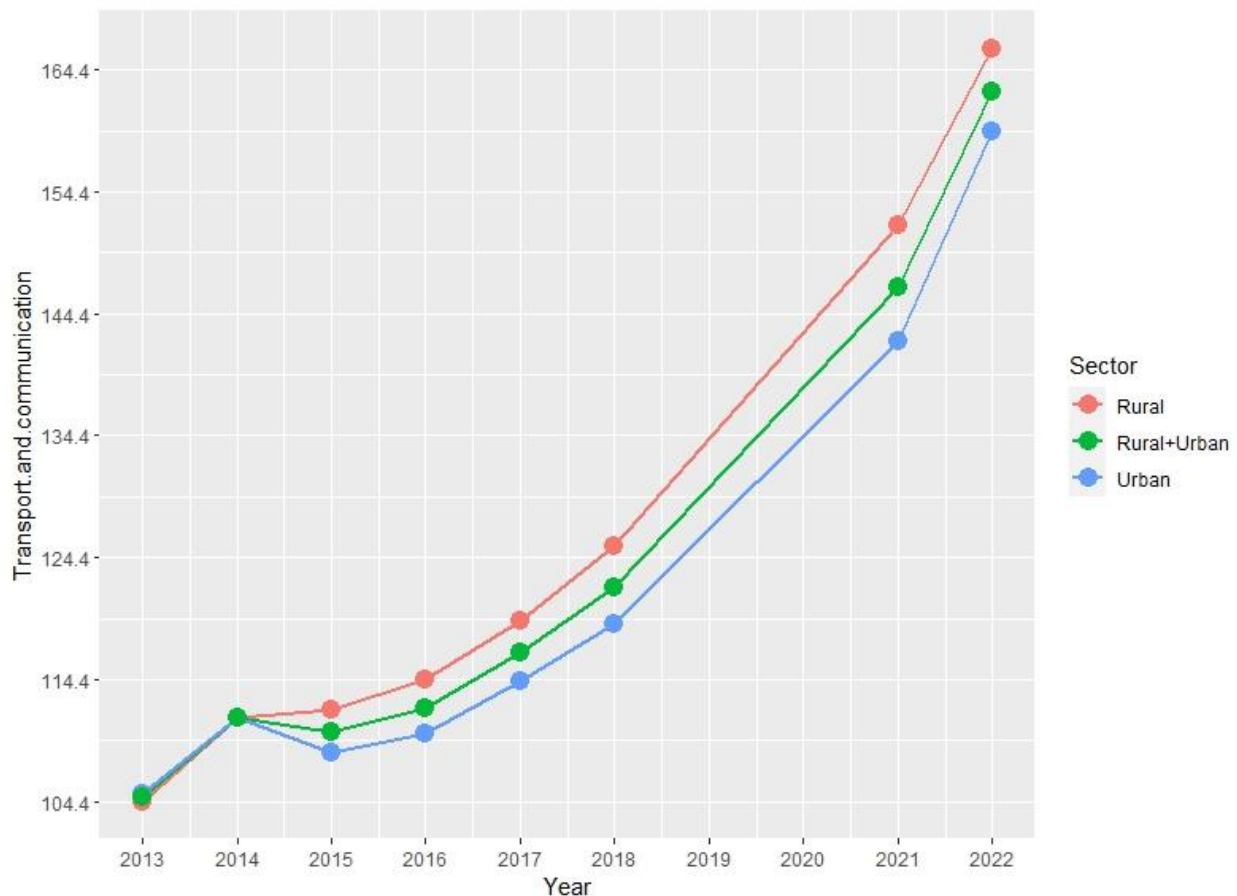


- **How volatile is price of 'health' across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of 'health' over the span of 10 years.
 - The line graphs for Rural and Urban are almost identical to each other. There has been a slight difference in the prices of 'health' in recent years with Rural sector prices being higher than urban.

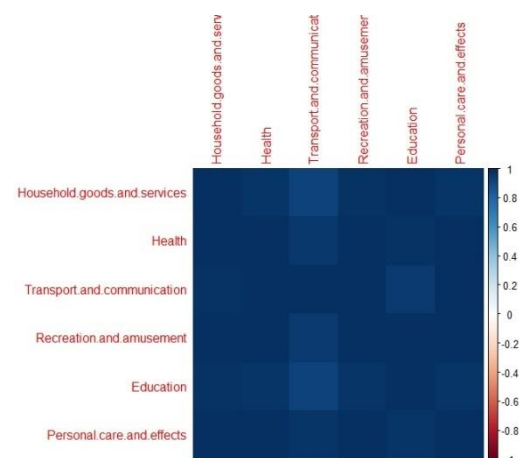


GROUP 5 COMMODITY 3: TRANSPORT AND COMMUNICATION

- Rate of inflation of Rural Sector is 59.19%, of Urban Sector is 51.71% and combined is 55.30%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

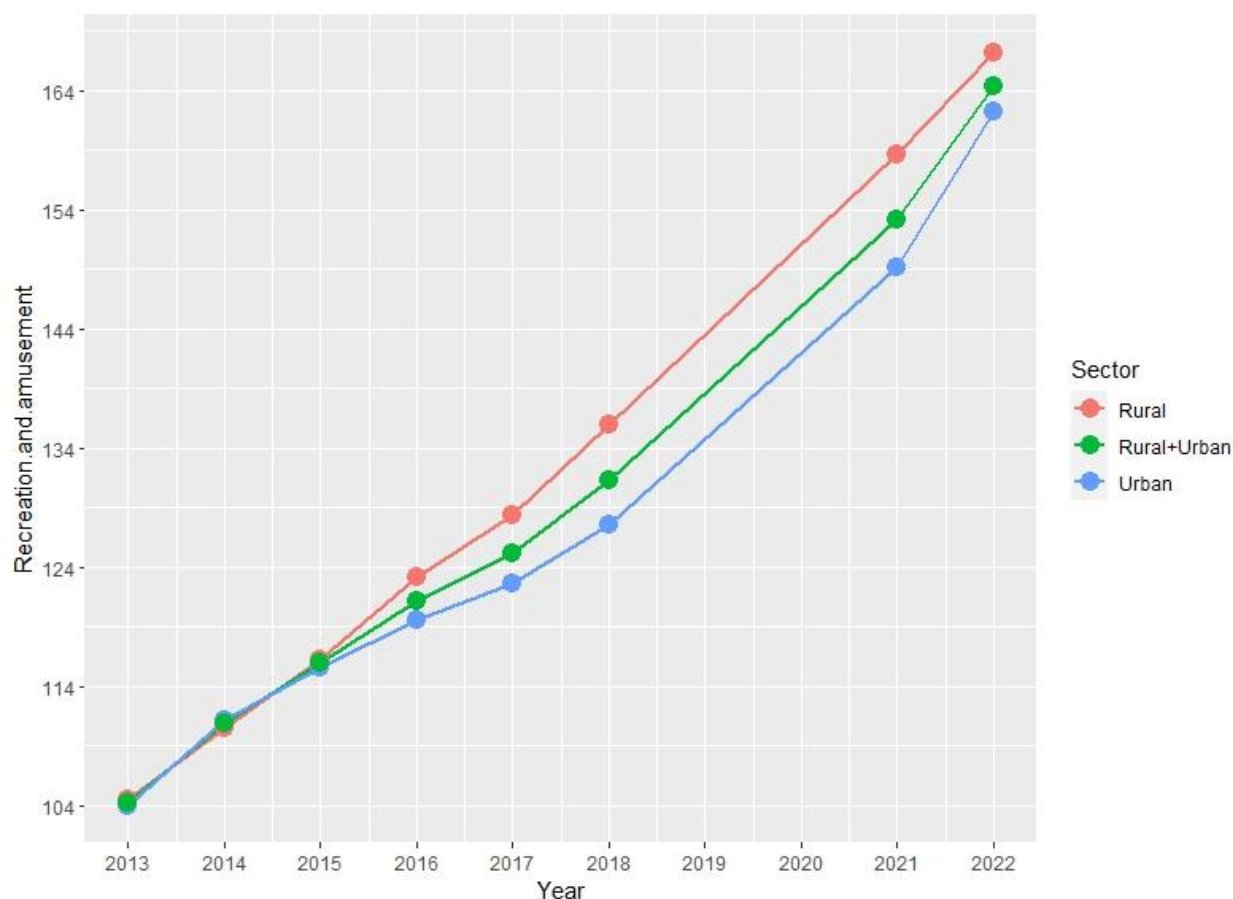


- **How volatile is price of 'transport and communication' across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - Except for a small dip in 2015, the graph rises steadily across sectors, indicating the consistent increase in price of transport and communication over the span of 10 years.
 - The line graphs for Rural and Urban are identical to each other. There has been a slight difference in the prices of transport and communication in recent years with Rural sector prices being higher than urban.

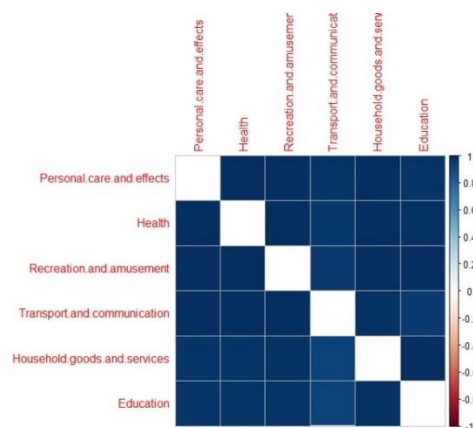


GROUP 5 COMMODITY 4: RECREATION AND AMUSEMENT

- Rate of inflation of Rural Sector is 60.00%, of Urban Sector is 55.96% and combined is 57.77%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

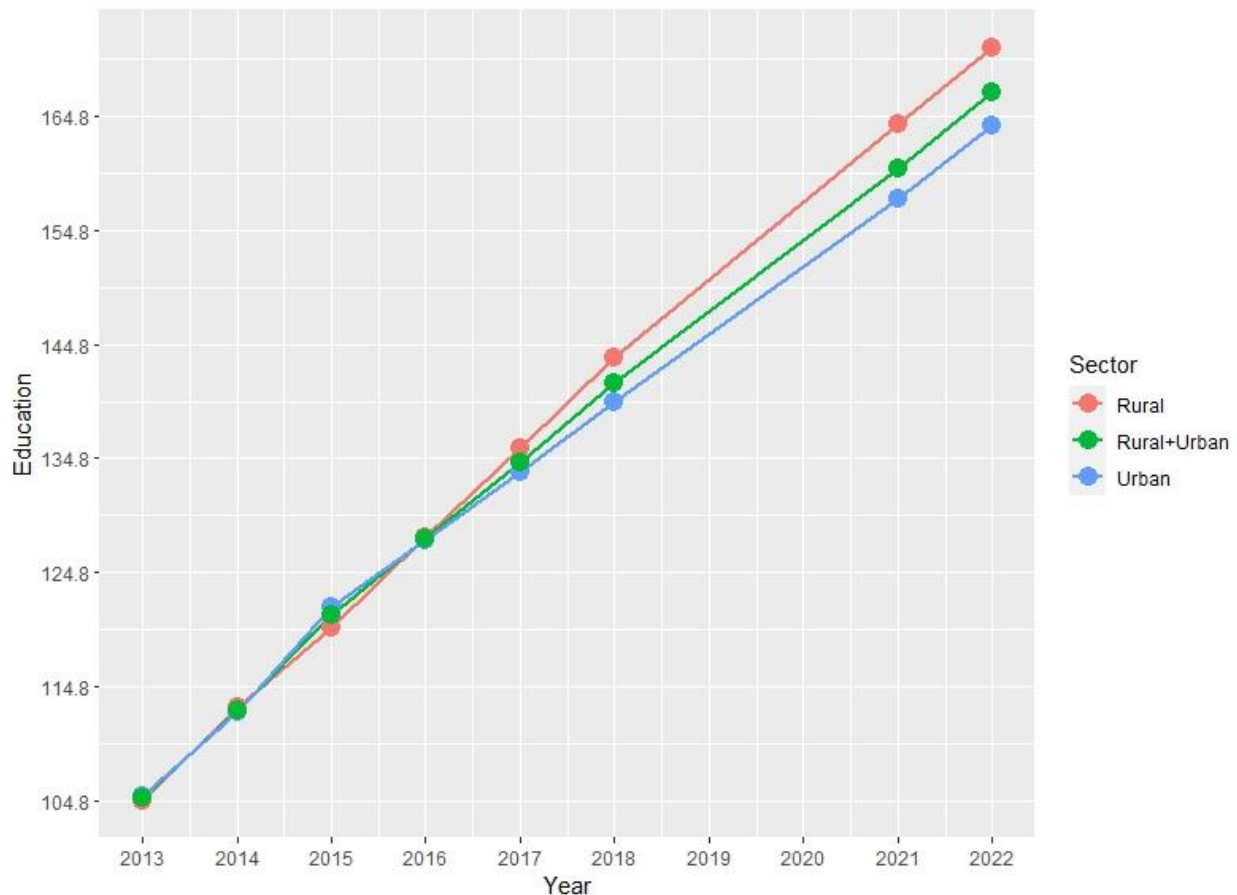


- **How volatile is price of ‘recreation and amusement’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of ‘recreation and amusement’ over the span of 10 years.
 - The line graphs for Rural and Urban are almost identical to each other. There has been a slight difference in the prices of ‘recreation and amusement’ in recent years with Rural sector prices being higher than urban.

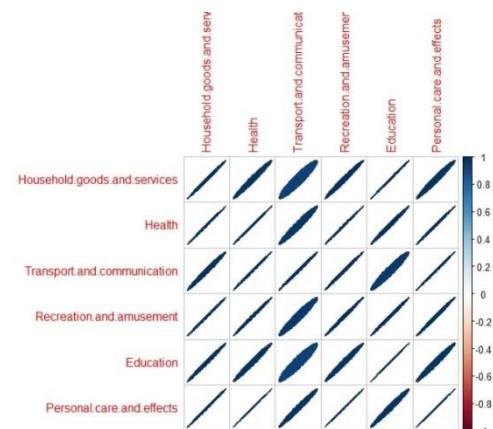


GROUP 5 COMMODITY 5: EDUCATION

- Rate of inflation of Rural Sector is 63.07%, of Urban Sector is 55.89% and combined is 58.95%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

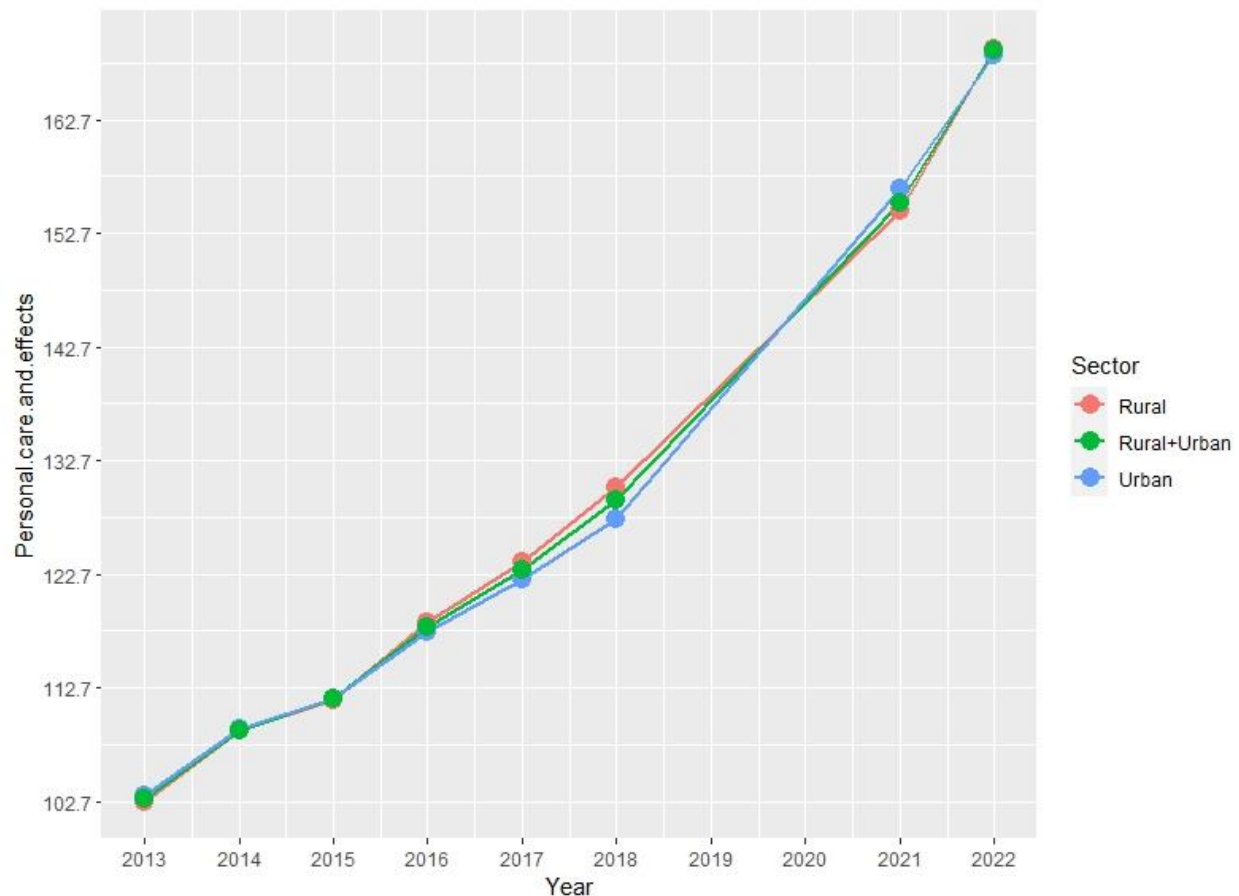


- **How volatile is price of 'education' across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of non-alcoholic beverages over the span of 10 years.
 - The line graphs for Rural and Urban are almost identical to each other. There has not been a significant difference in the prices of education across the various sectors.

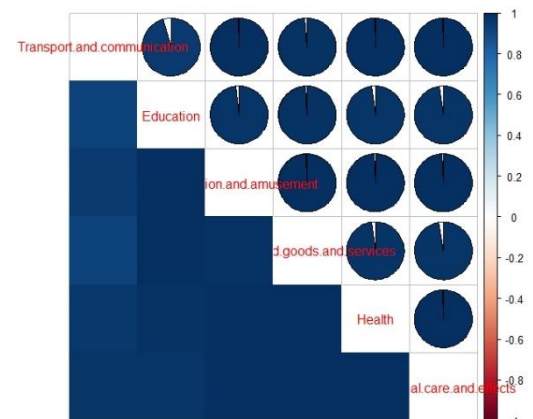


GROUP 5 COMMODITY 6: PERSONAL CARE AND EFFECTS

- Rate of inflation of Rural Sector is 64.55%, of Urban Sector is 63.17% and combined is 64.04%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

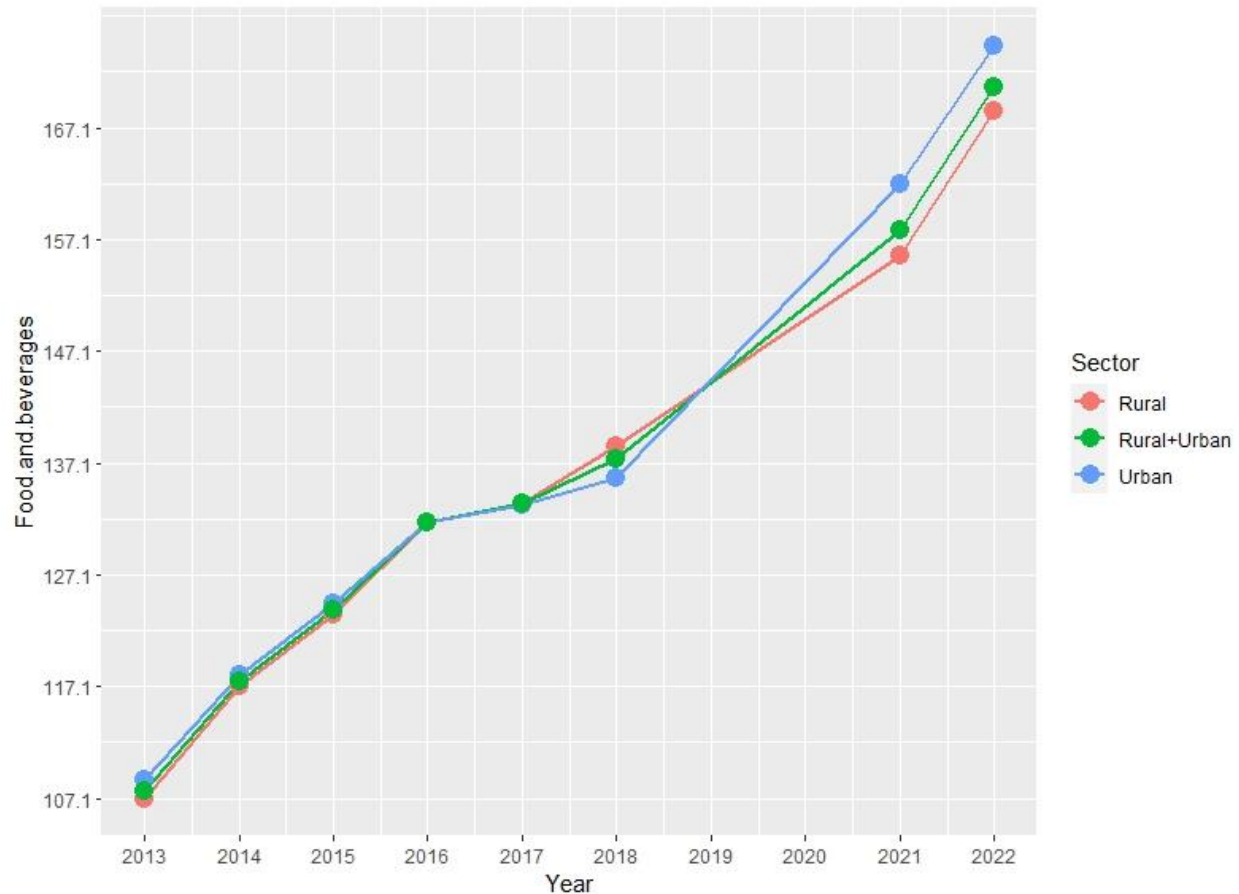


- **How volatile is price of 'personal care and effects' across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of non-alcoholic beverages over the span of 10 years.
 - The line graphs for Rural and Urban are coinciding and identical to each other indicating that the prices of personal care products across the various sectors have been the same.



GROUP 1: FOOD AND BEVERAGES

- Rate of inflation of Rural Sector is 61.87%, of Urban Sector is 45.56% and combined is 55.03%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

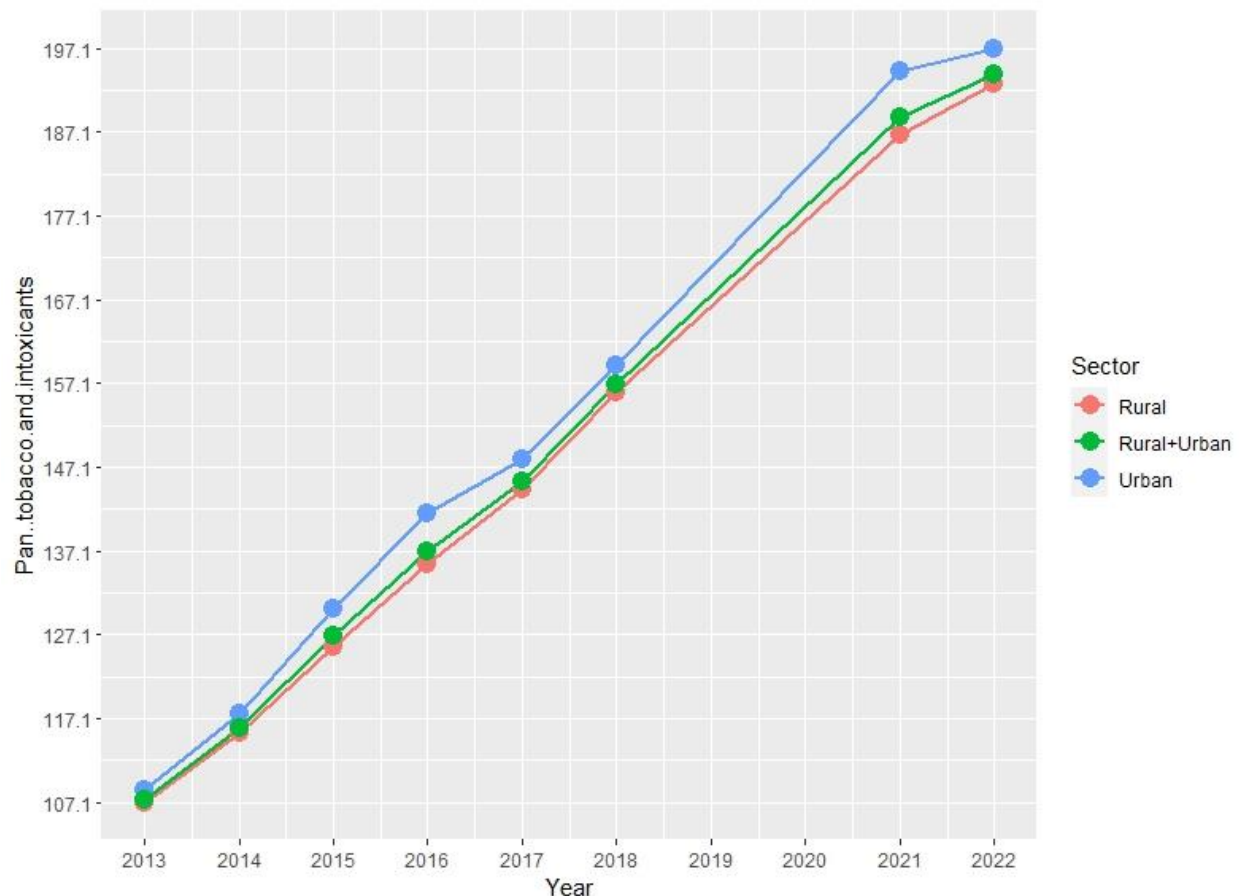


- **How volatile is price of ‘food and beverages’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of ‘food and beverages’ over the span of 10 years.
 - The line graphs for Rural and Urban are identical and coincidental to each other until 2018. There has been a slight difference in the prices of ‘food and beverages’ in recent years with Urban sector prices being higher than Rural.

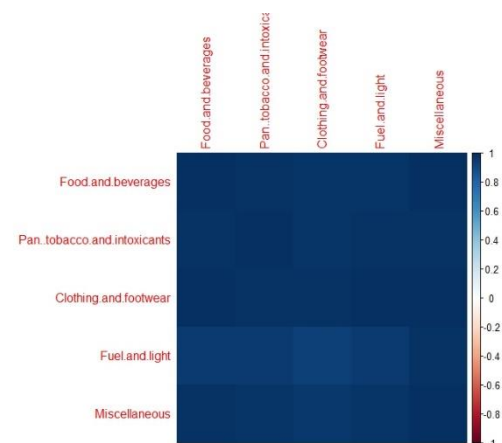


GROUP 2: PAN. TOBACCO AND INTOXICANTS

- Rate of inflation of Rural Sector is 80.01%, of Urban Sector is 81.65% and combined is 80.37%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.

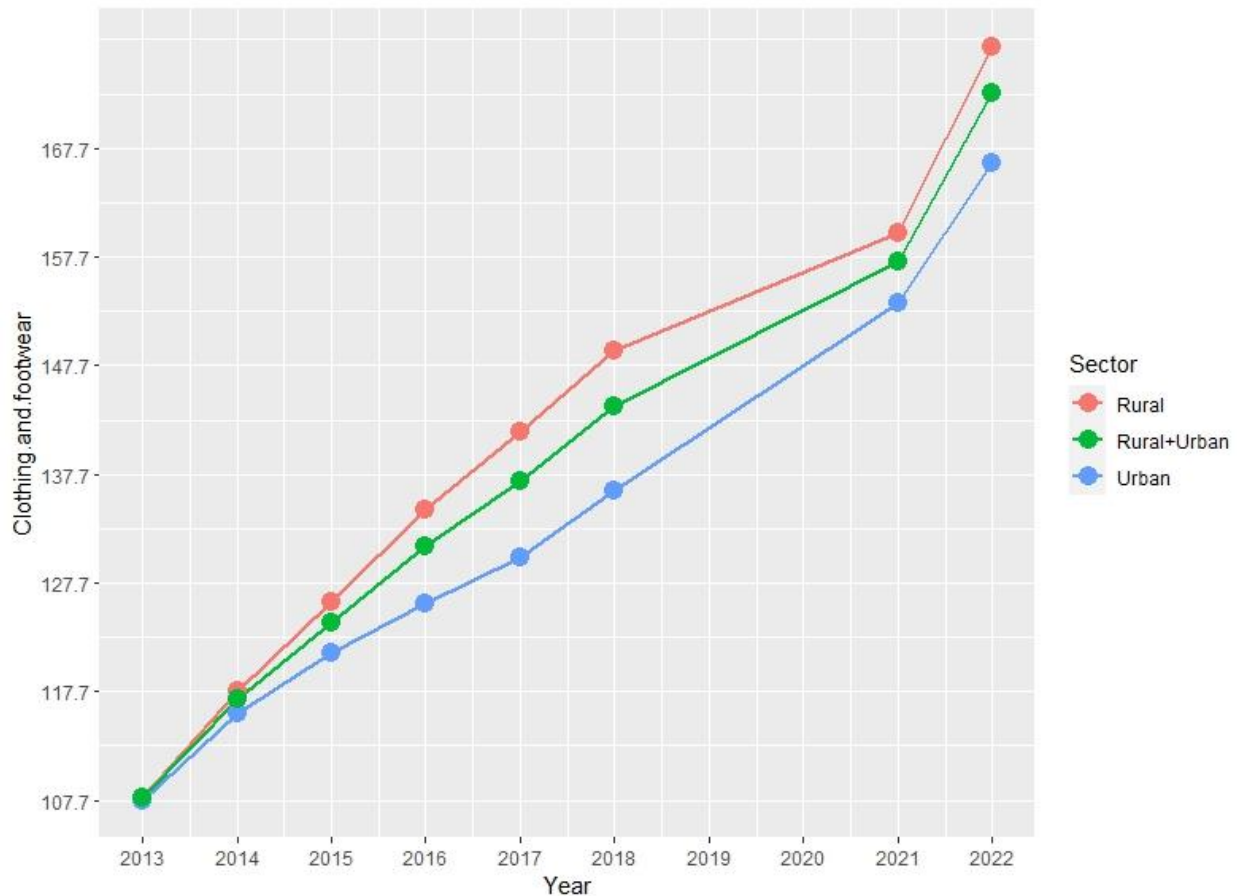


- **How volatile is price of ‘pan, tobacco and intoxicants’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of pan, tobacco and intoxicants over the span of 10 years.
 - The line graphs for Rural and Urban are almost identical to each other. There has not been a significant difference in the prices of pan, tobacco and intoxicants across the various sectors.



GROUP 3: CLOTHING AND FOOTWEAR

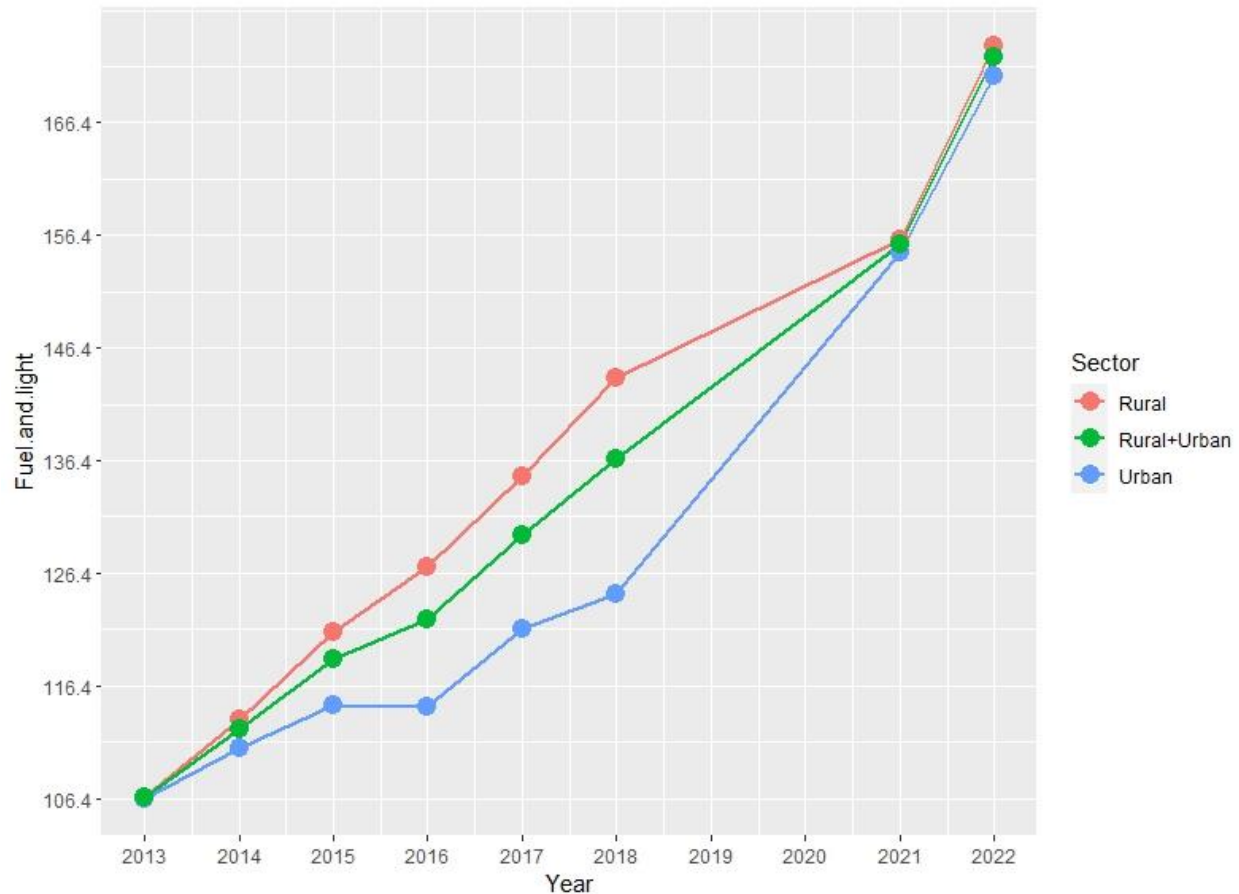
- Rate of inflation of Rural Sector is 63.98%, of Urban Sector is 54.41% and combined is 60.14%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.



- **How volatile is price of ‘clothing and footwear’ across the 3 sectors (urban, rural and combined over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of clothing and footwear products over the span of 10 years.
 - The line graphs for Rural and Urban are almost identical to each other. There has been a slight difference in the prices of ‘clothing and footwear’ in 2015-2018 with Rural sector prices being higher than urban. In 2021-2022 the difference in prices across sectors has decreased again.

GROUP 4: FUEL AND LIGHT

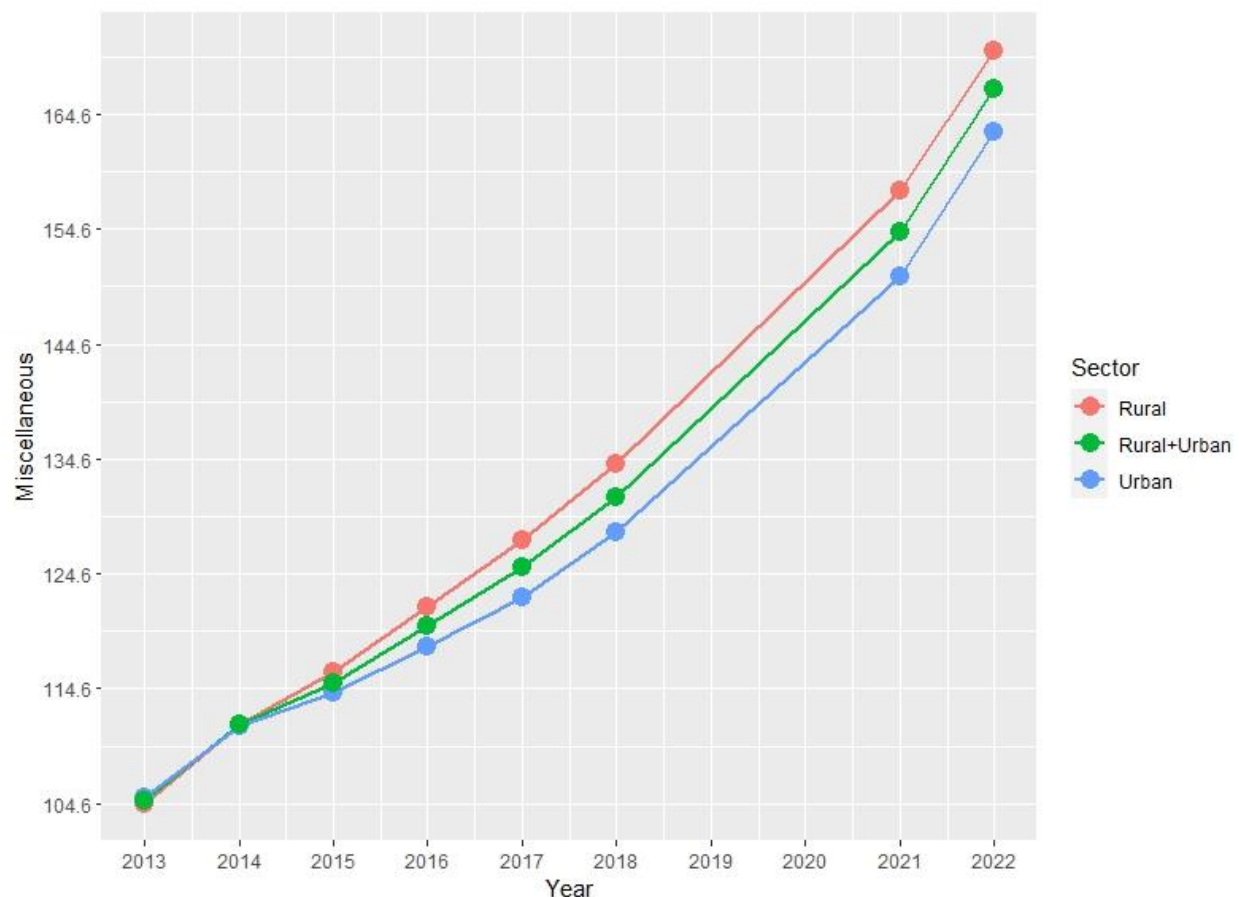
- Rate of inflation of Rural Sector is 62.72%, of Urban Sector is 60.24% and combined is 61.69%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.



- **How volatile is price of 'fuel and light' across the 3 sectors (urban, rural and combined over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of fuel and light products over the span of 10 years.
 - The line graphs for Rural and Urban are almost identical to each other. There has been a significant difference in the prices of 'fuel and light' in 2015-2018 with Rural sector prices being higher than urban. In 2021-2022 the difference in prices across sectors has decreased again.

GROUP 5: MISCELLANEOUS

- Rate of inflation of Rural Sector is 62.71%, of Urban Sector is 55.18% and combined is 59.16%
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.



- **How volatile is price of ‘miscellaneous’ across the 3 sectors (urban, rural and combined) over the span of 10 years (2013-2022)?**
 - The graph rises steadily across sectors, indicating the consistent increase in price of miscellaneous goods over the span of 10 years.
 - The line graphs for Rural and Urban are almost identical to each other. There has not been a significant difference in the prices of miscellaneous across the various sectors.

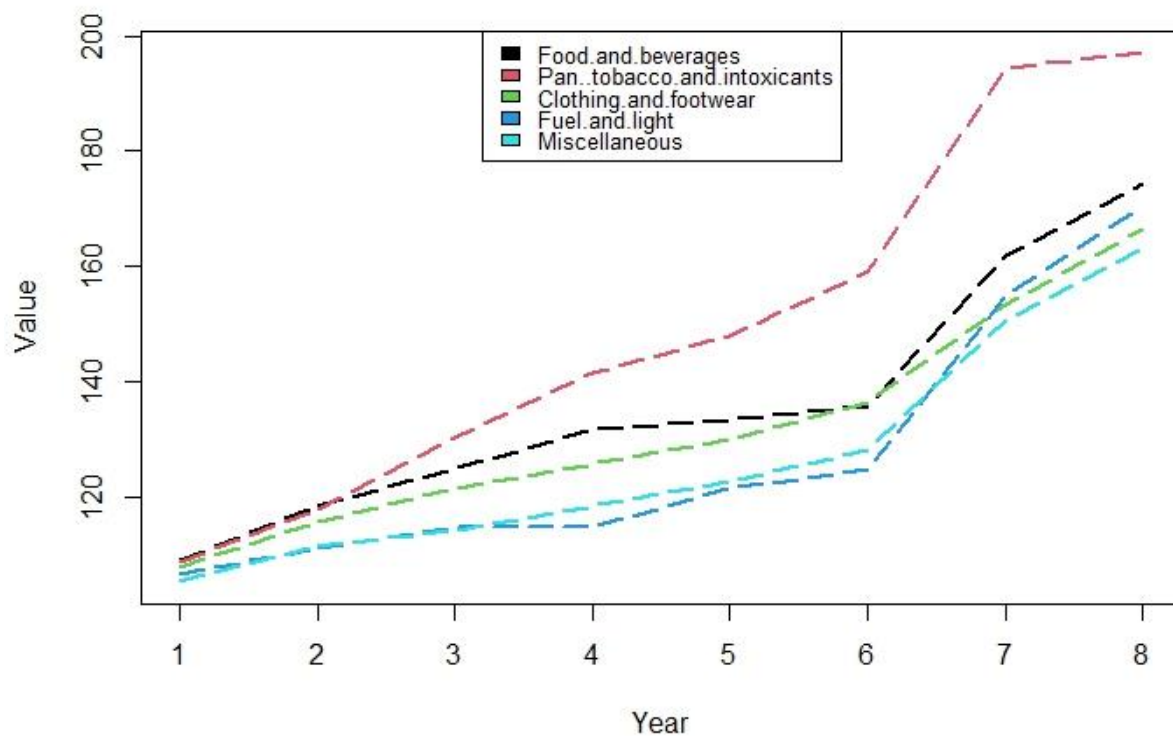
QUESTION 2

How volatile are the prices of all commodities in each sector? What is the correlation among prices of commodities in a given sector?

- To answer the first part of the question, we will perform trend analysis on price of all group of commodities and all commodities independently in a given sector by visualizing the data in form of line charts and note down (if any) interesting patterns formed in it.
- For the second part of the question, we will visualize the data in form of correlation heatmap and note down (if any) interesting patterns formed in it.

TREND ANALYSIS OF GROUP OF COMMODITIES IN URBAN SECTOR

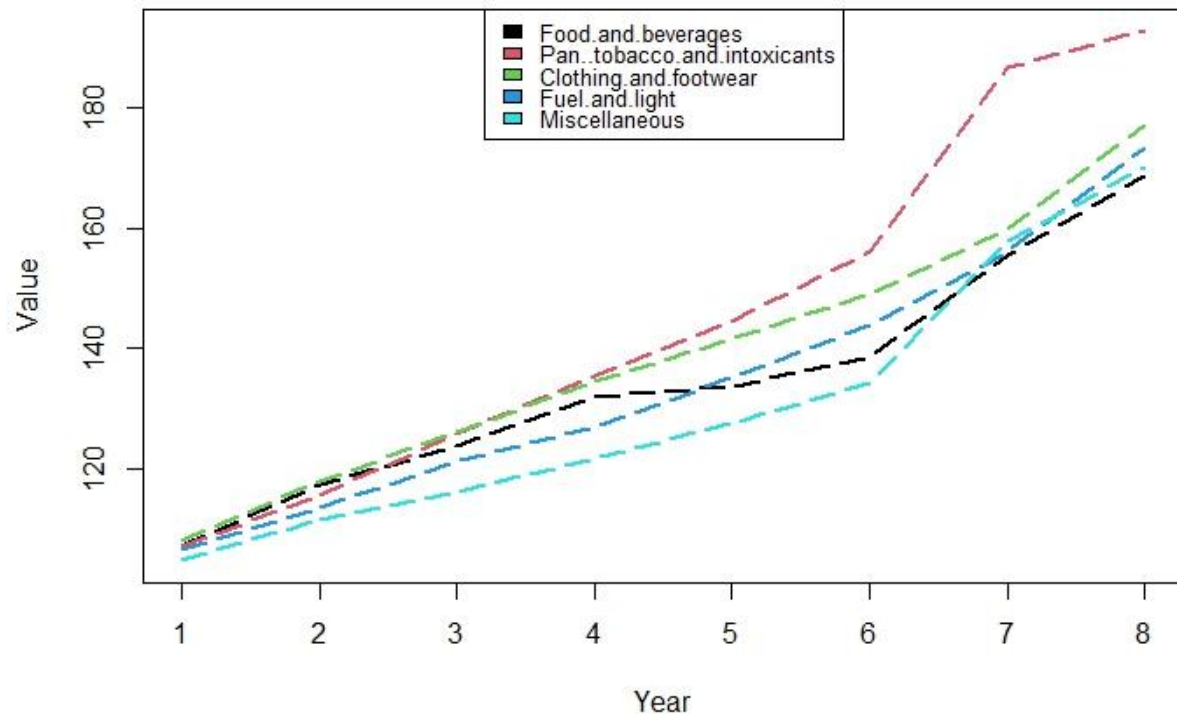
The line graph for all groups rises steadily across sectors, indicating the consistent increase in price of goods over the span of 10 years. The group 'Pan, Tobacco and intoxicants' have a much higher hike in price than the other groups. The price of goods in most groups lie in the range of 160 to 170 for the recent years where as the price of 'Pan, Tobacco and intoxicants' nears 200.



TREND ANALYSIS OF GROUP OF COMMODITIES IN RURAL SECTOR

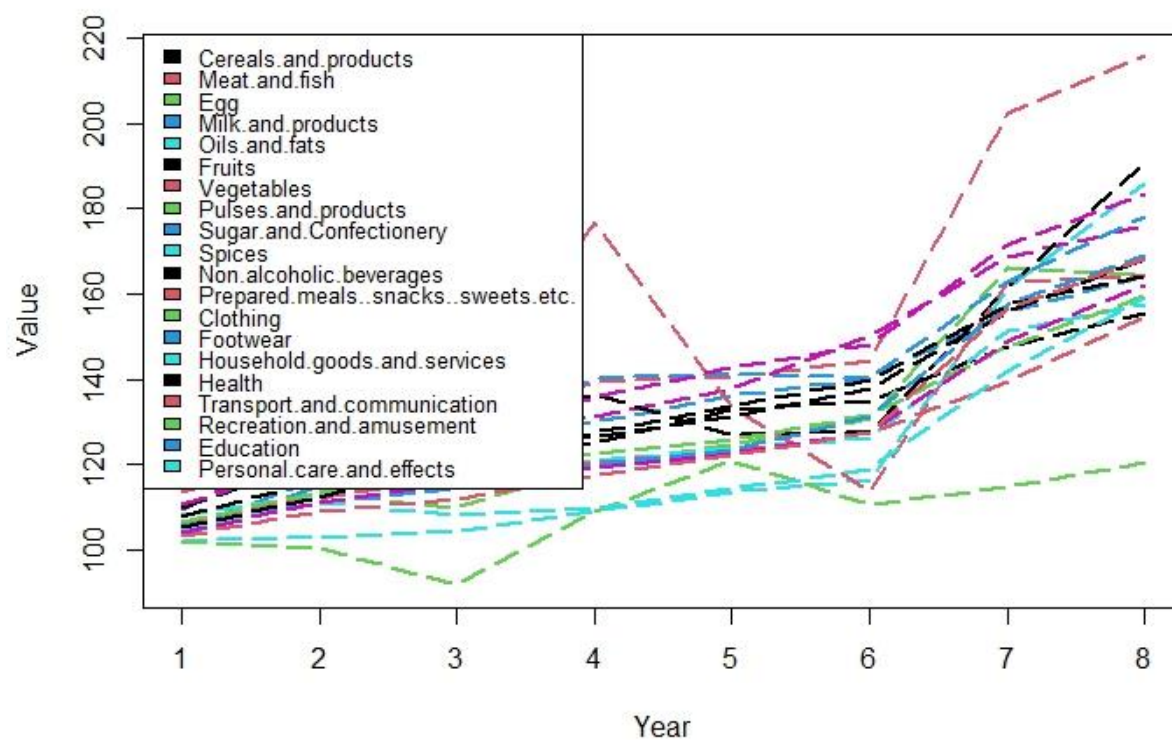
The line graph for all groups rises steadily across sectors, indicating the consistent increase in price of goods over the span of 10 years. The group 'Pan, Tobacco and intoxicants' have a much higher hike in price than the other groups. The price of goods in most groups lie in the range of 160 to 170 for the recent years where as the price of 'Pan, Tobacco and intoxicants' nears 200.

There is a slight decrease in the price of 'food and beverages' in the recent year. The price of group of commodities which are grown or eaten raw is lower in Rural sector when compared to Urban sector while those group of commodities which are manufactured or processed are slightly higher in rural sector. This can also be backed from the fact that CPI index for rural has given more



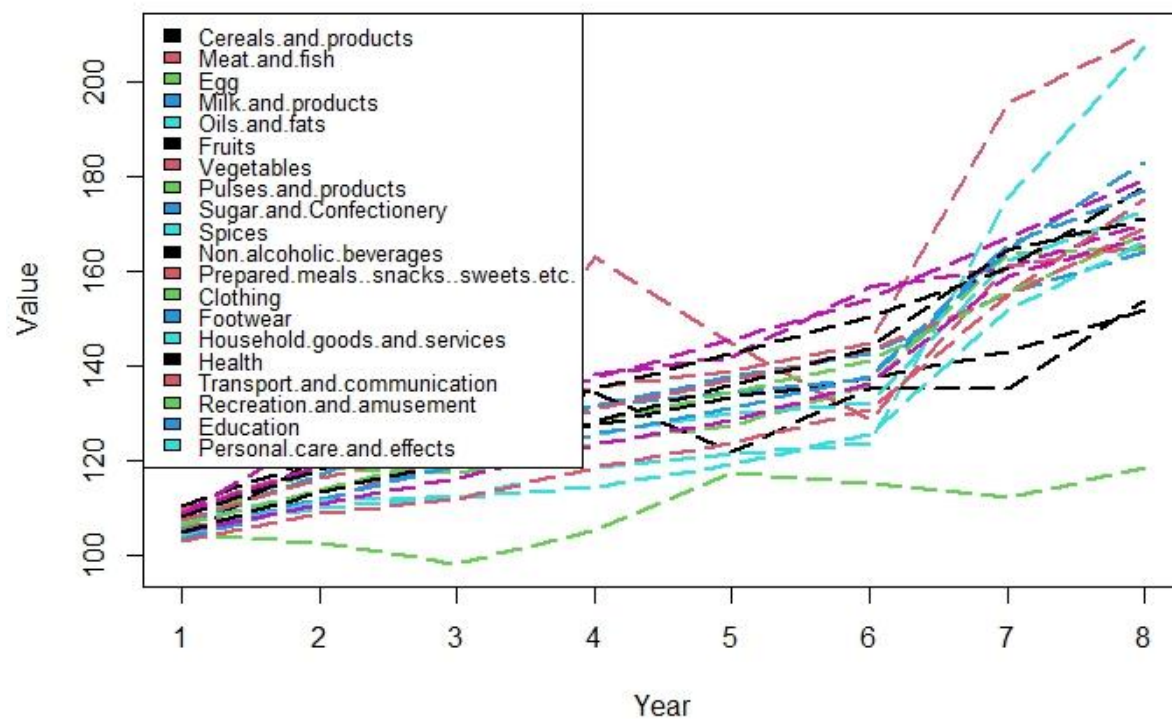
weightage (54.18% compared to 36.29%(U)) to food and beverages than other items, hence forcing government to focus more on controlling the prices of these group of commodities than others.

TREND ANALYSIS OF COMMODITIES INDEPENDENTLY IN URBAN SECTOR



- According to this, most values have remained in range of 140-180 while commodity “Meat and Fish” has crossed the mark of 200, making it the most inflationary commodity in the list.

TREND ANALYSIS OF COMMODITIES INDEPENDENTLY IN RURAL SECTOR



- According to this, most values have remained in range of 140-180 while commodities “Meat and Fish” and “Oils and fats” has crossed the mark of 200, making them the most inflationary commodities in the list.

CORRELATION HEATMAP OF GROUP OF COMMODITIES IN URBAN SECTOR



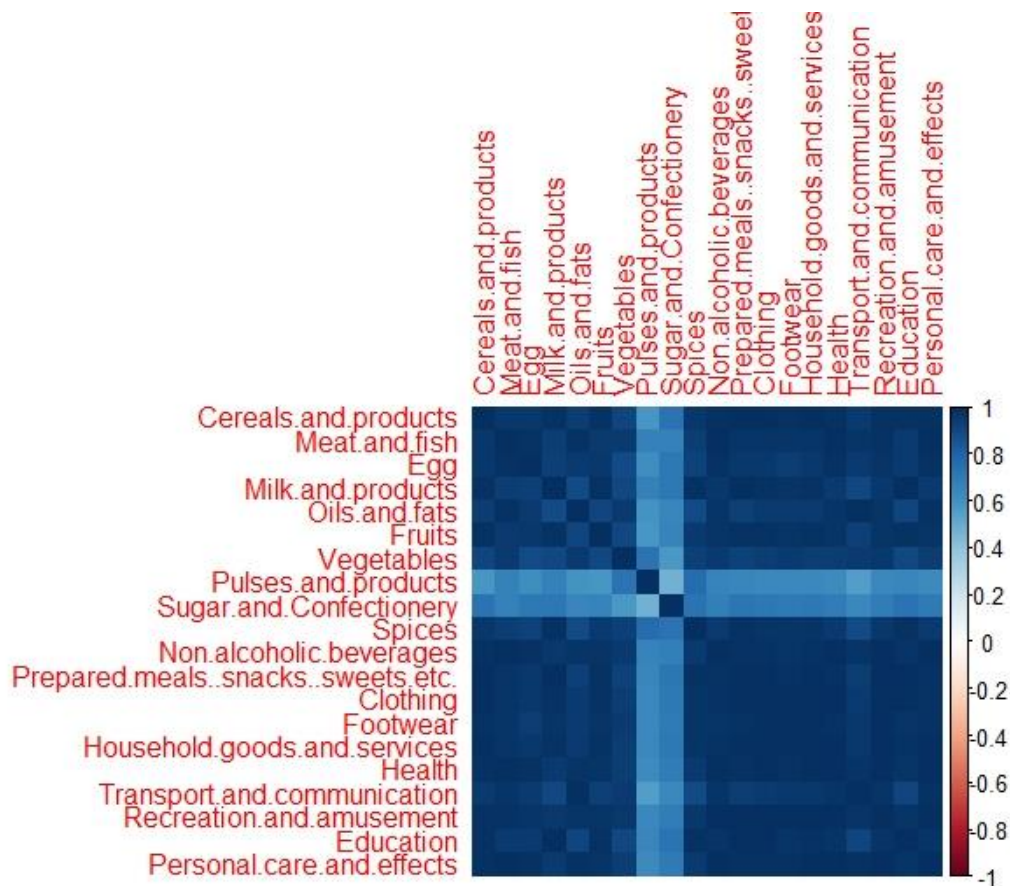
- There is very strong positive correlation among the prices of this group of commodities across the sectors.
- All the correlation coefficient values are $>+0.9$ in this group of commodities.

CORRELATION HEATMAP OF GROUP OF COMMODITIES IN RURAL SECTOR



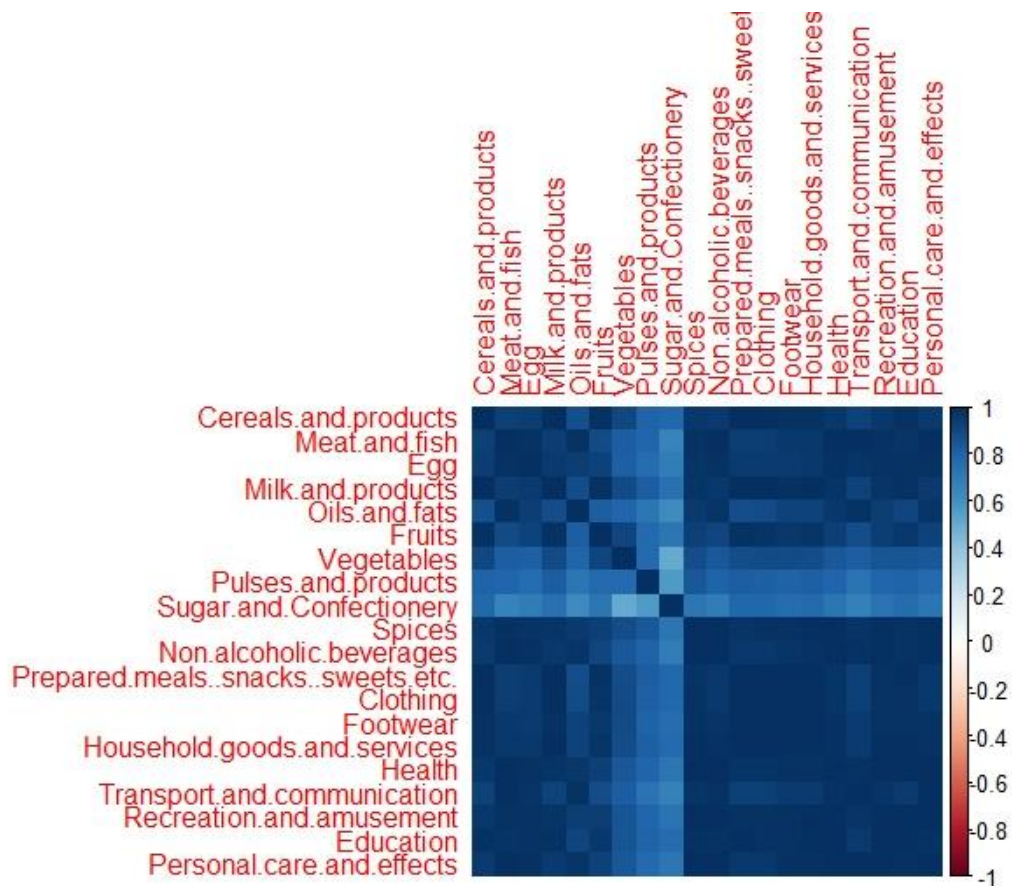
- There is very strong positive correlation among the prices of this group of commodities across the sectors.
- All the correlation coefficient values are $>+0.9$ in this group of commodities.

CORRELATION HEATMAP OF COMMODITIES INDEPENDENTLY IN URBAN SECTOR



- Since, price of all the commodities in urban sector has grown over the years, there's positive correlation among all the commodities.
- Not all the commodities have correlation coefficient $> +0.95$ among themselves.
- Sugar and Pulses have very weak correlation with all the other commodities; hence their prices are more volatile compared to others. Through the above charts, this has been confirmed.

CORRELATION HEATMAP OF COMMODITIES INDEPENDENTLY IN RURAL SECTOR

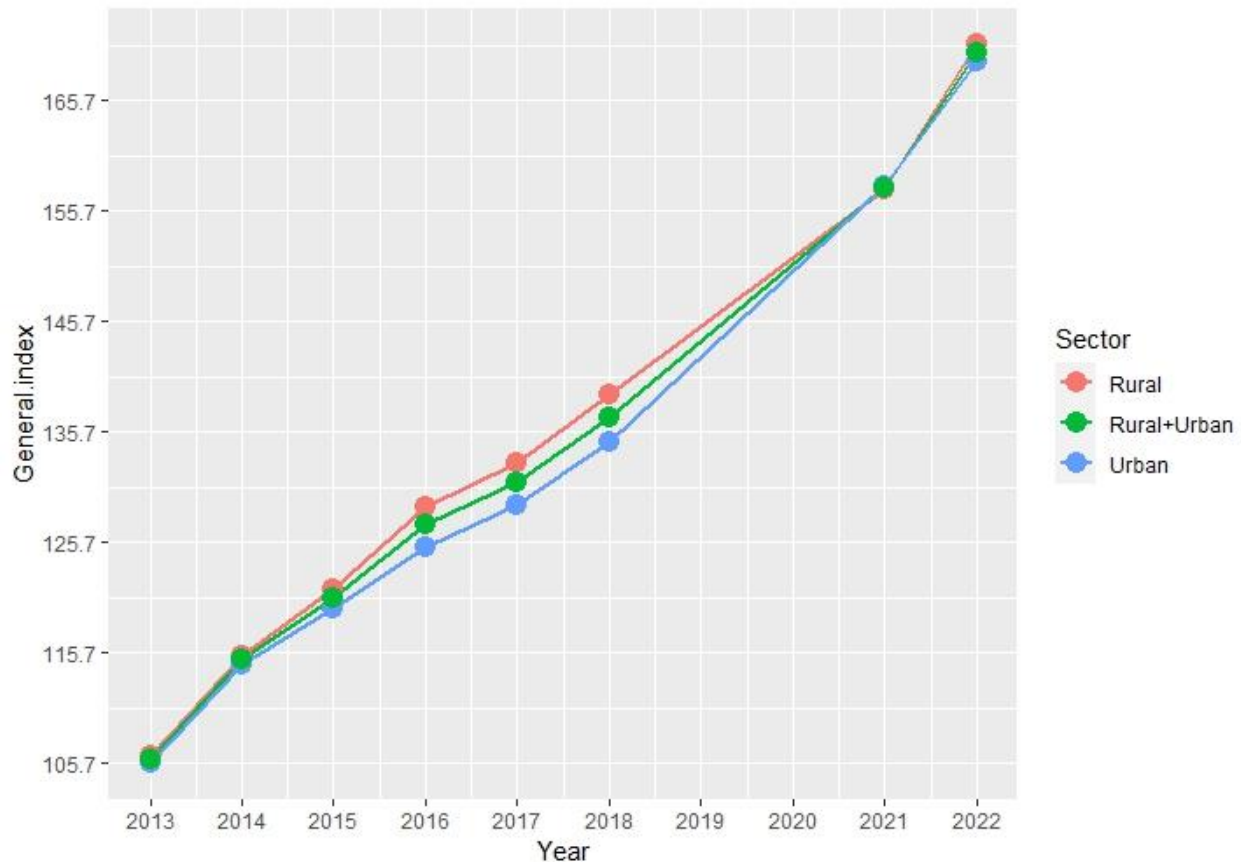


- Since, price of all the commodities in rural sector has grown over the years, there's positive correlation among all the commodities.
- Not all the commodities have correlation coefficient $> +0.95$ among themselves.
- Sugar and Pulses have very weak correlation with all the other commodities; hence their prices are more volatile compared to others. Through the above charts, this has been confirmed.

QUESTION 3

How volatile is the CPI index in general across the 3 sectors?

To answer this question, we will perform trend analysis on general index attribute across the 3 sectors by visualizing the data in form of line charts and note down (if any) interesting patterns formed in it.



- Rate of inflation of Rural Sector is 60.52%, of Urban Sector is 60.07% and combined is 60.3%.
- Lower bound rate of inflation based on RBI range for Rural, Urban and Combined is 21.89% and upper bound rate of inflation based on RBI range for Rural, Urban and Combined is 79.08%.
- The graph rises steadily across the three sectors, indicating the consistent increase in price of commodities over the span of 10 years. Graph is smooth because of weight adjustment performed on various group of commodities, reining in the volatility.
- Since, the line graphs for Rural and Urban are similar to each other. There has not been a significant difference in the prices of cereals and its products across the various sectors.

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- **Ministry of Statistics and Program Implementation**, (mospi.gov.in)
- **Data.Gov.In**, (data.gov.in)