Inflation Volatility and COVID-19 In Indonesian: ARIMA Method

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ARTICLE INFORMATION

ABSTRACT

Inflation is one of the most widely tested economic variables both theoretically and empirically. Stable inflation is a sign that sustainable economic growth provides benefits for improving people's welfare. This study aims to analyze the impact of Covid-19 on volatility inflation in Indonesian. The method used in this study is the ARIMA model. The results of this study are the ARMA (1.1.0) model suitable for testing inflation volatility in Indonesia. Forecasting results show that inflation over the next 5 months or until December 2022 tends to decrease. From the prediction results, the policy that can be applied to business sector actors is to carry out operational (marketing) activities carried out with an online system. The next policy that can be applied to companies is tax relaxation and easy access to credit to banks. Finally, the policies that can be applied due to the decline in commodity prices in the food and beverage and tobacco sectors are capital assistance and production equipment assistance for business actors.

Keywords: Volatility, Inflation, ARIMA, COVID19, Forecasting

INTRODUCTION

Inflation is a macroeconomic variable that has a significant impact on various other macro variables, such as economic growth, unemployment, poverty and so on. Therefore, inflation is one of the most studied economic variables, both theoretically and empirically. Stable inflation is a prerequisite for sustainable economic growth which in turn will provide benefits for improving people's welfare. Moreover, the presence of Covid-19 has a negative impact on the weakening of the community's economy. As an illustration, people's purchasing power may decline, which in turn will significantly reduce inflation. This can be seen in Figure 1 which shows the development of inflation in Indonesia over the last few years.

Figure 1. Inflation in Indonesia at the start of COVID-19
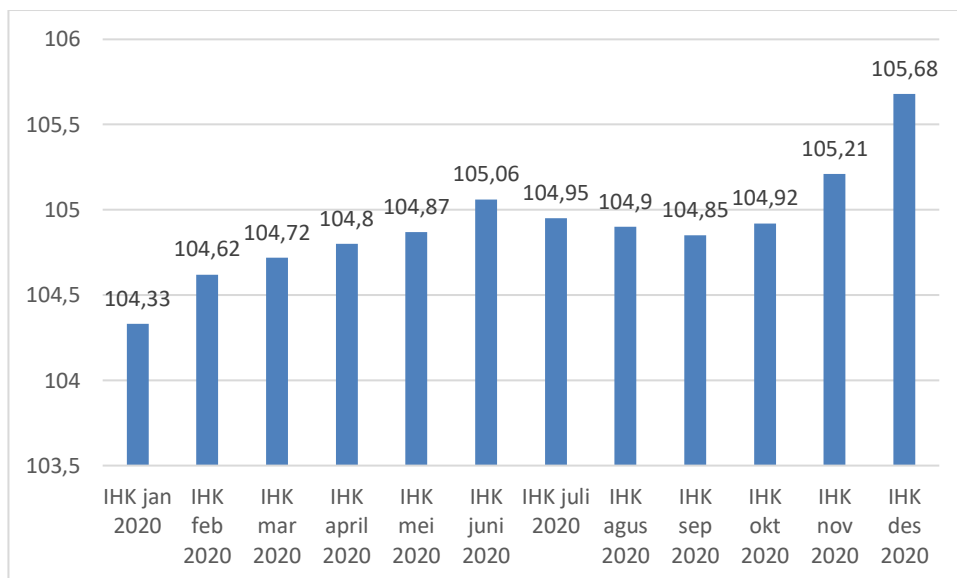
Source: Bank Indonesia, 2021

It can be seen in Figure 1 that Inflation tends to continue to decline due to the Covid-19 pandemic crisis. The Covid-19 pandemic has forced individuals to keep their distance and stay at home to reduce the spread of the virus. This has an impact on almost all sectors, from the economy, education, transportation, tourism, and even sports. Some economic activities were paralyzed and many had to go out of business. In addition, the result of the COVID-19 pandemic is a decrease in the purchasing power of household consumption. Based on BPS data, household consumption fell from 5.02 percent in the first quarter of 2019 to 2.84 percent in the first quarter of this year. This will certainly have an impact on the volatility of inflation in Indonesia.

Volatility is often used to measure stability and market mood; the greater the volatility of a value, the more unstable the value. Rother (2004) states that the negative consequences of inflationary volatility are a particular issue that needs attention. The high variability of inflation over time makes expectations of future prices more uncertain. Research on inflation volatility has been carried out in several countries, including Asian countries (Rizvi, Syed., Naqvi, Bushra, Borders, Christian, & Mirza, Nawazish, 2014), Thailand (Hossain & Arwatchanakarn, 2016), (Abdulrahman, Ahmed, & Abdellah., 2018).

Mensi, Sensoy, Vo, & Kang (2020) examines the impact of Covid-19 on the multiplicity of gold and oil prices based on fluctuating trends. The high variability of inflation over time creates long-term risks; increases the cost of hedging against inflation risk and creates uncertainty over the redistribution of wealth. Choi & Loungani (2015 stated that uncertainty is a risk for companies.

Therefore, research problem in this study is (i) to analyze the volatility of inflation and COVID-19. By using the ARIMA method, researchers can predict the volatility of inflation in the next 5 months or the period from August to December so that researchers can recommend policies in the future.

LITERATURE REVIEW

Inflation Theory

Inflation is a condition where there is an increase in the price level of various goods in general and continuously (Mishkin, 2004). Broadly speaking, theories that discuss inflation can be divided into three groups, including:

a) Quantity Theory
Quantity theory explains that inflation is only caused by one factor, namely due to an increase in the money supply (JUB). This quantity theory was proposed by Irving Fisher which is described in the following equation.

$$MV = PT$$

Factors that are considered constant are V and T, so if M (money in circulation) increases, there will be inflation (price increase).
b) Keynesian theory
Keynes's theory explains that inflation occurs because a society tends to want to live beyond the limits of its economic capacity. This situation is indicated by public demand for goods that exceed the amount of goods available. This creates an inflationary gap. When the inflationary gap persists, during that time the inflation process occurs and is sustainable.

Keynes disagreed with the views put forward in quantity theory. The quantity theory states that an increase in the money supply will cause an increase in the price level, but will not lead to an increase in national income. Then, Keynes argues that price increases are not only determined by the money supply, but are also determined by increases in production costs.

c) Structuralist Theory
Structuralist theory is a theory that explains the phenomenon of inflation in the long run. This is based on his explanation which highlights the causes of inflation that come from the rigidity or inflexibility of a country's economic structure. According to this theory, there are two main rigidities in the economy of developing countries that can lead to inflation, namely the rigidity of food supplies and export goods.

1. Stiffness of export acceptance
The stiffness of export receipts shows that the increase in the value of export revenues is always slower than the value of imports. As a result of this inaction, the state experienced difficulties in financing imports of both raw materials and capital goods such as machinery or other industrial equipment. Therefore, the government is trying to promote the establishment of domestic industries in order to substitute imported goods. However, in general, domestic industrial production costs tend to be more expensive, so that the selling prices of goods rise and inflation occurs.

2. Rigidity of food supply
In general, in developing countries the supply of food is slower than the increase in population and per capita income. This results in the price of food ingredients will rise and exceed the price of other goods. Because food is a primary need, rising food prices encourage workers to demand higher wages. Rising wages result in increased production costs in various companies which in turn causes the selling price of various goods and services to rise, resulting in inflation.

Inflation Volatility

Volatility is often used to measure stability; the greater the volatility of a value, the more unstable the value. Rother (2004) states that the negative consequences of inflationary volatility are a particular issue that deserves attention. The high variability of inflation over time makes expectations of future prices more uncertain.

The high variability of inflation over time creates long-term risks; increases the cost of hedging against inflation risk and creates uncertainty in the redistribution of wealth (Rother, 2004) Choi & Loungani (2015) states that uncertainty is a risk for companies, so companies prefer to postpone or prefer to reduce their investments, and change recruitment plans and increase unemployment.

Errais & Bahri (2016) stated that investment decisions are usually based on two investment components, namely risk and profit. Rother (2004) states that the negative impact of inflationary volatility is a problem that needs attention. High inflation volatility makes expectations of future prices more uncertain, which in turn increases risk, which also increases the cost of hedging inflation risk and increases unforeseen redistribution of wealth.

RESEARCH METHOD

Research Approach

This research uses a quantitative approach, which is a scientific search effort based on the philosophy of logical positivism (logical positivism) which operates with strict rules regarding logic, truth, and prediction (Watson, in Danim, 2002). A quantitative approach is used as an effort to analyze the impact of COVID-19 on inflation volatility in Indonesia.

Data Sources and Variable Operational Definitions

The data used in this study is secondary data obtained from the Central Statistics Agency (www.bps.go.id). The period used is 2010 to 2022 monthly data in Indonesia. To analyze the volatility of inflation in Indonesia, the method used is the Autogressive Integrated Moving Average (ARIMA). The following provides operational definitions of research variables.

Table 1. Variable Operational Definitions

No	Variable	Explanation	Source
1	Inflation	Monthly inflation rate (year on year) as measured by the Consumer Price Index (CPI) in Indonesia, in the form of monthly data from 2010 to 2022.	BPS

Source: Author, 2022

Method

ARIMA is a combination of AR and MA models through a differentiation process. The ARIMA model has a time lag. The lag time of 1 period in the autoregressive process is called first-order autoregressive or abbreviated as AR (1). The symbol to represent the amount of lag time in the autoregressive process is p. The lag time of 1 period in the first-order moving average process or abbreviated as MA (1). The symbol for the amount of time lag in the moving average process is q. The p-value and q-value can be more than 1.

The ARIMA model for AR(p), MA(q), and the difference d times is ARIMA (p,d,q). For example, in an ARIMA process using first-order autoregressive, first-order moving average, and once differentiation to obtain stationary data, the writing is ARIMA (1,1,1). Gujarati (2003) describes the Box-Jenkins methodology into four steps, including identification, estimation, diagnostic examination, and forecasting. For example, we will create a model to predict the value of Y. The general form of an autoregressive model of order p or AR(p) is:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \dots + \alpha_p Y_{t-p} + \varepsilon_t \tag{1}$$

Y_t : observed variable
α_0 : autoregressive constant
α_p : parameter

The general form of the qth-order moving average or MA(q) model is:

$$Y_t = \beta_0 + \beta_1 \varepsilon_{t-1} + \beta_2 \varepsilon_{t-2} + \dots + \beta_q \varepsilon_{t-q} \tag{2}$$

Y_t : observed variable
β_0 : moving average constant
β_q : parameter

The general form of the ARIMA model with p-order autoregressive and q-order moving average is:

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \dots + \alpha_p Y_{t-p} + \varepsilon_t + \beta_1 \varepsilon_t + \beta_2 \varepsilon_{t-1} + \dots + \beta_q \varepsilon_{t-q}$$

RESULTS

Table 2. Stationarity Test at Level

Null Hypothesis: IHK has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.095825	0.2467
Test critical values:	1% level	-3.474567	
	5% level	-2.880853	
	10% level	-2.577147	

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

Because the probability is 0.2467> 0.05, it is not stationary, so it is necessary to continue the stationary test on the first difference. Here are the test results.

Table 3. Stationarity Test on First Difference

Null Hypothesis: D(IHK) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=13)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-12.16673	0.0000
Test critical values:	1% level	-3.474874	
	5% level	-2.880987	
	10% level	-2.577219	

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

Because prob 0.0000 < 0.05, the CPI variable is stationary at the first difference so that ARIMA can be continued.

Table 4. Arima Best Model
Automatic ARIMA Forecasting

Selected dependent variable: LOG(IHK)

Sample: 2010M01 2022M12

Included observations: 150

Number of estimated ARMA models: 16

Number of non-converged estimations: 0

Selected ARMA model: (1,0) (0,0)

AIC value: -3.94208988636

Table 5. Arima Model Testing

Dependent Variable: D(IHK)
Method: ARMA Maximum Likelihood (OPG - BHHH)
Date: 07/08/22   Time: 07:56
Sample: 2010M02 2022M06
Included observations: 149
Coefficient covariance computed using outer product of gradients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.078913	0.720689	-0.109497	0.9130
AR (1)	0.937126	0.122807	7.630912	0.0000
MA (1)	-1.000000	399.7520	-0.002502	0.9980
SIGMASQ	16.71002	148.8985	0.112224	0.9108

R-squared	0.032531	Mean dependent var		-0.046443
Adjusted R-squared	0.012514	S.D. dependent var		4.169962
S.E. of regression	4.143789	Akaike info criterion		5.719416
Sum squared resid	2489.793	Schwarz criterion		5.800059
Log likelihood	-422.0965	Hannan-Quinn criter.		5.752180
F-statistic	1.625176	Durbin-Watson stat		1.954499
Prob(F-statistic)	0.186109			

Inverted AR Roots	.94
Inverted MA Roots	1.00

In the review's menu, there is Automatic ARIMA Forecasting (table 4), which shows that the best selected model is the arima model (1,1,0). Then it was confirmed again by doing a regression (in table 5) it appears that the probability of ar (1) is 0.0000<0.05 (significant) and the ma prob is 0.9987>0.05 (not significant). Therefore, the Arima (1,1,0) model was chosen.

**Figure 2.** Forecasting Inflation Using the ARIMA Model
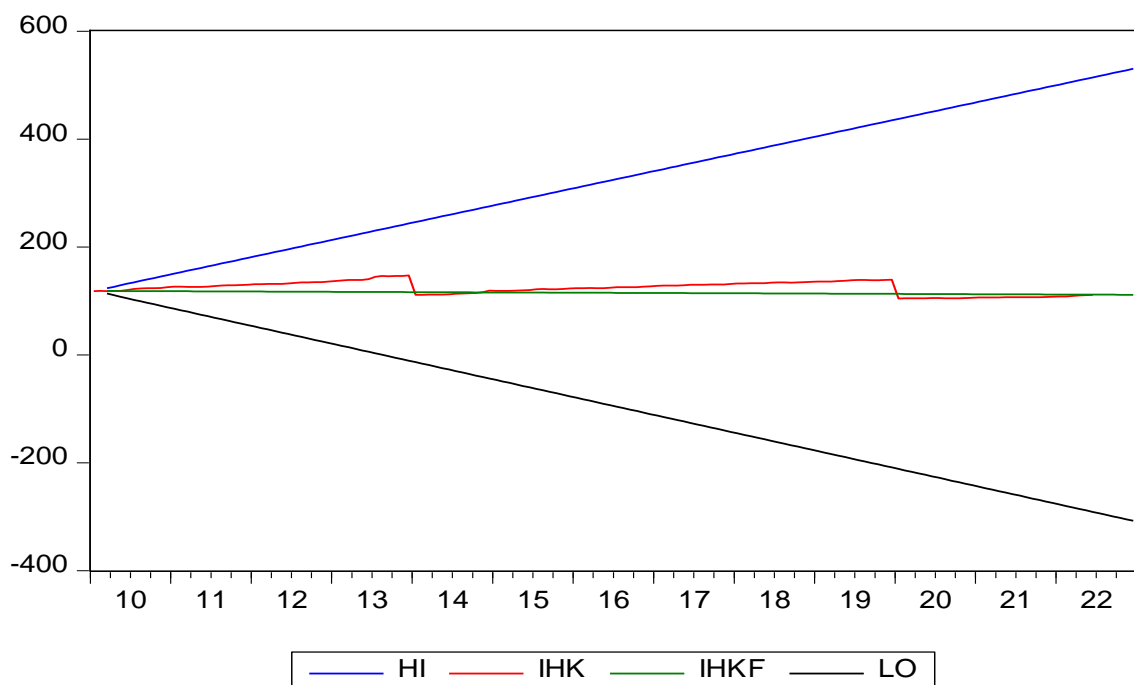
Based on the forecasting results above, it appears that the next 5 months (August to December) in 2022 the CPI (predicted CPI variable - green) has a downward trend. It can be seen in the picture above that the CPI variable (actual CPI variable-red) in early 2020 tends to decrease. This decline could be due to the fact that COVID-19 started in Indonesia.

DISCUSSION

Covid-19 has an impact on various sectors including the investment climate that is not too conducive. Based on Survei Kegiatan Dunia Usaha or SKDU (2020), In quarter IV-2020, investment realization decreased with WNB -1.48%, contracted deeper than the previous quarter with WNB -1.27%. Based on the economic sector, the slowdown in the realization of investment activities in the fourth quarter of 2020 is indicated to have occurred in the Mining and Quarrying sector with WNB 2.19% although it was still recorded positive.

Semesterically, the results of the SKDU show that the number of business actors conducting investment activities in semester II-2020 is lower than semester II-2019. This could be due to the community's declining economic capacity or several factors according to the Survei Kegiatan Dunia Usaha Survey (2020) that could hamper investment plans in the first semester of 2021, including the Covid-19 pandemic (recorded in other factors, 31.28%) and licensing issues (13.39%) (Figure 3) below.

Figure 3. Inhibiting Factors for Investment Plans
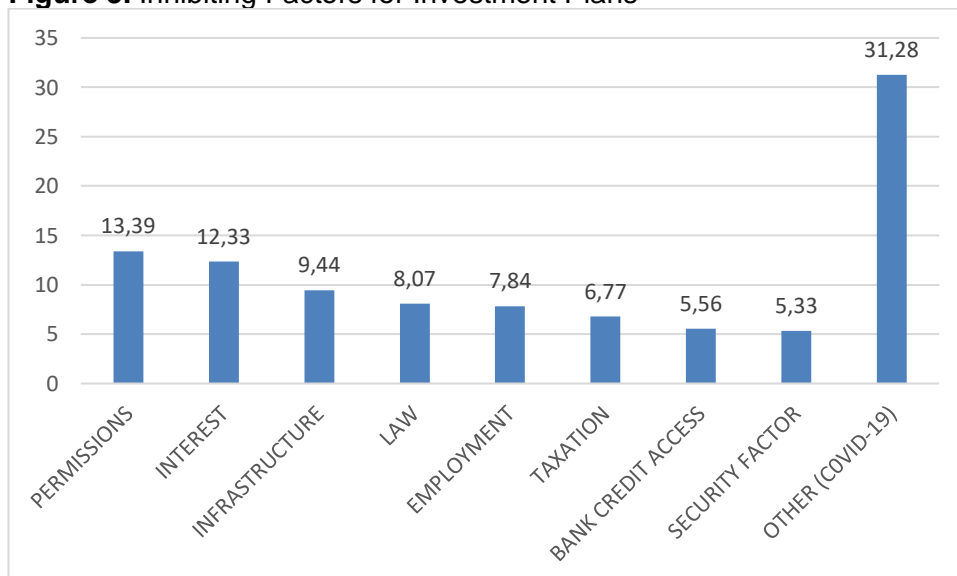
Source: Survei Kegiatan Dunia Usaha (SKDU, 2020)

COVID19 has also had a significant impact on banking financial conditions. In fact, the bank is a source of capital, a store of assets and a place to invest for companies. Moreover, in the midst of COVID-19 conditions, it is possible that there are several companies that require access to bank credit. Access to bank credit is an alternative for companies when facing uncertainty. Choi & Loungani (2015) stated that uncertainty is a risk for companies, so companies prefer to reduce their investment, and change their recruitment plans which causes an increase in unemployment. Because banks play an important role in the sustainability of the company, the bank's financial condition will be described (liquidity, profitability and access to bank credit in the last 3 months).

Figure 4. Financial Condition and Credit Access
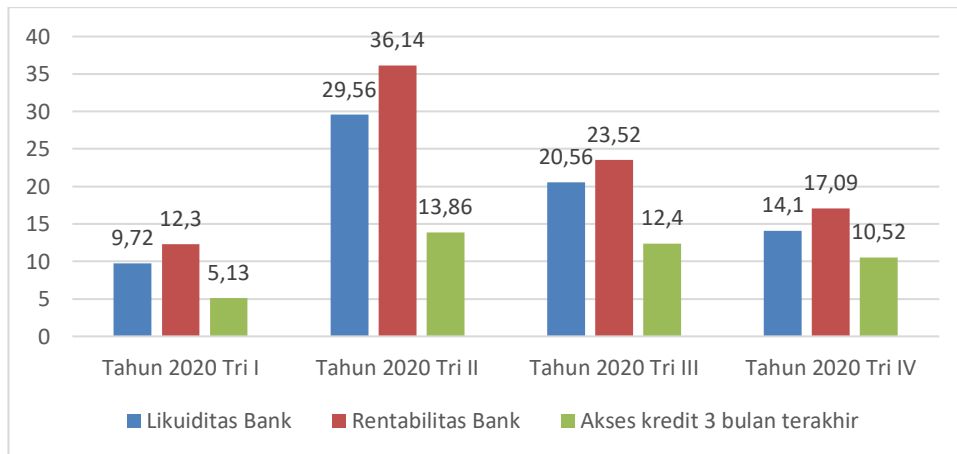
Source: Survei Kegiatan Dunia Usaha (SKDU, 2020)

From the banking world perspective, it appears that bank liquidity, which was declared "bad", increased in the second quarter. This indicates a poor ability to fulfill all obligations that must be paid off immediately in a short time. The profitability of banks that were declared "poor" also increased threefold compared to the previous year. This means that the bank's ability to generate profits is not good. Finally, access to credit in the last 3 months also increased 2.5 times higher. This is because banks tend to be careful in channeling their credit (credit crunch). The application of a credit crunch is carried out by banks by changing credit standards, where banks set higher margins and loan restrictions that affect the company's loan growth (Gert, 2014). This affects the distribution of bank funds to the public.

Moreover, the existence of social restrictions caused some people to experience a decrease in income. The decline in income certainly affects people's purchasing power so that inflation is at a low point. The low purchasing power of the people leads to low demand. Low demand is reflected in household consumption spending during the Covid-19 period, which only grew by around 2.84 percent or almost half when compared to the first quarter of last year which recorded growth of 5.02 percent. In fact, the driver of economic growth came from household consumption which reached 58.14 percent based on BPS data (2020). It can be said that the slowdown in household consumption is the main trigger for the slowdown in economic growth.

Based on the ARIMA method, it is predicted that in the next 5 months or August to December 2022, the inflation trend will decrease (figure 2). From the prediction results, the policy that can be implemented for business sector actors is to carry out their operational activities (marketing) with an online system. One of the benefits of an online system is cost efficiency. Moreover, this month of July (which is predicted by the Minister of Health as the peak of the COVID-19 sub-variant), could potentially cause companies that are less adaptive during the COVID-19 period, to make efficiency by reducing workforce. The reduction in the workforce causes the unemployment rate in Indonesia to increase which results in a decrease in people's purchasing power. This is one of the causes of the decline in the inflation rate in the short term.

From a business perspective, inflation has a significant effect on the costing and pricing of goods and services of a company. If the economic downturn (deflation) occurs

continuously, it is possible that the company will need leverage to encourage an increase in company profits. Onodugo, Ofoegbu & Anowor, (2018) suggests that companies need debt to finance various projects and take into account interest rates which are largely determined by inflation. Therefore, the policies that can be applied are tax relaxation for companies and ease of accessing credit to banks.

In terms of the business sector, the food, beverage and tobacco sectors actually recorded deflation with a share of minus 0.19% in 2020. The foodstuffs group also experienced inflation of minus 1.06% or deflation with a share of minus 0.19% in 2020 based on BPS data. This was due to the decline in the prices of a number of food commodities. The decline in the prices of a number of commodities tends to cause sellers to experience a decline in turnover and profit. The policies implemented are related to the decline in commodity prices with the help of capital and the assistance of production tools that can increase production efficiency so that profits can be obtained even though they are not high.

On the other hand, the highest contributor to inflation in July 2020 was spending on personal care and other services. Inflation reached 0.93% with a share of 0.06%. These two figures are the highest of the 11 indicator groups monitored by BPS. Commodity contributing to inflation in this category was the increase in gold prices that occurred in 80 of the 90 CPI cities that became the BPS database. It can be said that there is an increase in public interest in investing (gold) when inflation tends to decrease because gold is a relatively safe asset. Fajardo and Dantas (2017) results show that hyperinflation causes a lower desire to invest (stocks) than other assets. That is, in conditions that cause economic uncertainty (both deflation and hyperinflation) encourage individuals to invest in safer assets.

CONCLUSION

Based on Automatic ARIMA Forecasting (table 4), and based on testing the best ARIMA model (table 5), it shows that the best ARIMA model is the arima model (1,1,0) which is appropriate for analyzing inflation volatility in the next 5 months.

Based on the ARIMA method, it is predicted that in the next 5 months or August to December 2022, the inflation trend will decrease (figure 2). From the prediction results, the policy that can be implemented for business sector actors is to carry out their operational activities (marketing) with an online system. If the economic downturn (deflation) occurs continuously, it is possible for the company to need leverage to encourage an increase in company profits. Therefore, the policies that can be applied to companies are tax relaxation and ease of accessing credit to banks.

In terms of the business sector, the food, beverage and tobacco sectors actually recorded deflation with a share of minus 0.19% in 2020. The foodstuffs group also experienced inflation of minus 1.06% or deflation with a share of minus 0.19% in 2020 based on BPS data. The policies imposed due to the decline in the prices of these commodities are capital assistance and production equipment assistance for business actors in these commodities so that production efficiency increases and profits can be obtained, although not high.

For further researchers, it is possible to analyze inflation forecasting based on certain sectors. For example, forecasting inflation in the food sector, forecasting inflation in the manufacturing sector, forecasting inflation in the trade sector and others. Inflation forecasting can also be expanded the scope of research such as forecasting inflation in

various provinces in Indonesia so that it can be seen which provinces experience the highest inflation or deflation.

DECLARATION OF CONFLICTING INTERESTS
There is no conflict of interest in making this journal.

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