Jurnal Pendidikan Ekonomi & Bisnis, 11 (2) 2023, 142-165
JURNAL PENDIDIKAN EKONOMI & BISNIS
http://journal.unj/unj/index.php/jpeb

Analysis of South Korea's Macroeconomic Development with the Vector Error Correction Model

Eeng Ahman[1]*, Amir Machmud[2], Fadli Agus Triansyah[3]
[1,2,3] *Faculty of Economics and Business, Universitas Pendidikan Indonesia, Indonesia*

Article Info

Article history:
Received: 08 August 2023;
Accepted: 04 February 2024;
Published: 20 February 2024.

Keywords:
Gross Domestic Product; Import; Inflation; Unemployment; Vector Error Correction Model.

Abstract

This study examines the relationship between Gross Domestic Product (GDP), Import (IMP), Inflation (INF), and Unemployment (UNP) in South Korea using the panel vector error correction model (VECM), cointegration, and Granger. VECM is used to analyze the relationship or causality between variables involved in this research in the short and long run. From the estimation results, especially on the variables of interest, there is a positive and statistically significant relationship between Gross Domestic Product, Import, Inflation, and Unemployment, which refers more to short-term causality. Impulse Response Function analysis is used to determine the impact between variables where the results that had a positive effect during the Covid-19 pandemic were import shocks to GDP and unemployment shocks to GDP, while those that had a negative impact were inflation rate shocks to GDP in South Korea during the Covid-19 pandemic.

Abstrak

Penelitian ini mengkaji hubungan antara Produk Domestik Bruto (PDB), Impor (IMP), Inflasi (INF), dan Pengangguran (UNP) di Korea Selatan dengan menggunakan model panel vector error correction (VECM), kointegrasi, dan uji kausalitas Granger. VECM digunakan untuk menganalisis hubungan atau kausalitas antar variabel baik dalam jangka pendek maupun jangka panjang. Dari hasil estimasi khususnya pada variabel suku bunga, terdapat hubungan yang positif dan signifikan secara statistik antara Produk Domestik Bruto, Impor, Inflasi, dan Pengangguran yang lebih mengacu pada jangka pendek. hubungan sebab dan akibat. Analisis Impulse Response Function digunakan untuk mengetahui dampak antar variabel dimana hasil yang berpengaruh positif pada masa pandemi Covid-19 adalah guncangan impor terhadap PDB dan guncangan pengangguran terhadap PDB, sedangkan dampak negatifnya adalah tingkat inflasi kejutan terhadap PDB di Korea Selatan selama pandemi Covid-19.

How to Cite:
Ahman, E., Machmud, A., & Agus Triansyah, F. (2023). Analysis of South Korea’s Macroeconomic Development with the Vector Error Correction Model. *Jurnal Pendidikan Ekonomi & Bisnis, 11*(02), 142-165. https://doi.org/10.21009/JPEB.011.2.4

* Corresponding Author.
eengahman@upi.edu. Eeng Ahman

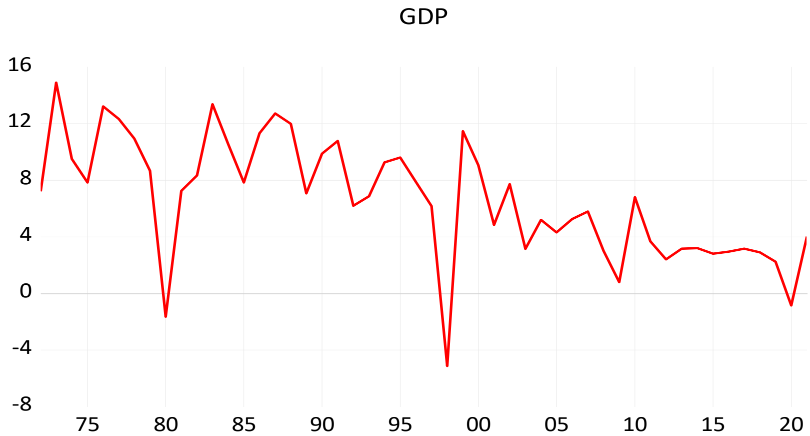
ISSN
2302-2663 (online)
DOI: doi.org/10.21009/JPEB.0011.2.4

INTRODUCTION

Economic growth is one of the most significant markers of a country's economic development and growth, which can boost the wealth and welfare of its citizens at the level of income per capita (Burger, 2017; DIMA, 2021). Economic growth can describe a country's economic development's success, which it can then use to explain other macro indicators such as the inflation rate, unemployment rate, and poverty rate, among others (Onder & Nyadera, 2020). Economic growth is a long-term process of increasing per capita production. The higher a country's economic growth, the greater its ability to meet the demands of its people and, therefore, the greater its capacity to prosper its people (Anokhina, 2022). A prior study also noted that economic growth is recognized as expanding economic activity that increases the production of products and services in society (Widarni & Bawono, 2021). Based on the prior explanation, economic growth is a process of growing the economy's production capacity and thoroughly creating more significant national income.

The rate of economic growth that depends on the previous production as a measure of economic growth can encourage the government through policies in the fields of macroeconomics, investment, trade, law, and legislation so that the government has an essential role in creating a conducive climate for optimal market work. In addition, the central bank, as a monetary policymaker, has a prominent role in building efficient conditions for the operation of the market mechanism. Sectoral and regional approaches are also essential to increase economic growth (Onder & Nyadera, 2020; Sappewali & Hasanuddin, 2022).

In reality, an unexpected coronavirus disease 2019 (Covid-19) has been spreading around the world since the end of 2019 in Wuhan, the central city in China, reporting the first cases of Covid-19 (Kim & Lee, 2021). In March 2020, several researchers and media outlets reported on how this awful epidemic had impacted the economies of the affected nations. The People's Republic of China, Italy, South Korea, France, Spain, Germany, Japan, and the United States have the highest number of confirmed cases worldwide (Or et al., 2021). This pandemic has also caused significant economic shocks to several economic sectors, forcing countries to determine the most effective policies to save their country's economy from being a lockdown (He et al., 2020; Jung, 2021; Kim et al., 2021; Rodriguez Tirado, 2022; Sravan & Mishra, 2022). During the Covid-19 situation, South Korea experienced the same economic situation as other countries. The financial data in South Korea is provided in Figure 1.



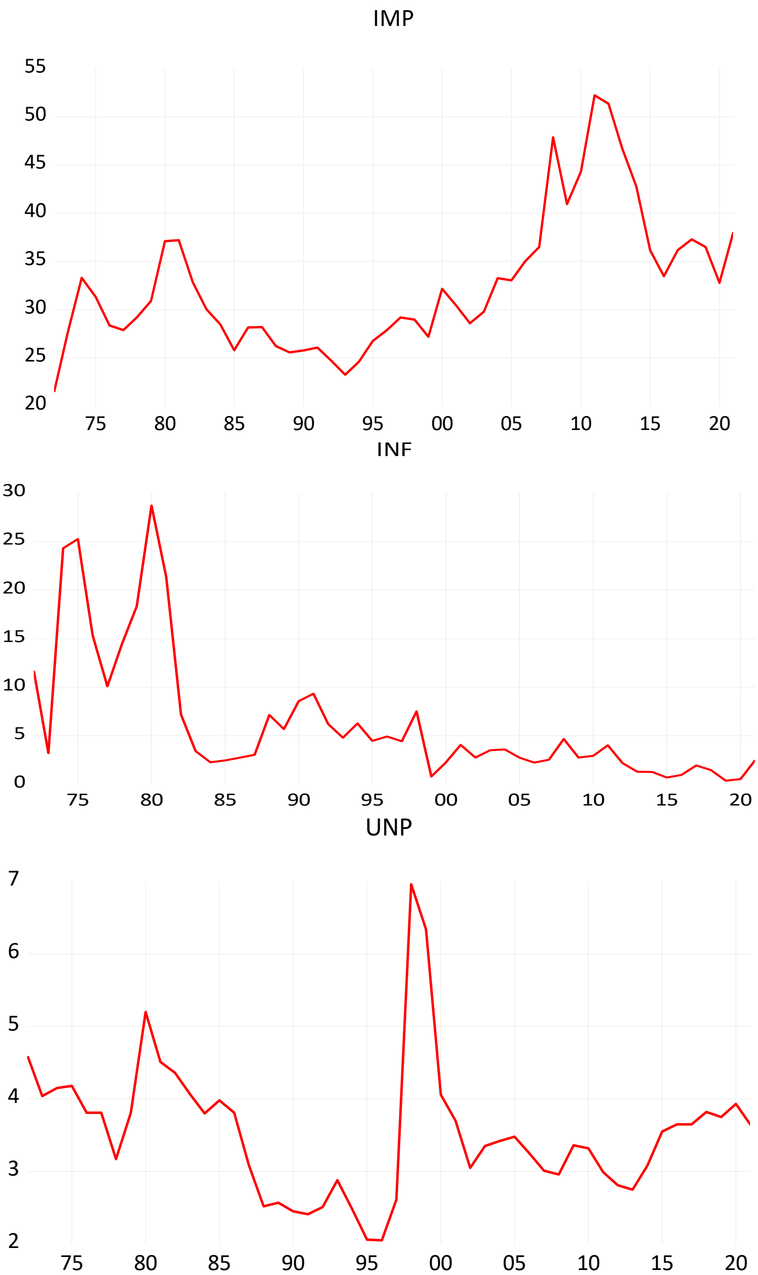


Figure 1. Percentage data for GDP, IMP, INF and UNP in South Korea from 1972 to 2021

The state of the South Korean economy from 1972 to 2021, when viewed from the growth rate of Gross Domestic Product from 1972 to 2021, was stagnant. Still, it can be known that in 2020 it experienced a very significant decline compared to the year in the previous period. The inflation rate (INF) decreased significantly from 2011 to 2019, then stagnated from 1995 to 2020. Furthermore, the import level (IMP) also experienced an increase or decline, with the highest growth in 2011. Finally, unemployment (UNP) experienced a significant decrease from 1998 to 2018. In 2020, due to the Covid-19, South Korea experienced an increase in unemployment of 3.93%. However, the unemployment rate in 2020 is still lower than in 1998, which was 6.96%.

Numerous studies have been undertaken to quantify the macroeconomics of a country, but the Vector Error Correction Model (VECM) has been utilized in only a few. As an illustration, Ababulgu Abasimel and Wana Fufa (2022) used quantitative analysis based on textual data to examine the effect of Covid-19 on the macro economy that occurred in the nation of Ethiopia. Then, Fourkan (2021) examines GDP growth and its impact on a nation's financial situation, considering the inflation rate, financial condition, unemployment, and economic development as influencing factors. The analysis uses panel data analysis and includes OLS, Fixed Effects, and Random Effects, and the findings

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

indicate that the balance sheet does not show a positive trend.

Furthermore, the preliminary paper by Adeseye (2021) showed a relationship between Gross Domestic Product (GDP), Export, and Import while there is no relationship at all with remittances. In the meantime, Sharma and Shrivastava (2021) involved the VECM analysis to estimate shocks to economic activity and the effect of world oil prices on economic growth in India. Their research findings indicate that GDP, unemployment, inflation, exchange rates, and stock prices have long-term causality with macroeconomics in India. Similarly, Moradi et al. (2021) noted that Iran's macro economy had a significant impact, particularly on inflation, unemployment, and stock price volatility, but not on GDP or currency exchange rates. As a consequence, it has a substantial effect on the overall economy in Iran.

Hafnida Hasan et al. (2021) adopted the Granger Causality analysis to estimate the impact of imports on the macro-economy in Bahrain. The findings indicate that there is no short-term causality of exports and imports on economic growth in Bahrain. In the context of Myanmar, Tang and Li (2021) revealed that the economic growth that has taken place in Myanmar up to this point has been proceeding favorably, even though Myanmar's level trade balance has experienced a deficit. In contrast, investments made by investors from countries outside Myanmar have increased. Despite this, the results of Tang and Li's research indicated that the economic growth that has taken place in Myanmar thus far has been going well.

Durguti et al. (2021) found that inflation and investment indicators were the most significant determinants of Balkan economic growth. Similarly to the study completed by Inchausti-Sintes et al., (2021), economic growth in the Canary Islands uses the panel data regression approach; the analysis findings indicate that economic growth is one of the primary variables in the tourism development region. In addition to economic growth influenced by the tourism industry, fiscal and monetary regulations in the macro economy must also be studied further, such as the research conducted by Chugunov et al. (2021), where research originates from Brazil, Kazakhstan, India, Russia, and Europe. Analyzing macroeconomic data using qualitative studies indicates that government policies influence economic growth in Kazakhstan, India, and Russia.

The theme of economic growth holds paramount importance both globally and locally. At a global level, economic growth is a crucial indicator of a nation's overall economic development and prosperity (Al-Qudah et al., 2022; Liu et al., 2022; Zhang & Dilanchiev, 2022). It significantly impacts the wealth and well-being of citizens, as reflected in income per capita. Economic growth is intricately linked to various indicators such as inflation, unemployment, and poverty. One's ability to meet people's demands and enhance their living standards is directly proportional to economic growth. This is emphasized by the fact that economic growth entails a continuous process of increasing per capita production, fostering a country's capacity to prosper its citizens. However, the unforeseen outbreak of the Covid-19 pandemic in 2019 has disrupted global economic landscapes, impacting various nations, including South Korea. This crisis has necessitated an examination of the pandemic's effects on economic growth, presenting a research gap in understanding the specific dynamics of economic shocks and recovery strategies.

The research gap in the existing literature lies in the limited utilization of VECM to quantify the macroeconomics of nations, particularly during the Covid-19 pandemic. While numerous studies have explored the macroeconomic aspects of various countries, the application of VECM remains underexplored. For instance, Ababulgu Abasimel and Wana Fufa (2022) examined the impact of Covid-19 on Ethiopia's macroeconomy using textual data, while Fourkan (2021) investigated GDP growth and its influence on a nation's financial situation. Adeseye (2021) analyzed the effects of migration on economic growth in Nigeria, and Sharma and Shrivastava (2021) explored shocks to economic activity and world oil prices on economic growth in India using VECM. However, none of these studies specifically used VECM to understand the effects of the pandemic on the macroeconomy. Therefore, the novelty of this research lies in applying VECM to assess the economic situation in South Korea during the Covid-19 pandemic, offering a unique perspective on the dynamics of economic growth, inflation, trade, and unemployment in the aftermath of a global crisis. This research aims to contribute valuable insights into policy-making by identifying effective strategies for mitigating economic shocks and fostering sustainable economic growth in the post-pandemic era.

METHOD

This study's goal is to revisit the correlation between macroeconomic indicators for South Korea's Gross Domestic Product (GDP), inflation, imports, and unemployment or underemployment (UNP) from 1972 to 2021. This framework will be suitable based on cointegration analysis with a vector error correction model (VECM). The cointegration approach's strength lies in its capacity to incorporate short-term dynamics and long-term equilibrium correlations between variables. The model developed by Johansen (1988) and expanded by Johansen and Juselius in 1990 is the one we utilize (1991). This technique is regarded as more reliable and effective than other maximum likelihood techniques since it makes handling multivariate analysis easier. The Johansen process outperformed the other four cointegration methods in a recent Monte Carlo simulation, according to Gonzalo (1994), who assessed all five alternatives. Although this model has been developed for a long time, it is suitable for developing causal relationships between variables in the long and short term and is widely used in developing economic models (Hossin & Hamid, 2021; Nkalu et al., 2020; Osuagwu, 2020; Yadav et al., 2022; Ybrayev, 2022).

The data contained in this study is secondary data. This data were gathered from the World Bank data (https://databank.worldbank.org/source/world-development-indicators), which consists of data on GDP, Inflation, Imports, and Unemployment Rate in South Korea from 1972 to 2021. This study involved a causal research design where the data form is time series data or time series data, which aims to provide an overview of the relationships between the independent variables and the dependent variable using the VECM approach. The model has several procedures before data analysis, namely Estimation specification and model examination consisting of unit root test, Johansen cointegration test, Model Estimation, and Examination, then Causality Analysis, Forecasting, and Structural analysis (Khan & Yoon, 2021; Ziesemer, 2021) which is presented in Figure 2.

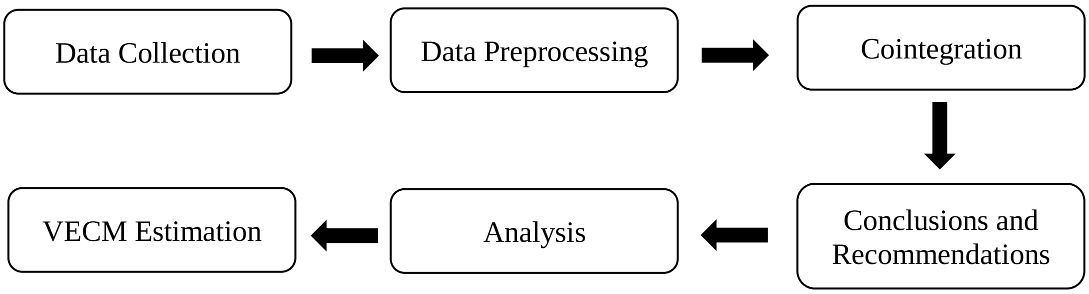


Figure 2. Vector Error Correction Model (VECM) Approach Method

The first process is to perform a unit root test. The model uses VECM based on non-stationary but cointegrated time series data. According to Zhao et al. (2021) state that it is necessary to carry out a unit root test using the Augmented Dickey-Fuller (ADF) analysis as follows:

$$\Delta x_t = \alpha_{r1\,r2} + \delta_{r1\,r2} x_{t-1} + \sum_{k-1}^{k} \beta_{r1r1}^{k} \Delta x_{t-k} + \mu_t$$

Which $\alpha_{r1\,r2}$ is a constant intercept, while $\delta_{r1\,r2}$ = 1 - $\alpha_{r1\,r2}$ and K is the number of lags selected by minimizing the Akaike Information Criterion (AIC) value or Bayesian Information Criterion (BIC), ut ~NID(0, σ_{r1r2}). In analyzing the stationarity of the data, you can use the unit root test with the hypothesis: H0: r = 0 (there is a unit root). Suppose the significance level (1 – a) is 100%. In that case, H0 is rejected, but if the ADF value less than Critical Value at the time a or p-value < a significance value so if H0 is rejected, then the data is stationary.

According to Mousavi and Gandomi (2021), the cointegration test the Johansen cointegration test is used as follows:

Yt = Atyt-1 + ... + Apyt-p + Bxt + εt

Where yt is se is a vector with k non-stationary variable I(1), xt is a vector with d deterministic variables, εt is an error vector. The equation $VA(p)$ can also be written as:

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

$$\Delta y_t = \prod Y_{t-1} + \sum_{i=1}^{p-1} \Gamma\ i\Delta y_{t-i} + Bx_t + \varepsilon_t$$

which

$$\prod = \sum_{i=1}^{p} \mathrm{A_i} - I, \qquad \Gamma_\mathrm{i} = -\sum_{i=1}^{p} \mathrm{A_j}$$

To test the hypothesis, trace test statistics can be used: LRtr(r | k) =

$$-T \sum_{i=r+1}^{k} \log(1-\lambda_\mathrm{i})$$

Maximum Eigenvalue test statistic

LRmax(r | r + 1) = -T log(1 – λr+1)

= LRtr(r | k) – LRtr(r + 1 | k)

for r = 0, 1, ... , k – 1

For the hypothesis used in the Johansen cointegration test, namely H0: there are r cointegration equations. If at a significance level (1 – a) 100%, then H0 is accepted if the trace test statistic and the maximum Eigenvalue are less than the critical value at the time of a or p-value > significance value. According to Ozkan (2021), Model fit test to see the serial correlation in the residuals uses the Portmanteau test statistics as follows:

$$Q_h = T \sum_{j\,=\,1}^{h} \mathrm{tr}(\hat{\mathrm{C}}_\mathrm{j}' \hat{\mathrm{C}}_0^{-1} \hat{\mathrm{C}}_\mathrm{j} \hat{\mathrm{C}}_0^{-1})$$

or

$$Q_h^* = T^2 \sum_{j\,=\,1}^{h} \frac{1}{T-J} \mathrm{tr}(\hat{\mathrm{C}}_\mathrm{j}' \hat{\mathrm{C}}_0^{-1} \hat{\mathrm{C}}_\mathrm{j} \hat{\mathrm{C}}_0^{-1})$$

With

$$\hat{\mathrm{C}}_\mathrm{i} = \frac{1}{T} \sum\nolimits_{t=i+1}^{T} \hat{\mathrm{U}}_\mathrm{t} \hat{\mathrm{U}}_t' - i$$

This test statistic has a distribution of $X^2{}_{(k^2{}_{(h-n^*)})}$, where n* represents the number of coefficients other than constants in the estimated VAR(p) model. In the VECM model, there is a causality analysis with the objective of long-run and short-run causality; as for the hypothesis, namely H0: There is no Granger causality relationship.

According to Dale and Sirchenko (2021), authors can choose the order lag p in the following way:

Akaike Information Criterion (AIC)

$$AIC(p) = \log\det(\Sigma_u^{\wedge}(p)) + \frac{2_p k^2}{T}$$

Schwarz Information Criterion (SC)

$$SC(p) = \log\det(\Sigma_u(p)) + \frac{^\wedge\log(T)pk^2}{T}$$

T is the sample size, and k is the number of endogenous variables. The lag p-value is chosen as

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

the p* value that minimizes the information criterion in the observed intervals of 1, ..., p max. The optimum lag is based on the smallest AIC and SC values. In VECM, causality analysis is intended to examine both long-run and short-run causality. Analysis of the long-term causality relationship between the independent variables and the dependent variable can be observed in the coefficients of the error correction term (ECT), which are based on the sign and the results of the coefficient significance test using the t-test statistic in the Ordinary Least Square (OLS) method. In the meantime, the Granger causality test can be utilized for each variable's short-term causality analysis. The Granger causality test is based on the Wald test statistic, which offers an alternative chi-square distribution or f-test. In the VECM model, there is a causality analysis that considers both long-term and short-term relationships (Abbasi et al., 2021). Regarding the hypothesis, H0 states that there is no Granger causal link.

Forecasting and structural analysis of the VECM is comparable to forecasting and structural analysis of the VAR model (Song et al., 2021). This analysis may utilize impulse response analysis and variance decomposition in VAR modeling. Impulse Response Analysis seeks to determine each endogenous variable's effect (influence) when a shock or impulse is applied (surprise). In contrast, variance decomposition analysis seeks to forecast each variable's contribution (% variance of each variable) to the variation of specific system variables. According to Ding et al. (2021), to determine the accuracy of forecast results from a model, we can use the Mean Absolute Percentage Error ($MAPE$):

$$MAPE = \frac{\sum_{t=1}^{n}\left(\frac{\hat{Y}_t - Y_t}{Y_t}\right)}{n} x\ 100\%$$

RESULTS AND DISCUSSION

The VECM Granger causality test is employed in this work to examine both long- and short-term causality in the GDP, imports, inflation, and unemployment (UNP). In detail, the statistical outputs are provided in Table 1.

Table 1. Descriptive data for GDP, INF, IMP, and UNP in South Korea from 1972 to 2021

	GDP	IMP	INF	UNP
Mean	6.642682	32.58190	6.309355	3.536000
Median	6.975184	30.66292	3.552769	3.515000
Maximum	14.89832	52.22858	28.69761	6.960000
Minimum	-5.129448	21.44246	0.383000	2.050000
Std. Dev.	4.220652	7.120264	6.781926	0.935752
Skewness	-0.315275	1.059332	1.872567	1.368995
Kurtosis	2.923357	3.662085	5.701560	6.222250
Jarque-Bera	0.840559	10.26479	44.42596	37.24894
Probability	0.656863	0.005902	0.000000	0.000000
Sum	332.1341	1629.095	315.4678	176.8000
Sum Sq. Dev.	872.8814	2484.210	2253.732	42.90600
Observations	50	50	50	50

GDP development in South Korea at the maximum value was around 14.89%, while the lowest value was -5.13% from 1972 to 2021. Then for Inflation (INF), the highest value was 28.69%, while the highest was 0,38%. The lowest was at 21.44% followed the Import value (IMP), with a maximum value of 52.22%, followed by Unemployment (UNP) which has the highest value of 6.96%, while the lowest value is 2,05%. The first stage is to conduct a unit root test of the four variables, including GDP, INF, IMP, and UNP data in South Korea from 1972 to 2021. The results of the unit root test calculation can be seen in Table 2.

Table 2. Undifferentiated GDP, INF, INP, and UNP data

Data	Critical Value (α)	Level	
		Stat. ADF	p value
GDP	5%	-4.304096 -0.569269	0.0012*
IMP	5%	-2.088791 -0.147280	0.2499*
INF	5%	-2.711051 -0.267137	0.0794*
UNP	5%	-4.067245 -0.493779	0.0025*

*MacKinnon (1996) one-sided p-values.

There is data that is not stationary, and for that it is necessary to do the first stage of differentiation. The results of statistical estimation are shown in Table 3.

Table 3. GDP, INF, IMP, and UNP data for the first stage of differentiation

Data	Critical Value (α)	Level	
		Stat. ADF	p value
GDP	5%	-6.976763 -3.302662	0.0000*
IMP	5%	-6.500332 -0.948875	0.0000*
INF	5%	-7.238217 -1.036463	0.0000*
UNP	5%	-6.440719 -1.237057	0.0000*

*MacKinnon (1996) one-sided p-values.

Table 2 shows that the GDP, INF, and UNP data in South Korea from 1972 to 2021 are data containing unit roots at the level or not stationary at the level. This can be seen from the unit root test technique, namely the level technique. The p-value of the ADF statistic for each variable is greater than 5%; this means accepting the H0 hypothesis, namely that there is a unit root in the data or that the data is not stationary. Meanwhile, in Table 3, the results of the first difference can be seen in the p-value of the ADF statistic for each variable, which is smaller than 5%. This means that the 0 hypotheses are rejected. Namely, the data does not contain unit roots or is stationary. Thus, GDP, INF, and UNP are first-order non-stationary variables.

Johansen cointegration test results using lag 4 (significant lag based on the VAR procedure) of the GDP, INF, IMP, and UNP variables using trace statistics and statistics of maximum Eigenvalues can be seen in Table 4 and Table 5, respectively. In Table 4, it can be seen that the results test the hypothesis using trace statistics for the hypothesis H0: There is a cointegration equation, H1: There is no cointegration equation.

Table 4. Johansen Cointegration Test Trace Statistic

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.701357	151.5224	47.85613	0.0000
At most 1 *	0.612131	94.72262	29.79707	0.0000
At most 2 *	0.461288	50.20947	15.49471	0.0000
At most 3 *	0.362188	21.13648	3.841465	0.0000

From the data obtained, the p-value is 0.00, which is less than α = 5% (the value of the trace statistic is 151.52, which is greater than the table's 47.85 value at α = 5%). This means that hypothesis

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

H0 is accepted. Thus, it can be concluded that there is a cointegration equation. For this reason, an examination is carried out for the next hypothesis.

Based on Table 4, we examine the following hypothesis test results: H0: There is one cointegration equation, H1: There are two cointegration equations. Table 4 shows that the p-value for each hypothesis is 0.00, which is less than the value α = 5% (the trace statistic is greater than the critical value when α = 5% for each hypothesis), indicating that H0 is accepted. Thus, it can be concluded that the cointegration test results using trace statistics indicate which can form at least three cointegration equations.

Table 5. Johansen Cointegration Test Max-Eigen Statistic

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.701357	56.79976	27.58434	0.0000
At most 1 *	0.612131	44.51315	21.13162	0.0000
At most 2 *	0.461288	29.07299	14.26460	0.0001
At most 3 *	0.362188	21.13648	3.841465	0.0000

From the data in Table 5, it can be seen that the results of the hypothesis test using the maximum Eigenvalue statistic, namely the p-value trace statistics for each hypothesis: H0: There is a cointegration equation H1: There is no cointegration equation p-value in Table and 5 it is clear that there is no cointegration, namely the p-value of 0.26 and the presence of cointegration at a p-value greater than the value of α = 0.05. There is cointegration at a p-value below α = 0.05.

An analysis to choose the best lag is conducted after completing a cointegration analysis. The Akaike Information Criterion (AIC) and Schwarz Information Criterion (SC) can be used for the best lag selection in VECM. Table 6 displays the outcomes of data processing for delays one through five using AIC and SC analysis. In statistical modeling, the usage of lags one through eight is justified by the parsimony principle (model simplicity), which results from the fact that the more lags employed, the more model parameter coefficients there are.

Table 6. VAR Lag Order Selection Criteria

Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	-408.0844	NA	1057.205	18.31486	18.47546	18.37473
1	-370.7448	66.38158*	411.0077*	17.36643*	18.16940*	17.66577*
2	-361.5987	14.63368	567.5943	17.67105	19.11638	18.20986
3	-349.1456	17.71108	695.6897	17.82869	19.91639	18.60697
4	-339.6845	11.77381	1017.701	18.11931	20.84938	19.13705

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

In table 6, we can interpret that lag 1 has the smallest AIC and SC values. Thus, we involved lag one to process VECM parameter estimation. Based on the optimum lag analysis results, the VECM equation's estimated form is VECM(1). Examination of the model was carried out using the residual assumption test analysis of the model, namely the residual correlation serial test, as shown in Table 7.

Table 7. VECM Residual Portmanteau Tests for Autocorrelations

Lags	Q-Stat	Prob.*	Adj Q-Stat	Prob.*	df
1	9.587323	---	9.795743	---	---
2	33.50636	0.2176	34.77785	0.1764	28
3	51.64805	0.1998	54.15647	0.1403	44
4	60.54297	0.4561	63.87882	0.3419	60

5	71.80629	0.6150	76.48301	0.4629	76
6	83.18024	0.7332	89.52145	0.5537	92
7	95.35157	0.8026	103.8228	0.5958	108
8	110.5084	0.8016	122.0887	0.5317	124
9	126.2585	0.7909	141.5690	0.4470	140
10	152.4170	0.5662	174.7975	0.1442	156
11	169.3072	0.5438	196.8485	0.0941	172
12	186.1225	0.5250	219.4291	0.0579	188
13	203.4401	0.4979	243.3681	0.0308	204
14	208.0512	0.7083	249.9355	0.0810	220
15	217.1861	0.8049	263.3524	0.1068	236

Then the equation for VECM(1) is made as follows:
===============================

Δ(GDP,2) = A(1,1)*(B(1,1)*Δ(GDP(-1)) + B(1,2)*Δ(IMP(-1)) + B(1,3)*Δ(INF(-1)) + B(1,4)*Δ(UNP(-1)) + B(1,5)) + C(1,1)*Δ(GDP(-1),2) + C(1,2)*Δ(IMP(-1),2) + C(1,3)*Δ(INF(-1),2) + C(1,4)*Δ(UNP(-1),2) + C(1,5)

Δ(IMP,2) = A(2,1)*(B(1,1)*Δ(GDP(-1)) + B(1,2)*Δ(IMP(-1)) + B(1,3)*Δ(INF(-1)) + B(1,4)*Δ(UNP(-1)) + B(1,5)) + C(2,1)*Δ(GDP(-1),2) + C(2,2)*Δ(IMP(-1),2) + C(2,3)*Δ(INF(-1),2) + C(2,4)*Δ(UNP(-1),2) + C(2,5)

Δ(INF,2) = A(3,1)*(B(1,1)*Δ(GDP(-1)) + B(1,2)*Δ(IMP(-1)) + B(1,3)*Δ(INF(-1)) + B(1,4)*Δ(UNP(-1)) + B(1,5)) + C(3,1)*Δ(GDP(-1),2) + C(3,2)*Δ(IMP(-1),2) + C(3,3)*Δ(INF(-1),2) + C(3,4)*Δ(UNP(-1),2) + C(3,5)

Δ(UNP,2) = A(4,1)*(B(1,1)*Δ(GDP(-1)) + B(1,2)*Δ(IMP(-1)) + B(1,3)*Δ(INF(-1)) + B(1,4)*Δ(UNP(-1)) + B(1,5)) + C(4,1)*Δ(GDP(-1),2) + C(4,2)*Δ(IMP(-1),2) + C(4,3)*Δ(INF(-1),2) + C(4,4)*Δ(UNP(-1),2) + C(4,5)

VAR Model - Substituted Coefficients:
===============================

Δ(GDP,2) = - 0.504427436857*(Δ(GDP(-1)) + 0.0480226464175*Δ(IMP(-1)) + 0.623980890018*Δ(INF(-1)) + 0.798941809401*Δ(UNP(-1)) + 0.367386300623) - 0.148851629255*Δ(GDP(-1),2) - 0.190903527321*Δ(IMP(-1),2) + 0.0463646273264*Δ(INF(-1),2) + 2.91673640079*Δ(UNP(-1),2) + 0.090037827431

Δ(IMP,2) = - 0.578470426639*(Δ(GDP(-1)) + 0.0480226464175*Δ(IMP(-1)) + 0.623980890018*Δ(INF(-1)) + 0.798941809401*Δ(UNP(-1)) + 0.367386300623) + 0.458726732606*Δ(GDP(-1),2) - 0.337265386616*Δ(IMP(-1),2) + 0.249766244786*Δ(INF(-1),2) - 0.145358253164*Δ(UNP(-1),2) - 0.0175166474251

Δ(INF,2) = - 1.72975841615*(Δ(GDP(-1)) + 0.0480226464175*Δ(IMP(-1)) + 0.623980890018*Δ(INF(-1)) + 0.798941809401*Δ(UNP(-1)) + 0.367386300623) + 0.658555063852*Δ(GDP(-1),2) + 0.154589318848*Δ(IMP(-1),2) + 0.310480808122*Δ(INF(-1),2) - 2.52333140342*Δ(UNP(-1),2) - 0.240935549879

Δ(UNP,2) = - 0.00998776948469*(Δ(GDP(-1)) + 0.0480226464175*Δ(IMP(-1)) + 0.623980890018*Δ(INF(-1)) + 0.798941809401*Δ(UNP(-1)) + 0.367386300623) - 0.0438161851984*Δ(GDP(-1),2) + 0.00486742084277*Δ(IMP(-1),2) - 0.00498026619609*Δ(INF(-1),2) - 0.458017179983*Δ(UNP(-1),2) - 0.00950521558732

The short-run causality relationship in a VECM equation can be seen using the Granger causality test (Wang & Huang, 2021). The results of the Granger causality test in the first equation of VECM(1) are as follows:

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

Table 8. Granger Causality Test: Dependent Variable ΔGDPt on GDP, INF, IMP, and UNP data in South Korea from 1972-2021

Excluded	Chi-sq	df	Prob.
Δ(IMP,2)	1.204873	1	0.2723
Δ(INF,2)	0.057601	1	0.8103
Δ(UNP,2)	9.554578	1	0.0020
All	13.80394	3	0.0032

P-value analysis using the Wald test statistic, namely: The Chi-sq value on the ΔIMPt variable is 1.204873 while the p-value is 0.2723, which is greater than the significant level α = 5%. This conclusion means that accepting the H0 hypothesis: There is no Granger causality relationship, which means that there is a long-term causality relationship between the level of imports (IMP) to the level of GDP in South Korea from 1972 to 2021.

The ΔINFt variable has a Chi-sq value of 0.057601 with a p-value of 0.8103, which is less than the significant level of α = 5%. This conclusion means accepting the H1 hypothesis. There is a Granger causality relationship, which means that there is a long-term causality relationship between the inflation rate (INF) and the GDP level in South Korea from 1972 to 2021.

Furthermore, the ΔUNPt variable has a Chi-sq value of 9.554578 with a p-value of 0.0020, which is greater than the significant level α = 5%. This conclusion means accepting the H0 hypothesis: There is no Granger causality relationship, which means that there is a long-term causality relationship between the unemployment rate or Un-Employment (UNP) to the GDP level in South Korea from 1972 to 2021.

Hence, it can be concluded as a whole in equation (1) there is a short-term causality relationship between the level of INF, IMP, and UNP to the level of GDP in South Korea from 1972 to 2021. It can be seen from the p-value = 0.0032, which is smaller than a significant level of α = 5%, which means that it accepts the H1 hypothesis. There is a Granger causality relationship which means that there is a short-term causality relationship between the INF, IMP, and UNP levels on the GDP level in South Korea from 1972 to 2021.

Table 9. Granger Causality Test: Dependent Variable ΔIMPt on GDP, INF, IMP, and UNP data in South Korea from 1972-2021

Excluded	Chi-sq	df	Prob.
Δ(GDP,2)	5.182978	1	0.0228
Δ(INF,2)	2.057381	1	0.1515
Δ(UNP,2)	0.029207	1	0.8643
All	5.485782	3	0.1395

P-value analysis using the Wald test statistic: The Chi-sq value on the ΔGDPt variable is 5.182978 while the p-value is 0.0228, which is greater than the significant level of α = 5%. This conclusion means accepting the H0 hypothesis: There is no Granger causality relationship, which means a long-term causality relationship between economic growth (GDP) and the import (IMP) level in South Korea from 1972 to 2021. The variable ΔINFt has a Chi-sq value of 2.057381 with a p-value of 0.1515, which is less than the significant level of α = 5%. This conclusion means accepting the H0 hypothesis. There is no Granger causality relationship, meaning there is a long-term causality relationship between the inflation rate (INF) and the import (IMP) level in South Korea from 1972 to 2021.

Furthermore, the ΔUNPt variable has a Chi-sq value of 0.029207 with a p-value of 0.0020, which is greater than the significant level α = 5%. This conclusion that accepting hypothesis H0: There is no Granger causality relationship, which means that there is a long-term causality relationship between the unemployment rate or Unemployment (UNP) to the import (IMP) level in South Korea from 1972 to 2021. So, it can be concluded as a whole in equation (1) that there is a short-term causality relationship between the GDP, INF, and UNP levels to the IMP level in South Korea from 1972 to 2021. We can be seen from the p-value = 0.1395 or greater than the significant level α = 5%, which means accepting hypothesis H0: There is no Granger causality relationship which means there is no

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

short-term causality relationship between the levels of GDP, INF, and UNP to the level of IMP in South Korea from 1972 to 2021.

Table 10. Granger Causality Test: Dependent Variable ΔINFt on GDP, INF, IMP, and UNP data in South Korea from 1972-2021

Excluded	Chi-sq	df	Prob.
Δ(GDP,2)	9.858498	1	0.0017
Δ(IMP,2)	0.897469	1	0.3435
Δ(UNP,2)	8.122936	1	0.0044
All	18.20658	3	0.0004

P-value analysis using the Wald test statistic: The Chi-sq value on the ΔGDPt variable is 9.858498 while the p-value is 0.0017, which is greater than the significant level α = 5%. This conclusion means accepting the H0 hypothesis: There is no Granger causality relationship, which means that there is a long-term causality relationship between the economic growth rate (GDP) and the inflation rate (INF) in South Korea from 1972 to 2021. The variable ΔIMPt has a Chi-sq value of 0.897469 with a p-value of 0.3435, which is greater than the significant level α = 5%. This conclusion means accepting hypothesis H0: There is no Granger causality relationship, which means there is no short-term causality relationship between the inflation rate (INF) and the import level (IMP) in South Korea from 1972 to 2021.

Furthermore, the ΔUNPt variable has a Chi-sq value of 8.122936 with a p-value of 0.0044, which is greater than the significant level α = 5%. This conclusion means accepting the H0 hypothesis: There is no Granger causality relationship, which means that there is a long-term causality relationship between the unemployment rate or Unemployment (UNP) and the Inflation rate (INF) in South Korea from 1972 to 2021. So that it can be concluded as a whole in equation (1), then there is a long-term causality relationship between the level of GDP, IMP, and UNP to the level of INF in South Korea from 1972 to 2021. We can be seen from the p-value = 0.0004 is smaller than the significant level α = 5%, which means that it accepts the H0 hypothesis, which means that there is a long-term causal relationship between GDP, IMP, and UNP on INF levels in South Korea from 1972 to 2021.

Table 11. Granger Causality Test: Dependent Variable ΔUNPt on GDP, INF, IMP and UNP data in South Korea from 1972-2021

Excluded	Chi-sq	df	Prob.
Δ(GDP,2)	0.790791	1	0.3739
Δ(IMP,2)	0.016122	1	0.8990
Δ(INF,2)	0.013680	1	0.9069
All	1.926222	3	0.5879

P-value analysis using the Wald test statistic: The Chi-sq value on the ΔGDPt variable is 0.790791 while the p-value is 0.3739, which is greater than the significant level α = 5%. This conclusion means accepting the H0 hypothesis: There is no Granger causality relationship, which means that there is a long-term causality relationship between the level of economic growth (GDP) and the unemployment rate (UNP) in South Korea from 1972 to 2021. The variable ΔIMPt has a Chi-sq value of 0.016122 with a p-value of 0.8990, which is smaller than the significant level of α = 5%. This conclusion means accepting the H1 hypothesis. A Granger causality relationship indicates a short-term causality between the import level (MP) and the unemployment rate (UNP) in South Korea from 1972 to 2021.

Furthermore, the ΔINFt variable has a Chi-sq value of 0.013680 with a p-value of 0.9069, which is smaller than the significant level of α = 5%. This conclusion means accepting the H1 hypothesis. There is a Granger causality relationship, indicating a short-term causality between the inflation rate (INF) and the unemployment rate or Unemployment (UNP) in South Korea from 1972 to 2021.
So that it can be concluded as a whole in equation (1), then there is a short-term causality relationship between the GDP, PMI, and INF levels to the UNP level in South Korea from 1972 to 2021. We can be seen from the p-value = 0.5879 greater than the significant level α = 5%, which means accepting

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

hypothesis H0: There is no Granger causality relationship which means there is no short-term causality relationship between the levels of GDP, INF, and UEM to the level of PMI in South Korea from 1972 to 2021.

This section will describe forecasting and structural analysis of forecasting using the VECM(1) model. We will first define structural analysis, which covers Impulse Response Function (IRF) analysis and variance decomposition, before talking about the study of predicting outcomes. There are nine Impulse Response Function (IRF) plots for the following 10 periods as a result of impulse-response (IRF) analysis, and these plots visually explain the response of a variable that results from shocks (shock/impulse) of one standard deviation from both itself and other variables.

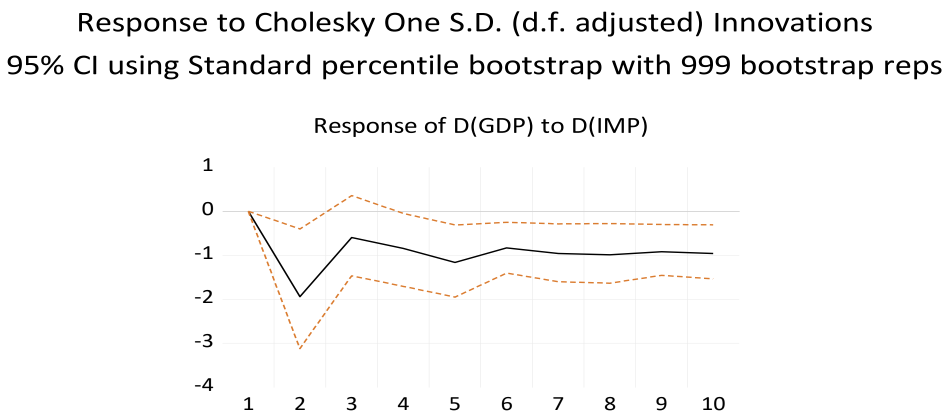


Figure 3. IRF GDP Rate Against IMP in South Korea from 1972 to 2021

The GDP level response to shocks to the IMP (Import) level is stagnant. From the Figure 3, explains that in the 2nd period, the response rate of GDP to import was in an unfavorable position, namely -1.94, but in the 5th period, it became -0.59. Therefore, it can be conclude that South Korea's GDP does not significantly impact the level of imports.

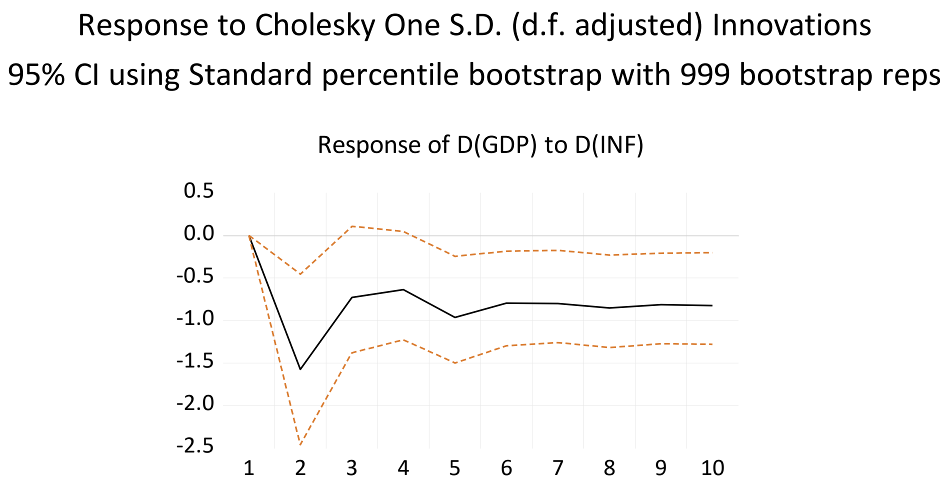


Figure 4. IRF GDP Rate Against INF in South Korea from 1972 to 2021

In addition, the GDP level response to shocks to the INF (Inflation) level is stagnant. As shown in Figure 4, in the 2nd period, the response rate of GDP to inflation was in an unfavorable position, namely -1.57, but in the 3th period, it became -0.72. In sum, South Korea's GDP does not significantly impact the level of inflation.

ISSN
2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

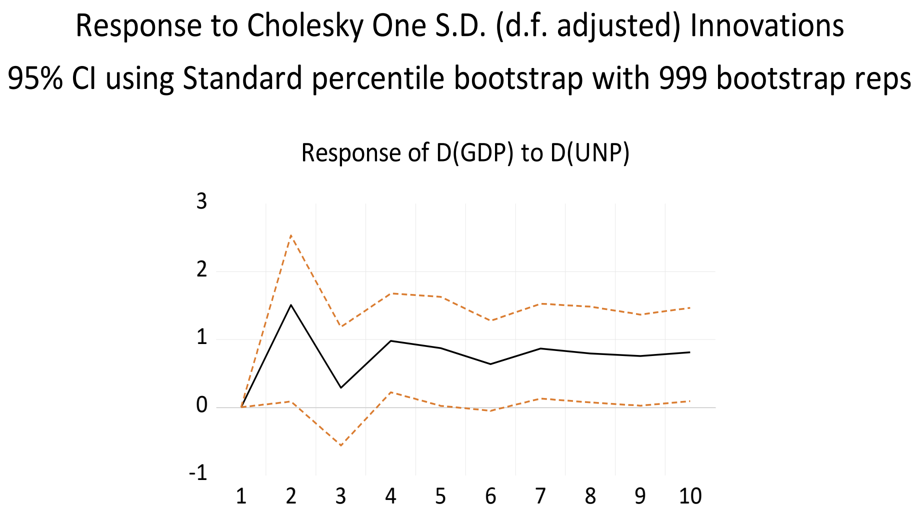


Figure 5. IRF GDP Rate Against UNP in South Korea from 1972 to 2021

The response of the GDP level to the unemployment rate (UNP) shock is stagnant in the positive area. Figure 5 explains that in the 3rd period, the level of response of GDP to unemployment is presented in a favourable position of 0.28. However, in the 4th period, it becomes 0.97. From these outputs, the GDP in South Korea has a considerable impact on the unemployment rate.

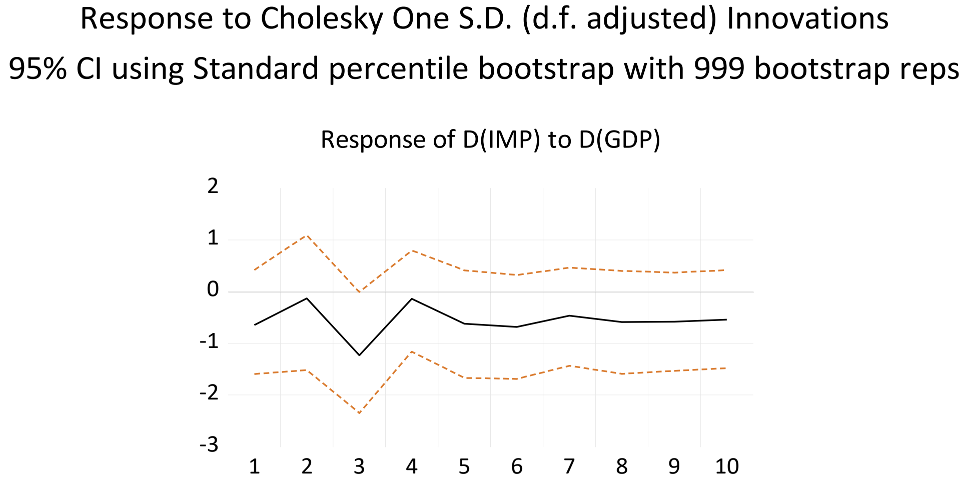


Figure 6. IRF IMP Rate Against GDP in South Korea from 1972 to 2021

Import rate response (IMP) to GDP level shocks is stagnant in the negative area. As illustrated in Figure 6, in the 2nd period, the response rate of the IMP to GDP is presented in an unfavorable position, namely -1.29, but in the 3rd period, it became -1.23. This indicates that the IMP in South Korea does not significantly impact economic growth.

ISSN
2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

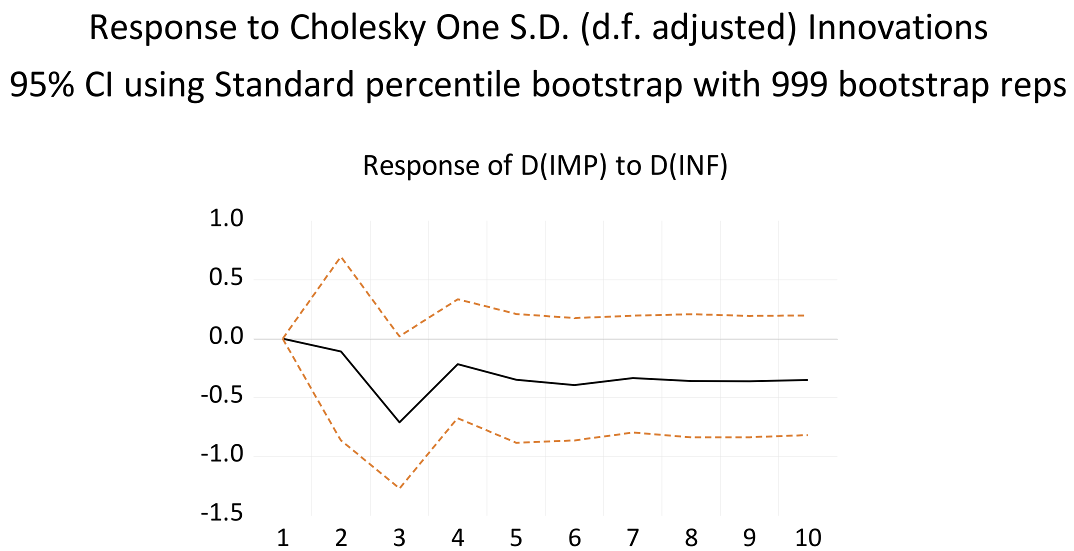


Figure 7. IRF IMP Rate Against INF in South Korea from 1972 to 2021

Import rate response (IMP) to INF level shocks is stagnant in the negative area. Figure 7 informs that in the 3rd period, the response rate of the IMP to INF is presented in an unfavorable position, namely -0.71 but in the 3rd period, it became -0.21. This remarks that the IMP in South Korea does not significantly impact the inflation.

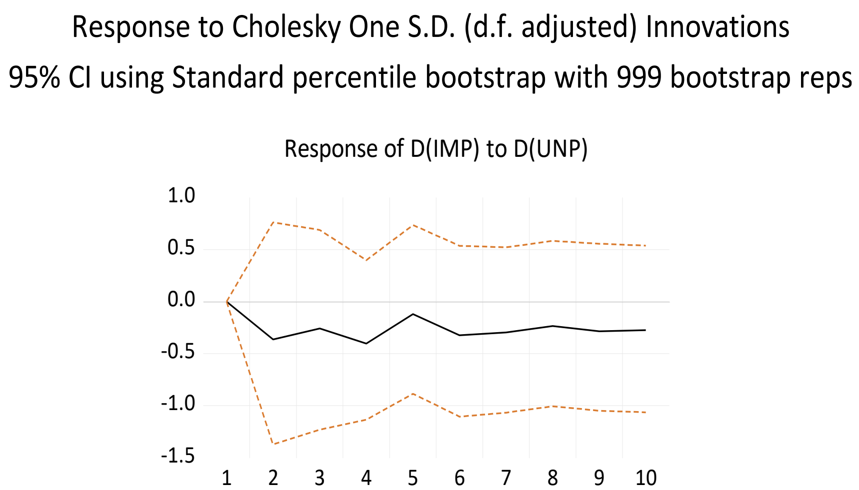


Figure 8. IRF IMP Rate Against UNP in South Korea from 1972 to 2021

Import rate response (IMP) to UNP level shocks is stagnant in the negative area. As shown in Figure 8, in the 3rd period, the response rate of the IMP to UNP is presented in an unfavorable position, namely -0,36 but in the 3rd period, it became -0.25. From these results, the IMP in South Korea does not significantly impact to Unemployment.

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

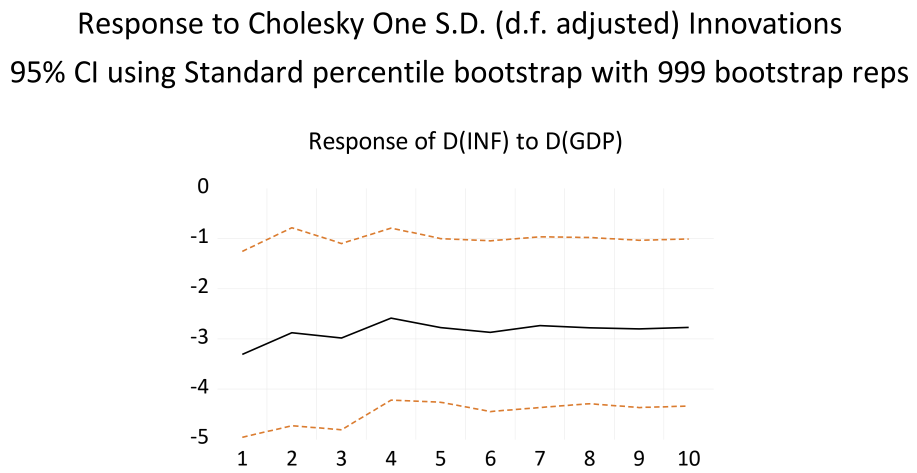


Figure 9. IRF INF Rate Against GDP in South Korea from 1972 to 2021

Inflation rate response (INF) to GDP level shocks is stagnant in the negative area. It can be seen in Figure 9, explaining that in the 2nd period, the response rate of the INF to GDP is presented in an unfavorable position, namely -2.98, but in the 3rd period, it became -2.58. The result indicates that the inflation in South Korea does not significantly impact economic growth.

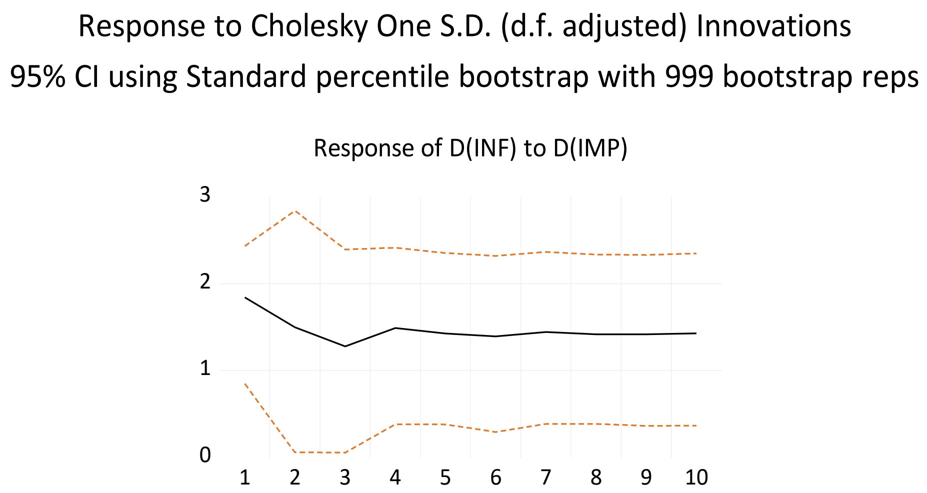


Figure 10. IRF INF Rate Against IMP in South Korea from 1972 to 2021

The GDP level response to shocks to the IMP (Import) level is stagnant. From Figure 10, it can be known that in the 3rd period, the response rate of inflation to import was in an unfavorable position, namely 1.27, but in the 4th period, it became 1.48. From these results, South Korea's INF has a considerable impact the level of imports.

ISSN
2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

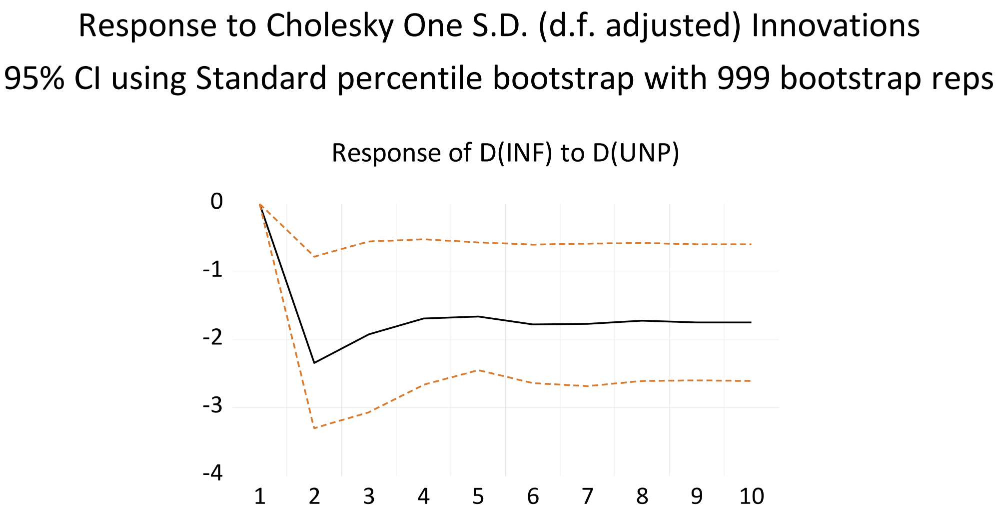


Figure 11. IRF INF Rate Against UNP in South Korea from 1972 to 2021

Inflation rate response (INF) to UNP level shocks is stagnant in the negative area. Figure 11 informs that in the 3rd period, the response rate of the INF to UNP is presented in an unfavorable position, namely -0,2.34 but in the 3rd period, it became -1.91. This remarks that the INF in South Korea does not significantly impact to Unemployment.

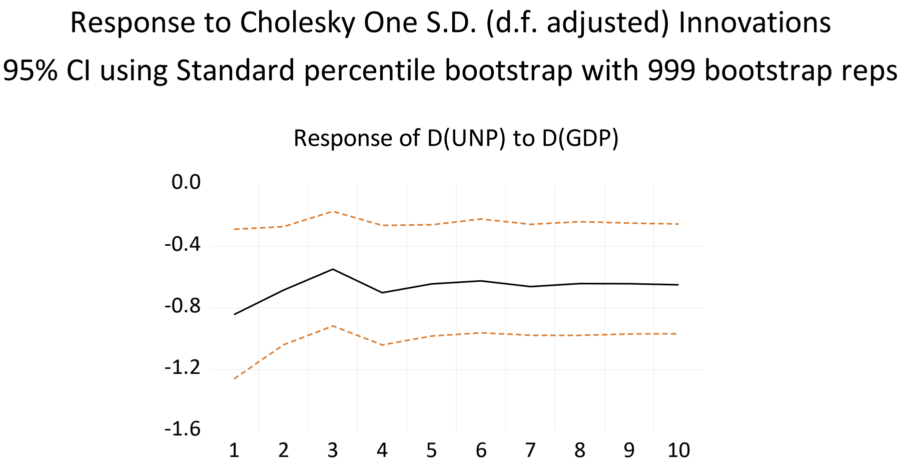


Figure 12. IRF UNP Rate Against GDP in South Korea from 1972 to 2021

Unemployment rate response (UNP) to GDP level shocks is stagnant in the negative area. We can be seen in Figure 12 explaining that in the 1st period, the response rate of the UNP to GDP is presented in an unfavorable position, namely -0.84, but in the 2nd period, it became -0.68. Thus, it can be concluded that unemployment in South Korea does not significantly impact economic growth.

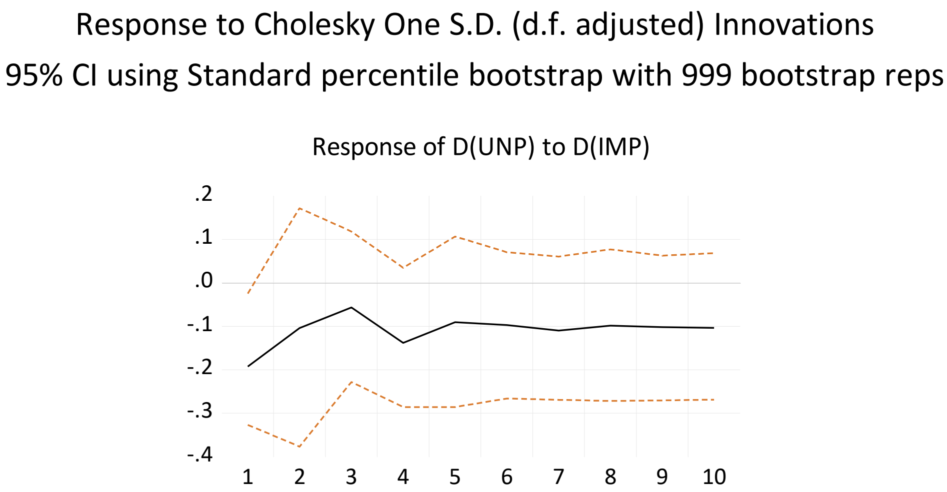


Figure 13. IRF UNP Rate Against IMP in South Korea from 1972 to 2021

Unemployment level response to shocks to the IMP (Import) level is stagnant. As shown in Figure 13, it informs that in the 1st period, the response rate of UNP to IMP was in an unfavorable position, namely -0.19, but in the 3rd period, it became -0.05. From these results, South Korea's UNP does not significantly impact the level of imports.

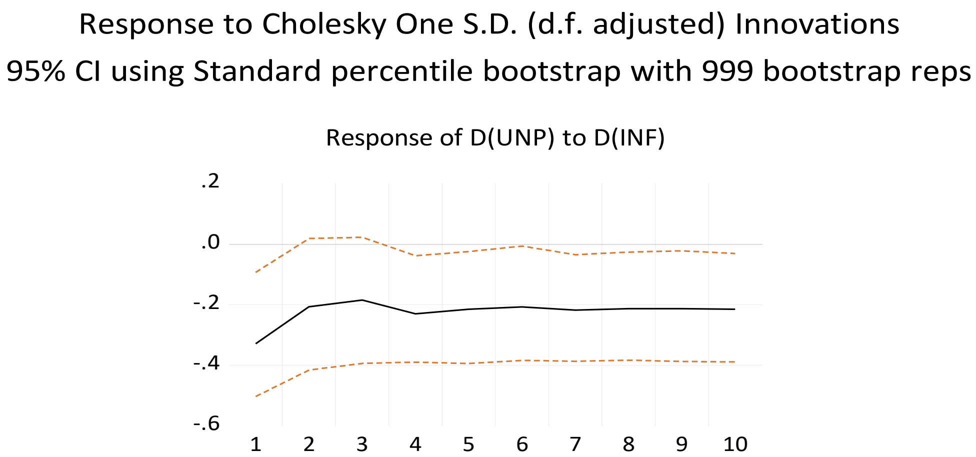


Figure 14. IRF UNP Rate Against INF in South Korea from 1972 to 2021

Unemployment rate response (UNP) to INF level shocks is stagnant in the negative area. It can be seen in Figure 14 explaining that in the 1st period, the response rate of the UNP to INF is presented in an unfavorable position, namely -0.32 but in the 2nd period, it became -0.20. Therefore, it can be concluded that the UNP in South Korea does not significantly impact the inflation.

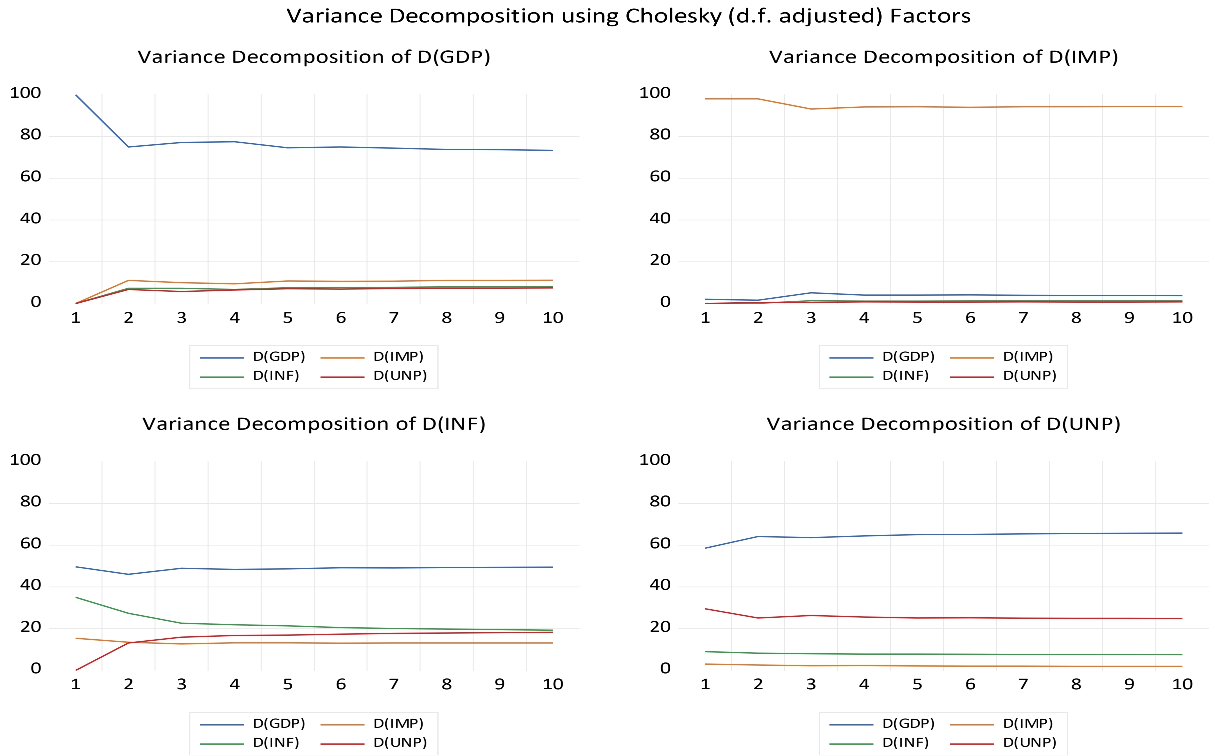


Figure 15. Variance Decomposition GDP, INF, IMP, and UNP in South Korea from 1972 to 2021

Table 12. Variance Decomposition GDP

Variance Decomposition of D(GDP):					
Period	S.E.	D(GDP)	D(IMP)	D(INF)	D(UNP)
1	5.006680	100.0000	0.000000	0.000000	0.000000
2	5.830264	74.95308	11.07244	7.292315	6.682168
3	6.433626	77.08771	9.956825	7.271097	5.684366
4	7.150571	77.38957	9.458096	6.682253	6.470076
5	7.578319	74.56511	10.78642	7.567352	7.081115
6	8.067896	74.89399	10.58665	7.651745	6.867619
7	8.539410	74.41270	10.71728	7.711026	7.158998
8	8.942704	73.74537	11.00013	7.940581	7.313916
9	9.353560	73.62172	11.02569	8.014688	7.337892
10	9.744249	73.31352	11.13341	8.101480	7.451586

FEDV analysis results for the level of GDP from the shocks given by each variable. FEDV analysis, which can draw from Table 12, states that in the short term, for example, in the fifth period, shocks to themselves result in a 74.5% increase in fluctuations in the level of GDP, and shocks to the level of Imports (IMP) result in a 10.7% increase in fluctuations in the level of GDP, and shocks to the rate of Inflation (INF) resulted in an increase of 7.5% in fluctuations in the rate of GDP. The unemployment rate (UNP) resulted in an increase of 7.8% in the fluctuation of the GDP rate in South Korea from 1972 to 2021.

Table 13. Variance Decomposition IMP

Variance Decomposition of D(IMP):					
Period	S.E.	D(GDP)	D(IMP)	D(INF)	D(UNP)
1	4.512881	2.053366	97.94663	0.000000	0.000000
2	5.299002	1.548934	97.93649	0.042087	0.472491
3	6.207731	5.075782	93.06313	1.343050	0.518036
4	7.013069	4.016775	94.09764	1.147271	0.738317
5	7.658415	4.024766	94.16184	1.169397	0.644000
6	8.276146	4.127051	93.94084	1.228250	0.703863

ISSN
2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

7	8.859431	3.875907	94.18326	1.214950	0.725885
8	9.390169	3.845586	94.21670	1.228899	0.708810
9	9.900880	3.805390	94.23538	1.238547	0.720683
10	10.38592	3.730387	94.30532	1.239903	0.724390

FEDV analysis results for the level of IMP from the shocks given by each variable, including the variable itself. FEDV analysis, which can draw from table 13, states that in the short term, for example, in the fifth period, shocks to themselves result in a 94.1% increase in fluctuations in the IMP rate, and shocks to the GDP level result in a 4.02% increase in changes in the PMI level, and shocks to the Inflation (INF) resulted in a rise of 1.16% in the fluctuations in the IMP rate. The unemployment rate (UNP) increased by 0.64% in the change of the IMP rate in South Korea from 1972 to 2021.

Table 14. Variance Decomposition INF

Variance Decomposition of D(INF):					
Period	S.E.	D(GDP)	D(IMP)	D(INF)	D(UNP)
1	4.697602	49.61721	15.39090	34.99189	0.000000
2	6.465250	46.00667	13.49590	27.38157	13.11587
3	7.586045	48.87452	12.64141	22.55734	15.92672
4	8.491365	48.28922	13.16697	21.87623	16.66758
5	9.351347	48.60926	13.18741	21.31085	16.89248
6	10.16389	49.11211	13.04302	20.49841	17.34646
7	10.89174	49.07533	13.11790	20.07592	17.73085
8	11.57434	49.21530	13.11629	19.76102	17.90738
9	12.22648	49.34583	13.10130	19.46916	18.08371
10	12.84138	49.38836	13.11373	19.25396	18.24394

FEDV analysis results for the inflation rate of the shocks given by each variable, including the variable itself. FEDV analysis, which can draw from table 14, states that in the short term, for example, in the fifth period, shocks to themselves result in a 21.3% increase in fluctuations in the INF rate, and shocks to the GDP rate result in a 48.6% increase in changes in the INF rate, and shakes to the INF rate import (IMP) resulted in a rise of 13.1% in fluctuations in the INF rate. The unemployment rate (UNP) increased by 16.8% in the change of the INF rate in South Korea from 1972 to 2021.

Table 15. Variance Decomposition UNP

Variance Decomposition of D(UNP):					
Period	S.E.	D(GDP)	D(IMP)	D(INF)	D(UNP)
1	1.103553	58.50903	3.051587	8.922498	29.51689
2	1.358126	64.13471	2.601305	8.218256	25.04573
3	1.528254	63.58552	2.192311	7.958614	26.26356
4	1.752960	64.35049	2.289063	7.777174	25.58327
5	1.918166	65.04042	2.135982	7.757619	25.06598
6	2.068575	65.06231	2.058206	7.680111	25.19937
7	2.221216	65.32999	2.028528	7.629002	25.01248
8	2.355664	65.51965	1.977836	7.604614	24.89790
9	2.484486	65.60496	1.946639	7.574874	24.87353
10	2.608592	65.72248	1.923364	7.552464	24.80170

FEDV analysis results for the unemployment rate from the shocks given by each variable, including the variable itself. FEDV analysis, which can draw from table 15, states that in the short term, for example, in the fifth period, shocks to themselves result in a 25.06% increase in fluctuations in the UNP rate, and shocks to the GDP rate result in a 65.04% increase in changes in the UNP rate, and shakes to the import (IMP) resulted in a 2.13% increase in UNP rate fluctuations. The inflation rate (INF) resulted in a rise of 7.75% in the change of the UNP rate in South Korea from 1972 to 2021.

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

Table 16. Forecast Evaluation

Variable	Inc. obs.	RMSE	MAE	MAPE	Theil
GDP	49	53.91504	50.09123	166.1862	0.953123
IMP	49	50.68683	44.77082	53.19812	0.437132
INF	49	85.97467	80.35594	89.01393	0.872333
UNP	49	1.638066	1.396284	36.52352	0.205038

RMSE: Root Mean Square Error
MAE: Mean Absolute Error
MAPE: Mean Absolute Percentage Error
Theil: Theil inequality coefficient

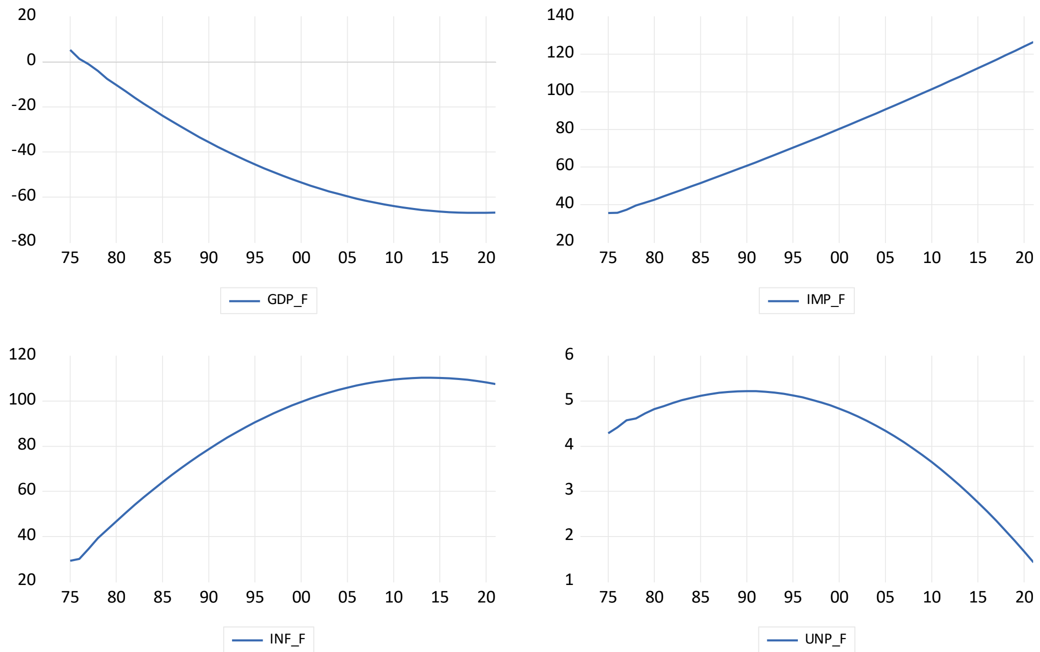


Figure 16. Forecast Graph GDP, INF, IMP, and UNP in South Korea from 1972 to 2021

The presented research utilizes the VECM Granger causality test to examine the long- and short-term causality relationships among GDP, imports (IMP), inflation (INF), and unemployment (UNP) in South Korea from 1972 to 2021. The statistical findings reveal a comprehensive analysis of the descriptive data, unit root tests, and cointegration tests. The study establishes that GDP, INF, and UNP are first-order non-stationary variables, leading to the exploration of cointegration relationships.

The unit root and cointegration tests play a pivotal role in determining the stationarity and integration order of the variables. However, the analysis lacks a robust discussion of the economic significance of the findings. It is essential to interpret the economic implications of the stationary and cointegrated series, providing insights into the long-term equilibrium relationships between the variables. Moreover, the paper lacks clarity in explaining the choice of lag orders in the VECM model, and the rationale behind selecting lag one for parameter estimation requires more detailed justification.

Additionally, the Granger causality test results indicate both short- and long-term causality relationships among the variables. While the statistical significance is presented, the research lacks a comprehensive discussion on the economic rationale behind the causal links. Further exploration of the economic mechanisms and potential policy implications of the identified causal relationships would enhance the depth of the analysis. Furthermore, the study could benefit from a more concise and organized presentation of the results to improve readability and comprehension. Overall, the research provides a foundation for further exploration, but a more nuanced interpretation of the economic implications and improved presentation could enhance its overall quality.

CONCLUSIONS AND SUGGESTION

The results of this study show that the impact of the Covid-19 pandemic has spread to various countries, including South Korea, and has also contributed to Canada's macroeconomic sector's decline. These impacts include a decrease in South Korea's GDP and import revenues in 2020, followed by an increase in Canada's unemployment and inflation rates. An in-depth analysis of the macroeconomic factors affecting the Covid-19 pandemic in South Korea shows that inflation rate volatility significantly influences GDP revenue. At the same time, inflation shocks also impact the unemployment rate, with unemployment hurting South Korea's economic conditions in 2020.

While this study provides valuable insights into the impact of the Covid-19 pandemic in South Korea, some limitations must be acknowledged. First, the focus on macroeconomic factors may have overlooked some microeconomic aspects that could also affect the impact of the pandemic. Second, the data used may be limited to a specific period and may change over time. Third, this analysis does not consider non-economic factors that may also play a role in the impact of the pandemic.

The results of this study have significant implications for economic policy in South Korea and Canada. The government and relevant institutions need to consider economic stimulus policies to stimulate economic growth and reduce unemployment. In addition, special attention needs to be paid to inflation control to manage the risks associated with price volatility. Based on these findings, several recommendations can be proposed. First, there is a need to actively monitor and manage inflation to avoid its negative economic impact. Second, there is a need for a fiscal policy strategy that focuses on the recovery of the most affected economic sectors. Third, collaboration between countries and the implementation of coordinative policies at the global level can help mitigate the impact of the pandemic more effectively.

REFERENCES

Ababulgu Abasimel, N., & Wana Fufa, H. (2022). The Horrors of COVID-19 and the Recent Macroeconomy in Ethiopia. *Journal of the Knowledge Economy*, *13*(1), 305–320. https://doi.org/10.1007/s13132-020-00713-6

Abbasi, K. R., Abbas, J., & Tufail, M. (2021). Revisiting electricity consumption, price, and real GDP: A modified sectoral level analysis from Pakistan. *Energy Policy*, *149*, 112087. https://doi.org/10.1016/j.enpol.2020.112087

Adeseye, A. (2021). The Effect of Migrants Remittance on Economy Growth in Nigeria: An Empirical Study. *Open Journal of Political Science*, *11*(01), 99–122. https://doi.org/10.4236/ojps.2021.111007

Al-Qudah, A. A., Al-Okaily, M., & Alqudah, H. (2022). The relationship between social entrepreneurship and sustainable development from economic growth perspective: 15 'RCEP' countries. *Journal of Sustainable Finance & Investment*, *12*(1), 44–61. https://doi.org/10.1080/20430795.2021.1880219

Anokhina, M. Y. (2022). Fuzzy cognitive model of agricultural economic growth. *Economic Systems Research*, *May*. https://doi.org/10.1080/09535314.2022.2065466

Burger, P. (2017). Economic growth and formal sector employment. *Journal for Studies in Economics and Econometrics*, *41*(3), 65–84. https://doi.org/10.1080/10800379.2017.12097320

Chugunov, I., Pasichnyi, M., Koroviy, V., Kaneva, T., & Nikitishin, A. (2021). Fiscal and Monetary Policy of Economic Development. *European Journal of Sustainable Development*, *10*(1), 42. https://doi.org/10.14207/ejsd.2021.v10n1p42

Dale, D., & Sirchenko, A. (2021). Estimation of nested and zero-inflated ordered probit models. *The Stata Journal: Promoting Communications on Statistics and Stata*, *21*(1), 3–38. https://doi.org/10.1177/1536867X211000002

DIMA, A. (2021). The Importance of Innovation in Entrepreneurship for Economic Growth and Development. A Bibliometric Analysis. *Review of International Comparative Management*, *22*(1), 120–131. https://doi.org/10.24818/rmci.2021.1.120

Ding, X., Hasanipanah, M., Nikafshan Rad, H., & Zhou, W. (2021). Predicting the blast-induced vibration velocity using a bagged support vector regression optimized with firefly algorithm.

Engineering with Computers, *37*(3), 2273–2284. https://doi.org/10.1007/s00366-020-00937-9

Durguti, E., Tmava, Q., Demiri-Kunoviku, F., & Krasniqi, E. (2021). Panel estimating effects of macroeconomic determinants on inflation: Evidence of Western Balkan. *Cogent Economics & Finance*, *9*(1). https://doi.org/10.1080/23322039.2021.1942601

Fourkan, M. (2021). Modeling Current Account Balance and General Government Net Lending and Borrowing and GDP Growth for Developed Countries. *Asian Journal of Economics, Finance and Management*, *3*(3), 11–19.

Gonzalo, J. (1994). Five alternative methods of estimating long-run equilibrium relationships. *Journal of Econometrics*, *60*(1–2), 203–233. https://doi.org/10.1016/0304-4076(94)90044-2

Hafnida Hasan, Mohammad Salem Oudat, B. J. A. A. (2021). Relationship Among Export, Import and Economic Growth: Using Co-Integration Analysis. *Psychology and Education Journal*, *58*(1), 5126–5134. https://doi.org/10.17762/pae.v58i1.2068

He, Q., Liu, J., Wang, S., & Yu, J. (2020). The impact of COVID-19 on stock markets. *Economic and Political Studies*, *8*(3), 275–288. https://doi.org/10.1080/20954816.2020.1757570

Hossin, M. S., & Hamid, M. K. (2021). Capital Market Performance and Bangladesh's Economy: An Empirical Study. *Global Business Review*. https://doi.org/10.1177/0972150920982247

Inchausti-Sintes, F., Voltes-Dorta, A., & Suau-Sánchez, P. (2021). The income elasticity gap and its implications for economic growth and tourism development: the Balearic vs the Canary Islands. *Current Issues in Tourism*, *24*(1), 98–116. https://doi.org/10.1080/13683500.2020.1722618

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, *12*(2–3), 231–254. https://doi.org/10.1016/0165-1889(88)90041-3

Jung, N. (2021). The importance of the manufacturing sector and locally specific epidemic responses: Lessons from the South Korean experience. *Local Development & Society*, *2*(1), 168–179. https://doi.org/10.1080/26883597.2021.1893610

Khan, M., & Yoon, S. M. (2021). Financial instability and environmental degradation: a panel data investigation. *Applied Economics*, *53*(54), 6319–6331. https://doi.org/10.1080/00036846.2021.1937508

Kim, D., Kim, M., & Shim, M. (2021). The Macroeconomic Consequences of Stimulating Offline Consumption during COVID-19. *Global Economic Review*, *50*(1), 20–42. https://doi.org/10.1080/1226508X.2021.1875868

Kim, M. J., & Lee, S. (2021). Can Stimulus Checks Boost an Economy Under Covid-19? Evidence from South Korea. *International Economic Journal*, *35*(1), 1–12. https://doi.org/10.1080/10168737.2020.1864435

Liu, H., Khan, I., Zakari, A., & Alharthi, M. (2022). Roles of trilemma in the world energy sector and transition towards sustainable energy: A study of economic growth and the environment. *Energy Policy*, *170*, 113238. https://doi.org/10.1016/j.enpol.2022.113238

Moradi, M., Appolloni, A., Zimon, G., Tarighi, H., & Kamali, M. (2021). Macroeconomic factors and stock price crash risk: Do managers withhold bad news in the crisis-ridden Iran market? *Sustainability (Switzerland)*, *13*(7), 1–16. https://doi.org/10.3390/su13073688

Mousavi, M., & Gandomi, A. H. (2021). Prediction error of Johansen cointegration residuals for structural health monitoring. *Mechanical Systems and Signal Processing*, *160*, 107847. https://doi.org/10.1016/j.ymssp.2021.107847

Nkalu, C. N., Ugwu, S. C., Asogwa, F. O., Kuma, M. P., & Onyeke, Q. O. (2020). Financial Development and Energy Consumption in Sub-Saharan Africa: Evidence From Panel Vector Error Correction Model. *SAGE Open*, *10*(3). https://doi.org/10.1177/2158244020935432

Onder, M., & Nyadera, I. N. (2020). The Role of Non -Economic Drivers in Development Planning: The Case of South Korea and Turkey. *International Journal of Public Administration*, *43*(4), 283–293. https://doi.org/10.1080/01900692.2019.1628057

Or, N. H. K., Cheng, E. W., Yue, R. P. H., & Yuen, S. W. H. (2021). Risk perceptions, anxiety and the future of international trade: a cross-national study of public trade preferences in Asia under COVID-19. *Journal of Elections, Public Opinion and Parties*, *31*(S1), 26–40.

ISSN
2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3

https://doi.org/10.1080/17457289.2021.1924732
Osuagwu, E. S. (2020). Empirical Evidence of a Long-Run Relationship Between Agriculture and Manufacturing Industry Output in Nigeria. *SAGE Open*, *10*(1). https://doi.org/10.1177/2158244019899045
Ozkan, O. (2021). Impact of COVID-19 on stock market efficiency: Evidence from developed countries. *Research in International Business and Finance*, *58*, 101445. https://doi.org/10.1016/j.ribaf.2021.101445
Rodriguez Tirado, A. (2022). Visualizing the impact of Covid-19 on economic complexity clusters: the case of Mexico. *Regional Studies, Regional Science*, *9*(1), 519–522. https://doi.org/10.1080/21681376.2022.2095298
Sappewali, B., & Hasanuddin, B. (2022). *Determ minant of Economic Growth*. *4*(2), 79–84.
Sharma, P., & Shrivastava, A. K. (2021). Economic Activities and Oil Price Shocks in Indian Outlook: Direction of Causality and Testing Cointegration. *Global Business Review*, 097215092199049. https://doi.org/10.1177/0972150921990491
Song, C.-Q., Chang, C.-P., & Gong, Q. (2021). Economic growth, corruption, and financial development: Global evidence. *Economic Modelling*, *94*, 822–830. https://doi.org/10.1016/j.econmod.2020.02.022
Sravan, C., & Mishra, P. P. (2022). Domestic renewable electricity generation vs electricity imports: Meeting India's long-run electricity consumption. *Sustainable Energy Technologies and Assessments*, *54*(October), 102842. https://doi.org/10.1016/j.seta.2022.102842
Tang, Q., & Li, M. (2021). Analysis of myanmar's macroeconomic development. *E3S Web of Conferences*, *235*, 01022. https://doi.org/10.1051/e3sconf/202123501022
Wang, D., & Huang, W.-Q. (2021). Forecasting macroeconomy using Granger-causality network connectedness. *Applied Economics Letters*, *28*(16), 1363–1370. https://doi.org/10.1080/13504851.2020.1817302
Widarni, E., & Bawono, S. (2021). Human Capital, Technology, and Economic Growth: A Case Study of Indonesia. *The Journal of Asian Finance, Economics and Business*, *8*(5), 29–35. https://doi.org/10.13106/jafeb.2021.vol8.no5.0029
Yadav, M. P., Khera, A., & Mishra, N. (2022). Empirical Relationship Between Macroeconomic Variables and Stock Market: Evidence from India. *Management and Labour Studies*, *47*(1), 119–129. https://doi.org/10.1177/0258042X211053166
Ybrayev, Z. (2022). Balance-of-payments-constrained growth model: an application to the Kazakhstan's economy. *Eurasian Economic Review*, *12*(4), 745–767. https://doi.org/10.1007/s40822-022-00217-5
Zhang, Y., & Dilanchiev, A. (2022). Economic recovery, industrial structure and natural resource utilization efficiency in China: Effect on green economic recovery. *Resources Policy*, *79*, 102958. https://doi.org/10.1016/j.resourpol.2022.102958
Zhao, Z., Wen, H., & Li, K. (2021). Identifying bubbles and the contagion effect between oil and stock markets: New evidence from China. *Economic Modelling*, *94*, 780–788. https://doi.org/10.1016/j.econmod.2020.02.018
Ziesemer, T. H. W. (2021). Semi-endogenous growth models with domestic and foreign private and public R&D linked to VECMs. *Economics of Innovation and New Technology*, *30*(6), 621–642. https://doi.org/10.1080/10438599.2020.1760423

ISSN 2302-2663 (online)
DOI: doi.org/10.21009/JPEB.007.2.3