**India CPI Inflation Case Study**

*Overview*

In India, the Consumer Price Index (CPI) is used to measure inflation, and it involves a fixed basket of goods and services. This basket is comprehensive and includes a wide array of items that an average Indian consumer uses. These items are not limited to just food and clothing but extend to transportation, medical care, electricity, education, and almost every other category that involves expenditure of money. The CPI is calculated by comparing the general price level in the markets during a particular time period with a base year. The items in the CPI basket are classified across various categories like food and beverages, clothing, housing, fuel and light, and recreation, among others.

The CPI basket contains categories like food and beverages, housing, apparel, transportation, medical care, and more. The weight of each category in the total index might differ based on its relative importance to the average consumer expenditure but for the purpose of this analysis consider equal weights across all categories.

*Dataset*

* The dataset provided is a CPI inflation index extracted from GOI and PPAC websites.
* Each number represents the index value for that month and category
* There are missing values in the dataset - use suitable imputation technique (like moving averages), if required
* The CPI is an index and not a direct measure of price levels, but rather a relative indicator used to measure inflation or the average change in prices over time. Consumer Price Index (CPI) values cannot be summed across different months to derive meaningful insights or aggregate measures.
* CPI-U (Urban): Reflects spending patterns for urban consumers.
* CPI-R (Rural): Reflects spending patterns for rural consumers
* The General Index gives you the overall Inflation for the month for all the categories combined.

***Problem Statement***

You are working with the National Statistical Office which is equipped to release inflation numbers in India. As an analyst, you are provided with CPI data and are equipped to find out insights from the data. Your senior wants you to find key trends and deep dive into the data to answer the following questions –

1. Based on the **latest**month’s data, identify the contribution of different broader categories (food, energy, transportation, education, etc.) towards the CPI basket. Broader categories (buckets) can be created by combining similar categories into one bucket; Ex.: Meals, Beverages, Cereals, can be clubbed to create “Food” category, etc.

* Which broader category  has the highest contribution towards towards CPI calculation
* Contribution is calculated by evaluating the underlying index values for broader category and should add to 100% when contribution from different broader categories are added .

2. A trend of Y-o-Y increase in CPI (rural + urban) inflation starting 2017 for the entire basket of products combined.

* Create a graph depicting the growth rate Y-o-Y and identify the year with highest inflation rate
* Highlight the reason why the year has the highest inflation (based on research).

3. With India's retail inflation reaching a 3-month high of 5.55% in November 2023, largely due to a sharp rise in food prices. Analyze the following for 12 months ending May’23

Investigate trends in the prices of broader food bucket category and evaluate month-on-month changes. Highlight month with highest and lowest food inflation

Identify the absolute changes in inflation over the same 12 months period and identify the biggest individual category contributor (only within broader food category) towards inflation.

4. Investigate how the onset and progression of the COVID-19 pandemic affected inflation rates in India. Analyze the Impact of key pandemic milestone ( first lockdown) on the CPI inflation %, specially focus on categories like healthcare, food, and essential services.

Hint: You can consider Mar’20 as the onset of covid, and can compare the inflation trend before and after Mar’20 to see if there is a change in inflation % before and after.

5. Investigate how major global economic events (like imported crude oil price fluctuations) have influenced India's inflation. This can include an analysis of imported goods and their price trends.

For the purpose of this analysis, focus only on the imported oil price fluctuations for years 2021 to 2023 (Month-on-month)

Identify trends in oil price change with change in inflation prices of all the categories and identify category whose inflation prices strongly changes with fluctuations in imported oil price (Hint: you can use =correl function)

***Other Information***

* Percentage Change: To understand inflation or deflation trends, calculate the percentage change in CPI between two periods (e.g., year-over-year or month-over-month). This shows how much prices have increased or decreased relative to the earlier period.
* For example, to calculate the monthly inflation rate between two consecutive months:
* Monthly Inflation rate=(CPI in current month−CPI in previous monthCPI in previous month)×100
* Annual Inflation Rate: For longer periods, such as yearly inflation, use the CPI values at the start and end of the period. This helps in understanding the overall inflation experienced over the year.
* Annual Inflation rate= ((CPI at end of year−CPI at start of year)/ CPI at start of year) ×100
* Any month can be considered as start of the year , then end of the year month will be considered 12 months after the month you have selected for start of the year

***Solutions***

**1. Analysis of Broader Category Contributions to the Consumer Price Index (CPI) Basket**

According to the available data, the most recent month is May 2023. The 26 various categories can be grouped into seven broad categories. The following seven broad groups are constructed by grouping some of the categories together.

* **Food And Drinks**: Cereals and products, Meat and fish, Egg, Milk and products, Oils and fats, Fruits, Vegetables, Pulses and products, Sugar and Confectionery, Spices, Non-alcoholic beverages, (Prepared meals, snacks, sweets etc.), Food and beverages
* **Fashion**: Clothing, Footwear, Clothing and Footwear.
* **Housing Expenses**: Housing, Fuel and Light, Household goods and services.
* **Personal Expenses**: Personal Care and Effects, Recreation and Amusement, Miscellaneous, (Pan, Tobacco and Intoxicants).
* **Health**: Health
* **Transportation and Communication**: Transportation and Communication
* **Education**: Education

Now, We sum up the values for each category above over all 3 sectors for May,2023 timeline. After calculating, the values will be as follows.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Broader Category | Food And Drinks | Fashion | Housing Expenses | Health | Transportation and Communication | Education | Personal Expenses |
| **Contribution** | 6,933 | 1,652 | 1,425 | 556 | 495 | 532 | 2,202 |

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Broader Category | Food And Drinks | Fashion | Housing Expenses | Health | Transportation and Communication | Education | Personal Expenses | **Total** |
| **% Contribution** | 50% | 12% | 10% | 4% | 4% | 4% | 16% | **100%** |

Now, if we make a Pie chart out of this formulated data. It will be as below.

A pie chart with different colored circles

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**Findings:**

Here, it is evident that the "Food and Drinks" Category is the Primary Contributor, making up 50% of the CPI Basket.

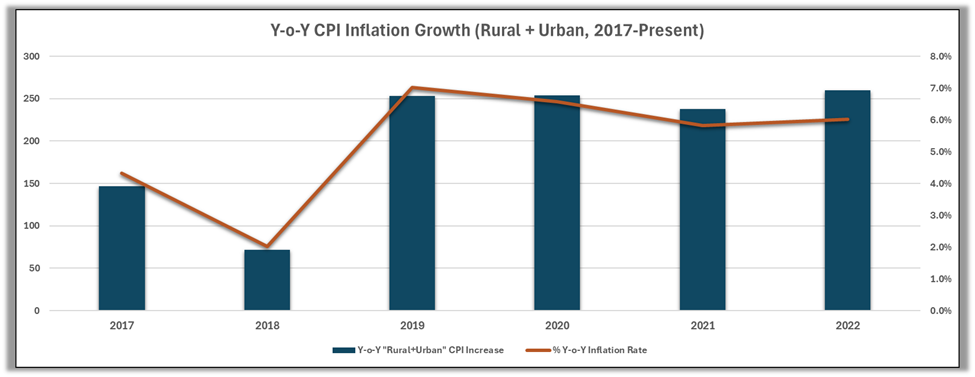
"Personal Expenses" rises to the position of the second-largest contributor.

The potential cause of "Food and Drinks" emerging as the main contributor could be attributed to high rates of food inflation, export prohibitions and other government policies, as well as effects from the global market.

**2. Analysis of Year-on-Year CPI Inflation Growth (Rural and Urban)**

In order to get the overall CPI index, we will add up all of the columns and total the numbers for “Rural+Urban” sector for each timeframe. Then we calculate the Year-on-Year CPI Increase and The Inflation rate respectively. And this is how the output table will appear.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Months | |  |  |
|  |  | **January** | **December** | **Y-o-Y "Rural+Urban" CPI Increase** | **% Y-o-Y Inflation Rate** |
| Year | 2017 | 3407 | 3554 | 147 | 4.3% |
| 2018 | 3545.5 | 3616.9 | 71.4 | 2.0% |
| 2019 | 3605.4 | 3858.6 | 253.2 | **7.0%** |
| 2020 | 3862.2 | 4116.4 | 254.2 | 6.6% |
| 2021 | 4093.1 | 4331.1 | 238 | 5.8% |
| 2022 | 4324.8 | 4584.8 | 260 | 6.0% |



**Findings:**

In this case, 2019 saw the largest CPI increase, with an inflation rate of 7%. Furthermore, despite changes in the CPI, inflation stayed between 6 and 7% in 2022 as a result of the COVID-19 effects.

Significant price increases were caused in 2019 by disruptions in the agricultural sector and problems with the supply chain, which primarily affected food items. The cost of imports increased due to fluctuations in the global economy and exchange rate, which raised inflation. Demand-pull inflation is caused by rising local demand, which is surpassing supply due to programs like "Made in India" and intensifying rivalry for commodities.

**3. Food Price Month-on-Month Inflation Analysis**

Here, We need to get the total CPI of “Food and Drinks” on a monthly basis from June’22 to May’23 and calculate the Inflation rate on Month-on-Month basis. And, the formulated table will be as follows.

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | "Food and Drinks" CPI | % Inflation Rate |
| **Timeline** | May-2022 | 6727.9 |  |
| June-2022 | 6797.7 | **1.04%** |
| July-2022 | 6810.4 | 0.19% |
| August-2022 | 6818.7 | 0.12% |
| September-2022 | 6855.1 | 0.53% |
| October-2022 | 6904.1 | 0.71% |
| November-2022 | 6898.9 | -0.08% |
| December-2022 | 6856.3 | **-0.62%** |
| January-2023 | 6886.1 | 0.43% |
| February-2023 | 6848 | -0.55% |
| March-2023 | 6848.4 | 0.01% |
| April-2023 | 6881.5 | 0.48% |
| May-2023 | 6932.7 | 0.74% |

**Findings:**

Here, the peak inflation rate for "Food and Drinks" occurred in June 2022 and the lowest inflation rate for "Food and Drinks" was observed in December 2022.

And then, we calculate the absolute change in different sub-categories of “Food and Drinks” which will look like below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  |  | Timeline | | Inflation | |
|  |  | June-2022 | May-2023 | Absolute Change | % Absolute Change in Inflation |
| "Food And Drinks" Category | Cereals and products | 466.3 | 521.6 | 55.3 | 11.9% |
| Meat and fish | 660 | 645.2 | -14.8 | -2.2% |
| Egg | 513.2 | 520.9 | 7.7 | 1.5% |
| Milk and products | 497.6 | 538.5 | 40.9 | 8.2% |
| Oils and fats | 597.6 | 507.7 | -89.9 | -15.0% |
| Fruits | 509.6 | 517 | 7.4 | 1.5% |
| Vegetables | 561.1 | 494.7 | -66.4 | -11.8% |
| Pulses and products | 492.5 | 527.4 | 34.9 | 7.1% |
| Sugar and Confectionery | 360.4 | 368.8 | 8.4 | 2.3% |
| Spices | 559.5 | 650.9 | 91.4 | **16.3%** |
| Non-alcoholic beverages | 501.2 | 518 | 16.8 | 3.4% |
| Prepared meals, snacks, sweets etc. | 552.1 | 583 | 30.9 | 5.6% |
| Food and beverages | 526.6 | 539 | 12.4 | 2.4% |

Now, we make a graph out of the above data, which will be as follows.

A graph with different colored squares

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**Findings:**

The "Spices" category under "Food and Drinks" has the highest absolute change in inflation, while the "Oil and Fats" category has the lowest absolute change in inflation within "Food and Drinks."

The high rate of inflation on June 22 may have been caused by factors such as fluctuations in the world's commodities markets and unfavorable weather. Perhaps a 41% increase in export demand during the June 22–May 23 timeframe was the reason for the greatest rate of inflation in spices.

**4. Impact of COVID-19 on Inflation Rates: Healthcare, Essential Services, and Food Prices from April'19 to February'21**

To investigate the impact of covid-19 on the inflation rates, I have chosen “March-2020” as the onset and considered the data 12 months prior and 12 months after the chosen timeline.

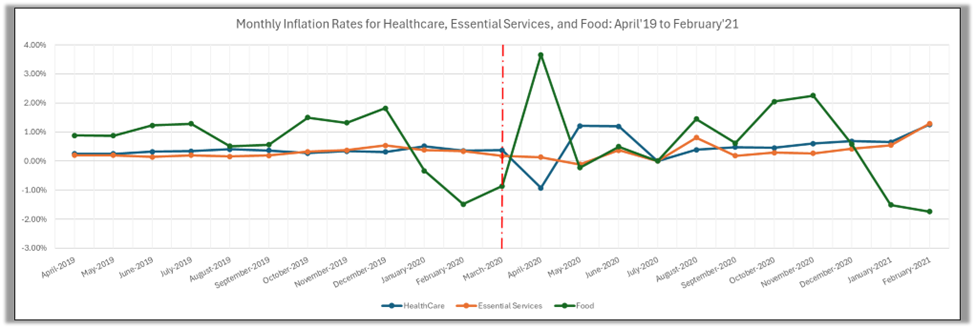
Here, I have made a Broader Category called “Essential Services” comprising of Transport, Clothing, Education, Housing Expense. Now, we retrieve and calculate the data, and the table formed is as follows.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  | Essential Services | | | |  |  |
|  |  | HealthCare | Transport | Clothing | Education | Housing Expenses | Food | Essential Services |
| Timeline | February-2019 | 434 | 372.3 | 1295.9 | 452.4 | 1138.2 | 5271.3 | 3258.8 |
| March-2019 | 435.8 | 374.4 | 1297.8 | 452.5 | 1143.5 | 5292.5 | 3268.2 |
| April-2019 | 436.9 | 374.8 | 1300.2 | 454.4 | 1145.35 | 5339 | 3274.75 |
| May-2019 | 438 | 375.2 | 1302.6 | 456.3 | 1147.2 | 5385.5 | 3281.3 |
| June-2019 | 439.4 | 374.4 | 1303.4 | 459.1 | 1149.1 | 5451.6 | 3286 |
| July-2019 | 440.9 | 377.4 | 1305.4 | 463.5 | 1146.2 | 5521.8 | 3292.5 |
| August-2019 | 442.7 | 378 | 1307.3 | 466.1 | 1146.4 | 5550.1 | 3297.8 |
| September-2019 | 444.3 | 378.9 | 1307.8 | 467 | 1150.3 | 5581.3 | 3304 |
| October-2019 | 445.5 | 379.5 | 1310 | 467.8 | 1157.5 | 5665.1 | 3314.8 |
| November-2019 | 447 | 380.4 | 1313.4 | 468.1 | 1165.2 | 5739.5 | 3327.1 |
| December-2019 | 448.4 | 390 | 1316.6 | 468.7 | 1169.6 | 5843.8 | 3344.9 |
| January-2020 | 450.7 | 393.3 | 1318.6 | 469.9 | 1175.9 | 5824.4 | 3357.7 |
| February-2020 | 452.3 | 391.5 | 1320.8 | 470.3 | 1186.6 | 5738 | 3369.2 |
| March-2020 | 454 | 390.3 | 1323.5 | 469.8 | 1191.4 | 5688.5 | 3375 |
| April-2020 | 449.8 | 398 | 1331.75 | 470.25 | 1179.4 | 5896.85 | 3379.4 |
| May-2020 | 455.25 | 398 | 1331.75 | 470.25 | 1175.65 | 5883.5 | 3375.65 |
| June-2020 | 460.7 | 405.7 | 1340 | 470.7 | 1171.8 | 5912.8 | 3388.2 |
| July-2020 | 460.7 | 405.7 | 1340 | 470.7 | 1171.8 | 5912.8 | 3388.2 |
| August-2020 | 462.5 | 416 | 1339.9 | 476.7 | 1182.9 | 5998.7 | 3415.5 |
| September-2020 | 464.7 | 419.3 | 1344.2 | 473.5 | 1184.8 | 6036 | 3421.8 |
| October-2020 | 466.8 | 422.4 | 1346.8 | 476.7 | 1185.8 | 6159.7 | 3431.7 |
| November-2020 | 469.6 | 421.7 | 1351.1 | 476.6 | 1191.5 | 6298.7 | 3440.9 |
| December-2020 | 472.8 | 422.6 | 1357.1 | 479.2 | 1196.6 | 6335 | 3455.5 |
| January-2021 | 475.9 | 426.3 | 1362.5 | 478.8 | 1206.7 | 6239.2 | 3474.3 |
|  | February-2021 | 481.9 | 435.8 | 1376 | 479.7 | 1227.7 | 6130.6 | 3519.2 |

Now, we calculate the Month-on-Month Absolute Change % for different broader categories. The table below shows the formulated data.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  | HealthCare | Essential Services | Food |
| Timeline | April-2019 | 0.25% | 0.20% | 0.88% |
| May-2019 | 0.25% | 0.20% | 0.87% |
| June-2019 | 0.32% | 0.14% | 1.23% |
| July-2019 | 0.34% | 0.20% | 1.29% |
| August-2019 | 0.41% | 0.16% | 0.51% |
| September-2019 | 0.36% | 0.19% | 0.56% |
| October-2019 | 0.27% | 0.33% | 1.50% |
| November-2019 | 0.34% | 0.37% | 1.31% |
| December-2019 | 0.31% | 0.54% | 1.82% |
| January-2020 | 0.51% | 0.38% | -0.33% |
| February-2020 | 0.36% | 0.34% | -1.48% |
| March-2020 | 0.38% | 0.17% | -0.86% |
| April-2020 | -0.93% | 0.13% | 3.66% |
| May-2020 | 1.21% | -0.11% | -0.23% |
| June-2020 | 1.20% | 0.37% | 0.50% |
| July-2020 | 0.00% | 0.00% | 0.00% |
| August-2020 | 0.39% | 0.81% | 1.45% |
| September-2020 | 0.48% | 0.18% | 0.62% |
| October-2020 | 0.45% | 0.29% | 2.05% |
| November-2020 | 0.60% | 0.27% | 2.26% |
| December-2020 | 0.68% | 0.42% | 0.58% |
| January-2021 | 0.66% | 0.54% | -1.51% |
| February-2021 | 1.26% | 1.29% | -1.74% |

Now, when we transform this data into a graphical representation, it will be as follows.



**Findings:**

From the graphical representation, it clearly shows Healthcare inflation, initially low and stable before March 2020, became more volatile afterward, while essential services maintained consistent inflation, and food prices showed significant volatility, especially post-March 2020.

During the pandemic, food prices experienced drastic swings, including a 4% spike in April 2020 followed by deflation, while essential services maintained stable but slightly more variable inflation, and healthcare inflation, previously stable below 0.5%, became more volatile with brief deflation and higher variability, reflecting sector-specific disruptions.

**5. Impact of Crude Oil Price Fluctuations on Consumer Goods in India**

Firstly, the Crude oil prices are obtained from ppac.gov.in. Now, we get all the relevant data through out the timeline between Jan-21 to May-23(latest month). Now, we correlate oil prices with all categories available. And, the graphical representation of that formulated data is as follows.

A graph with numbers and letters

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**Findings:**

The "Oil and Fats" category exhibits the strongest correlation with crude oil price inflation at 81.9%, followed closely by the "Meat and Fish" category with a significant 76.5% correlation.

Geopolitical factors like the Russia-Ukraine war, COVID-19 lockdowns, and OPEC+ production cuts raised global crude oil prices, increasing transportation, raw material, and production costs for oils and fats.