Causality Between Exchange Rates, Economic Growth and Inflation in Indonesia

Elisa Aprilia[1] | Ariodillah Hidayat[1] [*] | Imam Asngari[1]

[1] Sriwijaya University, Faculty of Economic, Department of Economic Development, Indonesia

ABSTRACT

The primary objective of this study is to examine the causal relationships among exchange rates, economic growth, and inflation in Indonesia. The data used in this research is secondary data with time series data for the period 2000 to 2019, obtained from the Bank Indonesia, Indonesia Central Bureau of Statistics, and World Bank. The method used in this research is Granger Causality. The outcomes of the analysis reveal a bidirectional causal relationship between economic growth and the exchange rate in the short term, as well as between inflation and the exchange rate. An appreciation of a country's exchange rate of one percent has an impact on changes in the overall price of goods, while an increase in the inflation rate causes a depreciation of the exchange rate. The relationship between inflation and economic growth shows that there is a one-way causal relationship, namely that inflation affects economic growth but not vice versa. These findings have significant policy implications, indicating that the Indonesian government needs to prioritize efforts to control inflation to support sustainable economic growth. Therefore, it is necessary to implement appropriate monetary and fiscal policies to maintain price stability and encourage balanced economic growth in Indonesia.

Keywords: e*xchange rate, economic growth, granger causality, inflation*

JEL Classification: E31, F31, F43

INTRODUCTION

The predominant challenge faced by nearly every country globally is the challenge of sustaining economic stability (Altbach, 2013). A successful government is characterized by its ability to address various issues within a nation. The government's objective to foster sustainability and prosperity for its citizens underpins economic development (Kline & Moretti, 2014). Initiatives aimed at attaining economic growth involve the maintenance of exchange rate stability and the regulation of inflation rates, both on regional and national scales (Mijiyawa, 2015).

The presence of economic stability and growth is a prerequisite for a nation's well-being (Acemoglu and Restrepo, 2018). As noted by Özokcu and Özdemir (2017), economic growth constitutes a key element in sustaining economic development and ensuring equitable societal services (Sari et al., 2023). Economic stability is instrumental in fostering the smooth and planned progression of economic growth and development, aligning with governmental objectives. Consequently, the meticulous and effective pursuit of both development and economic growth is imperative.

[*] Corresponding author, e-mail: ariodillahhidayat@fe.unsri.ac.id

As per Medvedev (2016), a factor capable of disrupting economic stability and impeding economic growth is a sustained increase in overall commodity prices. The Gross Domestic Product (GDP) data serves as an indicator to assess a country's economic status during a specific period (Kummu et al., 2018). The GDP value provides insight into how efficiently a country manages its available resources. According to a consensus among economists, a low inflation rate has a positive impact on the economy by enhancing national income and fostering work enthusiasm. Conversely, during periods of severe inflation, an escalating inflation rate poses a critical challenge for steering economic growth toward improvement (Mohseni & Jouzaryan, 2016). Improper inflation rates can result in adverse consequences, such as the depreciation of currency value, leading to a reduction in purchasing power, particularly for individuals with fixed incomes. Maintaining a low and stable inflation rate is considered a catalyst for stimulating economic growth.

The primary factor contributing to the elevated inflation rate of 77.63 percent in 1998 was the devaluation of the rupiah against foreign currencies, particularly the United States dollar (Pratama & Rizal, 2019). The decline in the rupiah's value in comparison to other currencies can influence the surge in export values, subsequently affecting both economic growth and inflation. Fluctuations in the exchange rate can also impact investment and international trade. The rise in import costs resulting from these conditions contributes to the overall high inflation rate. Foreign entities may be enticed by the relatively lower prices of domestic goods, leading to an increase in demand and gradual price hikes, thereby causing inflation (Bala & Chin, 2018).
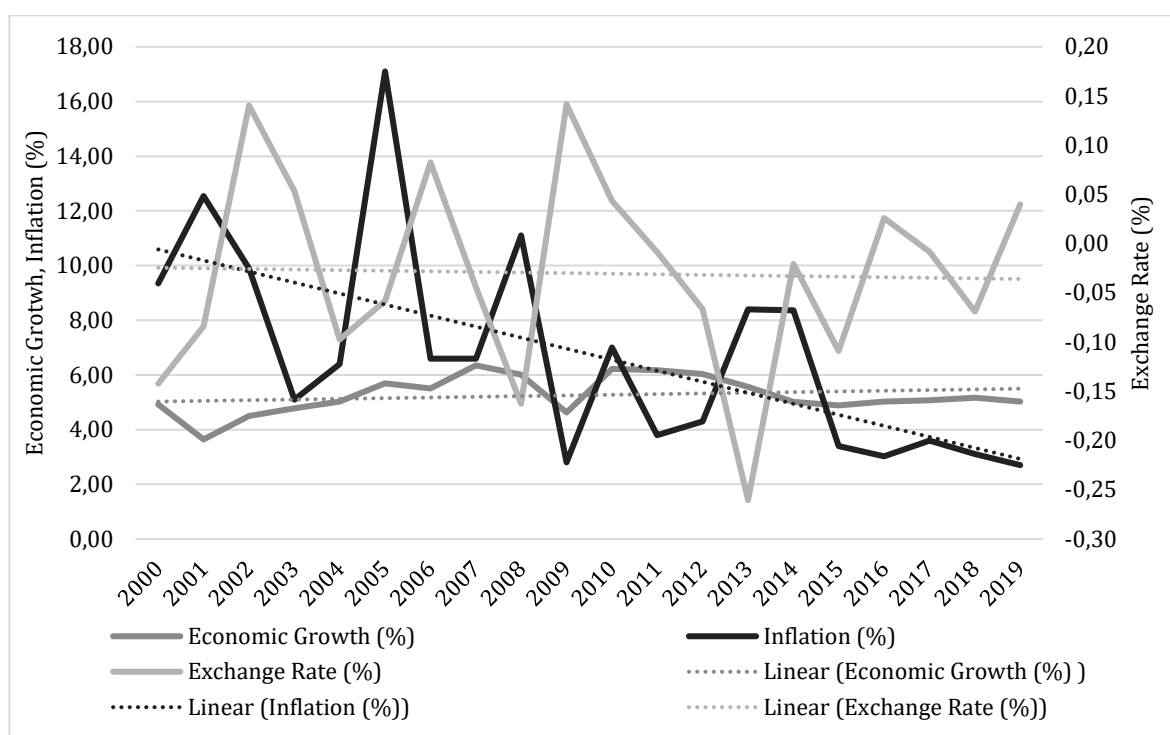

Figure 1. Exchange Rate (USD/IDR), Inflation, and Economic Growth in Indonesia
Source: Central Bureau of Statistics and Bank Indonesia (2021)

As illustrated in Figure 1, Indonesia witnessed a slowdown in economic growth, dropping from 5.56 percent to 5.02 percent between 2013 and 2014. This deceleration was linked to various economic sectors facing declines, notably exports, driven by diminished demand from key trade partners and falling prices of export commodities tied to natural resources (Resosudarmo & Abdurohman, 2018). Another noteworthy event in 2014 was the substantial appreciation of the

USD against the IDR, reaching Rp12,440/US$ with a 2.1 percent increase. The depreciation of the rupiah was instigated by the recovering U.S. economy, leading the United States Central Bank (the Fed) to consider interest rate hikes, resulting in capital outflows from developing nations, Indonesia being one of them. Furthermore, the economic slowdown in China played a role in the depreciation of the rupiah exchange rate, contributing to reduced exports of commodities from Indonesia.

The depreciation of the exchange rate was accompanied by inflation, which remained at 8.36 percent. Although this inflation rate is relatively high, it is slightly lower than the 8.38 percent recorded in 2013. The significant factors contributing to this elevated inflation rate include a 1.04 percent increase in fuel oil prices, reflecting the volatile nature of commodity prices throughout the 2014 period (Julitawaty, 2015). Other contributing factors encompassed electricity tariffs (0.64 percent), inner-city transportation (0.63 percent), red chili prices (0.43 percent), targeted prices (0.38 percent), and household fuel (0.37 percent).

Several previous studies and theories say that exchange rates, inflation, and economic growth have a causal relationship. The study by Loukil (2017) concluded that there is a unidirectional causal relationship between inflation and the exchange rate in Tunisia. Lado's (2015) research found that there is a two-way causality between inflation and exchange rates in South Sudan. Amoah et al. (2015) show the existence of a unidirectional causality relationship between the growth rate of GDP and the exchange rate and a two-way causal relationship between the Inflation rate and the Exchange Rate, and also between the Inflation rate and GDP. Results of Granger's Causality in research Chaudhry et al. (2012) show that economic growth and exchange rates affect each other bidirectionally. Based on previous research and theories, it is suggested that exchange rates, inflation, and economic growth in Indonesia are believed to be interrelated in a casual manner. This shows that this research topic is important to discuss, especially in Indonesia.

The primary objective of this study is to investigate and elucidate the interplay among exchange rates, economic growth, and inflation in Indonesia. Employing a descriptive approach with a quantitative framework, specifically the Granger Causality method, the research aims to discern potential causal relationships among exchange rates, economic growth, and inflation in Indonesia. In a changing global economy, a deep understanding of the causality relationships between these key variables is imperative for developing effective and responsive economic policies. The success of economic stability, the management of inflation rates, and the achievement of sustainable economic growth are key foundations in navigating the challenges faced by developing countries such as Indonesia. Understanding the causation between exchange rates and economic growth, along with inflation's role as an intermediary, involves a complexity of dynamics that need to be revealed through careful analysis. The recency of the analysis of this phenomenon becomes important to enrich the economic literature with deeper insights and nuances that can make a significant contribution to current economic thinking. In addition, this research has the potential to provide new insights related to the specific challenges faced by the Indonesian economy, and these findings not only serve as a reference source for the government and policymakers, but also stimulate further research in this area, thus contributing continuously to the development of economic literature and a broader understanding of regional economic dynamics. The Granger Causality approach was chosen because it allows researchers to evaluate the direction and strength of causality within a time frame and then provides a more detailed understanding of the dynamics of interactions between these variables.

The rest of the research is structured as outlined below. Section 2 delves into the literature review, while Section 3 investigates the data and methodology. The dynamics of variables, empirical findings, and subsequent discussion are presented in Section 4. Section 5 concludes the study and provides policy implications for the country of Indonesia.

LITERATURE REVIEW

Economic expansion can be characterized as the advancement of endeavors within the economy that lead to a rise in the quantity of goods and services generated within the community (Hidayat et al., 2023). Along with the development of economic literature, earlier theories made important contributions to understanding the causality relationship between exchange rate variables, inflation, and economic growth. For example, the Purchasing Power Parity Theory emphasizes that changes in exchange rates will be reflected in relative price changes and can, therefore, affect the inflation rate. In line with this view, the Mundell-Fleming Model highlights the impact of monetary as well as fiscal policy on exchange rate balance and inflation (Bouakez & Eyquem, 2015). From the perspective of economic growth, Solow-Swan theory also highlights the role of investment and capital accumulation on the long-run growth of a country, while Keynesian theory focuses attention on the effect of the inflation rate on consumption and investment levels (Van Wyk & Kapingura, 2021). Research of Bouchetara and Bendahmane, (2017) focuses on in-depth reviews of the complex relationship between exchange rates and inflation, emphasizing the role of government intervention and monetary policy in achieving economic stability.

The investigations conducted by Srithilat et al. (2018) and Yien, et al. (2017) delved into the intricate dynamics of the interplay among inflation, real exchange rates, and currency substitution within Southeast Asian economies, employing the VECM and Granger Causality analysis on panel data. The empirical outcomes from both studies consistently indicate the presence of cointegration panels, signifying an enduring relationship between inflation, real exchange rates, and currency substitution. Furthermore, they concur on the observation that escalating inflation rates and the devaluation of domestic currency positively impact currency substitution in the protracted duration. Additionally, the Granger Causality analysis at a concise temporal scale discloses the mutual influence between inflation and currency substitution, along with the unidirectional relationship from exchange rates to currency substitution within the Southeast Asian context.

On a contrasting note, the investigation conducted by Deka and Dube (2021) explores the prolonged and immediate interactions involving inflation, exchange rates, and the utilization of renewable energy in Mexico within the 1990-2019 timeframe, employing the ARDL boundary test methodology. The study's outcomes reveal a reciprocal causality relationship between inflation and exchange rates over an extended period.

Aligned with this perspective, Ayodeji and Adeyemi (2018) conducted a study investigating the repercussions of Monetary Policy on Economic Growth in Nigeria, employing the Engle-Granger and Granger Causality methodologies. The findings of the cointegration analysis reveal a persistent causal connection between monetary policy and long-term economic growth in Nigeria. Nevertheless, the outcomes of the Granger causality test indicate that while there is a positive impact of money supply and exchange rate on economic growth, this influence does not attain statistical significance.

In an alternative domain, the study conducted by Uddin et al. (2014) delves into the Causality between Exchange Rate and Economic Growth in Bangladesh, employing the Granger Causality regression approach. The empirical findings demonstrate a positive and substantial bidirectional association between exchange rates and economic growth. Similarly, the investigation by Ali et al. (2015), scrutinizing the impact of inflation, interest rates, and money supply on exchange rate volatility in Pakistan, utilizes the Granger Causality method to explore both short and long-term relationships. The outcomes indicate a sustained relationship in the long run, where increments in the money supply and escalating interest rates contribute to an augmented inflation rate, subsequently intensifying exchange rate volatility.

Thus, the integration of these theories is able to provide a comprehensive framework for understanding the dynamic relationship between exchange rates, inflation and economic growth, which is the basis for this research in exploring new dimensions and highlighting the

characteristics of the Indonesian economy. This research is able to fill the knowledge gap regarding the causality between exchange rates, economic growth and inflation. Unlike previous research, the main focus of this research is Indonesia as a research subject, using a Granger Causality approach and combining qualitative and quantitative analysis. The aim is to deepen understanding of the complex dynamics of these variables and provide a more contextual contribution to the economic factors influencing the country. Based on previous research and theories, this research hypothesis states that there is a causal relationship between the exchange rate, economic growth and inflation in Indonesia.

DATA AND METHODOLOGY

The analytical tool utilized for this examination is the Econometric Views (EViews) version 8.0 application. The dataset employed in this study comprises secondary data, specifically the most recent macroeconomic data for Indonesia, encompassing exchange rates, economic growth, and inflation. These data sources include publications from Bank Indonesia, the Indonesian Central Bureau of Statistics, and the World Bank, spanning 2000 to 2019.

In this research, the cause-and-effect relationship was measured using the Granger causality method. The causality test serves as a diagnostic tool for gauging the intensity of the connection between two or more variables. Additionally, it elucidates the directionality of the relationship between the independent variable and the dependent variable (Maziarz, 2015). The initial step in examining Granger causality involves conducting a test for stationarity. This stationarity examination is executed by assessing unit roots through a unit root test. Unstable data will exhibit units of roots, while stable data will not possess units of roots. The widely employed unit root test model in numerous investigations is the Augmented Dickey-Fuller (ADF) test model. The formula for the ADF test is articulated as follows:

$$\Delta Y = \beta 1 + \beta 2 + \delta Yt - 1 + \sum_{i=1}^{m} \alpha i \Delta Yt - 1 + \varepsilon t \tag{1}$$

Information:
Y= Observed variable; $\Delta Yt = Yt - Yt-1$; $\Delta Yt-1 = Yt - Yt-1$; T= Time trend. So, the form of the ADF test formula for the exchange rate, economic growth and inflation variables is as follows:

$$\Delta ERt = \beta 1 + \beta 2t + \delta ERt - 1 + \sum_{i=1}^{m} \alpha i \Delta ERt - 1 + \varepsilon t \tag{2}$$

$$\Delta EGt = \beta 1 + \beta 2t + \delta ERt - 1 + \sum_{i=1}^{m} \alpha i \Delta ERt - 1 + \varepsilon t \tag{3}$$

$$\Delta INFt = \beta 1 + \beta 2t + \delta INFt - 1 + \sum_{i=1}^{m} \alpha i \Delta INFt - 1 + \varepsilon t \tag{4}$$

To find out whether the data is stationary or not, compare the ADF statistical values (δYt -1) with the critical value of the MacKinnon distribution. If the statistical ADF value is greater than the critical value of the MacKinnon distribution, then the data is said to be stationary.

The formula employed to conduct the Granger Causality test is represented by the following equation:

$$ERt = \sum_{i=1}^{m} a_{11} ER_{t-i} + \sum_{j=1}^{m} a_{12} GE_{t-j} + \sum_{k=1}^{m} a_{13} INF_{t-k} + e_{ER} \tag{5}$$

$$GEt = \sum_{j=1}^{m} a_{21} GE_{t-k} + \sum_{k=1}^{m} a_{22} INF_{t-k} + \sum_{i=1}^{m} a_{23} ER_{t-i} + e_{GE} \tag{6}$$

$$INFt = \sum_{k=1}^{m} a_{31}INF_{t-k} + \sum_{i=1}^{m} a_{31}ER_{t-i} + \sum_{j=1}^{m} a_{33}GE_{t-j} + e_{INF} \ldots \tag{7}$$

Information:

INF = Inflation; ER= Exchange rate; GE = Economic Growth; M= Amount of Lag; t= Time; e= Disruptor variable.

RESULTS AND DISCUSSION

Variable Movement Analysis

Variable Movement Analysis of Exchange Rate in Indonesia

The USD to IDR exchange rate displayed notable fluctuations from 2000 to 2019, as illustrated in Figure 2. Examining the data, it becomes evident that the rupiah experienced its most significant appreciation against the USD in 2009, reaching a peak of 14.16 percent—the highest observed figure within the 2000-2019 timeframe. This noteworthy strengthening can be attributed to the economic downturn in the United States starting in 2007, prompting the Federal Reserve (Fed) to implement substantial interest rate cuts, reaching a historic low of 0.0 percent to 0.25 percent in early 2009 (Cukierman, 2013). Additionally, the Fed injected significant liquidity into the market to stimulate economic activity, contributing to the depreciation of the USD against the IDR in the 2009 period. In contrast, the most significant depreciation of the rupiah occurred in 2013, registering a decline of -26.05 percent.
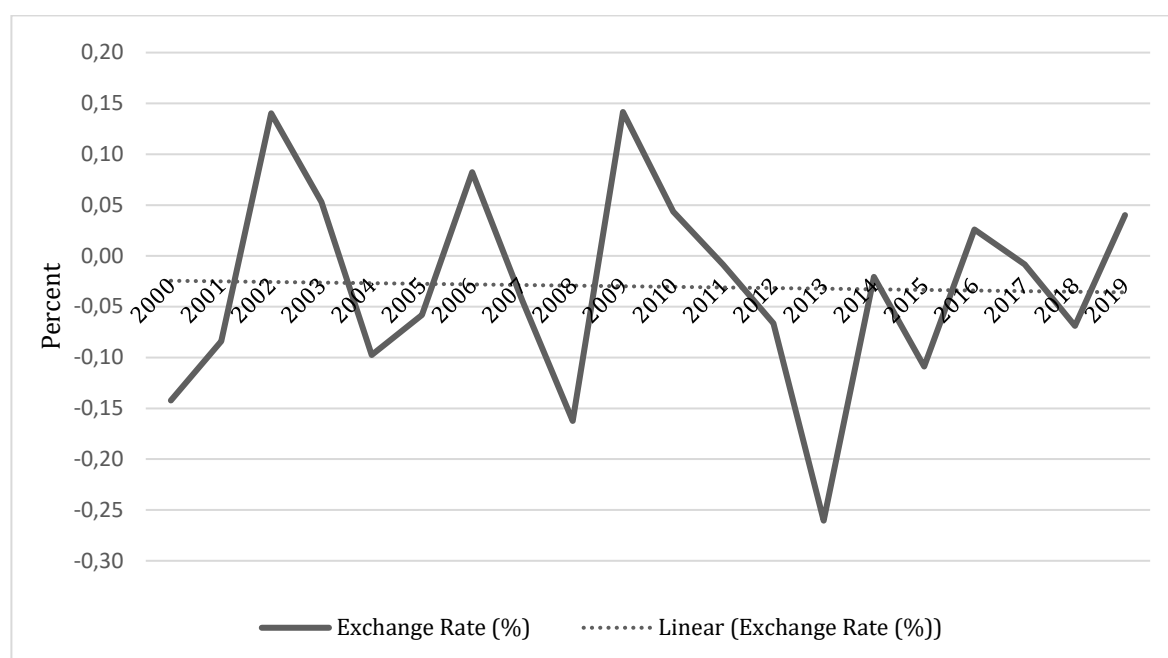

Figure 2. Rupiah Exchange Rate Movement against USD
Source: Bank Indonesia, 2020

The factor that can cause the depreciation of the rupiah exchange rate is the high current account deficit due to the trade balance (Purwono et al., 2018). This trade balance deficit was mainly caused by the increasing need for imported goods, such as fuel oil, which is an important commodity for the Indonesian economy. In this case, demand for foreign currency, especially the

United States dollar (USD), increased significantly. As a result of this, there was a high increase in demand for foreign currency to meet import needs, which ultimately led to a decline in the rupiah exchange rate against foreign currencies. In situations where the exchange rate experiences significant fluctuations, companies are forced to adjust product prices, which are reflected in changes in import costs (Auboin & Ruta, 2013). This creates uncertainty in the prices of goods and services, which in turn can trigger instability in the financial sector.

Variable Movement Analysis of Economic Growth in Indonesia

Economic growth is the augmentation of a country's capacity to produce goods and services within its economic pursuits. The success of economic development is discerned through sustained and stable growth. Figure 3 illustrates the annual variations in Indonesia's economic growth from 2000 to 2019, marked by alternating periods of expansion and contraction. The varying economic growth rates during this period can be attributed to several other economic factors. The data illustrated in the chart highlights a peak in Indonesia's economic growth rate in 2007, reaching 6.35 percent. This surge can be correlated with relatively stable global economic conditions and high economic growth in developed countries during that year (Antonakakis et al. 2015). Given Indonesia's status as an open economy, it is inherently linked to the global economic landscape. The notable growth in Indonesia's industrial sector in 2007 was propelled by government policies incentivizing investments in the industrial sector and the recovery of the manufacturing sector following the crisis of 1997-1998 (Szirmai & Verspagen, 2015).
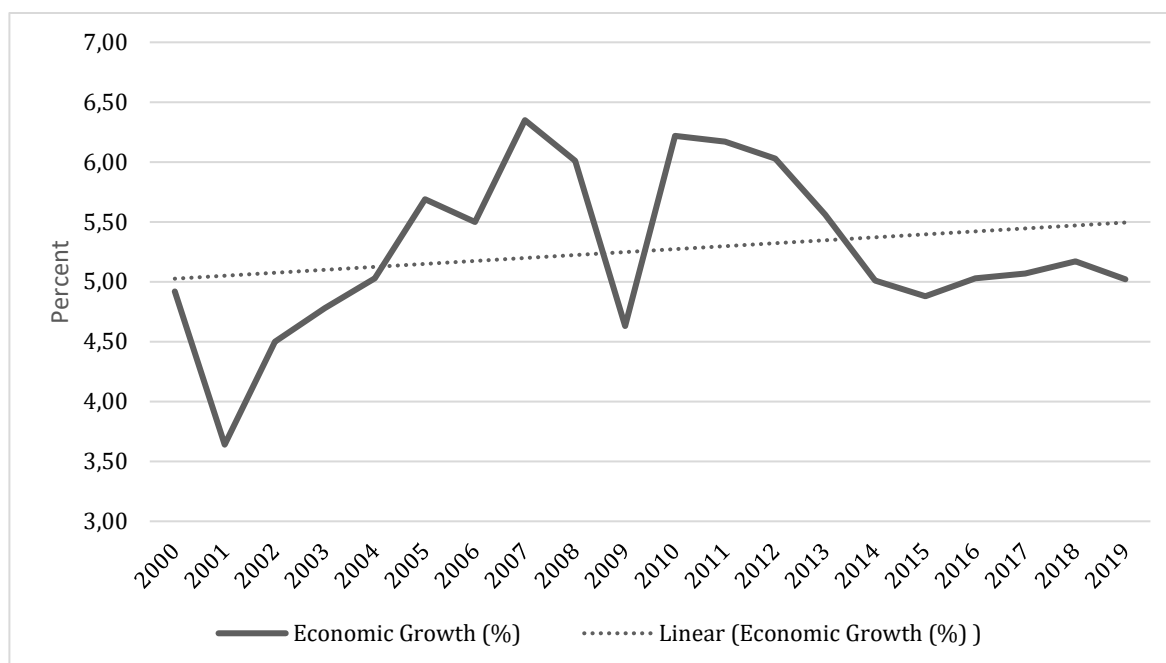

Figure 3. Economic Growth Movement in Indonesia
Source: World Bank, 2020

The decline in economic growth that occurred in 2009 was 4.63 percent, compared to the previous year's growth. This reflects the magnitude of the impact of the global economic crisis that hit the world from 2008 to 2009. The global economic crisis triggered by the collapse of the American financial market in 2008 caused a wave of falling asset prices, a decline in consumer purchasing power, and global economic uncertainty (Eaton, et al., 2016). The negative impact of this crisis extends to various sectors of the Indonesian economy, including international trade, investment and the financial sector, which are closely related to economic growth. This condition

caused a significant slowdown in economic growth and caused growth to reach its lowest point throughout the 2000-2019 period. However, after 2009, Indonesia's economic growth experienced an improvement and began to stabilize. This improvement was caused by a number of factors, including efforts to recover the global economy after the 2008-2009 crisis, fiscal and monetary policies implemented by the Indonesian government, as well as the growth of certain sectors in the economy. The stability of economic growth in this period reflects the resilience and adaptability of the Indonesian economy in facing global economic challenges. Even though the journey of economic growth has experienced ups and downs, this shows the ability of the Indonesian economy to recover and develop again after facing significant economic pressure in 2009.

Variable Movement Analysis of Inflation in Indonesia

Inflation is an economic condition characterized by a continuous and sustainable increase in prices in a country's economy (Hansen, 2016; Gilchrist et al., 2017). Inflation occurs due to economic turmoil within the country (Asmadina et al., 2021). This phenomenon occurs as a result of an increase in the amount of money and goods circulating in the economy. An overall increase in prices can affect people's purchasing power and have a significant impact on a country's economic stability. Changes in the inflation rate in Indonesia during the 2000-2019 period can be seen in Figure 4. In 2005, the inflation rate was the highest throughout the period in Indonesia during the research conditions, reaching 17.11 percent. This figure shows a significant increase compared to the previous year's inflation rate in 2004, namely 6.4 percent. The sharp increase in 2005 could be caused by several economic factors, such as fluctuations in international commodity prices, changes in domestic demand, monetary and fiscal policies, and global conditions.

Figure 4. Inflation Movement in Indonesia
Source: Indonesian Central Bureau of Statistics, 2020

The development of inflation in Indonesia in the 2000-2019 period reflects an effective response to economic factors that influence changes in price levels. After experiencing a significant increase in inflation in 2005, Indonesia succeeded in reducing the inflation rate in

2006, and this achievement continued in 2007 with an inflation rate of 6.6 percent. These results indicate that there are effective inflation control efforts in Indonesia. Indonesia's lowest inflation rate throughout the research period occurred in 2019, at 2.70 percent. This decline was caused by relatively controlled prices of high-value goods. For example, rice prices, which often trigger high inflation in Indonesia, could be managed well that year because of sufficient rice supplies. The low inflation rate is the result of appropriate policies in managing the supply and price of rice, as well as other factors that support controlling inflation (Putra et al., 2021). This reflects the ability of the government and economic authorities to face inflation challenges and maintain price stability in the country. Furthermore, the decline in the inflation rate in 2019 is concrete evidence that economic policies and supply management of strategic goods such as rice can have a significant impact on price stability. These results reflect the Indonesian government's serious efforts to keep inflation within acceptable limits, which in turn supports economic stability and sustainable growth. Thus, the development of inflation in Indonesia during the 2000-2019 period shows the importance of appropriate and efficient policies in efforts to maintain price stability in the economy.

Variable Movement Analysis

Descriptive Statistics

Descriptive statistical analysis is used as an initial approach to detailing and presenting the basic characteristics of the exchange rate, inflation and economic growth variables studied in Indonesia. Descriptive statistical results can be seen in Table 1.

Table 1. Descriptive Statistics

	ER	EG	INF
Mean	-0.030182	5.260500	6.758000
Median	-0.032414	5.050000	6.500000
Maximum	0.141553	6.350000	17.10000
Minimum	-0.260496	3.640000	2.700000
Std. Dev.	0.100861	0.679980	3.835814
Skewness	-0.212805	-0.221178	1.046127
Kurtosis	2.858567	2.887588	3.661293
Jarque-Bera	0.167623	0.173596	4.012361
Probability	0.919605	0.916862	0.134501
Sum	-0.603634	105.2100	135.1600
Sum Sq. Dev.	0.193285	8.785095	279.5559
Observations	20	20	20

Source: *Author's Estimation, 2021*

Descriptive statistical results show that the highest exchange rate was in 2002 with a value of 0.14, while the lowest point was in 2013 with a value of -0.26. In contrast, economic growth reached its highest peak in 2007 with a value of 6.35, and its lowest value in 2001 with a value of 3.64. The inflation rate reached its maximum value in 2005 at 17.1, while the lowest value in 2019 was 2.7. It also found that the variability of exchange rate data and economic growth was relatively low, while the inflation rate showed significant variations. The distribution of exchange rate data and economic growth tends to be symmetrical, while the inflation rate shows positive skewness, which indicates a long tail on the positive side of the distribution.

Unit Root Test

The initial stage before estimating a time series model involves conducting a unit root test. This examination is crucial to prevent spurious regression, which could lead to inaccuracies in the estimated results if a unit root is present in the variable under consideration.

Table 2. Unit Root Test

Variable	Significant Levels	Level		Information
		Critical Value	ADF-test	
ER	1%	-3.831511	-4.458487	Stationary
	5%	-3.029970		
	10%	-2.655194		
EG	1%	-3.831511	-2.431088	Non-Stationary
	5%	-3.029970		
	10%	-2.655194		
INF	1%	-3.831511	-3.260474	Non-Stationary
	5%	-3.029970		
	10%	-2.655194		

Source: Author's Estimation, 2021

The outcomes of the stationarity tests at the significant levels of 1%, 5%, and 10% for each variable indicate that nearly all the research variables employed are non-stationary at these levels. In other words, almost all the variables utilized in this study are non-stationary. As mentioned earlier, having non-stationary data for research variables can lead to inaccurate regression results or spurious regression. Henceforth, the subsequent step in the analysis involves conducting a unit root test at the first difference level. The results from this initial difference test are detailed in Table 3:

Table 3. Unit Root Test

Variable	Significant Levels	Level		Information
		Critical value	ADF-test	
ER	1%	-3.857386	-5.749681	Stationary
	5%	-3.040391		
	10%	-2.660551		
EG	1%	-3.857386	-6.137360	Stationary
	5%	-3.040391		
	10%	-2.660551		
INF	1%	-3.886751	-6.503407	Stationary
	5%	-3.052169		
	10%	-2.666593		

Source: Author's Estimation, 2021

The results of the first difference test, as presented in Table 3, indicate that all observed variables in the research have been confirmed as stationary with a consistent level of confidence. This is substantiated by the ADF test results surpassing the critical value in the first difference. The test clarifies that all variables considered in this study have achieved stationarity to a comparable extent.

Lag Length Criteria

The criteria for determining the lag length, also known as the optimal lag test, seek to identify the suitable lag duration for this research following the confirmation of stationary data through unit root testing. The determination of the most suitable lag is performed through an examination of three information criterion functions: Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC), and Hannan-Quinn Criterion (HQ). The results of the optimal lag assessment are delineated in Table 3.

Table 4. Lag Length Criteria

	LogL	LR	FPE	AIC	SC	HQ
0	-128.6397	ON	451.8473	14.62663	14.77503	14.64709
1	**-110.3605**	**28.43430***	**164.7784***	**13.59561***	**14.18919***	**13.67746***
2	-107.0265	4.074840	344.1741	14.22517	15.26394	14.36840

Source: Author's Estimation, 2021

The outcomes of the optimal lag testing (refer to Table 4) indicate that the AIC, SC, and HQ values presented in the output are chosen based on their minimal values, marked with the most asterisks, signifying the optimal lag under these conditions. The results spanning from lag 0 to lag 2 reveal the smallest AIC, SC, and HQ values. Specifically, for lag 1, the AIC has a value of 13.59561, SC has a value of 14.18919, and HQ has a value of 13.67746. Thus, it can be deduced that the optimal lag is at lag 1, as indicated by the smallest values across AIC, SC, and HQ outputs in the table. Consequently, this study will proceed with testing up to the 1st lag.

Granger Causality Test Results

The purpose of the causality test is to examine the interdependence among the research variables. A variable is considered to have a significant impact on other variables if the probability is < 0.05 confidence level, with a lag length of 1 in this test. The outcomes of the Granger causality test are displayed in Table 5.

Table 5. Granger Causality Test Results

Null Hypothesis:	Obs	F-Statistic	Prob.
EG does not Granger Cause ER	19	3.65462	0.0447
ER does not Granger Cause EG		11.0658	0.0043
INF does not Granger Cause ER	19	3.79198	0.0330
ER does not Granger Cause INF		10.8079	0.0121
INF does not Granger Cause EG	19	3.55836	0.0496
EG does not Granger Cause INF		0.18651	0.6716

Source: Author's Estimation, 2021

Based on the outcomes derived from the Granger causality test conducted over the research duration from 2000 to 2019, as presented in Table 5, it is evident that among the variables—exchange rates, economic growth, and inflation—there is bidirectional causality between all of them. However, a unidirectional causality is observed, specifically from inflation variables to exchange rates.

Turning our attention to the outcomes of the inflation variable test (INF), it becomes evident that inflation (INF) exerts a significant and positive impact on the exchange rate (ER), substantiated by an F-statistical value of 3.79198 and a probability of 0.0330, residing below the 0.05 threshold. In a reciprocal manner, the exchange rate variable (ER) significantly and positively influences inflation (INF), supported by an F-statistical value of 10.8079 and a probability of 0.0121, also falling beneath the alpha value of 0.05. Consequently, a bidirectional causality is established between inflation (INF) and exchange rate (ER), with the probability associated with each variable positioned below the 0.05 alpha level.

Turning to the relationship between the inflation variable (INF) and economic growth (EG), it is observed that inflation (INF) significantly and positively impacts economic growth (EG), demonstrated by an F-statistical value of 3.55836 and a probability of 0.0496, which is less than 0.05. However, the economic growth variable (EG) does not exhibit a statistically significant impact on inflation (INF), with an F-statistic of 0.18651 and a probability of 0.6716, exceeding the 0.05 threshold. Consequently, the results for the inflation and economic growth variables indicate a unidirectional causality relationship, with inflation significantly affecting economic growth.

Discussion

Causality Analysis of Exchange Rate and Economic Growth

The examination of the economic growth variables in conjunction with the exchange rate reveals a reciprocal association between the two. As a nation experiences economic expansion, there is an amplified demand for its currency, subsequently leading to an appreciation of the exchange rate (Bresser-Pereira & Nakano, 2020). This surge in demand stems from the increased need for the country's currency to facilitate transactions related to the augmented production of goods and services. Conversely, an elevated exchange rate can exert an impact on a country's economic growth trajectory (Guzman, et al., 2018). The heightened exchange rates render the country's goods and services more expensive in the global market, resulting in a decline in exports and an upswing in imports (Dogru, et al., 2019). This phenomenon has the potential to decelerate economic growth, given that exports constitute a pivotal factor propelling economic expansion. Furthermore, when a country's interest rates surpass those of other nations, investments within that country become more appealing, fostering an increased demand for the country's currency and consequently leading to exchange rate appreciation (Khalfaoui & Derbali, 2021). However, the concomitant escalation of exchange rates can render exports more costly and diminish competitiveness on the global stage, potentially impeding economic growth. Consequently, a bidirectional relationship exists between economic growth and exchange rates, where alterations in one variable can significantly influence the other.

Causality Analysis of Inflation and Exchange Rate

Based on the Granger causality results, it is evident that there is a positive and significant two-way causality relationship between the inflation variables and the exchange rate. This phenomenon is in line with previous findings, as observed by Deka and Dube (2021). This means that there is a causal relationship between inflation and the exchange rate. When a country's inflation rate increases, people's purchasing power generally decreases because they have to spend more money on the same goods and services (Khan, et al., 2019). As a result, demand for imported goods tends to increase because prices are relatively lower in the currency of a country experiencing inflation. This can cause an increase in the need for foreign currency and a weakening of the country's currency exchange rate. However, on the contrary, if the inflation rate is lower, it results in an appreciation of the exchange rate because people's purchasing power is relatively higher, and foreign investors are more interested in investing in countries where

inflation is under control (Bouraoui & Phisuthtiwatcharavong, 2015). This is one of the mechanisms underlying the positive causal relationship between inflation and the exchange rate.

Exchange rate depreciation refers to a scenario wherein a country's currency loses value in comparison to foreign currencies, thereby exerting a significant impact on domestic inflation (Ramasamy & Abar, 2015). This is caused by an increase in the cost of importing goods and services. When the rupiah exchange rate depreciates, the price of imported goods in the local currency will increase because one unit of the local currency will buy less foreign currency, such as dollars. As a result, domestic producers and consumers will face higher costs for imported goods, which could lead to an increase in the prices of goods and services in Indonesia. In addition, exchange rate appreciation, which is an increase in the value of a country's currency against foreign currencies, can also have a significant effect on inflation. In a situation of appreciation, the price of imported goods becomes lower in local currency since one unit of local currency will buy more foreign currency. The impact is a decrease in the price of imported goods, which can reduce domestic inflationary pressures (Islam, 2013). With lower prices of imported goods, domestic consumers tend to acquire imported goods at a lower cost, which can hinder the increase in prices of goods and services in the domestic economy.

Causality Analysis of Economic Growth and Inflation

The results of the subsequent causality evaluation reveal a statistically significant positive influence of inflation variables on economic growth. Conversely, the outcomes of the Granger causality test for economic growth variables on inflation suggest the absence of a unidirectional relationship between economic growth and inflation. In the Indonesian context spanning 2000-2019, there is no unilateral association between economic growth variables and inflation, primarily attributed to the inflation shock experienced in 2008. The prevailing notion suggests that inflation is not primarily shaped by real sectors, such as economic growth, but rather by monetary variables, exemplified by the continuous increase in the money supply in Indonesia during 2007 (1,649,622 billion rupiahs) and 2008 (1,895,838 billion rupiahs). This aligns with the findings of Adaramola and Dada (2020).

The correlation between economic growth and inflation is intricate, characterized by a nuanced interplay rather than a straightforward unidirectional causality. This relationship is contingent upon a myriad of factors that influence both economic growth and inflation, including factors of production, governmental policies, and the dynamics of market demand and supply. Economic growth has the potential to stimulate heightened production and productivity, thereby augmenting the abundance of goods and services within the economy (Myovella et al., 2020). Nevertheless, the constrained availability of production factors, such as labor and raw materials, can impose limitations on the economy's capacity to sustainably escalate production. In cases where production factors remain constrained, sustained economic growth may result in increased demand and pricing of goods, subsequently instigating inflation (Oreiro et al., 2020). Governmental monetary and fiscal policies play pivotal roles in influencing both the inflation rate and economic growth. A stringent monetary policy accompanied by elevated interest rates can quell inflation but concurrently impede economic growth (Abuselidze, 2019). Conversely, an expansive fiscal policy and substantial spending can foster economic growth but may also incite inflation. Therefore, a judicious balance in government policies is imperative, striving to control inflation while propelling economic growth forward. The upsurge in demand can stem from heightened consumption or increased investment, thereby contributing to economic growth (Shahbaz et al., 2020). However, if the surge in demand lacks a commensurate increase in supply, the prices of goods and services may ascend, precipitating inflationary pressures.

CONCLUSION

The study's findings suggest a bidirectional causal relationship between economic growth and exchange rate variables in the short term. Correspondingly, akin outcomes are observed in the association between inflation and exchange rates, displaying a bidirectional causal relationship. A 1 percent increase in a country's exchange rate induces a shift in the overall price of goods, whereas an escalation in inflation leads to the depreciation of the exchange rate. In contrast, the connection between inflation and economic growth variables demonstrates a unidirectional causal relationship; specifically, inflation has a causal effect on economic growth. This implies that the surge in overall prices impacting the income of the Indonesian populace does not necessarily translate into a reciprocal impact on the upswing in economic growth, marked by an increase in people's income, within the 2000-2019 period in Indonesia.

The Indonesian government needs to pay attention to the two-way causal relationship between economic growth and the exchange rate. In line with efforts to increase economic growth, the government needs to take careful steps in managing the rupiah exchange rate, considering that changes in the exchange rate can have a significant impact on the overall price of domestic goods. The government also needs to consider measures that can control inflation, considering the existence of a two-way causal relationship between inflation and the exchange rate. An increase in the overall price of an item can affect the exchange rate and vice versa. Therefore, Bank Indonesia and the government need to work together to ensure price and exchange rate stability, as well as mitigate risks that may arise due to exchange rate fluctuations. The relationship between inflation and economic growth is unidirectional; that is, inflation affects economic growth. The Indonesian government can focus on efforts to control inflation to support sustainable economic growth. The Indonesian government can also take appropriate monetary and fiscal policies to maintain price stability and encourage balanced economic growth.

REFERENCES

Abuselidze, G. (2019). Modern challenges of monetary policy strategies: Inflation and devaluation influence on economic development of the country. *Academy of Strategic Management Journal*, *18*(4), 1–10. https://ssrn.com/abstract=3591723

Acemoglu, D., & Restrepo, P. (2018). The race between man and machine: Implications of technology for growth, factor shares, and employment. *American Economic Review*, *108*(6), 1488–1542. https://doi.org/10.1257/aer.20160696

Adaramola, O. A., & Dada, O. (2020). Impact of inflation on economic growth: Evidence from Nigeria. *Investment Management and Financial Innovations*, *17*(2), 1–13. https://doi.org/10.21511/imfi.17(2).2020.01

Altbach, P. G. (2013). Advancing the national and global knowledge economy: The role of research universities in developing countries. *Studies in Higher Education*, *38*(3), 316–330. https://doi.org/10.1080/03075079.2013.773222

Amoah, E., Phil, M., Nyarko, E., & Asare, K. (2015). Fdi, Inflation, Exchange Rate and Growth in Ghana: Evidence From Causality and Cointegrated Analysis. *European Scientific Journal*, *11*(31), 1857–7881.

Antonakakis, N., Dragouni, M., & Filis, G. (2015). How strong is the linkage between tourism and economic growth in Europe? *Economic Modelling*, *44*(2), 142–155. https://doi.org/10.1016/j.econmod.2014.10.018

Asmadina, A. R., Hidayat, A., Asngari, I., & Andaiyani, S. (2021). The Covid-19 pandemic and inflation in Indonesia. *Romanian Journal of Economics*, *2*(62), 27–39. https://revecon.ro/content/volume-53-2021

Auboin, M., & Ruta, M. (2013). The relationship between exchange rates and international trade:

A literature review. *World Trade Review*, *12*(3), 577–605. https://doi.org/10.1017/S1474745613000025

Ayodeji, A., & Oluwole, A. (2018). Impact of Monetary Policy on Economic Growth in Nigeria. *Open Access Library Journal*, *05*(02), 1–12. https://doi.org/10.4236/oalib.1104320

Bala, U., & Chin, L. (2018). Asymmetric impacts of oil price on inflation: An empirical study of African OPEC member countries. *Energies*, *11*(11). https://doi.org/10.3390/en11113017

Bouakez, H., & Eyquem, A. (2015). Government spending, monetary policy, and the real exchange rate. *Journal of International Money and Finance*, *56*, 178–201. https://doi.org/10.1016/j.jimonfin.2014.09.010

Bouchetara, M., & Bendahmane, M. E. A. (2017). The Impact Of Monetary Policy On Economic Growth Of Algeria. *African Research Review*, *10*(42), 9. https://doi.org/10.54666/2334-000-001-016

Bouraoui, T., & Phisuthtiwatcharavong, A. (2015). On the Determinants of the THB/USD Exchange Rate. *Procedia Economics and Finance*, *30*(15), 137–145. https://doi.org/10.1016/s2212-5671(15)01277-0

Bresser-Pereira, L., & Nakano, Y. (2020). Economic growth with foreign savings? *Revista de Economia Política*, *22*(2), 3–27.

Chaudhry, I. S., Yasmin, Q., & Farooq, F. (2012). Monetary policy, inflation and economic growth in Pakistan: exploring the co-integration and causality relationships. *Pakistan Journal of Commerce and Social Sciences*, *6*(2), 332–347.

Cukierman, A. (2013). Monetary policy and institutions before, during, and after the global financial crisis. *Journal of Financial Stability*, *9*(3), 373–384. https://doi.org/10.1016/j.jfs.2013.02.002

Deka, A., & Dube, S. (2021). Analyzing the causal relationship between exchange rate, renewable energy and inflation of Mexico (1990–2019) with ARDL bounds test approach. *Renewable Energy Focus*, *37*(June), 78–83. https://doi.org/10.1016/j.ref.2021.04.001

Dogru, T., Isik, C., & Sirakaya-Turk, E. (2019). The balance of trade and exchange rates: Theory and contemporary evidence from tourism. *Tourism Management*, *74*(January), 12–23. https://doi.org/10.1016/j.tourman.2019.01.014

Eaton, J., Kortum, S., Neiman, B., & Romalis, J. (2016). Trade and the global recession. *American Economic Review*, *106*(11), 3401–3438. https://doi.org/10.1257/aer.20101557

Gilchrist, S., Schoenle, R., Sim, J., & Zakrajšek, E. (2017). Inflation dynamics during the financial crisis. *American Economic Review*, *107*(3), 785–823. https://doi.org/10.1257/aer.20150248

Guzman, M., Ocampo, J. A., & Stiglitz, J. E. (2018). Real exchange rate policies for economic development. *World Development*, *110*(1), 51–62. https://doi.org/10.1016/j.worlddev.2018.05.017

Hansen, B. (2016). A study in the theory of inflation. In *A Study in the Theory of Inflation*. https://doi.org/10.4324/9781315621487

Hidayat, A., Atiyatna, D. P., & Sari, D. D. P. (2023). The Influence of the Covid-19 Outbreak on the Open Unemployment Rate and Economic Growth in the Affected Sectors in Indonesia. *Indonesian Journal of Business Analytics*, *3*(1), 33–40. https://doi.org/10.55927/ijba.v3i1.2934

Islam, M. A. (2013). Impact of Inflation on Import: An Empirical Study. *International Journal of Economics, Finance and Management Sciences*, *1*(6), 299. https://doi.org/10.11648/j.ijefm.20130106.16

Julitawaty, W. (2015). Inflation Analysis and Interest Rate in Indonesian. *International Journal of Economics & Management Sciences*, *04*(06), 4–6. https://doi.org/10.4172/2162-6359.1000257

Khalfaoui, H., & Derbali, A. (2021). The determinants of foreign direct investment: what about the potential of the Arab Maghreb countries? *Journal of Investment Compliance*, *22*(4), 295–308. https://doi.org/10.1108/joic-04-2021-0010

Khan, M. K., Teng, J. Z., & Khan, M. I. (2019). Cointegration between macroeconomic factors and the exchange rate USD/CNY. *Financial Innovation*, *5*(1), 1–15. https://doi.org/10.1186/s40854-018-0117-x

Kline, P., & Moretti, E. (2014). People, places, and public policy: Some simple welfare economics of local economic development programs. In *Annual Review of Economics* (Vol. 6). https://doi.org/10.1146/annurev-economics-080213-041024

Kummu, M., Taka, M., & Guillaume, J. H. A. (2018). Gridded global datasets for Gross Domestic Product and Human Development Index over 1990-2015. *Scientific Data*, *5*(1), 1–15. https://doi.org/10.1038/sdata.2018.4

Lado, P. Z. E. (2015). Relationship between Exchange Rate and Inflation in South Sudan: Granger-Causality Approach. *Economics*, *4*(2), 34. https://doi.org/10.11648/j.eco.20150402.13

Loukil, S. (2017). Economic Challenges and Opportunities after the Revolution in Tunisia : Inflation and Exchange Rate. *Journal of Global Economics*, *5*(3). https://doi.org/10.4172/2375-4389.1000260

Mahmood Ali, T., Tariq Mahmood, M., & Bashir, T. (2015). Impact of Interest Rate, Inflation and Money Supply on Exchange Rate Volatility in Pakistan. *World Applied Sciences Journal*, *33*(4), 620–630. https://doi.org/10.5829/idosi.wasj.2015.33.04.82

Maziarz, M. (2015). A review of the Granger-causality fallacy. *Journal of Philosophical Economics*, *8*(2). https://doi.org/10.46298/jpe.10676

Medvedev, D. (2016). Social and economic development of Russia: Finding new dynamics. *Russian Journal of Economics*, *2*(4), 327–348. https://doi.org/10.1016/j.ruje.2016.11.001

Mijiyawa, A. G. (2015). What Drives Foreign Direct Investment in Africa? An Empirical Investigation with Panel Data. *African Development Review*, *27*(4), 392–402. https://doi.org/10.1111/1467-8268.12155

Mohseni, M., & Jouzaryan, F. (2016). Examining the Effects of Inflation and Unemployment on Economic Growth in Iran (1996-2012). *Procedia Economics and Finance*, *36*(16), 381–389. **https://doi.org/10.1016/s2212-5671(16)30050-8**

Myovella, G., Karacuka, M., & Haucap, J. (2020). Digitalization and Economic Growth: A Comparative Analysis of Sub-Saharan Africa and OECD Economies. *Telecommunications Policy*, *44*(2), 101856. https://doi.org/10.1016/j.telpol.2019.101856

Oreiro, J. L., da Silva, K. M., & Dávila-Fernández, M. J. (2020). A New Developmentalist model of structural change, economic growth and middle-income traps. *Structural Change and Economic Dynamics*, *55*, 26–38. https://doi.org/10.1016/j.strueco.2020.07.008

Özokcu, S., & Özdemir, Ö. (2017). Economic growth, energy, and environmental Kuznets curve. *Renewable and Sustainable Energy Reviews*, *72*(January), 639–647. https://doi.org/10.1016/j.rser.2017.01.059

Pratama, S. D., & Rizal, R. (2019). The Resilience of Islamic Banks in Facing the Economic Dynamics in Indonesia. *SSRN Electronic Journal*, *1*(218). https://doi.org/10.2139/ssrn.3311990

Purwono, R., Mucha, K., & Mubin, M. K. (2018). The dynamics of Indonesia's current account deficit: Analysis of the impact of exchange rate volatility. *Journal of Asian Finance, Economics and Business*, *5*(2), 25–33. https://doi.org/10.13106/jafeb.2018.vol5.no2.25

Putra, A. W., Supriatna, J., Koestoer, R. H., & Soesilo, T. E. B. (2021). Differences in local rice price volatility, climate, and macroeconomic determinants in the indonesian market. *Sustainability (Switzerland)*, *13*(8). https://doi.org/10.3390/su13084465

Ramasamy, R., & Abar, S. K. (2015). Influence of Macroeconomic Variables on Exchange Rates. *Journal of Economics, Business and Management*, *3*(2), 276–281. https://doi.org/10.7763/joebm.2015.v3.194

Resosudarmo, B. P., & Abdurohman. (2018). Is Being Stuck with a Five Percent Growth Rate a New Normal for Indonesia? *Bulletin of Indonesian Economic Studies*, *54*(2), 141–164. https://doi.org/10.1080/00074918.2018.1521776

Sari, D. M., Asngari, I., Hidayat, A., & Andaiyani, S. (2023). The Effect of Interest Rates, Exchange Rates and Output Gap on Inflation in Five ASEAN Countries: A Panel Data Evidence. *Journal of Applied Economic Research*, *22*(1), 6–29. https://doi.org/10.15826/vestnik.2023.22.1.001

Shahbaz, M., Raghutla, C., Chittedi, K. R., Jiao, Z., & Vo, X. V. (2020). The effect of renewable energy consumption on economic growth: Evidence from the renewable energy country attractive index. *Energy*, *207*, 118162. https://doi.org/10.1016/j.energy.2020.118162

Srithilat, K., Sun, G., Chanthanivong, T., & Thavisay, M. (2018). The Relationship between Inflation, Exchange Rate, and Currency Substitution: Evidence from Panel Vector Error Correction Model Approach. *International Journal of Economics and Financial Issues*, *8*(2), 79–84.

Szirmai, A., & Verspagen, B. (2015). Manufacturing and economic growth in developing countries, 1950-2005. *Structural Change and Economic Dynamics*, *34*, 46–59. https://doi.org/10.1016/j.strueco.2015.06.002

Uddin, K. M. K., Rahman, M. M., & Quaosar, G. M. A. A. (2014). Causality Between Exchange Rate and Economic Growth in Bangladesh. *European Scientific Journal*, *10*(31), 1857–7881.

van Wyk, B. F., & Kapingura, F. M. (2021). Understanding the nexus between savings and economic growth: A South African context. *Development Southern Africa*, *38*(5), 828–844. https://doi.org/10.1080/0376835X.2021.1932424

Yien, L. C., Abdullah, H., & Azam, M. (2017). Granger Causality Analysis between Inflation, Debt and Exchange Rate: Evidence from Malaysia. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, *7*(1), 189–196. https://doi.org/10.6007/ijarafms/v7-i1/2624