Inflation of Indonesia during the COVID-19 pandemic

D Yuniarti\textsuperscript{1,2}, D Rosadi\textsuperscript{1}, and Abdurakhman\textsuperscript{1}

\textsuperscript{1}Department of Mathematics, Faculty of Mathematics and Natural Sciences, Universitas Gadjah Mada, Indonesia
\textsuperscript{2}Department of Mathematics, Faculty of Mathematics and Natural Sciences, Mulawarman University, Indonesia

E-mail: desiyuniarti@mail.ugm.ac.id

Abstract. CoronaVirus Disease-2019 (COVID-19) pandemic has dramatically affected people's lives in Indonesia, including the economic sector. Central Bureau of Statistics (BPS) has announced that Indonesia's inflation tends to weaken, and in July 2020, it reached -0.01\%. This change in the inflation trend was due to an increase in layoffs (PHK) and the existence of a work scheme to become Work From Home (WFH). This study intends to find a model of Indonesia's inflation to the number of additional positive cases of COVID-19 infection using panel data regression analysis with the one-way (individual-effect) fixed-effects model approach. The data used are inflation rate data and the number of additional positive cases infected per province in Indonesia per month, from January to July 2020. Based on this inflation model, one can determine the relationship between the inflation rate and the number of additional positive cases infected. The analysis using panel data regression analysis with the one-way (individual-effect) fixed-effects model approach obtained that the increase in the number of positive cases affected Indonesia's inflation, where each addition of one case will reduce the inflation value by $5.14 \times 10^{-5}$.

1. Introduction

CoronaVirus Disease-2019 (COVID-19) is a disease caused by a new type of coronavirus that was first detected in Wuhan City, China, in December 2019. It spreads throughout the world due to human-to-human transmission of the virus. World Health Organization (WHO) declared COVID-19 as a pandemic on March 9, 2020. In Indonesia, the first positive cases of COVID-19 detected on March 2, 2020, and it continues to spread. On July 31, 2020, the number of positive patients infected was 108,376 patients, died 5,131 people, and recovered 65,907 people [1].

The government has made various efforts of Indonesia to prevent the spread of this disease in Indonesia, as described in [2] and [3], among others, the strict supervision of the routes of entry to Indonesia from other countries through airports, ports, and land border posts. Also, the primary protocol for handling cases of the spread of the COVID-19 was published. The government has made various efforts to prevent the spread of COVID-19. However, the spearhead of prevention is the people. The government conducts socialization so that people are discipline in using masks, washing their hands with soap and running water, avoiding crowds, maintaining health, not traveling anywhere, leaving the house as needed, and the rest staying at home [4].

The readiness of the Indonesian government has increased with the first positive case of COVID-19 infection on March 2, 2020. The President has called for work from home, a study
from home, and worship at home, and since then, the government and all levels of society have campaigned for social distancing to prevent transmission COVID-19. Until the end of March 2020, positive cases of COVID-19 in Indonesia continued to increase. Then, President established a regulation on Large-Scale Social Restrictions (PSBB) [2].

The first province to apply for the PSBB was DKI Jakarta, which has the highest coronavirus-affected area. With this PSBB, the DKI Jakarta government hopes that the prevention of COVID-19 transmission will be more effective because there are strict sanctions for violators. In principle, during the PSBB, police, TNI, or provincial government officials on patrol can provide strict sanctions against the restriction rules that have been applied previously. Several other regions followed this PSBB submission. Until the end of March, the Task Force for the Acceleration of Handling COVID-19 reported that 29 areas had implemented the PSBB, consisting of four provinces and 25 regencies/cities. Apart from that, the President also advised not to homecoming, and for the State Civil Service (ASN), the President imposed a ban on homecoming. In line with this appeal, the Minister of Transportation immediately made regulations on transportation control to prevent homecoming activities [2].

The implementation of this PSBB policy has hit the financial system and its economic defense because several components that shape economic growth are also affected. Household consumption has slowed down because of layoffs (PHK) due to slowing economic activity. The investment factor has also slowed further due to global uncertainty, falling commodity prices, and weakening economic activity [5]. The implementation of the PSBB policy also impacts the inflation rate in Indonesia, which tends to weaken. Indonesia recorded low inflation in May, only 0.07%, indicating that people’s purchasing power is falling. The downward trend in inflation will have an impact on Indonesia’s economic growth. The most worrying thing about this condition is the possibility that Indonesia will experience a recession, one of which affects the difficulty of getting jobs, followed by a fall in people’s purchasing power due to reduced income [6].

This study intends to find a model of Indonesia’s inflation during the COVID-19 pandemic against the number of additional positive cases of COVID-19 infection. The method used is panel data regression analysis because it uses panel data, namely inflation rate data and the number of additional positive cases infected per province in Indonesia per month, from January to July 2020. The panel data regression analysis used is limited to the analysis method with a one-way (individual-effect) fixed-effects model approach. Based on this inflation model, one can determine the relationship between the inflation rate and the number of additions positive cases infected every month per province in Indonesia. Also, based on this model, one can determine an estimate of the inflation rate in Indonesia for the increase of every one positive case infection.

2. Inflation of Indonesia

Inflation is a continuous increase in the prices of goods and services. Increased costs for goods and services will increase inflation. Consequently, it will reduce the value of money. Then inflation also means a decrease in the amount of money against the cost of goods and services in general. Inflation is determined based on the Consumer Price Index (CPI) value. The CPI is an index that calculates the average price change of a package of goods and services consumed by households over a certain period. Changes in the CPI over time reflect the rate of increase (inflation) or the quality of decline (deflation) of goods and services [7].

The inflation of Indonesia shows a trend that tends to weaken during this pandemic period. Until July 2020, it reached -0.01%. The people’s weak purchasing power has lowered the inflation rate [6]. COVID-19 pandemic has changed the trend of inflation in Indonesia. Until July 2020, the inflation trend showed a pattern, not in line with the trend in 2019. It can be seen from the data in July 2020, where there was inflation of minus 0.1% or deflation. This deflation occurred two months after the Ramadhan period, which ended in May 2020, in contrast to the 2019 trend where deflation occurred in the 3rd month after Ramadhan. This change in inflation
trend was caused by an increase in layoffs (PHK) and the existence of a work scheme to become Work From Home (WFH), which in turn had an impact on decreasing demand [8]. Indonesia’s inflation in January-July 2019 and 2020 shows in Figure 1.

![Figure 1. Inflation of Indonesia from January to July 2020 (%).](image)

This disruption in the inflation pattern can also be seen in the expenditure components recorded by the Central Bureau of Statistics (BPS) periodically [7]. The most obvious difference is the low education inflation in July 2020, namely 0.16%, even though it coincides with the opening of the new school year. Apart from education, changes in inflation patterns are also evident in the food, beverage, and tobacco categories, which experienced deflation of 0.73%. Likewise, the foodstuff category experienced deflation of 1.06%. It happened because of the fall in the prices of some food commodities. On the other hand, the highest contributor to inflation in July 2020 was expenditure on personal care and other services, amounting to 0.93%. Also, one of the commodities contributing to inflation was the increase in gold prices, one of which can be seen from the rise in Antam’s gold price. Some cause the increase of gold prices can be seen from the decision of some people to invest in assets that are considered safer from inflation and the decline in currency values [8].

3. Research methodology
This section explains the research data and analysis methods used to achieve the research objectives. The data analysis was carried out with the help of R software [9].

3.1. Research data
This study uses inflation rate data and the number of additional positive cases infected in each province in Indonesia from January to July 2020. This data is panel data, which is a combination of cross-section data and time-series data. The data used is from January to July 2020 for each province in Indonesia. Data was obtained through the website https://www.bps.go.id/ and the BPS website for each region. Data on the number of additional positive cases infected is data
on adding new positive cases every month per province in Indonesia. Data obtained through the website https://covid19.go.id/ and https://kawalcovid19.id/.

Provinces in Indonesia are cross-section units, and the data period, from January to July 2020, states the time-series units. The index $i$ for province and $t$ for data’s period show in Table 1 and Table 2, respectively. So that the amount of data is 238 data, the research variables explain in Table 3.

| $i$-index | Province          | Province abbreviation | $i$-index | Province          | Province abbreviation |
|-----------|-------------------|-----------------------|-----------|-------------------|-----------------------|
| 1         | Aceh              | Aceh                  | 18        | West Nusa Tenggara| NTB                   |
| 2         | North Sumatra     | Sumut                 | 19        | North Nusa Tenggara| NTT                   |
| 3         | West Sumatera     | Sumbar                | 20        | West Kalimantan   | Kalbar                |
| 4         | Riau              | Riau                  | 21        | Central Kalimantan| Kalteng               |
| 5         | Jambi             | Jambi                 | 22        | South Kalimantan  | Kalsel                |
| 6         | South Sumatera    | Sumsel                | 23        | East Kalimantan   | Kaltim                |
| 7         | Bengkulu          | Bengkulu              | 24        | North Kalimantan  | Kaltara               |
| 8         | Lampung           | Lampung               | 25        | North Sulawesi    | Sulteng               |
| 9         | Bangka Belitung   | Babel                 | 26        | Central Sulawesi  | Sulsel                |
| 10        | Riau Islands      | Kepri                 | 27        | South Sulawesi    | Sultra                |
| 11        | Special Capital Region of Jakarta | DKI | 28        | Southeast Sulawesi| Sultra                |
| 12        | West Java         | Jabar                 | 29        | Gorontalo         | Gorontalo             |
| 13        | Central Java      | Jateng                | 30        | West Sulawesi     | Sulbar                |
| 14        | Special Region of Yogyakarta | DIY | 31        | Maluku            | Maluku                |
| 15        | East Java         | Jatim                 | 32        | North Maluku      | Malut                 |
| 16        | Banten            | Banten                | 33        | Papua             | Papua                 |
| 17        | Bali              | Bali                  | 34        | West Papua        | Pabar                 |

| $t$-index | Month    |
|-----------|----------|
| 1         | January  |
| 2         | February |
| 3         | March    |
| 4         | April    |
| 5         | May      |
| 6         | June     |
| 7         | July     |
Table 3. Research variables.

| Variable       | Information               | Unit       |
|----------------|---------------------------|------------|
| Dependent (Y)  | Inflation rate of Indonesia | Percent (%)|
| Independent (X)| Additional number of positive cases infected | Cases |

3.2. Panel data regression

Panel data regression is a regression analysis method for combined cross-section data and time-series data. Generally, the panel data regression model is [10]:

\[ Y_{it} = \alpha + X_{it}' \beta + u_{it}; \quad i = 1, 2, ..., N; \quad t = 1, 2, ..., T \]  

(1)

\( \alpha \) is a scalar, \( X_{it} \) is the \( i \)-th observation at time \( t \) on \( K \) explanatory variables (\( X \)), and \( \beta \) is an estimated parameter of size \( K \times 1 \). Error component \( u_{it} \) model (1) can be divided into [10]:

(i) One-way error component model if \( u_{it} = \mu_i + v_{it} \) where \( \mu_i \) denotes the unobservable individual-effect and \( v_{it} \) denotes remainder disturbances. The \( \mu_i \) is time-invariant and shows any individual-effect that is not included in the regression. The remainder disturbance \( v_{it} \) varies with individuals and time and can be considered as the usual disturbance in the regression.

(ii) Two-way error component model if \( u_{it} = \mu_i + \lambda_t + v_{it} \) where \( \mu_i \) denotes the unobservable individual-effect, \( \lambda_t \) denotes the unobservable time-effect and \( v_{it} \) is the remainder stochastic disturbance term. Note that \( \lambda_t \) is individual-invariant and shows any time-effect that is not included in the regression.

Panel data models examine individual-effects, time-effects, or both. Some panel data regression models that can be considered are the fixed-effects model and the random-effects model. In the fixed-effects model, \( \mu_i \) are assumed to be fixed parameters to be estimated. While if \( \mu_i \) are assumed random, then the random-effects model is a fit model [10].

For the one-way (individual-effect) fixed-effects model, parameters can be estimated using the least-squares dummy variables (LSDV) method. See equation (1), in vector form, is written as [10]:

\[ y = \alpha_{NT} + X \beta + u \]  

(2)

where \( y \) is the dependent variable vector of size \( NT \times 1 \), \( X \) matrix of independent variables measuring \( NT \times K \). Also, \( u = Z_{\mu} \mu + v \) where \( u' = (u_{11}, \ldots, u_{1T}, u_{21}, \ldots, u_{2T}, \ldots, u_{N1}, \ldots, u_{NT}) \), and \( Z_{\mu} = I_N \otimes \epsilon_T \) where \( I_N \) is an identity matrix of dimension \( N \), \( \epsilon_T \) is a vector of ones of dimension \( T \). Given \( P = Z_{\mu}'(Z_{\mu}'Z_{\mu})^{-1}Z_{\mu}' \) is a matrix which averages the observation across time for each individual, and \( Q = I_{NT} - P \) is a matrix which obtains the deviations from individual means. Matrix \( Q \) wipes out the individual effects. The LSDV estimator of the parameters \( \alpha \) and \( \beta \) can be obtained by pre multiplying equation (2) by \( Q \) so that it is got [10]:

\[ Qy = QX \beta + Qv \]  

(3)

If \( \tilde{y} = Qy, \tilde{X} = QX \), and performing OLS on (3) then the LSDV estimator is obtained [10]:

\[ \tilde{\beta} = (X'QX)^{-1}X'Qy \]  

(4)
3.3. Panel data regression model selection testing
In selecting the panel data regression model, several tests were carried out, including the Chow test, Hausman’s test, and the Breusch-Pagan test. Chow test is to test the significance of the group effects. Hausman’s test is to determine between the fixed-effects model or the random-effects model. The Breusch-Pagan test is used to determine whether there is an individual or time-effects or both on panel data [10].

4. Results and discussions
This section will provide an overview of Indonesia’s inflation and how the relationship between Indonesia’s inflation and the number of new positive cases infected using panel data regression.

4.1. Descriptive statistics of research data
Figure 2 and Figure 3 respectively provide a diagram of inflation data and the number of additional positive cases infected by the province in Indonesia in July 2020.

Figure 2 shows that there are 11 provinces experiencing inflation, while 23 regions are experiencing deflation. The region with the highest inflation was Papua at 0.64%, while the lowest deflation was North Maluku, namely -0.95%. Furthermore, Figure 3 shows that in July, the province with the highest number of additional positive infected cases was DKI Jakarta, amounting to 9,975 cases. The lowest was Southeast Sulawesi, with 18 cases. Figure 4 shows the total number of additional positive cases infected per province in January until July 2020. The highest total was 22,089 cases in East Java Province, and the least was NTT province with 145 cases.

Furthermore, it will show the trend of inflation and the number of positive cases infected for East Java and NTT provinces from January to July 2020 which can be seen in Figure 5 to Figure 8. Figure 5 and Figure 6 show that the lowest inflation in East Java occurred in July, and in the same month, the highest number of positive cases infected occurred. Meanwhile, based on Figure 7 and Figure 8, the lowest inflation in NTT province occurred in March then continued to rise in April and May but fell again in succession in June and July. The number of positive cases of infection began to appear in April and peaked in May, fell in June, but rise again in July.
Figure 3. Number of positive cases infected with COVID-19 per province in Indonesia in July 2020 (cases).

Figure 4. Total number of additional positive cases infected COVID-19 in January-July 2020 (cases).

The relationship between inflation and number of additional positive cases of COVID-19 infection in Indonesia can be seen more clearly by using a panel data regression model. In this study, the analysis was carried out with a one-way (individual-effect) fixed-effects model approach and will be carried out in the next section.

4.2. Panel data regression model selection testing for inflation of Indonesia data
Model selection testing with Chow test and Hausman’s test obtained that the best method for modeling inflation data per province in Indonesia in January-July 2020 is the fixed-effects model. In the fixed-effects model, it is found that the increase in the number of additional positive cases infected affects Indonesia’s inflation.

Next, the testing was carried out to see if there were two-way effects, individual-effect, or time-effect using the Breusch-Pagan test. The analysis was carried out using R software and based on the test results, and it was found that there are two-way effects and individual-effect, but there is
4.3. One-way (individual-effect) fixed-effects model for inflation of Indonesia data

The panel data regression with one-way (individual-effect) fixed-effects model approach for this study based on the equation (1), is:

\[ Y_{it} = \alpha_i + X_{it} \beta + u_{it}; \quad i = 1, 2, \ldots, 34; t = 1, 2, \ldots, 7 \]  \hspace{1cm} (5)

where \( Y_{it} \) is the inflation rate of the \( i \)-th province at time \( t \) and \( X_{it} \) is the number of additional positive cases infected of the \( i \)-th province at time \( t \). The cross-section and time-series units are explained in Table 1 and Table 2, respectively. Since \( u_{it} = \mu_i + v_{it} \) then equation (5) became:

\[ Y_{it} = \alpha_i + X_{it} \beta + v_{it}; \quad i = 1, 2, \ldots, 34; t = 1, 2, \ldots, 7 \]  \hspace{1cm} (6)

with \( \alpha_i = \alpha + \mu_i \). The \( i \)-index on the intercept shows that the intercept of each unit cross-section is different.
4.4. Estimation of panel data regression model for inflation of Indonesia data

Estimation of the panel data regression model for inflation of Indonesia data using the one-way (individual-effect) fixed-effects model is determined with the help of R software. The estimation model is obtained according to equation (4):

\[ \hat{Y}_{it} = \hat{\alpha}_i - 5.14 \times 10^{-5} X_{it}; \quad i = 1, 2, ..., 34; \quad t = 1, 2, ..., 7 \]  

Values of \( \hat{\alpha}_i \) for each province in Indonesia can be seen in Table 4.

| i-index | Province index abbreviation | \( \hat{\alpha}_i \) | i-index | Province index abbreviation | \( \hat{\alpha}_i \) |
|---------|----------------------------|---------------------|---------|----------------------------|---------------------|
| 1       | Aceh                       | 0.19                | 18      | NTB                        | 0.02                |
| 2       | Sumut                      | 0.08                | 19      | NTT                        | 0.02                |
| 3       | Sumbar                     | 0.05                | 20      | Kalbar                     | 0.24                |
| 4       | Riau                       | 0.13                | 21      | Kalteng                    | 0.14                |
| 5       | Jambi                      | 0.12                | 22      | Kalsel                     | 0.05                |
| 6       | Sumsel                     | 0.15                | 23      | Kaltim                     | 0.14                |
| 7       | Bengkulu                   | 0.01                | 24      | Kaltara                    | 0.09                |
| 8       | Lampung                    | 0.12                | 25      | Sulteng                    | -0.18               |
| 9       | Babel                      | 0.05                | 26      | Sulteng                    | 0.11                |
| 10      | Kepri                      | -0.03               | 27      | Sulsel                     | 0.32                |
| 11      | DKI                        | 0.32                | 28      | Sultra                     | 0.17                |
| 12      | Jabar                      | 0.24                | 29      | Gorontalo                  | 0.04                |
| 13      | Jateng                     | 0.17                | 30      | Subbar                     | 0.30                |
| 14      | DIY                        | 0.11                | 31      | Maluku                     | 0.12                |
| 15      | Jatim                      | 0.28                | 32      | Malut                      | 0.09                |
| 16      | Banten                     | 0.17                | 33      | Papua                      | 0.29                |
| 17      | Bali                       | 0.08                | 34      | Pabar                      | 0.06                |

The estimation of panel data regression model for Indonesia’s inflation data in equation (7) can be interpreted that an increase in the number of positive cases infected has an effect on inflation where each addition of one case will reduce the inflation value by \(5.14 \times 10^{-5}\). Also, based on the value of \( \hat{\alpha}_i \) in Table 4, it is necessary to notice the provinces with high or too low inflation rates so that each local government can think of policies to prevent possible adverse impacts.

5. Conclusion

The results of the analysis show that the best method for modeling inflation data per province in Indonesia from January to July 2020 is the one-way (individual-effect) fixed-effects model. This model shows that the increase in the number of additional positive cases infected affects Indonesia’s inflation, where each addition of one case will reduce the inflation value by \(5.14 \times 10^{-5}\). Also, based on the amount of estimation \( \hat{\alpha}_i \) in Table 4, it is necessary to notice the provinces with high or too low inflation rates so that each local government can think of policies to prevent possible adverse impacts. For further research, it can be considered to model inflation based on other variables such as the consumer price index.
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