

# Note on Pattern Changes in Consumer Price Index (CPI) Year-On-Year (YoY) of the Republic of Korea Since the COVID-19 Pandemic via Statistical Analysis

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**Abstract:** As global supply chain disruptions continue, concerns about inflation are growing around the world. The Consumer Price Index (CPI) is a measure of the price fluctuations of goods and services that people purchase on a daily basis and is used as the most representative inflation indicator. In this paper, we compare the CPI year-on-year (YoY) in the Republic of Korea before and after the COVID-19 pandemic. Our analysis produced the following results: (i) the average difference in the CPI YoY in the Republic of Korea from January 2020 to August 2020 and that from January 2019 to August 2019 is not statistically significant; (ii) the CPI YoY increased significantly from January 2021 to August 2021 compared to that from January 2020 to August 2020; (iii) the CPI YoY increased significantly from January 2022 to August 2022 compared to that from January 2021 to August 2021. Our study shows statistically comprehensive results compared to the studies that limit their discussions to the average rate of increase (or decrease) compared with that of the previous year, as presented in a report by the Price Trend Department in the Economic Trend Statistical Review Officer in the Republic of Korea. Our results could be partly interpreted as the effect related to global supply chain disruptions resulting from the spread of the COVID-19 pandemic and the prolonged war between Russia and Ukraine. The implications of our findings are briefly discussed.

**Keywords:** Consumer Price Index (CPI), global supply chain disruptions, COVID-19 pandemic, inflation, statistical significance

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## 1. Introduction

According to news releases from the Organisation for Economic Cooperation and Development (OECD) (July 5, 2022), year-on-year (YoY) inflation in the OECD as measured by the Consumer Price Index (CPI) represents the sharpest price increase since August 1988. YoY inflation increased in all countries except Colombia, Japan, Luxembourg and the Netherlands (OECD, July 5, 2022). Central banks of major countries announced measures to raise base rates one after another in order to control inflation. For example, the Federal Reserve (Fed), the central bank of the United States,

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raised its base rate by 0.75 percentage points on September 21, 2022 (CNN Business, September 21, 2022). Since inflation did not subside despite the steep interest rate hike, an unusual three consecutive giant steps have been taken to raise the base rate by 0.75 percentage points at a time. As a result, the US base rate has risen to 3.00~3.25%. In the United Kingdom, the inflation rate reached 9.9%, and the Bank of England raised the base rate by 0.5 percentage points for the first time in 27 years. In India, the inflation rate rose to 7.0 per cent (y-o-y) in August 2022, and the Reserve Bank of India (RBI) on September 30, 2022 increased key interest rate by 50 basic points (bps) to 5.90% in its fourth hike this year (Reserve Bank of India (RBI); Economic Forecasts from the World's Leading Economists, 2022). See World Economic Forum (2022) and OECD (2022) for more details.

According to Global Economic Prospects (World Bank, 2022), the major shock from the war between Russia and Ukraine and China's COVID-19 lockdown is shaking the global economy. The Managing Director of the International Monetary Fund (IMF) emphasizes that policy efforts in the US to reach the target inflation rate must be continued and suggests that the Fed raise the base rate to the level of 3.5~4% as soon as possible (IMF Economic Prospects, 2022).

The Consumer Price Index (CPI) is the most commonly used price index. It is the most representative inflation indicator (OECD; U.S. Bureau of Labor Statistics). It can be considered as a price that directly affects households and individuals' lives because the target population of CPI is the consumer. Therefore, the announcement of the CPI has considerable influence on the overall economy, such as the base rate, exchange rate, direction of monetary policy, consumer sentiment, salary increase rate, etc. It also causes great volatility in capital markets such as stocks and real estate (Blanchard, 2000). If prices rise sharply, households' purchasing power will be weakened and the profitability of businesses may deteriorate. The strengthening of the value of the US dollar owing to the rise in the CPI leads to a burden on import prices in Republic of Korea as a result of the weakening of the Korean Won (KRW), which is reflected in the domestic consumer price with a time lag (Blanchard, 2000). In addition, a sharp rise in inflation has a detrimental effect on the current account by reducing economic activity. The sharp increase in CPI owing to the global supply chain disruptions caused by the spread of the COVID-19 pandemic and the prolonged war between Russia and Ukraine has become a major concern of all central banks (Chang & Lee, 2022; OECD, 2022). Note that the Republic of Korea is highly dependent on trade with the United States and China (E-Country Indicators Mobile Website in the Republic of Korea). As the monetary tightening policy of the US Fed is faster and stronger than expected, there is a possibility that foreign funds in Republic of Korea will flow out and the value of the KRW will drop significantly. It is important to note that if the problem of high CPI cannot be controlled, high inflation in the Republic of Korea will become fixed, causing further damage to the overall economy in the Republic of Korea. Considering the recent issues related to the CPI mentioned above, research on pattern changes of the CPI in the Republic of Korea since the COVID-19 pandemic is of great importance.

The rest of this article is organized as follows. In methods section, the definition of CPI in the Republic of Korea is presented, and CPI (YoY) statistics in the Republic of Korea from January 2019 to August 2022 are shown. In the results section, the CPI year-on-year (YoY) in the Republic of Korea is compared before and after the COVID-19 pandemic. The conclusion presents a summary of the main findings, their interpretations and importance.

## 2. Method

In this section, the definition of CPI in the Republic of Korea is presented, and CPI (YoY) statistics in the Republic of Korea from January 2019 to August 2022 are shown. We also present the advantage of our method.

### Definition of the Consumer Price Index (CPI)

The Consumer Price Index (CPI) is an index created to measure the price fluctuations of goods and services purchased by households for daily living. In the Republic of Korea, about 460 products and service items with a large proportion of purchases out of the total consumption expenditure are determined and calculated based on the consumer purchase prices surveyed (e-National Indicator System, Republic of Korea). In the Republic of Korea, the CPI is reorganized every five years to reflect changes in the consumption structure of households. It could be used as a reference point in making various fiscal and economic policy decisions. It should be noted that each country has slightly different CPI components (OECD). For details on the definition of CPI, see OECD, U.S. Bureau of Labor Statistics, e-National Indicator System, Republic of Korea.

### Year-on-Year (YoY) Growth Rate of CPI

The fluctuation rate is defined as the rate of increase (or decrease) at the time of comparison with respect to the base time, and the unit is expressed as a percent(%). The fluctuation rate is an important concept used in interpreting the price index and is classified in month-to-month (MoM) and year-on-year (YoY) ratios according to the base time. Generally, as a measure to represent the fluctuation rate of CPI, the year-on-year (YoY) ratio compared to the same month one year ago is used. For example, if the CPI growth rate in June 2022 is 6%, it means that the CPI in June 2022 increased by 6% compared to June 2021, the same month the previous year.

### Known Statistics

The CPI (YoY) in the Republic of Korea from January 2019 to August 2022 is presented in Table 1 (e-National Indicator System, Republic of Korea).

**Table 1 Consumer Price Index (Year-on-Year) - Total Index (in %)**

	<i>Year 2019</i>	<i>Year 2020</i>	<i>Year 2021</i>	<i>Year 2022</i>
January	0.8	1.2	0.9	3.6
February	0.5	0.9	1.4	3.7
March	0.4	0.8	1.9	4.1
April	0.6	0	2.5	4.8
May	0.7	-0.2	2.6	5.4
June	0.7	0.2	2.3	6.0
July	0.6	0.4	2.6	6.3
August	0.2	0.8	2.6	5.7

### Advantage of our Method

The report by the Price Trend Department in the Economic Trend Statistical Review Officer in the Republic of Korea is based on average rate of increase (or decrease) compared with that of the previous year, which is simple and easy to understand. However it does not give the decision maker detailed information about whether the difference is statistically significant. The analytical method presented in this paper is not just the average rate of increase (or decrease) compared with that of the previous year, as presented in a report by the Price Trend Department in Economic Trend Statistical Review Officer in the Republic of Korea. It has the advantage of providing statistically valid and reliable results. See Section 3 for details.

### 3. Findings and Discussions

In this section, we present statistical comparison results on the CPI YoY from January 2019 through August 2022 with three different hypothesis statements. The implications of the results are then discussed.

#### 3.1. Statistical reasoning and analysis (2019 vs 2020)

In this section, we present statistical comparisons of the two data sets: (i) CPI YoY in the Republic of Korea from January 2019 to August 2019 and (ii) CPI YoY in the Republic of Korea from January 2020 to August 2020.

The following hypotheses are set for the CPI YoY in Republic of Korea:

$H_0$  (**Null hypothesis**): CPI YoY in the Republic of Korea from January 2020 to August 2020  $\geq$  CPI YoY in the Republic of Korea from January 2019 to August 2019.

$H_1$  (**Alternative hypothesis**): CPI YoY in the Republic of Korea from January 2020 to May 2020  $<$  CPI YoY in the Republic of Korea from January 2019 to May 2019.

The basic principle of the analysis presented in this paper is same as that of the statistical control chart. We define the difference between CPI YoY in the Republic of Korea in a specific year and the CPI YoY in the Republic of Korea of the previous year as the error (or natural variability or the chance causes of variation). Under the assumption that  $H_0$  is true, the error (natural variability) is assumed to follow a normal distribution with a mean 0 and a finite variance that is greater than 0, which is an implicit assumption of our study.

Since two-time series in Table 1 are correlated, and each month's data is paired with each other, a pairwise test was used to compare the average differences between the two populations(Chang and Lee, 2021). Under the assumption that the null hypothesis is true, the CPIs YoY in the Republic of Korea from January 2019 to August 2019 are compared with those from January 2020 to August 2020. Table 2 shows the following results which were obtained from the pairwise comparison test (significant level of test = 0.01) using Excel.

*Table 2: Pairwise comparison (2019 vs 2020) test result (significant level of test = 0.01)  
t-test results: Pair wise comparison test*

	<i>CPI YoY from Jan 2019 to Aug 2019</i>	<i>CPI YoY from Jan 2020 to Aug 2020</i>
Average	0.5625	0.5125
Sample variance	0.0369642857	0.238392857
No. of observations	8	8
Pearson's correlation coefficient	-0.268221327	
Difference between two means	0	
d.f.	7	
t statistics	0.247797314	
P(T<=t) one-sided	0.405701441	
t statistics one-sided	2.997951567	
P(T<=t) two-sided	0.811402881	

*Source:* Author's findings

As can be seen from Table 2, the null hypothesis that the two population groups have the same mean is not rejected because the p-value is 0.405701441, which is greater than the 0.01 significance level. There is not enough evidence that the CPI YoY in the Republic of Korea from January 2020 to August 2020 was less than the CPI YoY in the Republic of Korea from January 2019 to August 2019, and the reliability of this conclusion is 0.99.

### 3.2. Statistical reasoning and analysis (2020 vs 2021)

A similar analysis was carried out, and we present our statistical results in Table 3.

The following hypotheses are set for the CPI YoY in Republic of Korea:

**H<sub>0</sub> (Null hypothesis):** CPI YoY in the Republic of Korea from January 2021 to August 2021  $\leq$  CPI YoY in the Republic of Korea from January 2020 to August 2020.

**H<sub>1</sub> (Alternative hypothesis):** CPI YoY in the Republic of Korea from January 2021 to August 2021 > CPI YoY in the Republic of Korea from January 2020 to August 2020.

**Table 3: Pairwise comparison (2020 vs 2021) test result (significant level of test = 0.01)**

**t-test results:** Pairwise comparison test

	<i>CPI YoY from Jan 2020 to Aug 2020</i>	<i>CPI YoY from Jan 2021 to Aug 2021</i>
Average	0.5125	2.1
Sample variance	0.238392857	0.417142857
No. of observations	8	8
Pearson's correlation coefficient	-0.765595971	
Difference between two means	0	
d.f.	7	
t statistics	-4.208357697	
P(T<=t) one-sided	0.00199694008	
t statistics one-sided	2.997951567	
P(T<=t) two-sided	0.00399388015	

**Source:** Author's findings

As can be seen from Table 3, the null hypothesis that the two population groups have the same mean is rejected because the p-value is 0.00199694008, which is less than the 0.01 significance level. There is significant evidence that the CPI YoY in the Republic of Korea from January 2021 to August 2021 was greater than the CPI YoY in the Republic of Korea from January 2020 to August 2020, and the reliability of this conclusion is 0.99.

### 3.3. Statistical reasoning and analysis (2021 vs 2022)

A similar analysis was carried out, and we present our statistical results in Table 4.

The following hypotheses are set for the CPI YoY in the Republic of Korea:

**H<sub>0</sub> (Null hypothesis):** CPI YoY in the Republic of Korea from January 2022 to August 2022  $\leq$  CPI YoY in the Republic of Korea from January 2021 to August 2021.

**H<sub>1</sub> (Alternative hypothesis):** CPI YoY in the Republic of Korea from January 2022 to August 2022 > CPI YoY in the Republic of Korea from January 2021 to August 2021.

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**Table 4.** Pairwise comparison (2021 vs 2022) test result (significant level of test = 0.01)

t-test results: Pairwise comparison test

	<i>CPI YoY from Jan 2021 to Aug 2021</i>	<i>CPI YoY from Jan 2022 to Aug 2022</i>
Average	2.1	4.95
Sample variance	0.417142857	1.117142857
No. of observations	8	8
Pearson's correlation coefficient	0.855910799	
Difference between two means	0	
d.f.	7	
t statistics	-13.32965444	
P(T<=t) one-sided	1.56597E-6	
t statistics one-sided	2.997951567	
P(T<=t) two-sided	3.13194E-6	

**Source:** Author's findings

As can be seen from Table 4, the null hypothesis that the two population groups have the same mean is rejected because the p-value is 0.00000156597, which is less than the 0.01 significance level. There is significant evidence that the CPI YoY in the Republic of Korea from January 2022 to August 2022 was greater than the CPI YoY in the Republic of Korea from January 2021 to August 2021, and the reliability of this conclusion is 0.99.

#### **4. Conclusion**

The Consumer Price Index year-on-year was compared in the Republic of Korea before and after the COVID-19 pandemic. Our analysis has produced the following results: (i) the average difference between the CPI YoY in the Republic of Korea from January 2020 to August 2020 and that from January 2019 to August 2019 is not statistically significant; (ii) the CPI YoY has increased significantly from January 2021 to August 2021 compared to that from January 2020 to August 2020; (iii) the CPI YoY has increased significantly from January 2022 to August 2022 compared to that from January 2021 to August 2021. Note that our analysis is based on the CPI statistics in the Republic of Korea from January 2022 to August 2022, and our conclusion is valid only for this period.

Possible interpretation of each comparative analysis result are summarized as follows:

- ① Interpretation of the comparison results (January 2019 to August 2019 vs January 2020 to August 2020)

Our results could be partly interpreted as the effects related to global supply chain disruptions owing to the spread of the COVID-19 pandemic, drop in international oil prices, shrinking demand as a result of social distancing in the Republic of Korea, etc.

- ② Interpretation of the comparison results (January 2019 to August 2019 vs January 2020 to August 2020)

Our results could be partly interpreted as the effects related to large scale economic stimulus measures in each country, resumption of economic activity, rise of international commodity prices, global liquidity expansion, recovery of domestic demand (such as personal service, petroleum, livestock products, etc.) in the Republic of Korea, etc.

- ③ Interpretation of the comparison results (January 2019 to August 2019 vs January 2020 to

August 2020)

Our results could be partly interpreted as the effects related to global supply chain disruptions owing to the spread of the COVID-19 pandemic, China's zero coronal policy, and the prolonged war between Russia and Ukraine.

Our study shows statistically comprehensive results compared to the studies that limit their discussions to average rate of increase (or decrease) compared to that of the previous year, as presented in a report by the Price Trend Department in the Economic Trend Statistical Review Officer in the Republic of Korea. It has the advantage of providing statistically valid and reliable results. Our analysis and results could be used to define the current situation related to the CPI in the Republic of Korea and provide a reference point in establishing related policies related to the CPI and in evaluating their performance.

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