Impact of climate change and Coronavirus Disease (COVID-19) on inflation in Indonesia

N L Wahidah and E Antriyandarti
1Study Program of Agribusiness, Faculty of Agriculture, Universitas Sebelas Maret, Jl. Ir. Sutami No. 36A Kentingan Surakarta, Central Java, 57126, Indonesia
2Corresponding author:ernoiz_a@staff.uns.ac.id

Abstract. The novel coronavirus COVID-19 outbreak was first reported in Indonesia on March 2, 2020 and then it called for prevention. At the same time, emissions of carbon dioxide reported to have decreased that imply global climate change. Furthermore, the climate change due to a reduction in CO₂ emissions during the COVID-19 pandemic affected the demand and supply side of goods and services which in turn had an impact on the economy. One of important indicators in macroeconomics is the inflation rate. Therefore, this study aims to examine the impact of climate change due to the reduction of CO₂ emissions during the COVID-19 pandemic and Coronavirus disease on inflation and food inflation in Indonesia. This study uses time series daily data and analysis using Ordinary Least Squares (OLS). The result show that the number of COVID-19 cases has a negative effect on both inflation and food inflation, while the number of recovered cases has a positive effect on both dependent variables. The number of death is only significant to the inflation rate, but it is not significant to the food inflation. The variable of temperature as a proxy variable of climate change has negative influence to the food inflation, but it has not any effects to the inflation rate. In addition, the level of citizen compliance with physical distancing will determine the level of CO₂ emission reduction.

1. Introduction
According to the World Meteorological Organization (WMO), during the COVID-19 pandemic, greenhouse gas (GHG) emissions decreased by 6 percent [1]. However, since countries in the world, including Indonesia, relaxes their lockdown policies for economic recovery, the level of CO₂ emissions from fossil fuels has increased again. Although previously experienced a drastic decline in March and April 2020. The increasing intensity of greenhouse gas emissions in the atmosphere continues to experience an increasing trend. Thus, it accelerates the occurrence of climate change. There is an evidence that atmospheric CO₂ also governs the temperature of Earth on geological time scales [2]. There also exists a clear phase relationship between changes of atmospheric CO₂ and the different global temperature records, whether representing sea surface temperature, surface air temperature, or lower troposphere temperature, with changes in the amount of atmospheric CO₂ always lagging behind corresponding changes in temperature [3].

Environmental risks and potential economic losses due to climate change are predicted to increase. Moreover, Indonesia is one of the countries that are prone to ecological disasters due to climate change. It is predicted that the temperature in the air can increase by 1-2 degrees. If there is an increase in temperature of 1 degree, the result is that many animals will become extinct, the ecosystem will be disturbed, and it will even disrupt the agricultural sector, especially food crops.
The previous studies showed that climate change which are responded by temperature change have a significant impact on the aggregate economy and inflation [4]. In addition, extreme weather events are likely to have the most significant impact on the agricultural sector especially for food crops [5].

COVID-19 pandemic has disrupted the inflation pattern in Indonesia. Until July 2020, Indonesia has experienced inflation of minus 0.1% or called deflation. This deflation is certainly unusual because it occurs two months after the Ramadan period which ends in May 2020. If it follows the 2019 pattern, deflation will only occur 3 months after Ramadan. In September 2019 after 3 months from June 2019, for example, there is inflation of minus 0.27%. The disruption of COVID-19 in Indonesia's previous inflation has also been seen in a low inflation in the month of Ramadan which fell during April-May 2020 where inflation in that month is 0.08 and 0.07% [6]. During the COVID-19 pandemic, there is not much money in circulation. This is the result of a decrease in demand and money circulation stemming from a decrease in economic activity.

The climate change due to a reduction in CO\(_2\) emissions during the COVID-19 pandemic affected the demand and supply side of goods and services which in turn has an impact on the economy. One of the important indicators in macroeconomics is the inflation and food inflation rate. Therefore, this study aimed to examine the impact of climate change due to the reduction of CO\(_2\) emissions during the COVID-19 pandemic and Coronavirus disease on inflation and food inflation in Indonesia. Because temperature is very important to the agricultural sector, and food is also a basic need that must be maintained during the COVID-19 pandemic, so this study also analyzes the effects of that on food inflation.

2. Methods
This study used time series daily data and analysis using Ordinary Least Squares (OLS) [7] as defined in equation 1 and 2. The secondary data was collected from BPS (Central Bureau of Statistics) and government website about COVID-19. Temperature was used to be a proxy of climate change due to the reduction of CO\(_2\) emissions during the COVID-19 pandemic.

\[
\begin{align*}
Inf_t &= C + \beta_1 Cov_t + \beta_2 R_t + \beta_3 D_t + \beta_4 T_t + \epsilon_t \\
FoodInf_t &= C + \beta_1 Cov_t + \beta_2 R_t + \beta_3 D_t + \beta_4 T_t + \epsilon_t
\end{align*}
\]

Where:
Inf\(_t\) = inflation rate (%), FoodInf\(_t\) = food inflation rate (%), Cov\(_t\) = the number of COVID-19 cases (people), D\(_t\) = the number of death cases due to COVID-19 (people), R\(_t\) = the number of recovered cases from COVID-19 (people), T\(_t\) = temperature (°C), \(\epsilon\) = random disturbance, and \(t\) = daily time

3. Results and discussion

![Figure 1. The Number of COVID-19 Cases in Indonesia [8]](image-url)
COVID-19 cases in Indonesia are still increasing. Especially after the new normal era was implemented to restore the economy (see Figure 1). The temperature in Indonesia, which had decreased due to lower CO₂ emissions at the start of the pandemic, has started to increase again and has fluctuated afterward.

On the other hand, the inflation rate and food inflation show an unusual pattern. Table 1 illustrated the estimation results of climate change effects and COVID-19 pandemic on inflation and food inflation.

Table 1. Climate change and COVID-19 pandemic effects on inflation

| Variable      | Inflation |                  | Food Inflation |                  |
|---------------|-----------|------------------|----------------|------------------|
|               | Coefficient | Standard Error | Coefficient | Standard Error |
| COVID-19      | -0.0000384[^a] | 0.0000209 | -0.0002834[^c] | 0.0000763 |
| Recovered     | 0.0000872[^c] | 0.0000197 | 0.0004722[^c] | 0.0000719 |
| Death         | -0.0004434[^c] | 0.0002632 | -0.0005386 | 0.0009061 |
| Temperature   | -0.0857815 | 0.0641266 | -0.887757[^c] | 0.2208068 |
| Constant      | 2.95568[^c] | 0.0186504 | 6.150313[^c] | 0.068066 |

[^a]Significant at 10% level;[^b]Significant at 5% level;[^c]Significant at 1% level

Table 1 showed negative coefficient suggest as the COVID-19 variable increases, the inflation and food inflation tend to decrease. On the other hand, positive coefficient as the recovered variable indicates that as the value of recovered variable increase, the inflation and food inflation also tend to increase. It means that the number of COVID-19 cases has a negative effect on both inflation and food inflation, while the number of recovered cases has a positive effect on both dependent variables. This shows that increasing the number of COVID-19 cases will lower inflation and food inflation. In contrast, an increase in recovered cases will actually increase inflation and food inflation at a 99% confidence level. This is in accordance with Mankiw [9] and Blanchard [10]. An increase in number of COVID-19 cases will lead companies/industries/offices to be careful and reduce the number of employees. Thus, there are many employment terminations, as a result, unemployment increases [11]. This finding is also linear with the Phillips curve theory [9], that inflation and unemployment are inversely related. On the other hand, the increase in the number of recovered sufferers will make the industrial world more optimistic and conducive, people will be more confident in doing activities outside, so that economic activity will run smoothly and people's purchasing power will increase.

In Table 1, it can be seen that the number of death is only significant to the inflation rate, but it is not significant to the food inflation. This suggests that the mortality rate does not affect food prices. Production and demand have not experienced a shock due to the death cases of COVID-19 sufferers. It seems the food sector in Indonesia is relatively stable.

The result from Table 1 also showed that variable of temperature as a proxy variable of climate change has negative influence to the food inflation, but it has not any effects to the inflation rate. This is in accordance with Carleton [12] and Zivin [13] stated that temperature has sensitive impacts on agricultural yields particularly in the production of staple crops. Crops are most sensitive to temperatures during specific phases of the growth cycle [12][13]. Economic impacts on labor supply and productivity can lower work intensity, reduce cognitive performance, and voluntarily shorten work hours in sectors of the economy most exposed to outdoor temperature [12][13]. In addition, the level of citizen compliance with physical distancing will determine the level of CO₂ emission reduction.
4. Conclusion
The result shows that the number of COVID-19 cases has a negative effect on both inflation and food inflation, while the number of recovered cases has a positive effect on both dependent variables. The number of death is only significant to the inflation rate, but it is not significant to the food inflation. The variable of temperature as a proxy variable of climate change has negative influence to the food inflation, but it has not any effects to the inflation rate. This study still has some limitations, since the level of citizen compliance with physical distancing will determine the level of CO\textsubscript{2} emission reduction.

References
[1] Reuters 2020 Pandemic to Drive Carbon Emissions Down 6% This Year: WMO https://www.reuters.com/article/us-health-coronavirus-climate-wmo/pandemic-to-drive-carbon-emissions-down-6-this-year-wmo-idUSKCN22411F. Accessed 2/9/2020
[2] Lacis A A, Schmidt G A, Rind D and Ruedy R A 2010 Science 330 356-359
[3] Humlum O, Stordahl K and Solheim J E 2013 Global and Planetary Change 100 51-69
[4] Batten S 2018 Bank of England Staff Working Paper 706
Burke M, Hsiang S M and Miguel E 2015 Nature 527 235-239
Tol R S J 2018 Review of Environmental Economics and Policy 12 pp 4-25
Chen Y, Liu A and Cheng X 2020 J. Science of Total Environment 703
Dell M, Jones B F and Olken B A 2014 J. Economic Literature 52 740-798
[5] Adi T B and Subrata B A G 2019 J. Agriculture 109
Oktaviani R, Amaliah S, Ringler C, Rosegrant M W and Sulser T B 2011 IFPRI Discussion Paper 01148
[6] BPS 2020 Indeks Harga Konsumen dan Inflasi Bulanan Indonesia. https://www.bps.go.id/statisticable/2009/06/15/907/indeks-harga-konsumen-dan-inflasi-bulanan-indonesia-2006-2020.html. Accessed 2/9/2020
[7] Woolridge J M 2013 Introductory econometrics : a modern approach. 5th. Edition Erin Joyner (Mason: Cengage Learning)
[8] Satuan Tugas Penanganan COVID-19 2020 Peta Sebaran COVID-19. https://covid19.go.id/peta-sebaran-covid19. Accessed 2/9/2020
[9] Mankiw N G 2009 Macroeconomics Fifth Edition (New York: Worth Publishers)
[10] Blanchard O 2017 Macroeconomics 7th Edition (New York: Pearson)
[11] Bluestein D L, Duffy R, Ferreira J A, Cohen-Scalici V, Cinnamon R G and Allan B A 2020 J. Vocational Behavior 119
[12] Carleton T A and Hsiang S M 2016 J. Social Sciences 353
[13] Zivin J G and Neidell M 2014 J. Labor Economics 32 pp 1-26