Optimum: Jurnal Ekonomi dan Pembangunan
Vol. 14, No. 1, March 2024, pp. 20-31
DOI:10.12928/optimum.v14i1.8935

Relative risk of COVID-19 pandemic and regional inflation convergence in Indonesia: Spatial panel data approach

Sayifullah [a,1*], Samsul Arifin [a,2,*]

[a] Shariah Economics Department, Faculty of Economy and Business, Sultan Ageng Tirtayasa University, Indonesia
[1] sayifullah@untirta.ac.id*; [2] samsularifin@untirta.ac.id

* corresponding author

ARTICLE INFO

Received : 28-08-2023
Revised : 28-12-2023
Accepted : 05-01-2024
Published: 25-01-2024

Keywords
Relative risk
Inflation convergence
COVID-19 pandemic
Spatial panel data
Bayesian spatial model

ABSTRACT

The purpose of this study is to investigate the relationship between the risk of a COVID-19 pandemic and regional inflation convergence in Indonesia. Because the COVID-19 recession differs from the previous inflation recession, it is important to investigate regional inflation convergences in order to evaluate the inflation rate and the impact of macroeconomic policy on inflation convergence. The spatial panel data used in this study ranges from 2020:M3 to 2021:M12. The dynamic econometric spatial panel data model is used to quantify relative risk without spatial or SIRs to calculate the impact of the COVID-19 pandemic on regional inflation convergence in Indonesia. On the contrary, for calculating the risk relative to spatial elements, the CAR Leroux or BSCL Bayesian Spatial Model is used. Using BSCL, the calculation of the relative risk value for the COVID-19 pandemic concludes that Sumatera Island, Java Island, Kalimantan Island, Sulawesi Island, Maluku Island, and Papua Island have high risks, while Bali Island and Nusa Tenggara Island have low risks. In both static and dynamic models, the influence of currency circulation on inflation convergence is positive, and the relative risk of a COVID-19 pandemic on inflation convergence is negative. Monetary phenomena during the COVID-19 pandemic determined inflation behavior in Indonesia. Studies show that the COVID-19 pandemic is a deterrent to inflation convergence, while the circulation of money drives inflation convergence.

1. Introduction

In addition to the main problems of inflation and health, the quantity theory of money versus the Keynesian became an interesting subject to study. The problem of inflation is becoming more apparent during the COVID-19 pandemic. Inflation, which can directly affect various macroeconomic variables, has always been a major concern in developing countries, including Indonesia (Kurniawan & Prawoto, 2014; Erdoğan et al., 2020; Anggraeni & Dwiputri, 2022). To identify the causes of regional inflation, the socio-economic characteristics of the region are often questioned. The hedonistic price theory states that price divergence in a region correlates with the socio-economic characteristics of the region, which in turn causes regional inflation rate differences around the world (Kuncoro, 2020). This study will look at how regional inflation during the COVID-19 pandemic correlated with socio-economic characteristics at the regional level using indicators of inflation, output, and change in currency circulation. This is a problem that will be discussed in this study for the following reasons : a) During the COVID-19 pandemic, it has not only disrupted the inflation patterns in Indonesia but has also shown that the occurrence of COVID-19 disruptions in monthly inflation even tends to show different inflation characteristics during 2020 and 2021; b) to mitigate the economic impact of the COVID-19 epidemic on inflation at the time the shutdown of economic activity is carried out through the relative risk mapping of the COVID-19 pandemic then incorporated into the conditional model of econometric spatial convergence; and c) existing studies largely ignore the role of COVID-19 in the regional inflation convergence model. This study hypothesizes that the relative risk of an increasingly pervasive COVID-19 pandemic with increasing risks places downward pressure on prices, or deflation, and increases the difficulty of interregional convergence. The lockdown and travel restrictions during the COVID-19 pandemic are a consequence of the still high risk of the disease, they have reduced demand for goods and services, and there is not much money circulating as a result of the cessation of the circulation of money from the decline in economic activity (Levin & Sinha, 2020; OECD, 2020; Wahidah & Antriyandarti, 2021; Wei & Han, 2021).

In general, previous research suggested that national data should no longer be used to analyze inflation dynamics in Indonesia, as the results tend to be dominated by inflation behavior on Java Island. Current research suggests that regional inflation convergence in Indonesia is based on a model to discern the regional inflation dynamics defined by country and district specific factors—also known as zones—as well as local idiosyncratic factors throughout the province. Big nations have to use provincial data because they can have territories with varying conditions, which can cause differences in inflation (Mehrota et al., 2007). It's becoming more and more challenging to cope with the regional inflation problem in a big country like Indonesia. This is because aspects of supply, such as production and distribution, are usually governed by government laws (Kuncoro, 2020; Purwono et al., 2020). Therefore, regional inflation research is crucial for Indonesia (Kusuma, 2014; Kuncoro, 2020). In some studies, inflation convergence is often associated with inflation targets (IT). Ridhwan (2016) emphasized the significance of coordination between central and regional governments for inflation convergence, and Purwono et al (2020) examined the impact of Regional Inflation Control Team, concluding that coordination among central and local governments was crucial to inflation convergence. The fact that the deployment of information technology contributes to the stability of inflation rates in Indonesia still raises concerns about how effective information technology is in mitigating continuous changes in regional inflation data. In addition, the use of regional inflation data, such as provinces, districts, or localities, when calculating inflation is anticipated to reduce aggregation bias (Kuncoro, 2020).

The behavior of inflation and its relationship with the amount of money circulating in Indonesia were very interesting during the COVID-19 pandemic. Indonesian inflation patterns have been disrupted by the COVID-19 pandemic. Inflation in Indonesia changed in 2020. This is different from the pattern of the previous year, such as in 2019, when inflation fell only three months after Ramadan, but at the time of the pandemic, inflation even fell two months after Ramadan. This shows the negative impact of the COVID-19 pandemic on inflation in Indonesia, as inflation is usually relatively high and tends to rise during Ramadan (BPS, 2020). The phenomenon of money circulation during the COVID-19 pandemic indicates a change in behavior. For example, in Indonesia, not much money is circulating because of the decline in economic activity, which stops the circulation of money (Wahidah & Antriyandarti, 2021). However, the situation is different all over the world. For example, during the global financial crisis, money in circulation in the US has grown by an average of 2 percent per month. However, during the COVID-19 pandemic, money has grown by 3.4 percent in the U.S. in March, 6.3 percent in April, and 4.9 percent in May 2020. US price levels have also risen significantly, and core of Personal Consumption Expenditures (PCE) even exceed target levels (Gharehgozli & Lee, 2022). As far as we know, the only inflation convergence research conducted in Indonesia—using a spatial econometric approach conducted by Tirtosuharto & Adiwilaga (2014) is at the provincial level, which covers 26 provinces, and also at the district or city level, which covers 86 districts or cities. If a convergence test is carried out, research on regional inflation becomes relevant if it is associated with the COVID-19 pandemic, as it shows a change in pattern and disruption of inflation. Some studies on regional inflation only know the cause without testing its convergence; for example, the Indonesian inflation model against an increase in cases of infection with COVID-19 (Yuniarti et al., 2021), the impact of a reduction in carbon dioxide emissions during the COVID-19 pandemic on inflation and food inflation in Indonesia (Wahidah & Antriyandarti, 2021), or the study of co-movement and differences in inflation dynamics in a country in a particular region (Ridhwan, 2016). However, none of these studies address how the COVID-19 pandemic has had a significant economic impact on Indonesian regional inflation. There is no additional information for this modeling (Ng, 2021). Therefore, this study fills the research gap by looking at how the COVID-19 pandemic affects the convergence of Indonesian regional inflation. It is important to examine regional inflation convergence in order to evaluate inflation rates (Purwono et al., 2020) and the impact of macro policy on inflation convergence (Lopez & Papell, 2012; Arestis et al., 2014; Khoirudin & Ardini, 2023), as closure and travel restriction policies have never happened in previous times of crisis. Therefore its important to analyze the regional inflation convergence.

2. Method

The study uses panel data from 33 province capitals in Indonesia during the period 2020:M3-2021:M12. The data used in this study include : a). inflation data is the monthly inflation of the capital of the province and source data from the Central Statistics Agency of Indonesia (BPS); b). relative risk of COVID-19 based on the additional data of COVID-19 infection cases calculated with the Bayesian spatial CAR Leroux and the source data from The Ministry of Health Republic of Indonesia and COVID-19 Task Force; and c). regional monetary indicator is the cartel money deducted from the price index in each capital of the province and source data from the Central Statistics Agency of Indonesia (BPS). The formulation of the model of relative risk calculation uses the independent spatial model for the relative risk value without spatial, or in this study, SIR, whereas for the calculation of risk relative to the space element, the Bayesian Spatial Model CAR Leroux, or in the study, BSCL, is used. Further, to examine the relative risk of the COVID-19 pandemic to regional inflation convergence in Indonesia, the dynamic model of spatial panel data econometric as follows:

$$lny_{it} =\propto_0 + \gamma lny_{i,t-1} + \rho W y_{it} + \sum\beta x'_{it} + \tau W x'_{it} + \eta_t + \alpha_i + \varepsilon_{it}, with\ \varepsilon_{it} = \mu_{it} \tag{1}$$

Where $\gamma = e^{-\theta}$, θ is the convergence rate and a value of $0 < \gamma < 1$ means that convergence to steady state is direct and does not involve oscillation. Convergence γ produces two indicators, i.e. the conversion speed test $s = \ln(1+\gamma)\,/T$ and half-life $\tau = \ln(2)\,/ln1(+\frac{\gamma}{T})$ calculates time into steady states where T is the time period 2020:M4-2021:M12 or T is 2 (Paas et al., 2007). Eq (1) describes three spatial interactions: "ρ" of endogenous interactions with non-free variables, "τ" of exogenic interactions between free variables and "λ" of residual interactions (Elhorst, 2003). The dynamic model allows us to see the short-run impact assumed on the equation above the value γ=0 whereas the long-run effect assumed yt=yt-1=y* or the γ≠0 value. β is the vector parameter variable of the clarifier, X is the variable vector, W is the spatial matrix, and it is the unit cross section i, for the time period t, $\mu_{it} \sim N(0,\sigma^2)$ is normally distributed error. ω_i and φ_t are constancies across individuals unobserved fixed effects and time effects. Based on the model estimate equation performed with variable Y is inflation π_{it} while variable X is a kind of relative risk RR_{it} and m_{it} is the ratio of money in circulation.

3. Results and Discussion

Pandemic Overview: Early Case vs Case Peak

Figure 1 shows the first COVID-19 cases were to have entered Indonesia on March 2, 2020, in Depok, West Java. Preliminary data on COVID-19 cases in Indonesia were recorded in March 2020 from 33 provinces in Indonesia. The rate of cases reached 32, with the highest case in DKI Jakarta reaching 408 and for NTT and Gorontalo none.

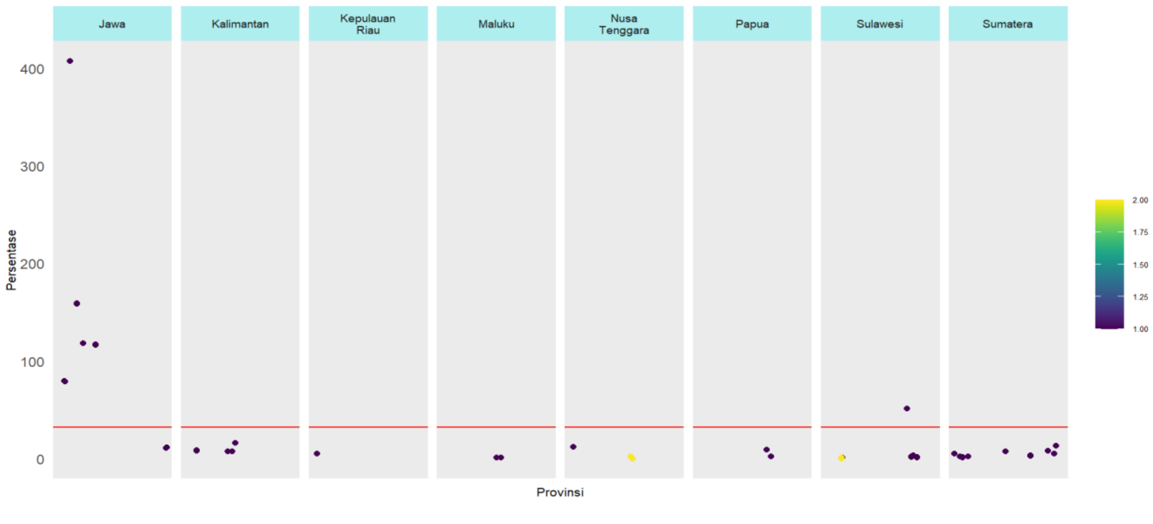


Figure 1. Distribution of COVID-19 cases March 2020

Vol. 14, No. 1, March 2024, pp. 20-31

Figure 2 shows the distribution after the next year and a half, in July 2021, the peak of COVID-19 cases in Indonesia occurred. Out of 33 provinces in Indonesia, the rate of cases reached 3,363, with the highest cases in DKI Jakarta reaching 21,731 and the lowest in NTT reaching 145.

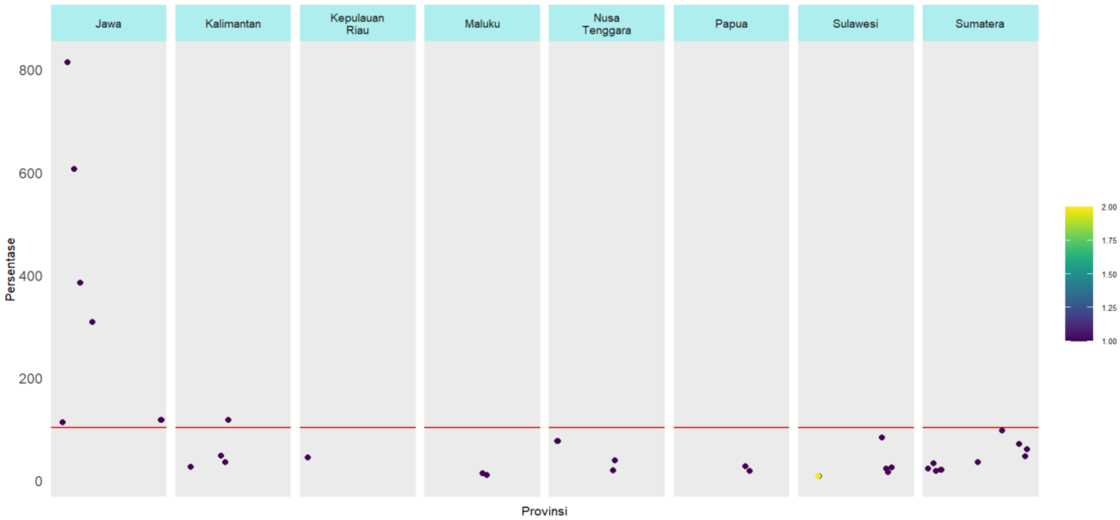
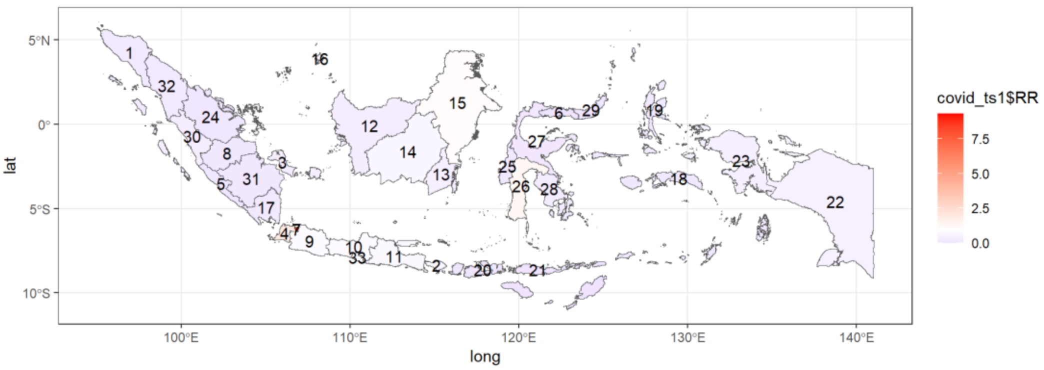
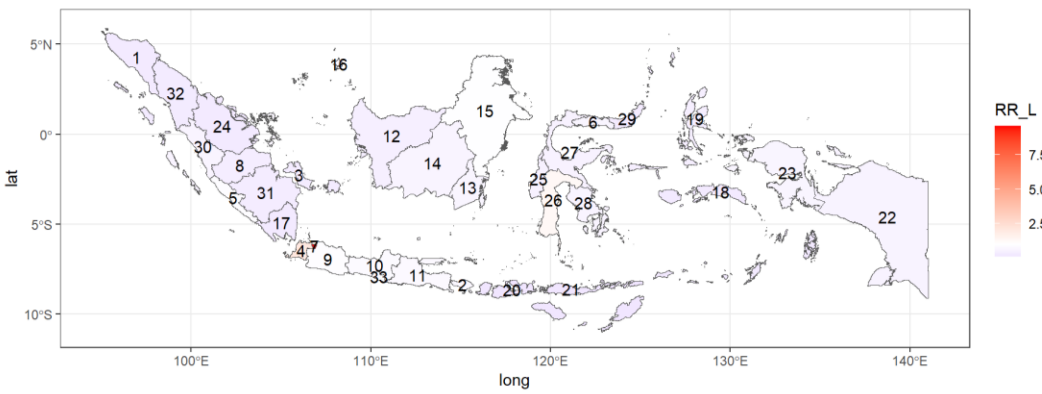


Figure 2. Distribution of COVID-19 cases July 2021

Based on Fig 1 and 2, we can see that the state of the province on the island of Java persists; the number of cases is always above the average of 33 Indonesian provinces, even reaching 8 times, as well as the shift from Sulawesi at the beginning of the pandemic to Kalimantan Island at the peak of the pandemic, with the province's number of cases above average. The spread of COVID-19 cases in Indonesia, which has 34 provinces comprising five major islands (Sumatera Island, Java Island, Kalimantan Island, Sulawesi Island, and Papua Island) as well as four archipelagos (Riau Islands, Bangka Belitung Islands, Nusa Tenggara Islands, and Maluku Islands), has become relevant when talking about the relative risk of COVID-19 cases.



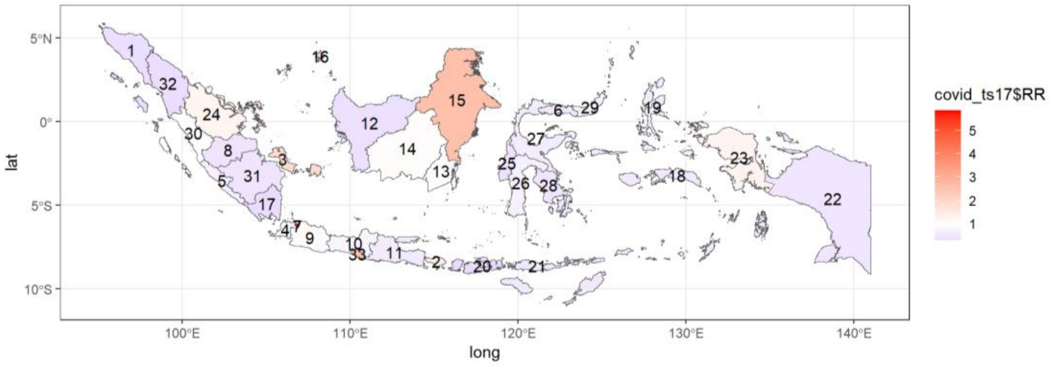
a) Relative risk map of COVID-19 based on SIR



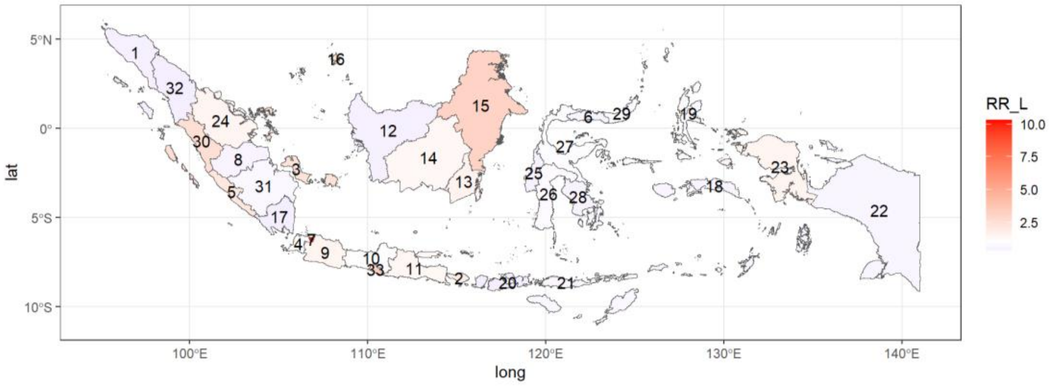
b) Relative risk map of COVID-19 based on BSCL

Figure 3. Thematic Map of Relative Risk March 2020

As of March 2020, out of 33 provinces in Indonesia, the ratio of risk values relative to calculations without spatial elements and spatial reached a figure below 1, which means that there is a low risk. Figure 3 shows no significant differences in the relative risk status of COVID-19 in 33 Indonesian provinces at the start of the March 2020 pandemic.



a) Relative risk map of COVID-19 based on SIR



b) Relative risk map of COVID-19 based on BSCL

Figure 4. Relative Risk Thematic Map July 2021

As of July 2021, out of 33 provinces in Indonesia, the ratio of risk values relative to calculations without spatial elements and spatial reached a figure above 1, which means that there is a high risk. Figure 4 shows the role of the spatial element in relation to the relative magnitude of the risk is evident at the peak of the COVID-19 case.

Inflation in Indonesia and Relative Risk Mapping

The relationship of relative risk to the inflation of the capital of the province during the COVID-19 pandemic is shown by the data on the inflation rate of Java, Sumatra, Kalimantan, Sulawesi, Bali-West Nusa Tenggara-East Nusa Tenggara (Balnustra), and Maluku-North Maluku-Papua-West Papua (Malpa), while the relative risk values are shown by SIR and BSCL data. The calculation of the BSCL relative risk value in this study refers to the results of the Aswi et al (2022) study, namely the Bayesian spatial CAR Leroux (BSCL) with hyperprior IG (0.1; 0.1).

Table 1. Inflation and Relative Risk Data for the Islands in Indonesia

Islands	Min			Max			Average		
	Inflation	SIR	BSCL	Inflation	SIR	BSCL	Inflation	SIR	BSCL
Java	-0.14	1.33	1.14	0.60	2.39	3.07	0.13	1.76	2.07
Kalimantan	-0.25	0.65	0.65	0.69	1.63	2.99	0.12	1.35	1.80
Sumatera	-0.36	0.25	0.38	0.65	0.94	1.37	0.14	0.69	1.03
Sulawesi	-0.32	0.34	0.63	0.81	1.35	1.88	0.17	0.84	1.06
Balnustra	-0.52	0.27	0.32	0.79	0.97	1.41	0.08	0.80	0.97
Malpa	-0.56	0.32	0.46	1.25	1.80	2.50	0.15	1.01	1.30

Noted: SIR and BSCL numbers > 1, meaning high risk and < 1 low risk.

Table 1 shows that BSCL is always higher than SIR, where the minimum value of the entire island has the same conclusion; for example, in Java, the SIR value of 1.33 and BSCL of 1.14 mean that both indicators conclude high risk or other examples. In the case of Sumatera and Sulawesi, the maximum value gives a different conclusion. For example, in Sumatra and Balnustra, the BSCL value concludes with high risk, but the SIR value concludes with low risk. Figure 5. positive linear lines show that the relationship is both positive and negative, meaning that a higher relative risk will lead to higher inflation, while negative linear conditions are the opposite. The empirical proof that will be carried out in the study is whether a COVID-19 pandemic, measured in terms of the magnitude of risk relative to high risk, causes a fall in inflation or vice versa.

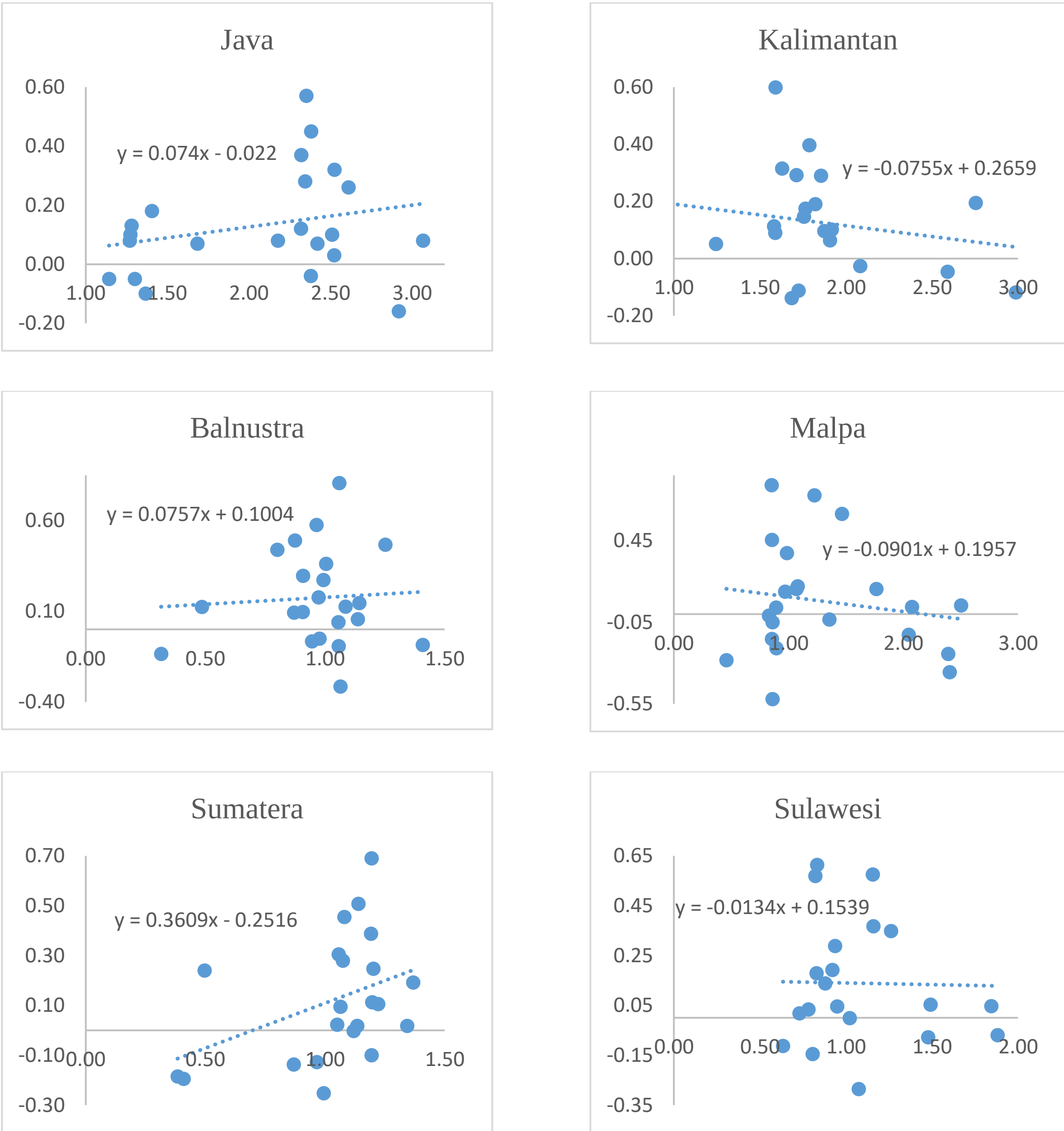


Figure 5. Scatter Plot Inflation and Relative Risk 2020:M3-2022:M12.

Figure 5, the Java Islands, Balnustra, and Sumatra show a positive relationship of risk relative to inflation, where the provinces in Sumatra tend to be more responsive, while Kalimantan, Malpa, and Sulawesi show a negative relationship of risk relative to inflation, as well as provinces within them that are relatively less responsive. During the research period from March 2020 to December 2021, the COVID-19 pandemic in 33 province capitals of Indonesia, based on Moran tests, showed the presence of spatial elements, so that the results of the BSCL estimates as the basis of the relative risk mapping became more accurate. The number of COVID-19 cases during the period from March 2020 to December 2021 was 4,226,757, with a population of 263,466,140 people. The capital of the province with the highest BSCL rating (6.32) is DKI Jakarta. There are 17 province capitals with a

BSCL value greater than 1, namely DKI Jakarta (6.32), East Kalimantan (3.77), Bangka Belitung Islands (3.58), Yogyakarta (3.49), Banten (2.24), West Papua (2.14), Riau Islands (2,05), Bali (1.98), Central Kalimantan (1.82), West Sumatra (1.55), Riau (1.52), Bengkulu (1.41), Central Sulawesi (1.30), South Kalimantan (1.28), West Java (1.16), East Nusa Tenggara (1.09), and North Maluku (1.06). By contrast, the capital of the province with the lowest BSCL is Aceh (0.55). The BSCL thematic map of COVID-19 cases in 33 province capitals in Indonesia is visualized in Figure 6.

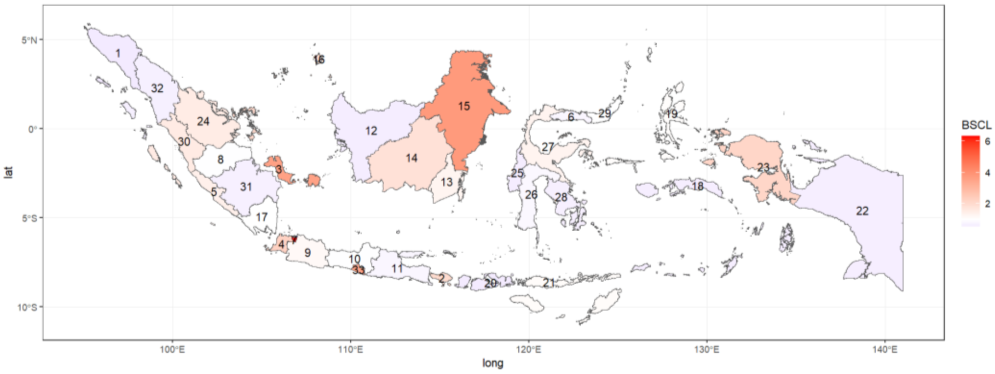


Figure 6. BSCL thematic map of the COVID-19 pandemic in Indonesia

On the static panel data model, the problem arises as to whether the assumption that no specific component is accepted on either the cross section or the time series. This is commonly known as the Pool Ordinary Least Squares (OLS) or Common Effect Model (CEM). But instead of believing that there is significant heterogeneity in either a cross-section or a time series, residual modeling should be done explicitly. This is commonly known as the Fixed Effect Model (FEM) or Random Effect Model (REM) (Baltagi, 2005). The Chow test is aimed at determining how the model is used using ordinary least squares or fixed effects, while the Hausman test is an advanced test for choosing a panel data regression model. This test is performed when the results shown by the Chow Model Test with fixed effects are better. In Hausman's test, it will be selected which is more suitable to use between fixed and random effects. Based on the results of the test showing that the chow results conclude FEM, the subsequent REM test results, as seen from the statistical probability values in Table 2, are less than 5%. The next panel model selected must meet the assumption that there is no occurrence of multicoliniearity, autocorrelation, or heteroskedasticity, but if this occurs, it can be corrected by using a robust standard error in the model.

Table 2. Data Panel Model Selection Test Results

Chow test	Hausman test
F(32.691) = 0.41	chi2(2) = 2.53
Prob > F = 0.9984	prob>chi2 = 0.2826

Source: Data processed

Table 3 shows there is no multicolinearity problems in the model, so the entire independent variable could be used in the model. This is indicated by the magnitude of the free variable correlation value of 0.0452, which is smaller than the tolerance limit of 0.8.

Table 3. Multicolinearity Assumption Test

	BSCL	M
BSCL	1	
M	0.0452	1

Source: Data processed

Table 4 are the assumption of heteroskedasticity in the model, based on the Breusch-Pagan/Cook-Weisberg test for heteroskedasticity for the PLS and LSDV models as well as the Wald test for heteroskedasticity for the FEM model, which obtained prob-chi2 statistic values smaller than prob (α) tables, which means that the observation data is not sufficient evidence to accept the zero hypothesis, that sigma(i)2 = sigma2 for all i or homoskedasticity. The autocorrelation test of the estimated results in Table 4 found the absence of autocorrelations based on the Breusch-Pagan Godfrey tests for the PLS and LSDV models as well as the wald test for autocorrelation for the FEM model, which obtained statistical prob-F values greater than prob (α) tables, which meant that the observation data were sufficient evidence to accept the zero hypothesis, no first-order autocorrellation. This result marks models that contain heteroskedasticity and/or autocorrelation problems, then performs a robust error estimator.

Table 4. Heteroskedasticity and Autocorrelation Assumption Test

Identification	CEM	LSDV	FEM
Breusch-Pagan test for heteroskedasticity			
• $chi^2()$	(1); 10.84	(1); 17.72	
• Prob-chi^2	0.0010	0.0000	
Wald test Heteroskedasticity			
• $chi^2()$			(33); 1172.56
• Prob-chi^2			0.00000

Noted: Breusch-Pagan, Ho: constant variance; Modified Wald test for groupwise heteroskedasticity in a fixed effect regression model, H0: sigma(i)2 = sigma2 for all i

Table 5 shows that during the COVID-19 pandemic, the magnitude of the relative risk parameter (BSCL) for all models was marked negative but non-significant, while the magnitude of the amount of money in circulation (LnM) parameter for all models was marked positive and very significant. These results prove that during the COVID-19 pandemic, there was a deflationary trend, and during the COVID-19 epidemic in Indonesia, inflationary behavior still tended to be dominated by monetary phenomena.

Table 5. Result of Static Panel Data

Variables	PLS	LSDV	FEM	REM
BSCL	-0.0025	-0.0028	-0.0028	-0.0025
LnM	4.7081***	4.890***	4.891***	4.7081***
C	-17.891***	-18.519***	-19.589***	-17.891***
Model *Error*	OLS *error robust*	OLS *error robust*	FEM *error robust*	GLS
R2	0.105	0.122	0.112	
R2_a	0.103	0.079	0.110	

Noted: ***Significant 1%, **significant 5%, *significant 10%.

The panel dynamic model when the dependent variable lag appears, or what is commonly called the predictive endogeneity problem, will be inconsistent and biased (Verbeek, 2004), as suggested by (Arellano & Bond, 1991) a moment condition that can be approached through the Generalized Method of Moment (GMM) framework (Baltagi, 2005). The dynamic panel model selected has met Arellano-Bond consistency, the validity of test instruments, and is non-biased, commonly called the best guess on panel dynamics. Dynamic panel analysis results with estimated First-Difference Generalized Method of Moment (FD-GMM) approach. Tabel 6 shows that GMM panel data is more efficient than FEM and OLS.

Table 6. Result of Static Panel Data

Criteria	Panel Analysis FD
Consistency test:	
m_1 (H1; autocorrelation)	-1.9471*
m_2 (Ho; no autocorrelation)	-0.09124
Instrument Validity:	
Ho: over identifying restrictions are valid	J-statistic 29.180 Prob(J-statistic) 0.5081
Bias Test: Continum $\longrightarrow$ Fixed Random GMM OLS	Parameter Results FEM < GMM < OLS

Noted: ***Significant 1%, **significant 5%, *significant 10%

Meanwhile, the validity test result of the instrument used to estimate the model of the J-statistic test also yielded an insignificant result at α = 5% and a non-significant test result on m2 at α = 10%. Insignificant statistics of m2 indicate a lack of second-order serial correlation within the residual, so the assumption is said to be consistent, and the result of J-statistic testing shows that there is no autocorrelation series on errors, and over-identifying restrictions detect no problem with instrument validity. Continuously biased test results require GMM parameters smaller than the OLS result and larger than the FEM/REM.

Table 7. Bias Testing Estimator FD-GMM

Variable	FEM	Two step FD GMM	OLS
Inflation (-1)	0.098**	0.116***	0.111**
BSCL	-0.009	-0.046***	-0.0076
Ln(M)	4.733***	6.289***	4.5053***
C	-17.990***	-	-17.119***

Noted: * p<0.10, ** p<0.05, *** p<0.01

Table 7 shows that the dynamic data panel model with fixed effect for FD has met the unbiased criteria, and the instrument is valid and consistent so that the resulting parameters can be used. Empirical evidence related to the trend during the COVID-19 pandemic is that deflation and inflation behavior still tend to be dominated by monetary phenomena through the use of data at the regional level, i.e., provinces are expected to be able to avoid weak use of national data in estimating inflation dynamics in Indonesia due to the highly dominant influence of certain provinces in national data. This is demonstrated by the results of research that showed that the national inflation data movement is very similar to the inflation in Java, with no significant change from the conditions ten years ago and in line with the research conducted by Insukindro & Utama (2015) and Utama et al (2017). Using provincial panel data to estimate dynamic inflation would more precisely characterize the actual inflation conditions throughout Indonesia. It is in line with the research Mehrota et al (2007) that regional differences can be a source of differences in the formation of inflation. The existence of price behavior in Indonesia tends to be heterogeneous and is expected to reduce aggregation bias (Kuncoro, 2020) and not less important is to improve understanding of the characteristic nature of inflation in the context of monetary union (Ridhwan, 2016).

At the time of the COVID-19 pandemic in Indonesia, the money circulation phenomenon showed differences in behavior; there was not much money circulating as a result of the cessation of cash circulation due to the decline in economic activity (Wahidah & Antriyandarti, 2021). The COVID-19 pandemic has disrupted the inflation pattern in Indonesia. Inflation in Indonesia found inflation patterns in 2020 different from previous years, such as in 2019, where deflation would only occur 3 months after Ramadan, but at the time of the pandemic, it occurred 2 months following Ramadan. The disruption of COVID-19 in Indonesian inflation is indicated by low inflation in the month of Ramadan, even falling, where inflation is usually relatively high in Ramadan with an upward trend (BPS, 2020). Study from Aswi et al (2022) that aggregate data for 34 provinces from March 2020 to September 2022 was used, and then in the study for each province, mapping was carried out in each period, i.e., from March 2020 to December 2021, with mutually reinforcing results, e.g., in the province of Aceh, which concluded has a relatively low category risk and the majority in each time period obtained a relative risk calculation less than the number 1, i. e., low risk, and only the period September–October 2020 was worth above 1.

The influence of the relative risk of the COVID-19 pandemic on negative inflation for both static and dynamic models is not significant in the static panel (Table 5) model but significant for dynamic panel models (Table 7). Results of the variable-dependent lag parameter, in this case inflation (-1) in the dynamic model, to detect inflation convergence. The result of the parameter concludes that inflation convergence occurs with a significant negative influence of the COVID-19 pandemic and a significant positive influence of the money in circulation. In this study, inflation convergence means a condition in which the rate of each province of 33 regions converges on the line of balance of average national inflation which means inflation movement towards a point (Barro & Sala-i-Martin, 1992) and there is no significant change in the inflation rate between 33 provinces in Indonesia so that the disparity between regions is reduced (Kočenda & Papell, 1997). The negative impact of BSCL can be understood as the COVID-19 pandemic inhibiting inflationary convergence while money moves drive inflation. The result of the BSCL parameter (-0.046) as well as the average inflation (0.137) and BSCL (1.345) are used to calculate elasticity with the formula $\in_{inflation,BSCL}= \frac{\partial_{BSCL}}{\partial_{inflation}} \frac{averageBSCL}{averageInflation}$ is obtained with a magnitude of -0.45, or non-elasticity, meaning that large changes in BSCL only cause small changes in inflation. A rise in the relative risk value of one percent only reduces inflation by 0.45 percent, which shows that inflation is not responsive to relative risk. The COVID-19 pandemic affects inflation negatively but is not responsive. On a static model, the insignificant negative influence of BSCL on inflation became strong evidence.

The negative relationship data between BSCL and inflation shown in Figure 5 occurred in the islands of Kalimantan, Malpa, and Sulawesi, with the relative risk conditions of the provinces that tended to be at low risk while inflation was relatively stable and low. COVID-19 pandemics in Kalimantan, Sulawesi, and Malpa are likely to lead to deflation. Positive data on the relationship between BSCL and inflation occurred in Java, Sumatra, and Balnustra, which means that in these islands the COVID-19 epidemic is still causing inflation. A positive picture (Figure 5) of the correlation between the COVID-19 pandemic and inflation in the Java region depicts the epidemic events that are surrounded by the policy of lockdown of the territory, which is unable to restrict the consumer behavior of the population so that the stimulus of price rise (inflation) persists. It's in line with the theory at a time when rising demand amid supply constraints will cause prices to rise. The COVID-19 pandemic clearly shows a decrease in production, but on one side, demand remains as a response to panic, so stockpiling or facilitating online shopping facilities This is not happening outside the Java Islands, like Kalimantan, Sulawesi, and Malpa, so the COVID-19 pandemic caused deflation.

4. Conclusion

Based on the argument that has been outlined, the relative risk influence of the COVID-19 pandemic on inflation convergence is either negative or deflationary for both static and dynamic models. Inflation behavior in Indonesia still tends to be dominated by monetary phenomena, even during the COVID-19 pandemic. The positive influence of money in circulation on both static and dynamic models shows this, both in terms of inflation determinants and inflation convergence. Research has found evidence that the COVID-19 pandemic is inhibiting inflationary convergence while money circulates, driving inflation. The implication of the study that government should to maintance the stability of price although there are certain events such as Ramadhan or idul fitri etc.

Acknowledgment

We extend our thanks to all those who have helped and contributed in the research and preparation of this article, in particular to the Sultan Ageng Tirtayasa University which has supported funding through a research grant competition. Hopefully this article have the benefit to many parties as well as the development of science in the field of economics.

Declarations

Author contribution	:	This article is the result of research carried out by the authors and all authors contributing to the creation of this published article. All authors have read and agree to this article.
Funding statement	:	This research is funded by the grant of the internal research competition of Sultan Ageng Tirtayasa University in 2023.
Conflict of interest	:	The authors declare no conflict of interest.
Additional information	:	No additional information is available for this paper.

References

Anggraeni, D., & Dwiputri, I. N. (2022). Variabel-variabel yang mempengaruhi inflasi di Indonesia. *Jurnal Ekonomi Pembangunan*, *11*(2), 119–128. doi: 10.23960/jep.v11i2.490

Arellano, M., & Bond, S. (1991). Some test of specification for panel data: Monte carlo evidence and an application to employment equations. *The Review of Economic Studies*, *58*(2), 277–297. doi: 10.2307/2297968

Arestis, P., Chortareas, G., Magkonis, G., & Moschos, D. (2014). Inflation targeting and inflation convergence: International evidence. *Journal of International Financial Markets, Institutions and Money*, *31*, 285–295. doi: 10.1016/j.intfin.2014.04.002

Aswi, Sukarna, & Nurhilaliyah. (2022). Pemodelan kasus COVID-19 di Indonesia menggunakan analisis spasial dengan pendekatan Bayesian. *Jurnal Matematika Dan Statistika Serta Aplikasinya*, *10*(2), 40–47. doi: 10.24252/msa.v10i2.33221

Baltagi, B. H. (2005). *Econometric analysis of panel data* (3rd ed.). John Wiley & Sons, Ltd.

Barro, R. J., & Sala-i-Martin, X. (1992). Convergence. *Journal of Political Economy*, *100*(2). doi: 10.1086/261816

BPS. (2020). *Indeks Harga Konsumen dan Inflasi Bulanan Indonesia*. https://www.bps.go.id/statictable/2009/06/15/907/indeks-harga-konsumen-dan-inflasi-bulanan-indonesia-2006-2022.html

Elhorst, J. P. (2003). Specification and estimation of spatial panel data models. *International Regional Science Review*, *26*(3), 244–268. doi: 10.1177/0160017603253791

Erdoğan, S., Yildirim, D. Ç., & Gedikli, A. (2020). Dynamics and determinants of inflation during the covid-19 pandemic period in european countries: A spatial panel data analysis. *Düzce Tıp Fakültesi Dergisi*, *22*(Special Issue 1), 61–67. doi: 10.18678/dtfd.794107

Gharehgozli, O., & Lee, S. (2022). Money Supply and Inflation after COVID-19. *Economies*, *10*(5), 101–118. doi: 10.3390/economies10050101

Insukindro, & Utama, C. (2015). Povincial inflation dynamics in Indonesia: Hybrid new keynesian phillips curve approach. *EcoMod*, *8599*.

Khoirudin, R., & Ardini, D. (2023). Analisis determinan inflasi di Indonesia. *Management Studies and Entrepreneurship Journal (MSEJ)*, *4*(5), 7378–7390.

Kočenda, E., & Papell, D. H. (1997). Inflation convergence within the European Union: A panel data analysis. *International Journal of Finance and Economics*, *2*(3), 189–198. doi: 10.1002/(SICI)1099-1158(199707)2:3<189::AID-IJFE46>3.0.CO;2-6

Kuncoro, H. (2020). Regional inflation dynamics and its persistence: The case of selected regions in Indonesia. *Regional Statistics*, *10*(2), 95–116. doi: 10.15196/RS100211

Kurniawan, M. L. A., & Prawoto, N. (2014). Pertumbuhan ekonomi dan penentuan titik ambang batas inflasi di Indonesia. *Jurnal Ekonomi Dan Studi Pembangunan*, *15*(1), 71–77.

Kusuma, I. W. (2014). The Dynamics of Indonesian Inflation: What can We Learn from Inflation Disaggregation? *Buletin Ekonomi Moneter Dan Perbankan*, *16*(1), 39–72. doi: 10.21098/bemp.v16i1.437

Levin, A., & Sinha, A. (2020). *Limitations on the Effectiveness of Monetary Policy Forward Guidance in the Context of the COVID-19 Pandemic* (No. 27748). doi: 10.3386/w27748

Lopez, C., & Papell, D. H. (2012). Convergence of Euro area inflation rates. *Journal of International Money and Finance*, *31*(6), 1440–1458. doi: 10.1016/j.jimonfin.2012.02.010

Mehrota, A. N., Peltonen, T. A., & Rivera, A. S. (2007). *Modelling inflation in China - A regional perspective* (BOFIT Discussion Paper No.19/2007; ECB Working Paper). doi: 10.2139/ssrn.1010629

Ng, S. (2021). *Modeling macroeconomic variations after COVID-19* (No. 29060; NBER Working Paper Series). http://www.nber.org/papers/w29060. doi: 10.3386/w29060

OECD. (2020). *Evaluating the initial impact of COVID-19 containment measures on economic activity*. http://www.oecd.org/coronavirus/

Paas, T., Kuusk, A., Schlitte, F., & Võrk, A. (2007). *Econometric analysis of income convergence in selected EU countries and their nuts 3 level regions* (Working Paper No. 60). doi: 10.2139/ssrn.1078863

Purwono, R., Yasin, M. Z., & Mubin, M. K. (2020). Explaining regional inflation programmes in Indonesia: Does inflation rate converge? *Economic Change and Restructuring*, *53*(4), 571–590. doi: 10.1007/s10644-020-09264-x

Ridhwan, M. M. (2016). Inflation differentials, determinants, and convergence: Evidence from Indonesia subnational data. *The Journal of Developing Areas*, *50*(5), 257–276. doi: 10.1353/jda.2016.0030

Tirtosuharto, D., & Adiwilaga, H. (2014). Decentralization and regional inflation in Indonesia. *Buletin Ekonomi Moneter Dan Perbankan*, *16*(2), 149–166. doi: 10.21098/bemp.v16i2.30

Utama, C., Wijaya, M. B. L., & Lim, C. (2017). The role of interest rate and provincial monetary aggregate in maintaining inflation in Indonesia. *Bulletin of Monetary Economics and Banking*, *19*(3), 1–20. doi: 10.21098/bemp.v19i3.666

Verbeek, B. H. (2004). *A guide to modern econometric* (2nd ed.). John Wiley & Sons, Ltd.

Wahidah, N. L., & Antriyandarti, E. (2021). Impact of climate change and Coronavirus Disease (COVID-19) on inflation in Indonesia. *Earth and Environmental Science Paper*, 5–9. doi: 10.1088/1755-1315/724/1/012105

Wei, X., & Han, L. (2021). The impact of COVID-19 pandemic on transmission of monetary policy to financial markets. *International Review of Financial Analysis*, *74*(37), 101705. doi: 10.1016/j.irfa.2021.101705

Yuniarti, D., Rosadi, D., & Abdurakhman. (2021). Inflation of Indonesia during the COVID-19 pandemic. *Journal of Physics: Conference Series 1821(1)*, 012039. doi: 10.1088/1742-6596/1821/1/012039