Analysis of Inflation Persistence and Sources of Inflationary Pressure in Java, Indonesia

Cicilia Melly Andita Hendary^{1,*}, Firmansyah²

¹Master Program in Economics, Universitas Diponegoro, Semarang, Indonesia

²Department of Economics and Development Studies, Universitas Diponegoro, Semarang, Indonesia

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Abstract Inflation disaggregation across all provinces in Java is persistent. Mapping results show that all provinces fall into the category of low inflation and high persistence. This study aims to analyze inflation persistence and sources of inflationary pressure in Java Island. The sample includes six provinces, observed from 2015 to 2019. The variables are inflation, consumer price index, money supply, and government spending. The method used is Autoregressive dan Davidson-Mackinnon Panel Data Regression. This study finds that inflation in Java Island is persistent in terms of general inflation, disaggregation of inflation, inflation in expenditure groups by COICOP, and inflation in the 5 volatile food commodities that have the largest weight. In general, inflation in Java falls into the category of low inflation and high persistence. This study also finds that the source of inflationary pressure in Java Island was monetary behavior. The results of this study are in accordance with the quantity theory which states that the money supply has a role in the process of increasing prices. Theoretically, if the money supply increases, while the aggregate supply is considered constant, then inflation will occur. An increase in the money supply reflects an increase in aggregate demand, but because the stock of goods and services remains constant, producers will increase prices. In general, the contribution of government spending to GDP in Java is indeed far below consumption and investment, so government spending cannot explain inflationary behavior in Java.

Keywords Inflation Persistence, Sources of Inflationary Pressure, Autoregressive and Davidson-Mackinnon Panel Data Regression

1. Introduction

One of the macroeconomic variables that can affect the level of welfare in a country is inflation. Inflation is defined as the tendency of prices to rise in general and continuously [1]. High inflation can cause a decrease in real income so that it has implications for a lower standard of living [2]. A deeper consequence of high inflation is the decline in people's purchasing power to meet their daily needs. Inflation does not always have a negative connotation for the economy. Inflation can be a stimulus for business actors in increasing their production due to the expectation that inflation can increase total revenue and income. Inflation can have a positive impact only if inflation is low and stable, as is a prerequisite for sustainable economic growth [3]. As the monetary authority, Bank Indonesia has a single goal, namely to achieve and maintain stability in the value of the rupiah. Stability in question is the stability of the prices of goods and services and the stability of the rupiah exchange rate with the currencies of other countries. Bank Indonesia uses monetary policy to control inflation. However, monetary policy can only manage inflation originating from the

aggregate demand side (demand pull inflation). In addition, inflation can be caused by a shock from the aggregate supply side (cost push inflation).

Iskandar [4] argues that the characteristics of inflation in Indonesia are quite sensitive to supply side shocks, thus requiring special policies to overcome this problem. If you look at historical data, actual inflation cannot always be achieved in accordance with the inflation target set. Sometimes actual inflation may miss the target. This condition is the reason why research is needed to study inflation behavior through the study of inflation persistence. Willis [5] defines inflation persistence as the speed to return to baseline conditions after a shock, which is then the definition of inflation persistence developed by Marques [6] as the speed of inflation to return to its equilibrium level after a shock / pressure occurs. The terms baseline and equilibrium in the definitions of Willis [5] and Marques [6] are defined as averages, so it can be interpreted that inflation persistence is the rate at which inflation returns to its average value. The definition of Marques [6] is often used in several researches on inflation persistence. Several studies on inflation persistence have been carried out in Indonesia. One of them is a study conducted by Yanuarti [7] which shows that the degree of persistence of inflation in Indonesia is still relatively high. So far, several studies on inflation persistence have focused on the national scale, while regional studies are still limited [8]. The study of inflation persistence on a regional scale becomes very important considering that national inflation is calculated based on regional inflation. Inflation persistence can be said as a form / movement of prices. So, anything that causes prices must cause inflation and also its movement. Theoretically, the factors that influence the persistence of inflation are pressures from the supply and demand sides.

Bank Indonesia has the power to influence the economy from the demand side through expansionary and contractionary monetary policies. If the government wants to expand the economy, then Bank Indonesia can increase the money supply or lower interest rates, but the consequence will be an increase in prices. In addition, inflation can also be affected by fiscal policy. An increase in government spending and a decrease in taxes can stimulate aggregate demand and increase GDP, but it also causes an increase in prices. So, fiscal and monetary policy is a form of shock / pressure from the demand side that can affect inflation. Several studies, such as those conducted by Abou-Zaid [9]; Nguyen [10]; Cao [11]; and Joshi [12] show that government spending and the money supply have a significant positive effect on the CPI. This means that if there is an increase in government spending and/or the money supply, the CPI will also increase and affect price movements (which is nothing but persistence). Meanwhile, the factors that influence the persistence of inflation from the supply side are natural conditions, seasons, disasters, fluctuations in prices of imported raw

materials, smooth distribution of goods, and so on [13 – 15].

2. Literature Review

2.1. Inflation Theory

According to Friedman [16], inflation is an ever-present phenomenon and is a monetary event. Boediono [1] states that inflation is a very important monetary event and occurs in many countries. In addition, Boediono [1] defines inflation as a general and continuous upward trend in prices. It should be underlined that an increase in one or two goods cannot be called inflation unless the increase affects the prices of other goods. Price increases that occur occasionally due to certain events such as holiday celebrations, seasonality, and that occur occasionally cannot be called inflation because they are not considered as economic problems/diseases that require special policies. In other literature, Mankiw [17] defines inflation as the percentage change in the price level, where there is a continuous upward trend in prices. This understanding is also in line with the notion put forward by Nopirin [18], where inflation is a form of stages of increasing the price of goods/services whose increase occurs continuously over a certain period of time. From this understanding, several types of classification of inflation then arise. The classification is based on the severity of inflation, the causes of inflation, and the origin of inflation.

2.2. Inflation Persistence

Referring to various literatures, there are many definitions of inflation persistence. Batini & Nelson [19] and Batini [20] define inflation persistence in 3 different types, namely: (1). Positive serial correlation in inflation; (2). Lags between systematic monetary policy action and their (peak) effect on inflation; (3). Lagged responses of inflation to non-systematic policy action (i.e., policy shocks). In other literature, inflation persistence is also defined by Marques [6] as the speed of an inflation rate to return to its equilibrium point after a shock.

This understanding of Marques is based on a modification of the previous understanding by Willis [5] where he defines inflation as the speed with which the inflation rate returns to its initial position after a shock. In addition to the above understanding, Roache [21] also explains that inflation persistence is the tendency of price shocks to push the inflation rate away from the steady state, including the long-term inflation target. The number of definitions is triggered by the lack of a proper definition related to the persistence of inflation.

In various other literatures it has been agreed that persistence is a speed, where the speed in question is the speed of the inflation response when a shock occurs. This speed can be seen through the degree of persistence. If the

degree of persistence is high, it indicates that inflation is slow to return to its natural rate. On the other hand, if the degree of persistence of inflation is low, it indicates the speed of inflation to return to its natural level. Studies on inflation persistence can be used to improve inflation projection capabilities, see the dynamic effects of exogenous prices shocks, obtain the right monetary policy, and also assess that a different monetary policy can cause different persistence [22].

3. Methodology

This study uses a quantitative approach with the object of research in 6 provinces in Java from 2015 – 2019. In estimating inflation persistence, the type of data used is secondary data obtained from Bank Indonesia. The data used is monthly inflation data (year-on-year) which is measured using the CPI for the base year 2012. The research period is from 2015 to 2019, so that 60 observations are obtained. The selection of year-on-year inflation data is not without reason, this is because month-to-month or quarter-to-quarter inflation contains seasonal factors, so it is feared that there will be bias when making estimates. In estimating sources of inflationary pressure, the type of data used is secondary data obtained from Bank Indonesia and the Central Statistics Agency. The data used is quarterly data (quarter-to-quarter). The research time period is from 2015 to 2019 and because it includes the observation level for each province, a panel data structure is obtained with a total of 120 observations.

3.1. Estimated Inflation Persistence

In this study, inflation persistence is estimated using the univariate autoregressive (AR) model as many previous researchers have done. According to Marques [6], the AR model is a fairly good measure of inflation persistence. Estimates will be made in every province on the island of Java. The univariate autoregressive (AR) model to be estimated is as follows:

$$\pi_t = \beta_0 + \sum_{i=1}^k \beta_i \pi_{t-i} + \varepsilon_t$$

Information:

π_t : Monthly inflation at time t

β_0 : Constant

$\sum_{i=1}^k \beta_i$: Sum of coefficient AR

ε_t : Error term

After estimating the model, then calculating how long it will take to absorb 50 percent of the shocks / shocks that occur before inflation returns to the baseline or on average using the following formula:

$$h = \frac{p}{1-p}$$

After that, the categorization between inflation and its persistence is carried out. High inflation if $> 10\%$, and high persistence if > 0.8 , and vice versa [23].

3.2. Determining the Source of Inflationary Pressure

In this study, to determine the source of inflationary pressure, a model of fiscal behavior and monetary behavior was formed. Then, the Davidson-Mackinnon test is conducted on both models to determine whether the source of inflationary pressure comes from fiscal or monetary behavior. The model used is panel data regression. In general, panel data regression has 3 models, namely the Common Effect Model, Fixed Effect Model, and Random Effect Model. To see which model is the best, the Chow test and Hausman test are carried out. The model to be estimated is as follows:

Fiscal Behavior Model:

$$IHK_{it} = \lambda_0 + \lambda_1 PP_{it} + \mu_{it}$$

Monetary Behavior Model:

$$IHK_{it} = \gamma_0 + \gamma_1 JUB_{it} + v_{it}$$

Information:

IHK : Consumer price index

λ_0 : Constant in the model of fiscal behavior

λ_1 : Government spending coefficient on fiscal behavior model

PP : Government spending on the fiscal behavior model

μ : Error term on fiscal behavior model

γ_0 : Constants in the monetary behavior model

γ_1 : Coefficient of the money supply in the monetary behavior model

JUB : The money supply in the model of monetary behavior

v : Error term in monetary behavior model

i : Province on the island of Java

t : Quarter

4. Results

4.1. Sources of Inflationary Pressure in Java

The conclusion drawn from the Davidson-Mackinnon test results is obtained from the estimation results in each model after entering the fitted value variable from the rival model. If you want to know whether the fiscal behavior model is the right model, the fiscal behavior model will be estimated by including the fitted value of the monetary behavior model ($\hat{Y}_M$). If you want to know whether the monetary behavior model is the right model, the monetary behavior model will be estimated by including the fitted value of the fiscal behavior model ($\hat{Y}_F$).

Figure 1. Return period of general inflation in Java provinces to average value (months)

Figure 2. Money Supply in 6 Java Provinces (Quarterly, 2015 – 2019)

Table 1. Estimated Results of the Monetary Behavior Model

Hausman Test Probability	0.0000			
	Best Model: Fixed Effect			
Dependent Variable: CPI				
Independent Variable	Fixed Effect Model		Random Effect Model	
	Coeff	Prob	Coeff	Prob
C	91.0912***	0.0000	106.7256***	0.0000
JUB	0.0749***	0.0000	0.0439***	0.0000
	R ² = 0.7774		R ² = 0.4048	
Note: ***significant at α=1%; **significant at α=5%; *significant at α=10%				

Source: Data processed, 2021

Given that the data structure used to determine the source of inflationary pressure is a combination of time series data and cross section data, the estimation is carried out using panel data regression. In this study, the author will compare 2 common models in panel data, namely fixed effects and random effects, while the common effects model is not considered because the model will produce the same coefficients for all individuals (in this case every province on the island of Java) (Figure 2). In fact, in reality, it is rare to find the same individual characteristics.

Table 1 shows the estimation results of the monetary behavior model. Based on the Hausman test, the fixed effect model is the best model. Then the constants and coefficients from the model are used to calculate the fitted value of the monetary behavior model where the result will be a new variable, namely $\hat{Y}_M$. Variable $\hat{Y}_M$ then entered into the model of fiscal behavior as the second independent variable after government spending.

Table 2 shows the estimation results on the model of fiscal behavior after including the variable $\hat{Y}_M$. Based on the Hausman test, the random effects model was obtained as the best model, so that drawing conclusions to determine whether the fiscal behavior model is the right model will refer to the random effects model. Variable $\hat{Y}_M$ shows a probability value of 0.0000, meaning that it can be concluded that the fiscal behavior model is not appropriate.

Table 3 shows the estimation results from the model of fiscal behavior. Based on the Hausman test, the random effect model was obtained as the best model. Then the constants and coefficients from the model are used to calculate the fitted value of the fiscal behavior model, where the result will be a new variable, namely $\hat{Y}_F$. Variable $\hat{Y}_F$ then entered into the model of monetary behavior as the second independent variable after the money supply.

Table 2. Estimation Results of Fiscal Behavior Model After Entering Variables $\hat{Y}_M$

Hausman Test Probability	0.9523			
	Best Model: Random Effect			
Dependent Variable: CPI				
Independent Variable	Fixed Effect Model		Random Effect Model	
	Coeff	Prob	Coeff	Prob
C	-1.5162	0.8569	-0.4302	0.9484
PP	-0.0144	0.6412	-0.0079	0.7290
ŶM	1.0131***	0.0000	1.0041***	0.0000
	R² = 0.7778		R² = 0.7776	
Note: ***significant at α=1%; **significant at α=5%; *significant at α=10%				

Source: Data processed, 2021

Table 3. Estimation Results of Fiscal Behavior Model

Hausman Test Probability	0.2006			
	Best Model: Random Effect			
Dependent Variable: CPI				
Independent Variable	Fixed Effect Model		Random Effect Model	
	Coeff	Prob	Coeff	Prob
C	126.6323***	0.0000	126.8204***	0.0000
PP	0.1861***	0.0002	0.1709***	0.0005
	R ² = 0.3137		R ² = 0.0985	
Note: ***significant at α=1%; **significant at α=5%; *significant at α=10%				

Source: Data processed, 2021

Table 4. Estimation Results of Monetary Behavior Model After Entering Variables $\hat{Y}F$

Hausman Test Probability	0.0000			
	Best Model: Fixed Effect			
Dependent Variable: CPI				
Independent Variable	Fixed Effect Model		Random Effect Model	
	Coeff	Prob	Coeff	Prob
C	101.4799***	0.0000	-19.3238*	0.0982
JUB	0.0759***	0.0000	0.0026***	0.0098
ŶF	-0.0844	0.6412	1.1393***	0.0000
	R ² = 0.7778		R ² = 0.3267	
Note: ***significant at α=1%; **significant at α=5%; *significant at α=10%				

Source: Data processed, 2021

Table 5. Conclusion of Davidson-Mackinnon Test Results

Hypothesis: $\gamma_2 = 0$	Hypothesis: $\lambda_2 = 0$	
	Received	Rejected
Received	Fiscal Behavior Model and Appropriate Monetary Behavior Model	Correct Monetary Behavior Model, Improper Fiscal Behavior Model
Rejected	Correct Fiscal Behavior Model, Improper Monetary Behavior Model	Improper Fiscal Behavior Model and Monetary Behavior Model

Source: Data processed, 2021

Table 4 shows the estimation results on the monetary behavior model after including the variable $\hat{Y}F$. Based on the Hausman test, the fixed effect model is obtained as the best model, so that conclusions to determine whether the monetary behavior model is the right model will refer to the fixed effect model. Variable $\hat{Y}F$ shows a probability value of 0.6412, meaning that it can be concluded that the monetary behavior model is correct.

Based on the results of the Davidson-Mackinnon test using panel data regression, it is known that the hypothesis $\lambda_2 = 0$ which is the coefficient of $\hat{Y}M$ rejected, while the hypothesis $\gamma_2 = 0$ which is the coefficient of $\hat{Y}F$ received. So, it can be concluded that the source of inflationary pressure in Java is monetary behavior. The results of this study are in accordance with the quantity theory, which states that the money supply has a role in the process of increasing prices. The results of this study are also in accordance with several previous studies such as those conducted by Joshi [12]; Ofori et al. [24]; and Wimanda [25] that the money supply has a significant positive effect on the CPI.

This study is slightly different from the results of a similar study conducted by Maitrinia [26], which tries to see whether inflation on the island of Sumatra is a fiscal or monetary behavior. The results of research of Maitrinia [26] show that inflation on the island of Sumatra is a fiscal and monetary phenomenon. Here there is a difference that inflation on the island of Sumatra, apart from being a monetary behavior, is also a fiscal behavior. Meanwhile, in Java, it is only monetary behavior. Based on Table 1, if the money supply increases by IDR 1 trillion, then the CPI will increase by 0.0749 (inflation occurs because the CPI

increases). Theoretically, if the money supply increases, while the aggregate supply remains constant, then inflation will occur. This is very easy to understand because an increase in the money supply reflects an increase in aggregate demand, but because the stock of goods and services remains constant, producers will increase prices [27].

Compared with research Maitrinia [26] in terms of fiscal behavior, if we look at the large percentage of government spending on GRDP, it can be seen that the proportion of government spending on GRDP in Java is lower than in Sumatra. The average proportion of government spending in Java is 8.66%, while in Sumatra it is 10.97%. Java Island has a lower percentage than Sumatra Island, therefore the influence of government spending on Java Island is not as large as on Sumatra Island. In general, the contribution of government spending to GDP in Java is indeed far below consumption and investment, so that government spending is not sufficient to explain inflation behavior in Java [28].

5. Conclusion

Based on the results of the analysis of inflation persistence and sources of inflationary pressure in Java during the 2015 – 2019 period, the following conclusions were obtained. General inflation in all provinces in Java is persistent. Mapping results show that all provinces fall into the category of low inflation and high persistence. Provinces that have the highest to lowest degree of inflation persistence are Banten (0.94), East Java (0.94),

DKI Jakarta (0.93), DI Yogyakarta (0.89), West Java (0.89), and Central Java (0.87). The longest time required for general inflation to return to its natural condition (on average) is Banten (16 months), while Central Java is the fastest (6.85 months). For the core inflation component, the provinces with the highest to lowest inflation persistence degrees were East Java (0.96), West Java (0.95), DI Yogyakarta (0.95), DKI Jakarta (0.93), Banten (0.92), and Central Java (0.90). In the core inflation component, the longest time required to return to natural conditions (on average) is East Java (22.44 months), while Central Java is the fastest (8.63 months). For the volatile food component, the provinces with the highest and lowest levels of inflation persistence are East Java (0.90), DKI Jakarta (0.87), West Java (0.84), DI Yogyakarta (0.84), Central Java (0.84), and Banten (0.84).

In the volatile food component, the longest time required to return to its natural state (on average) is East Java (8.95 months), while Banten is the fastest (5.06 months). For the administered price component, the provinces with the highest to lowest levels of inflation persistence were Banten (0.90), Central Java (0.89), DI Yogyakarta (0.87), West Java (0.87), East Java (0.86), and DKI Jakarta (0.85). In the administered price component, the longest time required to return to natural conditions (on average) is Banten (9.14 months), while DKI Jakarta is the fastest (5.61 months). For the 5 commodities in volatile food that have the highest inflation weight, the commodities with the highest to the lowest degree of inflation persistence are rice (0.89), chicken eggs (0.82), shallots (0.80), broiler meat (0.75) and red chili (0.50).

Inflation of expenditure groups based on COICOP for all provinces in Java is persistent. Mapping results show that the majority of provinces fall into the category of low inflation and high persistence. The source of inflationary pressure in Java is monetary behavior. The results of this study are in accordance with the quantity theory which states that the money supply has a role in the process of increasing prices. Theoretically, if the money supply increases, while the aggregate supply is considered constant, then inflation will occur. An increase in the money supply reflects an increase in aggregate demand, but because the stock of goods and services remains constant, producers will increase prices. In general, the contribution of government spending to GDP in Java is indeed far below consumption and investment, so government spending cannot explain inflationary behavior in Java.

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