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The Application of Error Correction Model (ECM) in Assessing the Impact of Exchange, Interest, and Inflation Rates on the Gross Domestic Product of Indonesia

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Keywords
Exchange Rate
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Error Correction Model

Abstract
Economic growth is influenced by several factors, both in developing and developed countries, where the indicator of seeing high or low is seen through Gross Domestic Product (GDP). On the other hands, GDP is also influenced by other variables, in this paper the author aims to further review the relationship between GDP and interest rates, exchange rates, and inflation rates in Indonesia using a time-series technique, during the period 2010 Q1 to 2020 Q4. The data for this study were provided by Bank Indonesia and the International Monetary Fund. Since the model has a spurious problem, the error correction model was used to compare the results of the analysis in the long and short run. The cointegration estimation based on trace and max-eigen statistic is greater than the critical value which means it is cointegrated. The findings indicate that in the long run and short run, there are variables insignificantly GDP and there are changes in correlation between variables and GDP in each method that have been used, owing to this further study is needed. When to the one or two aligned macroeconomic variables applied in previous related research, this paper casts an empirical light into understanding the link. Derived from the research results, the Indonesian government should adopt appropriate policies to stabilise the monetary sector, especially the central bank which is deemed essential to improve the flexibility in adjusting and anticipating more economic issues as well as future challenges.

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1. Introduction

The goods market is arguably the most decisive sector in macroeconomics, inasmuch as some experts believe that consumption plays a large role but it is inevitable that there are factors that influence the level of contribution of each variable in the goods market equilibrium equation. Of course, this is not obvious, but it allows other factors to be controlled. For instance, in the open economy exchange rate affects the composition of consumption spending.

The rate of inflation will be affected by this consumption expenditure scenario, which will be represented in the consumer price index. The higher the rate of consumption in the society, the more probable it is that market prices will adjust to rise as well. As a result, it is unsurprising that the government is highly concerned about and paying attention to the trend of public consumption, which it is attempting to manage through one of its policies, namely interest rate regulation, so that prices do not decrease freely. The simple way interest rate's function is that when interest rates rise, individuals choose to store their money in banks, thus reducing the money supply or real sector transactions, which then suppresses the quantity of national consumption and vice versa. Inevitably, this cycle has a significant effect on the country's economic growth.

Economic growth itself is an indicator of whether the country is prosperous or not, this can be seen from the annual Gross Domestic Product (GDP) report released by the government. In the second quarter of 2017 Indonesia's GDP grew only about 5.01%, the same as the first quarter of 2017. The 5.01 % (y/y) growth figure in Q2-2017 is the same growth pace that was recorded in the preceding quarter and may also be an indicator that full-year growth has stagnated. When looking at history from 2009 to 2017, each time there was an acceleration in GDP growth from the first to the second quarter, full-year economic growth accelerated from the (full-year) result in the preceding year. However, when people see a falling growth rate from the first to the second quarter, then full-year GDP growth tends to fall compared to full-year growth in the preceding year. If this trend, which occurred between 2009 and 2016 continues, then it would mean that Indonesia's economic growth will stagnate at 5.0 % (y/y) this year. What is also worrying is that economic growth in Q2-2017 is lower compared to the 5.19 % (y/y) GDP growth recorded in the same quarter in 2016. This shows that economic activity has lost some steam in Q2-2016. On a quarterly, non-seasonally adjusted basis, Indonesia's GDP expanded by 4.07 % in April-June 2017.

Growth in Indonesia's household spending, which accounts for about 55-60 % of total GDP, was recorded at 4.95 % (y/y), nearly flat from first quarter growth, and below the targeted 5 % growth line. Recently, Indonesian households have been saving rather than spending (evidenced by rapidly rising third-party funds in the banking sector up to June 2017). As such, retail sales have been bleak so far this year in Indonesia. Meanwhile, economic growth was undermined by falling government spending (-1.9 %). BPS Chairman Suhariyanto partly attributed this decline to a delay in payment of bonuses to civil servants (the "13th month wage").

Exports also failed to support accelerating economic growth. Export growth slowed to a pace of 3.4 %. Weak trade data were attributed to a slowdown in domestic goods production and supply of imported goods. Meanwhile, growth in fixed capital formation, on the other hand, picked up to a pace of 5.35 % due to rising investment. The bleak GDP growth data did not impact significantly on the performance of Indonesia's benchmark Jakarta Composite Index. The rupiah exchange rate also remained stable. The coordinating minister for the economy clarified that the slowing economic growth was due to Indonesia and even other countries being in a dynamic period, the impact of the global recovery five years ago. If it was true, this slowdown began in the first quarter of 2013 which was 5.56% lower than the first quarter of 2012 which was 6.03% (BPS, 2021).

This incidence is also the result of rising real consumption, which is slowing due to a desire to cut down on spending. Furthermore, there is a shift in people's purchasing patterns, as seen by increasing rise in pastime consumption. Additionally, it has been proven that Indonesia experienced the highest peak of inflation in 2013 and 2014, at 8.38 % and 8.36 %, respectively (BI, 2021). At this point, it is required to control condition well so this situation does not grow any deteriorate, such as monetary policy. Interest rates might control the situation in the short term or the exchange rate control in the long term.

Based on the aforementioned connection, this study will examine whether changes in the monetary sector, such as exchange rates, interest rates, and inflation rates, may raise or reduce GDP. Previous researchers found an evidence that was different from the basic theory, where the sign of the variable on the allegedly negative interest rate contradicted the estimated results in the long run and in the short run (Adaramola and Dada, 2020). Lubis et al. (2017) who used panel data showed that the exchange rate has a considerable and beneficial influence on GDP, unlike Adaramola and Dada (2020), who posited

that the exchange rate has a negative correlation. Semuel, Hatane and Nurina (2015) found a relationship that inflation and the exchange rate have a positive impact on GDP, but the interest rate has a negative one. There is evidence also from Mkhatshwa et al. (2015) in the long run and short run that indicates that exchange rate has a positive relation on GDP and inflation has a different result, namely negative relation in the long term and positive relation in the short term. Only a few research employed panel data, whereas the majority utilised time series using error correction models.

This paper sheds empirical light on understanding the link between macroeconomics variables (interest rate, exchange rate and inflation) toward GDP in Indonesia during period 2010-2020 by employing OLS and ECM approaches. In particular, the research objective of this study is to re-align existing macroeconomic theory with reality in the field; hence the results may be compared to previous research, which on average had one or two variables that contradicted the theory. The remaining part of the paper is arranged as follows: section 2 contains the literature review, section 3 contains the theoretical model, section 4 contains the empirical model, and section 5 present the study's conclusion.

2. Literature Review

In the current environment, the depreciation of the spot rate produced by asset-market equilibrium helps to lower the relative price of domestic products, hence raising aggregate demand and inducing inflationary pressure rather than increasing output. Where here it can be seen that GDP is very vulnerable to being affected by the monetary sector, some previous researchers mostly used the inflation rate, interest rate and exchange rate variables (Adaramola and Dada, 2020; Ha et al., 2020; Musa et al., 2019; Najafi et al., 2022; Pujiastuti et al., 2020; Purwaningsih, 2019; Ramzan, 2021; Roux et al., 2018; Sinaga et al., 2018; Singh, 2018; Van Dinh, 2020)the study employs the autoregressive distributed lag on the selected variables, i.e. real gross domestic product (GDP.

Adaramola and Dada's (2020) research used specified variables, such as real GDP, inflation rate, interest rate, exchange rate, degree of economic transparency, supply of money, and government expenditures; they also used the vector autoregressive lag, for the period 1980–2018 in Nigeria's economic development. Inflation and the real exchange rate have a major negative impact on economic development, according to the research, whereas rates of interest and the supply of money have a positive significant effect.

Singh (2018) stated that, with a negative correlation, inflation is found to be insignificantly influential for GDP and unemployment. It is argued that inflation plays a significant role in India's macroeconomic factors, but only in relation to GDP and unemployment. The adverse effect orientation of unemployment and inflation on GDP is negligible (Ramzan, 2021). Inflation is a continuing occurrence in every economy, and in most economies, inflation has a strong impact where there is an increased employment level, discount rates, price level, objects of regular needs, spending costs, and discount rates. It could be concluded that inflation can indeed be assessed with other factors for investigating essential circumstances due to economic compasses (Ha et al., 2020).

Van Dinh (2020) showed that inflation and economic growth have a one-way relationship in the medium and long term, with the inflation rate influencing economic growth. According to the findings of his study, the inflation rate has a positive impact on economic growth in the first year but it does not lead to inflation. Furthermore, the inflation rate reacts to economic growth by impulse in the second year. The outcomes indicate that economic growth and inflation are co-integrated, with inflation having an annual lag on economic growth. In the long term though, if price level rises faster than the rate of economic growth, the economy will indeed be stricken with inflationary pressures, causing the economy to contract.

A previous study on interest rates discovered cointegration in the majority of countries for each of the three specifications. Furthermore, interest rate reductions boost economic growth through the savings and investment accounts. The research thus suggests that market forces ought to decide real interest rates, and that artificially low real interest rates may damage economic growth (Roux et al., 2018). High interest rates have a negative influence on the implementation of finding the optimum mix of various factors of production in the aggregate production function, which could be credited to a variance in the relative relationship between the variables of production and their prices. Overall, building a strong local currency exchange rate with reduced inflation and interest rates might create additional sector efficiency and allow the aggregate production function to be regulated in a way that efficiently lessens the average price of aggregate output (Helmy, 2022).

Pujiastuti et al. (2020) concluded that inflation, interest rates, the rupiah's exchange rate against the US dollar, and GDP all have a 5% influence on the Composite Stock Price Index (CSPI). In this regard, bulging and loan expenses have no effect on the CSPI, whereas the rupiah's exchange rate over the Us dollar

has a negative effect on the CSPI while GDP has a positive impact on the CSPI. Increases in inflation and interest rates reduce performance of the supply chain. Increases in the Human Development Index (HDI), on the other hand, boost GDP and improve supply chain performance. Furthermore, GDP acts as a moderator for both HDI and supply chain performance, positively influencing supply chain performance via HDI (Sinaga et al., 2018). As an outcome, this study provides clues for the government to improve supply chain performance by controlling inflation and interest rates.

Musa et al. (2019), while investigating exchange rate, established that both the crude oil price and the exchange rate had a positive and significant impact on economic growth. In addition to the long run model estimations, a short run model was employed for the model. The findings also revealed that all explanatory variables, namely crude oil price and exchange rate, had a positive and significant influence on economic growth in the short run. This suggests that both the crude oil price and the exchange rate could have an impact on economic growth in both the long and short run. Another study found that interest rates, exchange rates, GDP, inflation, and Indonesia Composite Index (ICI) all have a significant impact on mutual fund performance, with an overall percentage age of influence of 99.94%, with an overall percentage age of influence of 99.94%, with the residual 0.06 % described by other variables not included in the model findings (Purwaningsih, 2019). On the other hand, it has been suggested that the exchange rate has no real relationship with GDP in Iran, Iraq, and Turkey, whereas inflation has a substantial negative relationship with GDP (Najafi et al., 2022).

3. Conceptual Framework

The model used in this paper relies on the theory of macroeconomics by Olivier Blanchard and David R. Johnson. The real interest rate (the rate that enters the IS relation) is the interest rate that influences spending and production; the function as follows, $r = i - \pi e$ where *r* is the rate of interest in real terms, *i* is the nominal rate of interest, and πe is the expected of inflation. Putting the equation together to form an IS formula produces:

$$Y = C(Y-T) + I(Y, r) + G \quad (1)$$

Where Y is output (i.e., GDP), C is consumption, T is tax, I is investment spending, and G is government expenditure. Since the demand for goods is a rising factor of output, and an increase in the interest rate leads to a fall in output, equilibrium in the good market demands that production Y equals the

demand for goods, *Z*. What real interest rate is required for a given amount of expenditure, and hence a certain level of production, for given levels of G and T is to be determined.

The pace at which the price level rises is assumed to be the inflation rate. One of the practical issues to measure the price level through the Gross Domestic Product.

$$P_t = \frac{Nominal\ GDPt}{Real\ GDPt} = \frac{\$Yt}{Yt} \qquad (2)$$

where P_t is the price level (i.e., inflation rate), Nominal GDP_t represented by Y_t, Real GDP_t represented by Y_t, and *t* is time period. Defining the price level as GDP Deflator implies a simple relation. It might be deduced that the price level is equal to 1 from this calculation. It is important to note that the GDP deflator is referred to as an index number. Its value is determined at random and has no economic significance. However, its rate of change has a definite economic meaning; it represents the pace at which the overall level of prices rises over time, or inflation. Furthermore, equilibrium in the goods market output is affected by the real exchange rate. Using this link, the equation becomes

$$Y = C(Y-T) + I(Y, r) + G - IM(Y, \epsilon)/\epsilon + X(Y^*, \epsilon) \qquad (3)$$

where Y is domestic output, the quantity of imports (IM), depends positively on both output and the real exchange rate (ϵ), exports (X), depends positively on foreign output (Y*) and negatively on the real exchange rate. When consumption is favorably correlated with disposable income and investment is positively correlated with production and negatively correlated with the real interest rate, accepting government expenditure continues to be taken for granted.

Imports are the portion of domestic demand that is satisfied by purchasing foreign goods. They are obviously influenced by domestic income: more domestic income leads to increased domestic demand for all commodities, both domestic and imported. They are also clearly influenced by the real exchange rate, if the price of domestic goods is measured in terms of foreign goods: the more expensive domestic goods are in comparison to foreign goods, or the cheaper foreign goods are in comparison to domestic goods, the higher is domestic demand for foreign goods. As a result, an increase in the actual exchange rate leads to an increase in imports. This positive impact of income on imports is associated with the Y sign. When the actual exchange rate rises, imports rise as well; this positive influence of income on imports belongs to ϵ sign.

Increased foreign income indicates higher foreign demand for all items, both foreign and domestic, simply because exports constitute a component of foreign

demand. As a result, as foreign wealth rises, exports rise as well. They are also influenced by the actual exchange rate: the lower the foreign demand for domestic products, the higher the price of domestic commodities in terms of foreign goods. In other words, when the actual exchange rate rises, exports fall. According to the formula, a rise in foreign income, Y*, leads to an increase in exports (positive sign), whereas an increase in the real exchange rate, ϵ, leads to a fall in exports (negative sign)

The researcher created the econometric equation in the next part based on equations (1), (2), (3) and use it to empirically examine the influence of gross domestic product. Theoretically, only the exchange rate possesses a positive link with output growth, and even then, it might be a negative relationship depending on the cycle associated with it (import or export). Interest rates and inflation rates, on the other hand, have a negative impact on output. In the following discussion, the entire study will be addressed.

3.1. Data

This research uses quarterly data from Bank Indonesia and International Monetary Fund. Data Stream for the period 2010 Q1 to 2020 Q4. This yields a sample size of 44 observations. Bank Indonesia provided the GDP and inflation rate statistics, which can be found in the Indonesian Economic and Financial Statistics section. IMF International Financial Statistics provided the interest rate and exchange rate.

The base period was chosen because it represents the time when the economy of 2010 was able to burst through the 6 % barrier, having grown rapidly in the fourth quarter of the previous year, substantially outperforming the 5.8 % growth rate in the third quarter. This particular year is a good start for Indonesia to organise the economy so that it rises in class, but the facts show otherwise. After 2010, the Indonesian economy continued to decline, only reaching 6.17 % in 2011 from 6.22 % the year before, until it fell to 5.01 % in 2014. When examined more closely, this is attributable to the effect of the presidential election on July 9, 2014, as well as slowing economic growth in Indonesia's two main trading partner countries.

In the limit base year, 2020, Indonesia was hit the hardest 5.02% down to 2.97%. This crisis occurred again after the 1998 and 2008 monetary crises; the 2020 crisis could be seen as more terrible or worse than the previous crises, because the problems above are beyond human control (the rise and fall of COVID-19 cases). Comparatively, the crises at 1998 and 2008 were caused by humans, so they can still be controlled.

3.2. Method

The term "spurious correlation" refers to a scenario in which two variables are linked because of a third variable's connection. We detected a substantial link between *y* and *x* when we regressed *y* on *x*. When another variable, such as *z*, was controlled for, the partial effect of *x* on *y* was zero. This may also occur with variables in time series situations. It is feasible to discover a fictitious association between time series with rising or falling trends. The problem is easily handled by introducing a time trend in the regression model if the series are weakly reliant regarding their time trends.

Granger and Newbold (1974) demonstrated that this is not the case: despite the fact that y_t and x_t are independent, the regression of y_t on x_t generates a statistically significant *t* statistic a substantial proportion of the time, far greater than the nominal significance level. The false regression problem was coined by Granger and Newbold (1974): there is no sense in which *y* and *x* are connected, yet an OLS regression using standard *t* statistics will frequently imply a relationship.

Engle and Granger (1987) formalized the concept of cointegration, which makes regressions incorporating variables theoretically relevant. We can use this to describe a more comprehensive modeling approach if y_t and x_t are cointegrated. A regression of y_t on x_t is misleading and tells us nothing important as y_t and x_t are not cointegrated: there is no long run link between *y* and *x*. We may still use the first differences, y_t and x_t, to perform a regression with delays. These regressions, however, should be interpreted for what they are: they describe the discrepancy in *y* in terms of the difference in *x* and have nothing to do with a level relationship (Wooldridge, 2013).

As a result, an error correction model must be used to treat its affected model. Let us analyse the short run dynamics of the connection between y and x using an error correction model. Consider the following model without y_t and x_t lags for simplicity:

$$\Delta yt = \boldsymbol{\alpha}_0 + \gamma_0 \Delta x_t + \beta_0 \boldsymbol{u}_{t-1} + \varepsilon t \qquad (4)$$

The error correction term is $\beta_0 \boldsymbol{u}_{t-1}$, and the model (4) is an example of an error correction model. The contemporaneous change in x, Δx_t, is ignored in certain error correction models. Whether it is included or not is partially determined by the equation's aim (Wooldridge, 2013).

3.3. The Empirical Model

The purpose of this study is to assess the impact of movements in exchange rates, rate of interest, and rate of inflation on GDP. Using logarithmic transformation, GDP growth is a function of growth in the rate of exchange, the rate of interest,

and the rate of inflation. Nevertheless, we consider about comparing models in the long run and short run, therefore ordinary least square and error correction model application are selected. In linear form, the econometric model proposed in the empirical analysis is:

$$LGDP_t = \beta_0 + \beta_1 LER_t + \beta_2 LIR_t + \beta_3 LINF_t + \varepsilon_t \quad (5)$$

where:
LGDP = is the logarithm of GDP
LER = is the logarithm of exchange rate
LIR = is the logarithm of interest rate
LINF= is the logarithm of inflation rate
t = is the observation subscript; and
ε = is the error term

Table 1: The Estimated Variable Sign Based on Theories

Dependent Variable	Independent Variable	Expected Relationship Based on the Theories
Gross Domestic Product (GDP)	Rate of Exchange (ER)	+/-
	Rate of Interest (IR)	-
	Rate of Inflation (INF)	-

Exchange rate policies in emerging nations are frequently delicate and contentious, owing to the kind of structural changes that are necessary, such as lowering imports or growing non-oil exports, which usually result in a depreciation of the nominal exchange rate. Domestic adjustments are seen as harmful to the economy because of their short term influence on pricing and demand. Ironically, in emerging countries that rely on imports for production and consumption, the inefficiencies caused by an inflated exchange rate system are rarely discussed (Eme and Johnson, 2011).

The output of an open economy with a fixed exchange rate is determined by the real exchange rate. A rise in the real exchange rate, also known as a real appreciation, causes a drop in production. At the same time, an increase in the real exchange rate reduces demand for domestic products, resulting in a reduction in output. A fall in the actual exchange rate, on the other hand, leads to an increase in output.

The aggregate demand link between price level and output stays the same in a closed economy, but the channel is significantly different; the price level impacts

output itself through the effect on the real money stock and, in turn, its influence on the interest rate. The price level affects the actual exchange rate in an open economy with a fixed exchange rate. A rise in the domestic price level causes an increase in the real exchange rate, given the fixed nominal exchange rate and the foreign price level. As a result of the real appreciation, demand for domestic goods decreases, and output decreases.

According to the particular theory of price level, the price level decreases as long as production is well below the natural level output. A consistent real depreciation results from a reduction in the price level over time. This real depreciation causes a rise in production, which continues until output reaches its natural level. People's assumption that the international price level is constant leads to the consequence that prices fall throughout the adjustment route. If instead people thought that international prices were rising over time, what would be required is for domestic prices to rise less than overseas prices, or, to put it differently, for domestic inflation to be less than foreign inflation for a period of time (Blanchard and Johnson, 2013).

4. Result and Analysis

4.1. Cointegration of Variables in the Model

The classical assumption test, which comprises four tests including normality (Jarque and Bera, 1980), autocorrelation, heteroscedasticity (Jarque and Bera, 1980), and multicollinearity tests to acquire the proper model in the application of the technique, must be performed on this model before carrying out the cointegration test (Carroll and Ruppert, 1988; Myers, 1990). The results of the normality test show that Jarque-Bera and probability are greater than the significance level (0.24 > 1%, 5%, 10%), therefore H_0 is rejected meaning that the data is normally distributed. The Durbin-Watson autocorrelation test with k = 3 n = 44 and DW value of 0.81 yields dL 1.3749 and dU1.6647. DW < dL = reject no serial correlation null hypothesis and Breushch-Godfrey Serial Correlation LM Test shows that Prob. F0.0038 and Prob. Chi-Square 0.0037 < 1% = reject null hypothesis. When applying the white test to measure heteroscedasticity, a probability F (0.0013) and a Chi-Square Probability (0.0066) less than 0.01 indicates that heteroscedasticity occurs. Lastly, the multicollinearity test revealed that no link existed between the variables LER to LIR (-0.39 < 0.80), LER to LINF (-0.50 < 0.80), and LINF to LIR (0.79 < 0.80). The model has satisfied the conditions to be regressed according to the technique to be used, based on the test results.

Due to historical data, our first priority was to determine the optimal estimate strategy by testing the stationary and non - stationary properties of each variable in the model. The unit root test, which has grown immensely prominent in recent years, is a test of stationarity (or non-stationarity) (Gujarati and Porter, 2009). In this study, we utilized The Augmented Dickey-Fuller test (ADF) with lag length automatic Schwarz Info Criterion. The entire set of variables are stationer in the first difference level with an intercept, significant at 1% level; however the inflation rate was stationary also at level with trend and intercept, but significant at 10% level.

Table 2: The Result of Augmented Dickey-Fuller Unit Root Test

Null Hypothesis	Lag Length	In Level, Trend and Intercept	Lag Length	In 1st difference and intercept
LGDP has a unit root	2	0.9144	1	0.0000
LER has a unit root	1	0.7491	1	0.0003
LIR has a unit root	2	0.2884	0	0.0014
LINF has a unit root	0	0.1779	0	0.0000

To determine whether there is a long-term association between different time series, a cointegration test is utilized. The results of cointegration tests reveal situations in which two or more non-stationary time series are combined that they are unable to depart from equilibrium over the long term, as a suggested by Johansen (1995). Assessing cointegration from the trace and the max-eigenvalue, it asserts that at the 1% and 5% level of significance. The selection of the cointegrating equations to be included in the error correction model is generally based on the vector that has the proper signs as expected by economic theory when the Johansen cointegration technique points to numerous cointegrating interactions. However, in our situation, both cointegrating equations have theoretically valid signs, therefore we chose the equation that includes all of the variables, as shown in equation (4).

Table 3 Johansen Cointegration Test Results, (2010: Q1-2020: Q4)

Unrestricted Cointegration Rank Test		
Trace Statistic	**5% Critical Value**	**Prob.**
52.75	47.85	0.01
Max-Eigen Statistic	**5% Critical Value**	**Prob.**
28.77	27.58	0.03

According to the projected long run equilibrium equation, all of the predicted coefficients of the right-hand variables are most significant at 1% level, except inflation rate, which is not significant at any level (prob.; 0.25). The long run equation (standard errors in parentheses) is shown below:

$$LGDP_t = 8.428 + \underset{(0.038)}{0.689}\ LER_t + \underset{(0.051)}{(-0.133)}\ LIR_t + \underset{(0.026)}{(-0.030)}\ LINF_t \quad (6)$$

The conclusion of the long run estimate is that increase in the rate of exchange, the rate of interest, and the rate of inflation will affect GDP. Returning to macroeconomic theory, a rise in the rate of exchange causes a spike in output, an increase in interest rates causes a drop in output, and an increase in inflation results in a reduction in output (Semuel, Hatane and Nurina, 2015). More specifically, a 1% rise in the exchange rate boosts GDP by around 0.68%, a 1% increase in the interest rate lowers GDP by about 0.13%. Unfortunately, when inflation is regressed in the model, the findings is insignificant; however, when regressed one-on-one, the inflation is significant at the 1% level. As this has also been observed by previous researchers, the outcome is compatible with the current theory (Adaramola and Dada, 2020).

In fact, this result is supported by other previous research in the long run estimation; for example, the positive exchange rate as evidenced by study Lubis et al. (2017) where it was observed that the ASEAN-5 countries improved their output growth by increasing the exchange rate. The target variable's long run result (inflation rate) demonstrates a considerable negative association with economic growth. This is because inflation diminishes money's buying power, thereby deterring investment that could have boosted the economy's growth potential (Adaramola and Dada, 2020; Al Taeshi, 2016; Mkhatshwa et al., 2015). Then negative interest rate relationship with GDP according to the study of Bhat and Laskar (2016) reveals that GDP decreases as interest rates rise and vice versa.

Error Correction Model

The cointegration of LGDP, LER, LIR, and LINF means that the typical vector autoregressive model is constrained. As a result, the typical VAR model's estimations will be inaccurate (Engle and Granger, 1987). And also, the result of OLS shows that this model is spurious, R-squared (0.934748) was greater than DW (0.814970). An error correction model, initially proposed by Sargan and Hendry (2016) has been suggested as a solution to these problems. The error correction model incorporates a cointegration limitation into the specification, making it

suitable for use with cointegrated nonstationary series. It uses the error correction term to limit the long run behaviour of endogenous variables to converge to their cointegrating relationship while permitting a greater variety of short run dynamics (Musila and Belassi, 2004). To see the cointegration of variables, the relationship between variables can be expressed as ECM, therefore from equation (4) we can change it in the form of a short run.

$$\Delta LGDP_t = \beta_0 + \beta_1 \Delta LER_t + \beta_2 \Delta LIR_t + \beta_3 \Delta LINF_t + \beta_4 \boldsymbol{u}_{t-1} + \varepsilon_t \quad (7)$$

where ε_t is a white noise error term and $\boldsymbol{u}_{t-1}$ is the lagged value of the error term. The residual of error correction model has to be negatively significant and stationary at level (Gujarati and Porter, 2009).

Table 4 reports the ordinary least square estimate for the error correction model of the kind in equation (6). The standard error regression, the adjusted coefficient of determinant (R), and the Durbin-Watson (DW) statics are all presented. In addition, four classic assumption tests were reported during the short run. The Jarque-Bera normality test, the Breush-Godfrey Serial Correlation LM test, the white heteroskedasticity test, and the multicorrelation test are among them.

Table 4: Error Correction Estimates, Dependent Variable = (LGDP)

	Constant	0.013* (0.004)
	$(LER)_{-1}$	-0.023 (0.156)
	$(LIR)_{-0}$	0.096*** (0.053)
	$(LINF)_{-0}$	-0.027*** (0.016)
	EC_{-1}	-0.276* (0.106)
R^2 = 0.272	DW = 2.115	S.E. of regression = 0.023
Normality test:	Jarque-Bera= 2.804	Prob.= 0.272
Breusch-Godfrey Serial Correlation LM Test:	Prob. F = 0.000	Prob. Chi-Square = 0.000
White Heteroskedas-ticity test:	Obs* R^2 = 13.743	Prob. = 0.532

VIF test:	Multicollinearity	Centered VIF LER = 1.633 LIR = 1.274 LINF =1.072 EC_{-1} = 1.404

The standard error in parentheses and the sign *, **, *** indicate 1%, 5%, and 10% levels of significances. The lag length is determined by the SIC. The ADF Unit root test was performed on the EC_t series, which revealed that it was stationary at the 1% level of significance in level, trend and intercept.

The error correction model estimates suggest that a rise in exchange rate has a negative relation, and this is supported by previous research Adaramola and Dada (2020) and an insignificant effect on GDP at any level (0.88). A rise in interest rates, on either hand, has a beneficial and considerable impact on GDP at a 10% level with an estimated coefficient of 0.09. Inflation rate shows negative and significance at the10% level also. This means that a 1% increase in inflation rate will lead to reduce GDP as much 0.02%. The residual results are also consistent with the theory, which states that the outcomes must be negative and significant. Previous study supports the sign of the variable coefficient in the short run estimate results (Adaramola and Dada, 2020).

Table 5: One-on-one, long run, and short run estimation results

Variable	Coefficient	t-statistic	Prob.
One-on-one relationship			
LER	0.78	18.28	0.00
LIR	-0.43	-4.48	0.00
LINF	-0.23	-5.38	0.00
Long run relationship			
LER	0.68	17.78	0.00
LIR	-0.13	-2.60	0.01
LINF	-0.03	-1.14	0.25
Short run relationship			
DLER	-0.02	-0.14	0.88
DLIR	0.09	1.80	0.07
DLINF	-0.02	-1.60	0.11
ECM (-1)	-0.27	-2.60	0.01

Inflation is one of the proven macroeconomic determinants in stifling an economy's growth, according to the research. In the long run, monetary institutions' efforts to counter this issue have not generated favorable effects. The results show that in the long run, while the exchange rate has a considerable beneficial influence on GDP such as fostering growth of international trade, which would be a major source of growth, especially for developing countries, and avoiding currency depreciation, the interest rate has a significant negative effect at the 1% level. Inflation, on the other hand, does not have a causal link with GDP, and it occurs at the exchange rate in the short run with a probability of 0.881. The sign of the variable interest rate then changes from negative in the long run (-0.13) to positive in the short run (0.09).

This conceptual paper shows that some regression analysis findings cannot match the established macroeconomic theory, in which the exchange rate should have a significant positive or negative relationship with GDP, and the other way around for both inflation and the exchange rate having a negative relationship with GDP. This study's findings show that inflation and the exchange rate, in one method, are not even significant. This is similar to the Egyptian research study, where the long run exchange rate had no effect on GDP. In their explanation, it was stated that there are indeed some selected countries where the exchange rate has no relationship with GDP (Najafi et al., 2022). The cause of this incident could be a country's weak export power, which allows the exchange rate to have no effect on the country's income, particularly in middle east and African countries. Furthermore, according to the findings of this study, there is a shift in the relationship between interest rates in the long run and short run, where Adaramola and Dada (2020), who conducted his study in Nigeria, also achieved positive results in both the long run and short run. All of them have a positive relationship with GDP. This will undoubtedly necessitate a more in-depth investigation to determine the factors that influence it.

In contrast, the independent variable used in this study focuses purely on the exchange rate, interest rate, and inflation rate in influencing GDP, without adding other determinant variables. While Adaramola and Dada (2020) and Najafi et al. (2022) use more determinant variables (such as saving rates, domestic credit granted to private sector, level of free trade, and money supply) these can affect the results of the main independent variables in this study such that the results obtained between studies will be different because of the variation of these variables. Therefore, it can be asserted that this research is more accurate in observing the relationship between the exchange, interest, and inflation rate

without being influenced by other variables that may or may not have a constructive relationship with GDP. Given that several additional variables are said to be formed by the policies implemented in each country, it becomes clear that the research background differs.

Realizing the results of the study which is aimed to contribute toward the development of government policies at the macro level, this study suggests the necessity for the central bank to have enough flexibility to respond to more complex economic events, as well as the financial sector's growing influence on macroeconomic stability, through their policy of the Inflation Targeting Framework (ITF) which also includes control of the exchange rate and interest rate, but only fulfills the necessary conditions, not the adequacy conditions. It is clear that this policy must be re-assessed, in the short term such as the determination of the BI 7 Day Reverse Repo Rate (BI 7DRRR) in accordance with market conditions and opportunities.

5. Conclusion

The focus of this study has been on using series data from the very first quarter of 2010 through to the final quarter of 2020, to estimate the influence of the rate of exchange, rate of interest, and rate of inflation on Indonesia's gross domestic product. Inflation is one of the proven macroeconomic determinants in stifling an economy's growth, according to the research. In the long run, monetary institutions' efforts to counter this issue have not generated favourable outcomes. The results show that in the long run, while the exchange rate has a considerable beneficial influence on GDP, the interest rate has a significant negative effect. Inflation, on the other hand, does not have a causal link with GDP, and it occurs at the exchange rate in the short run. The sign of the variable interest rate then changes from negative in the long run to positive in the short run. In the end it can be concluded that the results of this study are still not the same as existing macroeconomic theory would propose, regarding the relationship between independent variables (exchange rate, interest rate, inflation rate) and GDP. Where there are variables that are not significant and variables that experience changes in correlation with GDP, both in the long run and short run, it is considered too early to accurately judge what the absolute antecedents are. Further research in related topics is, therefore, imperatively suggested. Owing to this, the central bank is recommended to more aggressively manage inflation in order to avoid its negative consequences by maintaining a tolerable level of inflation.

6. References

Adaramola, O. A., and 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

Al Taeshi, H. T. A. (2016). *the Impact of Inflation on Economic Growth : Evidence of Malaysia From the Period 1970-2014 the Impact of Inflation on Economic Growth : Evidence of Malaysia From the Period 1970-2014* [Near East University]. http://docs.neu.edu.tr/library/6429447589.pdf

Bhat, S. A., and Laskar, R. (2016). Interest Rate, Inflation Rate and Gross Domestic Product of India. *International Journal of Technical Research and Science*, *1*(9), 284–288. www.ijtrs.com

Bank Indonesia. (n.d.). Indikator; www.bi.go.id. Retrieved December 14, 2021, from https://www.bi.go.id/id/statistik/indikator/data-inflasi.aspx

Blanchard, O., and Johnson, D. R. (2013). *Macroeconomics* (D. Alexander (ed.); Sixth Edit).

Badan Pusat Statistik. (n.d.). Badan Pusat Statistik; www.bps.go.id. Retrieved December 14, 2021, from https://www.bps.go.id/statictable/2009/06/15/907/indeks-harga-konsumen-dan-inflasi-bulanan-indonesia-2006-2021.html

Carroll, R., & Ruppert, D. (1988). *Transformation and Weighting in Regression*. Chapman & Hall. https://www.routledge.com/Transformation-and-Weighting-in-Regression/Carroll-Ruppert/p/book/9780367403379

Eme, O., and Johnson, A. (2011). Effect of Exchange Rate Movements on Economic Growth in Nigeria. *CBN Journal of Applied Statistics*, *02*(02), 1–14. https://www.econstor.eu/handle/10419/142047

Engle, R. F., and Granger, C. W. J. (1987). Co-Integration and Error Correction : Representation , Estimation , and Testing. *Econometric Society*, *55*(2), 251–276. https://www.jstor.org/stable/1913236

Granger, C. W. J., and Newbold, P. (1974). Spurious Regressions in Econometrics. *A Companion to Theoretical Econometrics*, *2*, 557–561. https://doi.org/10.1002/9780470996249.ch27

Gujarati, D. N., and Porter, D. C. (2009). *Basic Econometrics* (Fifth Edit). McGraw-Hill Irwin.

Ha, J., Marc Stocker, M., and Yilmazkuday, H. (2020). Inflation and exchange rate pass-through. *Journal of International Money and Finance*, *105*, 102187. https://doi.org/10.1016/j.jimonfin.2020.102187

Helmy, A. (2022). The Impact of Interest, Exchange, and Inflation Rates on the Efficiency of the Real Sector: Empirical Study of Egypt. *African Journal of Business and Economic Research*, *17*(1), 77–99. https://journals.co.za/doi/abs/10.31920/1750-4562/2022/v17n1a4

Jarque, C. M., and Bera, A. K. (1980). Efficient tests for normality, homoscedasticity and serial independence of regression residuals. *Economics Letters*, *6*(3), 255–259. https://doi.org/10.1016/0165-1765(80)90024-5

Johansen, S. (1995). A Statistical Analysis of Cointegration for I (2) Variables Author (s): Søren Johansen A STATISTICAL ANALYSIS. *Econometric Theory*, *11*(1), 25–59. https://doi.org/129.180.1.217

Lubis, M. R. G., Karim, N. A.-H. A., Tha, G. P., and Ramli, N. R. (2017). Exchange Rate Effect on Gross Domestic Product in the Five Founding Members of ASEAN. *International Journal of Academic Research in Business and Social Sciences*, *7*(11). https://doi.org/10.6007/ijarbss/v7-i11/3565

Mkhatshwa, Z. S., Tijani, A. A., and Masuku, M. B. (2015). Analysis of the Relationship between Inflation, Economic growth and Agricultural growth in Swaziland from 1980-2013. *Journal of Economics and Sustainable Development Www. Iiste.Org ISSN*, *6*(18), 189–205. www.iiste.org

Musa, K. S., Maijama'a, R., Shaibu, H. U., and Muhammad, A. (2019). Crude Oil Price and Exchange Rate on Economic Growth: ARDL Approach. *Open Access Library Journal*, *6*(12). https://doi.org/10.4236/oalib.1105930

Musila, J., and Belassi, W. (2004). The Impact of Education Expenditures on Economic Growth In Uganda: Evidence From Time Series Data. *The Journal of Developing Areas*, *38*(1), 123–133. https://doi.org/10.1353/jda.2005.0015

Myers, R. H. (1990). *Classical and Modern Regression with Application* (Second Edi). Duxbury Thomson Learning.

Najafi, B., Akbari, B., Hadizadeh, A., and Bayat, N. (2022). Impact of exchange rates and inflation on GDP : A data panel approach consistent with data from Iran , Iraq and Turkey. *Int. J. Nonlinear Anal. Appl. In Pres*, *6822*(November 2021), 1–16. https://doi.org/http://dx.doi.org/10.22075/ijnaa.2022.6278

Pujiastuti, T., Satmoko, A., and Nugraha, E. K. (2020). The Influence of Inflation, Interest Rate, Exchange Rate, and Gross Domestic Products (GDP) on Joint Stock Price Index (CSPI) in Indonesia Stock Exchange (BEI) Period 2009-2018. *The International Conference of Business, Economy, Entrepreneurship and Managemen*, *Icbeem 2019*, 359–366. https://doi.org/10.5220/0009966903590366

Purwaningsih, S. S. (2019). An Analysis of Influence of Interest Rates, Rupiah Exchange Rates, Gross Domestic Product (GDP), Inflation, and Indonesia Composite Index (ICI) on the Performance of Mutual Funds Using Panel Data Methods. *Proceedings of the International Conference On Applied Science and Technology 2019 - Social Sciences Track (ICASTSS 2019)*, *January 2019*. https://doi.org/10.2991/icastss-19.2019.62

Ramzan, M. (2021). Impact of Inflation and Unemployment on Economic Growth of Pakistan. *European Journal of Business and Management Research*, *6*(4), 282–288. https://doi.org/10.24018/ejbmr.2021.6.4.993

Roux, L., Moyo, C., and Le Roux, P. (2018). Interest rate reforms and economic growth: the savings and investment channel Interest rate reforms and economic growth: the savings and investment channel. *Munich Personal RePEc Archive*, *85297*. https://mpra.ub.uni-muenchen.de/85297/1/MPRA_paper_85297.pdf

Sargan, J. D., and Hendry, D. F. (2016). *J . Denis Sargan and the Origins of LSE Econometric Methodology*. *19*(3), 457–480. https://doi.org/10.1017/S0266466603

Semuel, H., and Nurina, S. (2015). Analysis of the Effect of Inflation , Interest Rates , and Exchange Rates on Gross Domestic Product (GDP) in Indonesia. *Proceedings of the International Conference on Global Business, Economics, Finance and Social Science*, *February*, 20–22. https://core.ac.uk/download/pdf/32452864.pdf

Sinaga, O., Saudi, M. H. M., and Roespinoedji, D. (2018). The relationship between economic indicators, gross domestic product (GDP) and supply chain performance. *Polish Journal of Management Studies*, *18*(1), 338–352. https://doi.org/10.17512/pjms.2018.18.1.25

Singh, R. (2018). Impact of GDP and Inflation on Unemployment Rate : " A Study of Indian Economy in 2011- 2018 ". *International Journal of Management, IT and Engineering*, *8*(3), 329–340. https://www.ijmra.us/project doc/2018/IJMIE_MARCH2018/IJMRA-13524.pdf

Van Dinh, D. (2020). Impulse response of inflation to economic growth dynamics:

VAR model analysis. *Journal of Asian Finance, Economics and Business*, *7*(9), 219–228. https://doi.org/10.13106/JAFEB.2020.VOL7.NO9.219

Wooldridge, J. M. (2013). *Introductory Econometrics; A Modern Approach*. South-Western Cengage Learning. https://economics.ut.ac.ir/documents/3030266/14100645/Jeffrey_M._Wooldridge_Introductory_Econometrics_A_Modern_Approach__2012.pdf

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