

An Integrated Analysis of Recent Changes in Year-on-Year Consumer Price Index and Aggregate Import Price Index in Republic of Korea through Statistical Inference*

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Abstract

Purpose - Our previous study (Chang & Lee, 2023) presented observations on the recent changes in the year-on-year (YoY) Consumer Price Index (CPI) of the Republic of Korea (ROK) after the COVID-19 pandemic. The purpose of this article is to present an integrated analysis and interpretation of the recent changes in CPI and the Aggregate Import Price Index (IPI) by incorporating recent data, specifically data from September 2022 to December 2022.

Design/methodology/approach - This study collected CPI (YoY) data in the ROK from January 2019 to December 2022 using e-National Indicator System provided by the ROK. Statistical analysis was employed to analyze the data.

Findings - First, we confirm the extended results of the existing study by Chang and Lee (2023). Second, we demonstrate that the Aggregate IPI in ROK increased significantly in 2022 compared to 2021. We then provide an integrated interpretation on the significant increase in CPI and aggregate IPI in ROK, which complements Chang and Lee (2023) that limits their discussion to YoY CPI. Moreover, we show that the IPI of the semiconductor in ROK decreased significantly in 2022 compared to 2021.

Research implications or Originality - Our results provide important insights into the recent changes in the CPI in the ROK. The results suggest that these changes can be partially attributed to various factors, such as the global supply chain disruptions resulting from the spread of the COVID-19 pandemic and the prolonged war between Russia and Ukraine, the side effect of quantitative easing by the US Federal Reserve, heat waves and droughts caused by climate change in ROK, a surge in demand following a gradual daily recovery, US-China trade conflict, etc. Our study shows statistically comprehensive results compared to the studies that limit their discussion to YoY average growth rate.

Keywords: Consumer Price Index, Import Price Index, Inflation, Statistical Significance

JEL Classifications: A10, Z00

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I. Introduction

According to news releases from the Organisation for Economic Cooperation and Development (OECD) (December 6, 2022), year-on-year (YoY) inflation in the OECD as measured by the Consumer Price Index (CPI) rose to 10.7% in October 2022, as food prices continued to increase in most countries. Double-digit inflation was reported in 18 out of 38 OECD countries, with the highest rates observed in Estonia, Hungary, Latvia, Lithuania, and Turkey (OECD, 2022). Food inflation continued to rise in the OECD in October, reaching its highest rate since May 1974, with rises in 33 of 38 OECD countries. The Reserve Bank of India (RBI) on December 7, 2022, raised its key repo rate by 35 bps to 6.25% in its fifth hike 2022 (Reserve Bank of India (RBI)). The 5th consecutive rate hike is to control lingering inflation pressures. See OECD (2022), World Bank Blog (2023) and World Economic Forum (2023), for details.

Note that the CPI is the most commonly used price index and is the most representative inflation indicator (OECD; U.S. Bureau of Labor Statistics; Bank of Korea). The Import Price Index (IPI) is a business cycle indicator which measures the overall price level of imported goods (OECD, U.S. Bureau of Labor Statistics; Bank of Korea). The IPI is used to identify price trends of imported goods, help measure exchange rates, and measure terms of trade through mutual comparison of imported price indices, etc. (OECD; Blanchard, Olivier, 2000). CPI and IPI are often used as reference points in establishing fiscal and monetary policy (OECD; Blanchard, Olivier, 2000).

According to the Managing Director of the International Monetary Fund (IMF), with economic recessions in the US, the EU, and China, this year (2023) will be tougher than last year (2022). She warned that a third of the world is expected to fall into a recession, and that even in the countries that are not in recession, hundreds of millions of people will also feel as though they are in recession (Financial Times, 2023).

For the successful monitoring and policy solutions to reduce inflation, continuous update of research findings on pattern changes in the CPI is of the utmost importance. The updated information on pattern changes in the CPI promotes exchange of knowledge and communication between researchers, scientists, policymakers, government agencies, and professionals working in the field of management/business/economy, or other related areas.

The OECD and IMF have homepages for monitoring global CPI, whereas the World Bank provides monthly data coverage (updated daily and populated upon availability) for CPI and other economic indicators such as exchange rates, equity markets, interest rates, emerging market bond indices, high-tech market indicators, etc. (IMF; IMF Blog). In Chang and Lee (2022), we present a summary of literature review on recent issues in supply chain management including the pattern change of CPI after COVID-19 pandemic.

The rest of this article is organized as follows. In the Research Contribution section, we present the contribution of this article and advantages of our methods. In the Analysis and Finding section, we present updated results in Chang and Lee (2023) and compare the average differences in YoY CPI of the ROK after the COVID-19 pandemic. We also found that the aggregate IPI in the ROK increased significantly in 2022 compared to 2021, complementing our previous findings in Chang and Lee (2023). In the Conclusion, we provide an integrated interpretation on the significant increase in YoY CPI and aggregate IPI in ROK, which complements Chang and Lee (2023) that limits their discussion to YoY CPI. In the Appendix, we

show that the CPIs of foodstuffs and non-alcoholic beverages, housing, water supply, fuel, transportation, electricity, clothing, and education, and IPIs of crude oil and natural gas increased significantly in 2022 compared to 2021. We also show that the IPI of the semiconductor in ROK decreased significantly in 2022 compared to 2021, which complement Chang and Lee (2023). We briefly provide interpretation of our results in Appendix.

II. Research Contributions

1. The Contributions of This Article

In this section, we highlight the contributions of this article, which are as follows:

(1) In contrast to our previous study (Chang and Lee, 2023) that only focused on the analysis of YoY CPI in ROK, this article presents additional analysis on aggregate IPI in ROK. We then provide an integrated interpretation of the significant increase in YoY CPI and aggregate IPI in 2022 (see Conclusion). Furthermore, we offer additional analysis and interpretation on the pattern change of the aggregate IPI of three major export industries in ROK (semiconductors, natural gas, and crude oil) for 2022 compared to 2021 (see Conclusion and Appendix).

(2) We present updated results of our previous study (Chang & Lee, 2023) by incorporating recent data from September 2022 to December 2022. We confirm the extended results of Chang and Lee (2023).

2. The Advantages of Our Methods

In this section, we present the advantages of our method.

The report by the Price Trend Department in the Economic Trend Statistical Review Officer in ROK 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 decision-makers detailed information about whether the difference is statistically significant or not. Our study presents statistically comprehensive results in contrast to studies that focus solely on the average rate of increase (or decrease) compared to the previous year, as is commonly presented in reports by the Price Trend Department in the Economic Trend Statistical Review Officer in the ROK. This provides decision makers with information on the statistical significance of the analysis as well as the YoY average growth rate. See the Analysis and Finding section for details.

III. Analysis and Finding

In this section, we present statistical comparison results on the YoY CPI from January 2019 through December 2022 with three different hypothesis statements. We also present statistical comparison results on the aggregate IPI from January 2021 through December 2022. The implications of the results are then discussed.

1. Known Statistics

In this section, we show CPI (YoY) statistics in the ROK from January 2019 to December 2022. We also present aggregate IPI statistics in ROK from January 2021 to December 2022.

〈Table 1〉 presents the CPI (YoY) in the ROK from January 2019 to December 2022 (e-National Indicator System, Republic of Korea; Bank of Korea).

Table 1. Consumer Price Index (Year-on-Year) – Overall Index (in %)

	Year 2019	Year 2020	Year 2021	Year 2022
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	0.0	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	0.0	0.8	2.6	5.7
September	-0.4	0.9	2.4	5.6
October	0.0	0.1	3.2	5.7
November	0.2	0.6	3.8	5.0
December	0.7	0.6	3.7	5.0

Source: e-National Indicator System, Republic of Korea; Bank of Korea (2019-2022).

〈Table 2〉 presents the Aggregate Import Price Index (dollar basis) in the ROK from January 2021 to December 2022 (e-National Indicator System, Republic of Korea; Bank of Korea).

Table 2. Aggregate Import Price Index based on 2015 = \$100

	Year 2021	Year 2022
January	104.65	125.56
February	107.87	130.82
March	109.71	138.11
April	110.60	136.06
May	113.48	137.03
June	116.79	137.00
July	118.58	130.33
August	118.42	128.10
September	120.18	125.44
October	125.07	123.78
November	123.83	122.35
December	125.56	120.82

Source: e-National Indicator System, Republic of Korea; Bank of Korea (2021-2022).

2. Statistical Reasoning and Analysis (2019 vs 2020): CPI YoY

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

The following hypotheses are proposed for the CPI YoY in ROK:

H_0 (Null hypothesis): CPI YoY in the ROK from January 2020 to December 2020 \geq CPI YoY in the ROK from January 2019 to December 2019.

H_1 (Alternative hypothesis): CPI YoY in the ROK from January 2020 to December 2020 $<$ CPI YoY in the ROK from January 2019 to December 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 ROK in a specific year and the CPI YoY in the ROK 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 & Lee, 2023). Under the assumption that the null hypothesis is true, the CPIs YoY in the ROK from January 2019 to December 2019 are compared with those from January 2020 to December 2020. <Table 3> shows the following results which were obtained from the pairwise comparison test (significant level of test = 0.01) using Excel.

Table 3. Results of Pairwise Comparison Test (2019 vs 2020): CPI YoY

t-test results: Pairwise comparison test (significant level of test = 0.01)

	CPI YoY 2019	CPI YoY 2020
Average	0.4	0.525
Sample variance	0.138182	0.182045
No. of observations	12	12
Pearson's correlation coefficient		-0.21208
Difference between two means		0
d.f.		11
t statistics		-0.69561
P(T<=t) one-sided		0.250553
t statistics one-sided		2.718079
P(T<=t) two-sided		0.501106
t statistics two-sided		3.105807

As can be seen from <Table 3>, the null hypothesis that the two population groups have the same mean is not rejected because the p-value is 0.250553, which is greater than the 0.01 significance level. There is not enough evidence to demonstrate that the CPI YoY in the ROK from January 2020 to December 2020 was less than the CPI YoY in the ROK from January 2019 to December 2019. The reliability of this conclusion is 0.99.

3. Statistical Reasoning and Analysis (2020 vs 2021): CPI YoY

A similar analysis was carried out, and the results are presented in Table 4. The following hypotheses are proposed for the CPI YoY in ROK:

H_0 (Null hypothesis): CPI YoY in the ROK from January 2021 to December 2021 \leq CPI YoY in the ROK from January 2020 to December 2020.

H_1 (Alternative hypothesis): CPI YoY in the ROK from January 2021 to December 2021 $>$ CPI YoY in the ROK from January 2020 to December 2020.

Table 4. Results of Pairwise Comparison Test (2020 vs 2021): CPI YoY

t-test results: Pairwise comparison test (significant level of test = 0.01)

	CPI YoY 2020	CPI YoY 2021
Average	0.525	2.491667
Sample variance	0.182045	0.711742
No. of observations	12	12
Pearson's correlation coefficient		-0.45397
Difference between two means		0
d.f.		11
t statistics		-6.16643
P(T<=t) one-sided		3.52E-05
t statistics one-sided		2.718079
P(T<=t) two-sided		7.04E-05
t statistics two-sided		3.105807

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 0.0000352, which is less than the 0.01 significance level. There is significant evidence that the CPI YoY in ROK from January 2021 to December 2021 was greater than the CPI YoY in ROK from January 2020 to December 2020. The reliability of this conclusion is 0.99.

4. Statistical Reasoning and Analysis (2021 vs 2022): CPI YoY

A similar analysis was carried out, and the results are presented in (Table 5). The following hypotheses are proposed for the CPI YoY in ROK:

H_0 (Null hypothesis): CPI YoY in the ROK from January 2022 to December 2022 \leq CPI YoY in the ROK from January 2021 to December 2021.

H_1 (Alternative hypothesis): CPI YoY in the ROK from January 2022 to December 2022 $>$ CPI YoY in the ROK from January 2021 to December 2021.

Table 5. Results of Pairwise Comparison Test (2021 vs 2022): CPI YoY

t-test results: Pairwise comparison test (significant level of test = 0.01)

	CPI YoY 2021	CPI YoY 2022
Average	2.491667	5.075
Sample variance	0.711742	0.783864
No. of observations	12	12
Pearson's correlation coefficient		0.570515
Difference between two means		0
d.f.		11
t statistics		-11.1571
P(T<=t) one-sided		1.23E-07
t statistics one-sided		2.718079
P(T<=t) two-sided		2.45E-07
t statistics two-sided		3.105807

As can be seen from (Table 5), the null hypothesis that the two population groups have the same mean is rejected because the p-value is 0.000000123, which is less than the 0.01 significance level. There is significant evidence that the CPI YoY in ROK from January 2022 to December 2022 was greater than the CPI YoY in ROK from January 2021 to December 2021. The reliability of this conclusion is 0.99.

5. Statistical Reasoning and Analysis (2021 vs 2022): Aggregate Import Price Index

A similar analysis was carried out, and the results are presented in (Table 6). The following hypotheses are proposed for the Aggregate Import Price Index (dollar basis) in ROK:

H_0 (Null hypothesis): Aggregate Import Price Index in the ROK from January 2022 to December 2022 \leq Aggregate Import Price Index in the ROK from January 2021 to December 2021.

H_1 (Alternative hypothesis): Aggregate Import Price Index in the ROK from January 2022 to December 2022 $>$ Aggregate Import Price Index in the ROK from January 2021 to December 2021.

Table 6. Results of Pairwise Comparison Test (2021 vs 2022): Aggregate IPI

t-test results: Pairwise comparison test (significant level of test = 0.01)

	Import Price Index - Overall Index 2021	Import Price Index - Overall Index 2022
Average	115.8717	129.6167
Sample variance	42.89616	38.68501
No. of observations	12	12
Pearson's correlation coefficient	-0.53644	
Difference between two means	0	
d.f.	11	
t statistics	-4.25387	
P(T<=t) one-sided	0.000678	
t statistics one-sided	2.718079	
P(T<=t) two-sided	0.001357	
t statistics two-sided	3.105807	

As can be seen from (Table 6), the null hypothesis that the two population groups have the same mean is rejected because the p-value is 0.000678, which is less than the 0.01 significance level. There is significant evidence that the Aggregate Import Price Index in ROK from January 2022 to December 2022 was greater than the Aggregate Import Price Index (YoY) in ROK from January 2021 to December 2021. The reliability of this conclusion is 0.99.

IV. Conclusion

This article presents an integrated analysis and interpretation of the recent changes in the YoY CPI and the Aggregate Import Price Index (IPI) in ROK by incorporating recent data, specifically data from September 2022 to December 2022. In addition to confirming the extended results of our previous study (Chang & Lee, 2023), we demonstrated that the aggregate IPI in the ROK increased significantly in 2022 compared to 2021, complementing our previous findings in Chang and Lee (2023). The results were as follows: (i) the average difference in the CPI YoY in the ROK from January 2020 to December 2020 and that from January 2019 to December 2019 is not statistically significant; (ii) the CPI YoY increased significantly from January 2021 to December 2021 compared to that from January 2020 to December 2020; and (iii) the CPI YoY increased significantly from January 2022 to December 2022 compared to that from January 2021 to December 2021. Note that our results are only valid from 2019 to 2022. In the Appendix, we show that the CPIs of foodstuffs and non-alcoholic beverages, housing, water supply, fuel, transportation, electricity, and education, and IPIs of crude oil and natural gas in ROK increased significantly in 2022 compared to 2021.

We make brief comments on the implications of our findings:

(1) Integrated interpretation on significant increases in CPI (YoY) and aggregate IPI in ROK in 2022: Our results (significant increases in CPI (YoY) and aggregate IPI in ROK in 2022)

could partly be explained based on the argument in classical textbooks in business and economy. The strengthening of the value of the US dollar owing to the Fed's aggressive tightening (March, May, June, July, September, November and December in 2022) leads to the significant increase in aggregate IPI in ROK, which is reflected in the domestic consumer prices in ROK with a time lag. In the Appendix, we provide an interpretation of the comparison results for the IPI of the top three imports (crude oil, natural gas, and semiconductor) in ROK between 2021 and 2022. Notably, the IPI of semiconductors in ROK decreased significantly in 2022 compared to 2021, while the IPI of crude oil and natural gas in ROK increased significantly in 2022 compared to 2021. See the Appendix for further details on their interpretations.

(2) Interpretation of CPI (YoY) comparison results (January 2021 to December 2021 vs January 2022 to December 2022):

Our study provides insights into the recent changes in the CPI in the ROK. The results suggest that these changes can be partially attributed to various factors, such as the global supply chain disruptions resulting from the spread of the COVID-19 pandemic and the prolonged war between Russia and Ukraine, the side effect of quantitative easing by the US Federal Reserve, heat waves and droughts caused by climate change in ROK, a surge in demand following a gradual daily recovery, US-China trade conflict, etc.

(3) There are several measures that can be taken to address the rise in the CPI in ROK. The government of ROK and the Bank of Korea can attempt to adjust monetary policy through interest rate increases. However, there can be potential drawbacks (such as decrease in consumer spending and business investment, increase in the cost of borrowing for households and firms, a potential increase in default rates, etc) to raising interest rates as a policy response to rising consumer price inflation. It is important for policymakers to carefully consider the potential benefits and drawbacks of different policy responses to rising inflation before implementing any specific measures.

Our study shows statistically comprehensive results compared to the studies that limit their discussions to YoY average growth rate, as presented in a report (by the Price Trend Department in the Economic Trend Statistical Review Officer in the ROK). It can provide decision makers with information on statistical significance of the analysis as well as YoY average growth rate. As such, our study contributes to a more nuanced understanding of the economic situation in ROK, which can be used as a reference point in making rational decisions in navigating the challenges of a rapidly changing global economic landscape.

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Appendix

Since the outline of the analysis in Appendix is the same as that presented in the section 3.2. “Statistical Reasoning and Analysis (2019 vs 2020): CPI YoY,” we only present the final pairwise comparison results for CPI of foodstuffs and non-alcoholic beverages, housing, water supply, fuel, transportation, electricity, clothing, and education, and for IPI of the top three imports (crude oil, natural gas, and semiconductors) in the ROK. See Online Supplementary Materials for summary of CPIs of foodstuffs and non-alcoholic beverages, housing, water supply, fuel, transportation, electricity, clothing, and education, and IPI statistics in ROK from January 2021 to December 2022.

Table 7. Results of Pairwise Comparison (2021 vs 2022) Test: CPI for Foodstuffs and Non-Alcoholic Beverages based on 2015 = \$100

t-test results: Pairwise comparison test (significant level of test = 0.01)

	CPI: foods & non-alcoholic beverage 2021	CPI: foods & non-alcoholic beverage 2022
Average	105.8858	112.15
Sample variance	1.871081	5.668345
No. of observations	12	12
Pearson's correlation coefficient		0.667234
Difference between two means		0
d.f.		11
t statistics		-12.1428
P(T<=t) one-sided		5.15E-08
t statistics one-sided		2.718079
P(T<=t) two-sided		1.03E-07
t statistics two-sided		3.105807

As can be seen from Table 7, the null hypothesis that the two population groups have the same mean is rejected because the p-value is 0.0000000515, which is less than the 0.01 significance level. There is significant evidence that the CPI of foodstuffs and non-alcoholic beverages in the ROK from January 2022 to December 2022 was greater than the CPI of foodstuffs and non-alcoholic beverages in the ROK from January 2021 to December 2021. The reliability of this conclusion is 0.99.

Table 8. Results of Pairwise Comparison Test (2021 vs 2022): CPI for Housing, Water Supply, Electricity, and Fuel based on 2015 = \$100

t-test results: Pairwise comparison test (significant level of test = 0.01)

	CPI: housing, water supply, electricity and fuel 2021	CPI: housing, water supply, electricity and fuel 2022
Average	101.6333	107.1917
Sample variance	1.079497	6.156215
No. of observations	12	12
Pearson's correlation coefficient		0.906701
Difference between two means		0
d.f.		11
t statistics		-12.032
P(T<=t) one-sided		5.66E-08
t statistics one-sided		2.718079
P(T<=t) two-sided		1.13E-07
t statistics two-sided		3.105807

As can be seen from Table 8, the null hypothesis that the two population groups have the same mean is rejected because the p-value is 0.0000000566, which is less than the 0.01 significance level. There is significant evidence that the CPI of housing, water supply, electricity, and fuel in the ROK from January 2022 to December 2022 was greater than the CPI of housing, water supply, electricity and fuel in the ROK from January 2021 to December 2021, and the reliability of this conclusion is 0.99.

Table 9. Results of Pairwise Comparison Test (2021 vs 2022): CPI for Transportation based on 2015 = \$100

t-test results: Pairwise comparison test (significant level of test = 0.01)

	CPI: transportation 2021	CPI: transportation 2022
Average	106.3333	116.6817
Sample variance	8.703697	19.1918
No. of observations	12	12
Pearson's correlation coefficient		0.166094
Difference between two means		0
d.f.		11
t statistics		-7.37879
P(T<=t) one-sided		6.98E-06
t statistics one-sided		2.718079
P(T<=t) two-sided		1.4E-05
t statistics two-sided		3.105807

As can be seen from Table 9, the null hypothesis that the two population groups have the same mean is rejected because the p-value is 0.00000698, which is less than the 0.01 significance level. There is significant evidence that the CPI of transportation in ROK from January 2022 to December 2022 was greater than the CPI of transportation in ROK from January 2021 to December 2021, and the reliability of this conclusion is 0.99.

Table 10. Results of Pairwise Comparison Test (2021 vs 2022): CPI for Education based on 2015 = \$100

t-test results: Pairwise comparison test (significant level of test = 0.01)

	CPI: education 2021	CPI: education 2022
Average	100.8683	102.2275
Sample variance	0.076942	0.201839
No. of observations	12	12
Pearson's correlation coefficient		0.917595
Difference between two means		0
d.f.		11
t statistics		-21.0391
P(T<=t) one-sided		1.55E-10
t statistics one-sided		2.718079
P(T<=t) two-sided		3.1E-10
t statistics two-sided		3.105807

As can be seen from Table 10, the null hypothesis that the two population groups have the same mean is rejected because the p-value is 0.00000000155, which is less than the 0.01 significance level. There is significant evidence that the CPI of education in ROK from January 2022 to December 2022 was greater than the CPI of education in ROK from January 2021 to December 2021, and the reliability of this conclusion is 0.99.

Table 11. Pairwise comparison (2021 vs 2022) test result: CPI for health based on 2015 = \$100

t-test results: Pairwise comparison test (significant level of test = 0.01)

	CPI: health 2021	CPI: health 2022
Average	99.92167	100.7558
Sample variance	0.052924	0.05439
No. of observations	12	12
Pearson's correlation coefficient		-0.54394
Difference between two means		0
d.f.		11
t statistics		-7.09916
P(T<=t) one-sided		9.98E-06
t statistics one-sided		2.718079
P(T<=t) two-sided		2E-05
t statistics two-sided		3.105807

As can be seen from Table 11, the null hypothesis that the two population groups have the same mean is rejected because the p-value is 0.00000998, which is less than the 0.01 significance level. There is significant evidence that the CPI of health in ROK from January 2022 to December 2022 was greater than the CPI of health in ROK from January 2021 to December 2021, and the reliability of this conclusion is 0.99.

Table 12. Pairwise comparison (2021 vs 2022) test result: Import Price Index for crude oil and natural gas based on 2015 = \$100

t-test results: Pairwise comparison test (significant level of test = 0.01)

	Import Price Index - crude oil and natural gas 2021	Import Price Index - crude oil and natural gas 2022
Average	121.8227	178.3182
Sample variance	248.1999	206.9389
No. of observations	11	11
Pearson's correlation coefficient		0.232527
Difference between two means		0
d.f.		10
t statistics		-10.0193
P(T<=t) one-sided		7.81E-07
t statistics one-sided		2.763769
P(T<=t) two-sided		1.56E-06
t statistics two-sided		3.169273

As can be seen from Table 12, the null hypothesis that the two population groups have the same mean is rejected because the p-value is 0.000000781, which is less than the 0.01 significance level. There is significant evidence that the Import Price Index- crude oil and natural gas in ROK from January 2022 to December 2022 was greater than the Import Price Index - crude oil and natural gas in the ROK from January 2021 to December 2021, and the reliability of this conclusion is 0.99.

Our results (significant increase in price of natural gas) in Table 12 could be partly interpreted as the effect related to a surge in demand for natural gas due to restrictions on natural gas supply in Russia. The significant increase in crude oil price in Table 12 could be partly interpreted as the effect related to global supply chain disruptions resulting from the prolonged war between Russia and Ukraine, adjustment of OPEC+'s production cut, increased demand for oil due to large scale economic stimulus measures in each country after COVID-19 pandemic, etc.

Table 13. Pairwise comparison (2021 vs 2022) test result: Import Price Index for semiconductor based on 2015 = \$100

t-test results: Pairwise comparison test (significant level of test = 0.01)

	Import Price Index - semiconductor 2021	Import Price Index - semiconductor 2022
Average	72.315	68.16417
Sample variance	1.413736	7.162099
No. of observations	12	12
Pearson's correlation coefficient		-0.61506
Difference between two means		0
d.f.		11
t statistics		4.068578
P(T<=t) one-sided		0.000928
t statistics one-sided		2.718079
P(T<=t) two-sided		0.001856
t statistics two-sided		3.105807

As can be seen from Table 13, the null hypothesis that the two population groups have the same mean is rejected because the p-value is 0.000928, which is less than the 0.01 significance level. There is significant evidence that the Import Price Index – semiconductor in the ROK from January 2022 to December 2022 was less than the Import Price Index – semiconductor in the ROK from January 2021 to December 2021, and the reliability of this conclusion is 0.99.

Our results (significant decrease in semiconductor prices in 2022) in Table 13 could be partly interpreted as the effect related to sluggish global demand for semiconductor due to economic recession in 2022.