Original Research Article

Testing Factors Affecting Unemployment Rates

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ABSTRACT

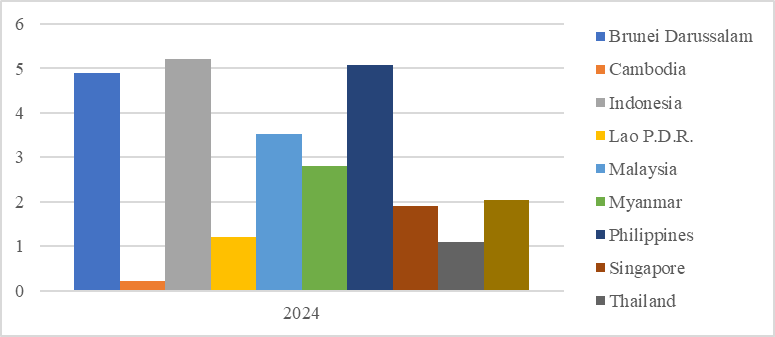
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| --- |
| **Aims:** The unemployment rate is influenced by various macroeconomic factors, including interest rates, which affect investment and job creation. Besides, renewable energy consumption, foreign direct investment (FDI), and gross domestic product (GDP) growth play significant roles in driving economic activity and absorbing labor. Based on these premises, this study focuses on macroeconomic determinants—namely renewable energy consumption, interest rates, FDI, and GDP per capita—in relation to the unemployment rate.  **Methodology:** The case study focuses on Indonesia. Time series data from 1991 to 2023 were collected from secondary sources. The data were then tabulated using the Autoregressive Distributed Lag (ARDL) approach.  **Results:** The study found that renewable energy consumption has a significant but inconsistent short-term effect on unemployment, suggesting a time lag in job creation. Interest rates exhibit a positive and significant impact on unemployment in both the short and long term, as higher rates restrict access to financing. Statistically, FDI also shows a positive relationship with unemployment across both time horizons, likely due to the concentration of investment in technology-intensive and automated sectors with low labor absorption capacity. Meanwhile, GDP per capita has a negative and significant effect on unemployment. This finding reveals that inclusive economic growth contributes to reducing unemployment rates, consistent with Okun's law.  **Conclusion:** The study's findings underscore the urgency of implementing targeted interest rate policies, strategically managing foreign investment, promoting inclusive economic growth initiatives, and ensuring an equitable energy transition driven by skills development and data-driven labor market planning. |

*Keywords: unemployment; renewable energy; interest rate; FDI; GDP.*

1. INTRODUCTION

Unemployment is an undesirable economic phenomenon and continues to pose a challenge globally (Daniel et al., 2021; Mark, 2023). Imbalances in unemployment rates—whether excessively high or unusually low—can disrupt the stability of a country's economic system, particularly in developing nations. Beyond diminishing purchasing power and social welfare, high unemployment can also hinder economic growth, exacerbate social inequality, and reduce national productivity (Faturohim et al., 2023; Pohlan, 2019; Tjahjanto et al., 2023).

In Indonesia, the unemployment rate remains a critical issue that demands attention in regional economic studies. Data from the World Economic Outlook reports that Indonesia faces structural challenges in the labor market (International Monetary Fund, 2025). For three consecutive years, Indonesia has recorded the highest unemployment rate in the ASEAN region, underscoring the need for a more in-depth analysis of the factors driving this issue. Figure 1 illustrates the unemployment rate trends in ASEAN countries as of July 2024.



**Fig. 1. Unemployment rate trends in ASEAN countries, 2024**

*Source: International Monetary Fund (2025).*

In addition to relatively high unemployment rates, the phenomenon of mass layoffs (PHK) presents a complex challenge. Recent data confirms that the number of workers affected by layoffs continues to rise each year. Between January and November 2023, 57,923 workers were laid off, and by July 2024, the number had reached 42,836 (Rachman, 2024). Changes in workforce structure and shifts across various sectors contribute to both the creation and reduction of job opportunities. Moreover, rapid technological advancements have reduced job availability in certain sectors, thereby exacerbating unemployment conditions in Indonesia (Ferdinan, 2013).

The unemployment rate in a country is influenced by various macroeconomic factors. Key components often associated with unemployment include renewable energy consumption, interest rates, FDI, and GDP. Several articles, such as those by Borhan et al. (2023), Febriyanti et al. (2024), Ramadhani and Ananda (2024), and Yehosua et al. (2019), examine the links among these components and their impact on unemployment rates in Indonesia. In conclusion, these studies suggest that increases in renewable energy consumption, interest rates, and FDI positively affect Indonesia's GDP.

Although Indonesia's unemployment rate has shown a downward trend since the COVID-19 pandemic, it remains relatively high, at 5.86% in 2023 compared to 5.18% before the pandemic. Meanwhile, Indonesia's real interest rate has fluctuated throughout the period from 1991 to 2023. Notably, over the past three decades, interest rates peaked in 1998. This anomaly in Indonesia's interest rates during that year was closely linked to the monetary crisis that paralyzed most sectors, except for Micro, Small, and Medium Enterprises (MSMEs).

Renewable energy consumption data over the past few years has fluctuated but shown a dramatic increase overall. This upward trend has been evident since 2016 and continues to the present. This growth is driven primarily by government policies supporting the energy transition. A vital policy is Presidential Regulation No. 22 of 2017 on the National Energy Master Plan (RUEN), which sets targets for increasing the share of renewable energy in the national energy mix (Apriliyanti et al., 2024). In contrast, FDI data exhibits inconsistent year-to-year trends. Specifically, FDI in Indonesia has not yet fully optimized its potential to stimulate the macroeconomy (Fazaalloh, 2024; Millia et al., 2023).

Furthermore, Indonesia's GDP per capita generally exhibits an upward trend year over year, reflecting economic recovery and potential growth in job creation. However, during certain periods, Indonesia has experienced economic slowdowns that have adversely affected GDP per capita, such as during the 1998 Asian financial crisis and the 2020 COVID-19 pandemic (Akita & Alisjahbana, 2023; Nasution, 2002). Despite contractions during both periods, GDP per capita has recovered in tandem with improvements in economic conditions and government policies aimed at fostering growth.

This study contributes to the examination of unemployment in Indonesia by incorporating renewable energy consumption as an independent variable, a factor rarely explored in previous papers. Substantively, the use of broader data coverage allows for a more comprehensive analysis of long-term trends. Methodologically, the study employs ARDL techniques to investigate both the long-term and short-term relationships between these variables and the unemployment rate in Indonesia.

2. METHODOLOGY

**2.1 Material Data**

The data used in this study are secondary data obtained from the World Bank, Our World in Data, the International Labour Organization (ILO), and the International Monetary Fund (IMF). The collected secondary data consist of time series spanning the period from 1991 to 2023. The data objects in this study include the unemployment rate, real interest rates, the percentage of renewable energy consumption relative to total primary energy, FDI as a proportion of GDP, and GDP per capita, all within the context of Indonesia.

**2.2 Econometrics and Analytical Tools**

This section presents the econometric model applied and describes the ARDL model used in this study. The unemployment model is constructed based on various macroeconomic factors compiled from similar scientific works. The long-term model framework in this study is created as follows:

 (1)

Meanwhile, the short-term coefficient estimation model is expressed as follows:

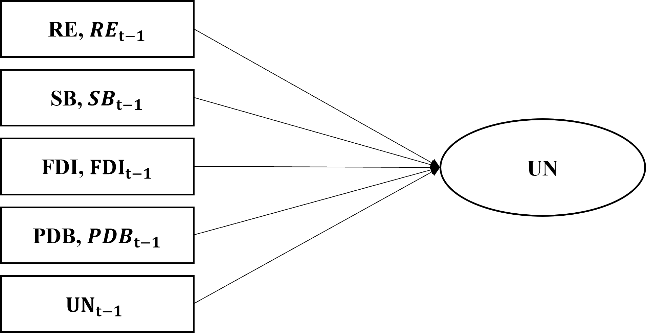
 (2)

*where*; θ and φ = short-term coefficient, γ = speed of adjustment, = error term, ∆ = first difference operator, t = lag size, t–1 = the optimal lag determined, p = number of lagged dependent variables, q = number of explanatory variable lags, UN = unemployment (%), RE = renewable energy (%), SB = interest rate (%), FDI = foreign direct investment (%), and GDP = GDP per capita (USD).

The analysis employed the ARDL model because it effectively captures both long-term and short-term relationships. Additionally, it is well-suited for time series data with variables integrated at different orders. The sequence of analyses includes: (1) descriptive statistics, (2) stationarity tests, (3) cointegration tests, (4) short-term and long-term relationship assessments, and (5) diagnostic tests. Technically, the statistical software used for data extract was EViews version 12. The analysis begins with descriptive statistics, which systematically summarize the data for easier interpretation. This is followed by unit root tests, specifically the Augmented Dickey-Fuller and Phillips-Perron tests. Subsequently, cointegration tests and ARDL model estimation are conducted to identify long-term and short-term interactions among variables. Finally, post-estimation diagnostic tests are performed to evaluate the reliability and robustness of the applied methods.

**2.3 Study Paradigm**

In a study, a paradigm functions as a framework for visualizing the direction and relevance among the variables being tested. Paradigms also assist researchers in creating a logical flow for their studies. Figure 2 below illustrates the study paradigm. This study employs a quantitative paradigm aimed at validating the influence of macroeconomic variables on the unemployment rate in Indonesia. Within this paradigm, the unemployment rate is positioned as the dependent variable, predicted by independent variables including renewable energy consumption (as a percentage of total primary energy), interest rates, FDI as a percentage of GDP, and GDP per capita.



**Fig. 2. Study paradigm**

*Source: Authors own.*

3. results and discussion

**3.1 Empirical Findings**

First, Table 1 summarizes the descriptive statistical results for each study variable. Overall, the average values for unemployment (UN), interest rates (SB), renewable energy (RE), foreign direct investment (FDI), and GDP per capita during the period 1991–2023 are 6.54%, 5.23%, 4.87%, 1.3%, and 2,628.891 USD, respectively. The median values for these variables are 6.18%, 6.5%, 3.84%, 1.78%, and 2,377.255 USD, respectively. According to Table 1, the maximum values for UN, SB, RE, FDI, and GDP are 11.24%, 15.60%, 10.79%, 2.91%, and 4,247,853 USD, respectively, occurring in 2005, 1992, 2021, 2005, and 2023. The minimum values are 2.67%, -24.60%, 2.47%, -2.75%, and 1,556.807 USD, respectively.

Second, the stationarity of each variable was assessed using the Augmented Dickey-Fuller (ADF) unit root test. To determine whether the data are stationary, the p-value for each variable was compared to a significance level (alpha) of 5%. If the p-value exceeds 5%, the data are considered non-stationary; conversely, if the p-value is less than 5%, the data are considered stationary. Table 2 shows that, based on the original data without transformation, only the interest rate variable was stationary from the outset. This test was conducted directly on the raw time series values. After transforming the data by taking first differences, in addition to the interest rate, the unemployment rate, renewable energy consumption, FDI, and GDP were classified as stationary according to the criteria at the first difference level. These varying levels of stationarity satisfy the requirements for the ARDL parameters.

**Table 1. Descriptive statistics matrix**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Statistics** | **UN** | **SB** | **RE** | **FDI** | **GDP** |
| Mean | 6.542667 | 5.232548 | 4.874809 | 1.304912 | 2628.891 |
| Median | 6.180000 | 6.501564 | 3.847700 | 1.787856 | 2377.255 |
| Maximum | 11.24000 | 15.60691 | 10.79370 | 2.916115 | 4247.853 |
| Minimum | 2.670000 | –24.60017 | 2.477300 | –2.757440 | 1556.807 |
| Std. Dev. | 2.099667 | 7.176327 | 2.378827 | 1.338369 | 832.7800 |
| Skewness | 0.268931 | –2.154766 | 1.565836 | –1.432318 | 0.499275 |
| Kurtosis | 2.757973 | 10.15128 | 3.973817 | 4.613852 | 1.840633 |
| Jarque-Bera | 0.478325 | 95.85527 | 14.78907 | 14.86466 | 3.219196 |
| Probability | 0.787287 | 0.000000 | 0.000615 | 0.000592 | 0.199968 |
| Sum | 215.9080 | 172.6741 | 160.8687 | 43.06211 | 86753.41 |
| Sum Sq. Dev. | 141.0752 | 1647.989 | 181.0821 | 57.31938 | 22192722 |
| Obs. | 33 | 33 | 33 | 33 | 33 |

*Source: the data was processed using EViews version 12.*

**Table 2. Summary of stationary tests**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables** | **Level** | | **1st Difference** | |
| **t-Stat.** | **Prob.** | **t-Stat.** | **Prob** |
| UN | –2.047943 | 0.266 | –5.057275 | 0.0003\* |
| SB | 0.529607 | 0.9852 | –6.413334 | 0.0000\* |
| RE | –6.070705 | 0.0000\* | –10.37393 | 0.0000\* |
| FDI | –2.211488 | 0.2063 | –5.358602 | 0.0001\* |
| GDP | 1.644433 | 0.9993 | –3.983258 | 0.0045\* |

*Source: the data was processed using EViews version 12.*

*Noted: (\*) indicates that it is significant at the 5% level.*

Third, to determine whether there is long-term cointegration in the model, it is necessary to confirm this through an F-statistic test. The F-statistic value exceeds the upper critical bound at the 1%, 5%, and 10% significance levels. Specifically, with an F-statistic value of 17.40787, which is higher than the upper bound value of 4.37, it can be articulated that the proposed model exhibits a significant long-term relationship at the 1% significance level (see Table 3).

**Table 3. Cointegration bound test**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **F-Bounds Test** | | **Null Hypothesis: No levels relationship** | | |
| Test statistic | Value | Sig. | I(0) | I(1) |
|  |  |  | Asymptotic: n = 1000 |  |
| F-statistic | 17.40787 | 10% | 2.2 | 3.09 |
| k | 4 | 5% | 2.56 | 3.49 |
|  |  | 2.5% | 2.88 | 3.87 |
|  |  | 1% | 3.29 | 4.37 |

*Source:* *the data was processed using EViews version 12.*

Fourth, the ARDL estimation produces two outputs: a short-term (dynamic) model and a long-term (static) model. This study aims to calculate both the short-term dynamics and long-term relationships among interest rates, renewable energy consumption, FDI, and GDP on the unemployment rate in Indonesia. Table 4 presents the results of the short-term model estimation. The optimal lag lengths, determined using the Schwartz Information Criterion (SIC), are 4, 4, 3, 4, and 3. In the short term, all variables significantly impact the unemployment rate. Without lag effects, renewable energy consumption and FDI do not significantly affect the unemployment rate. In contrast, the interest rate variable without lag effects has a positive and significant impact on unemployment. With a coefficient of 0.077656, a 1% increase in the interest rate corresponds to a 7.765% increase in the unemployment rate. Quantitatively, GDP has a negative and significant effect on unemployment; with a coefficient of -0.006922, every 1 USD increase in GDP reduces unemployment by 0.692%.

**Table 4. Short-term estimates**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables** | **Coefficient** | **Std. Error** | **t-Statistic** | **Prob.\*** |
| D(UN(-1)) | –0.660586 | 0.048342 | –13.66476 | 0.0000\* |
| D(UN(-2)) | –0.643886 | 0.065518 | –9.827635 | 0.0002\* |
| D(UN(-3)) | –0.769601 | 0.091104 | –8.447505 | 0.0004\* |
| D(UN(-4)) | 0.192068 | 0.069885 | 2.748350 | 0.0404\*\* |
| D(RE) | –0.019615 | 0.063848 | –0.307213 | 0.7711 |
| D(RE(-1)) | 0.185524 | 0.071893 | 2.580543 | 0.0494\*\* |
| D(RE(-2)) | 0.239188 | 0.076141 | 3.141393 | 0.0256\*\* |
| D(RE(-3)) | 0.120728 | 0.068443 | 1.763926 | 0.1380 |
| D(RE(-4)) | –0.264579 | 0.074134 | –3.568925 | 0.0161\*\* |
| SB | 0.077656 | 0.010308 | 7.533620 | 0.0007\* |
| SB(-1) | 0.127373 | 0.012071 | 10.55177 | 0.0001\* |
| SB(-2) | 0.105475 | 0.009594 | 10.99438 | 0.0001\* |
| SB(-3) | 0.057202 | 0.010006 | 5.717037 | 0.0023\* |
| D(FDI) | 0.052269 | 0.071356 | 0.732518 | 0.4967 |
| D(FDI(-1)) | 0.237452 | 0.054704 | 4.340659 | 0.0074\* |
| D(FDI(-2)) | 0.085317 | 0.051824 | 1.646266 | 0.1606 |
| D(FDI(-3)) | 0.438887 | 0.055525 | 7.904301 | 0.0005\* |
| D(GDP) | –0.006922 | 0.000736 | –9.402487 | 0.0002\* |
| D(GDP(-1)) | –0.003510 | 0.000794 | –4.420290 | 0.0069\* |
| D(GDP(-2)) | –0.009117 | 0.000815 | –11.18610 | 0.0001\* |
| D(GDP(-3)) | –0.011673 | 0.001288 | –9.065771 | 0.0003\* |
| D(GDP(-4)) | –0.003922 | 0.000763 | –5.141708 | 0.0036\* |
| C | 1.161625 | 0.107468 | 10.80908 | 0.0001\* |
| R-squared | 0.995141 |  |  |  |
| Adjusted R-squared | 0.973760 |  |  |  |
| F-statistic | 46.54311 |  |  |  |
| Prob(F-statistic) | 0.000226 |  |  |  |
| Durbin-Watson | 2.892802 |  |  |  |

*Source: the data was processed using EViews version 12.*

*Noted: (\*) and (\*\*) indicate significance at the 1% and 5% critical values.*

Table 4 above also shows that the unemployment rate variable has a negative and significant effect with lags of one to four periods. On the contrary, renewable energy exhibits a positive effect with lags of one and two periods, while energy consumption has a negative effect with a lag of four periods. Also, the results indicate that both interest rates and FDI have a positive and significant impact on the unemployment rate with lags of one to three periods. The adjusted *R²* value of 0.97376 indicates that 97.37% of the variation in the unemployment rate is explained by the independent variables in the short term. Furthermore, the F-statistics probability value of less than 5% confirms that the estimated model is statistically significant.

In the long-term estimates covered in Table 5, three independent variables significantly affect the long-term unemployment rate: interest rates and FDI have a positive effect, while GDP has a negative effect. These findings contrast with the variable of renewable energy consumption, which shows no significant impact on the unemployment rate in the long term. The coefficient for the interest rate is 0.127587, indicating that a 1% increase in the interest rate corresponds to a 12.76% increase in the unemployment rate. The FDI coefficient is 0.282416, suggesting that a 1% increase in FDI leads to a 28.24% rise in the unemployment rate. As is known, the GDP coefficient is -0.012195, meaning that a 1 USD increase in GDP results in a 1.22% decrease in the unemployment rate over the long term.

**Table 5. Long-term estimates**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Variables** | **Coefficient** | **Std. Error** | **t-Statistic** | **Prob.** |
| D(RE) | 0.090647 | 0.040331 | 2.247597 | 0.0745 |
| SB | 0.127587 | 0.006224 | 20.49953 | 0.0000\* |
| D(FDI) | 0.282416 | 0.035002 | 8.068581 | 0.0005\* |
| D(GDP) | –0.012195 | 0.000326 | –37.40843 | 0.0000\* |
| C | 0.403061 | 0.028197 | 14.29426 | 0.0000\* |

*Source: the data was processed using EViews version 12.*

*Noted: (\*) and (\*\*) indicate significance at the 1% and 5% critical values.*

**Table 6. Diagnostic test**

|  |  |
| --- | --- |
| **Test** | **Prob.** |
| Normality | 0.139958 |
| Autocorrelation | 0.7321 |
| Heteroscedasticity | 0.4502 |

*Source: the data was processed using EViews version 12.*

Fifth, diagnostic tests were conducted to assess the suitability of the data. These tests included normality, autocorrelation, and heteroscedasticity assessments. Table 6 displays the results of diagnostic tests used in the modeling process. The study model passes all diagnostic tests, as the p-values for normality, autocorrelation, and heteroscedasticity exceed 5%. In other words, the model satisfies the assumptions required for the Best Linear Unbiased Estimator (BLUE). As well, with the blue line on the Cumulative Sum (CUSUM) and Cumulative Sum of Squares of Recursive Residuals (CUSUMQ) plots remaining within the two red lines at the 5% significance level, the model is concluded to be stable.

**3.2 Justification**

Based on a series of tests, it was found that renewable energy variables affect the unemployment rate in the short term, particularly during the previous two periods with a positive effect and the previous four periods with a negative effect. This indicates the presence of a time-lag effect, where the impact of renewable energy on job creation within the same period does not occur uniformly but requires time to adjust to economic performance and the labor market (Afriyanti et al., 2021). Moreover, the findings of this study align with those of Borhan et al. (2023), Kurniadi et al. (2022), and Rafiq et al. (2018), who state that although investment in the renewable energy sector can generate new job opportunities, the transition process from non-renewable to renewable energy can cause temporary disruptions in the labor market. These disruptions are driven by differences in skill requirements between the renewable energy sector and the conventional energy sector, which in turn lead to skill mismatches among the workforce.

Both short-term and long-term interest rate variables have a significant positive impact on unemployment rates. As noted in previous publications by Audrino and Offner (2024), Mahadika and Wibowo (2021), Muttaqim and Hwihanus (2024), and Sun (2023), higher interest rates are associated with increased unemployment rates, and vice versa. The key point is that when the Bank of Indonesia raises interest rates, domestic households are more likely to postpone or avoid banking transactions, including loan applications. Consequently, many individuals face difficulties obtaining capital to start or expand businesses, which can lead to higher open unemployment rates. Conversely, when the government sets low interest rates, the public is encouraged to access banking services to secure business capital. In this way, interest rate policies can stimulate national economic growth and effectively reduce unemployment rates.

The analysis also indicates that both long-term and short-term FDI have a positive relationship with the unemployment rate. Fundamentally, these findings contradict the Harrod-Domar Theory, which posits that an increase in foreign investment should lead to a decrease in the unemployment rate in Indonesia (Rayhan et al., 2025). According to Dao et al. (2023), Kukaj et al. (2022), Nguyen et al. (2024), and Tanaya and Suyanto (2023), this issue arises because foreign investment tends to concentrate in high-tech and automation-based sectors, thereby reducing reliance on human labor. Industries receiving substantial foreign investment generally aim to enhance efficiency through the adoption of automated technologies, which directly affects the demand for traditional labor (Lubis et al., 2015). On the other hand, although investment realization increases, job creation does not always keep pace and, in some sectors, has even declined.

Specifically, every increase in economic growth, measured here by GDP per capita, tends to be followed by a decrease in the unemployment rate in Indonesia. This observation is supported by Okun's law, which emphasizes that sustained and positive economic growth, as indicated by GDP growth, generally leads to a reduction in unemployment. This relationship exists because an increase in GDP reflects an expansion in national economic activity, including the production, distribution, and consumption of goods and services across various industrial sectors. As these sectors grow, the demand for labor rises to meet production requirements and support other operational activities. Thus, strong economic growth serves as a primary driver for creating new job opportunities and reducing unemployment rates, as demonstrated by Kurniawan et al. (2021).

4. Conclusion

This study was designed to explore the causal relationships between interest rates, GDP per capita, FDI, and renewable energy consumption on unemployment rates in Indonesia. First, interest rates have a positive and significant impact on unemployment rates in both the short and long term. In practice, increases in interest rates tend to raise unemployment because they make financing less accessible. Second, GDP per capita has a negative and significant effect on unemployment. It is well established that economic growth contributes to reducing unemployment rates, consistent with Okun's Law. Third, FDI exhibits a positive effect on unemployment in both the short and long term. This is because FDI often flows into technology-intensive and automated sectors that absorb relatively little labor. Fourth, renewable energy consumption has a significant impact only in the short term and displays inconsistent patterns, suggesting a time-lagged effect on job creation. Therefore, controlling unemployment rates in Indonesia is largely influenced by effective interest rate management, inclusive economic growth, strategic investment policies, and a targeted energy transition.

This study provides valuable insights for policymakers, particularly the government. It is recommended that the government develop more targeted fiscal and monetary policies aimed at job creation. Also, the government should enhance incentives for the renewable energy sector and labor-intensive foreign investments. Besides, prioritizing improvements in productivity and economic inclusion through per capita GDP growth is essential for sustainably addressing the unemployment issue.

Finally, this study has certain limitations, one of which is that the factors influencing the unemployment rate are restricted to interest rates, GDP per capita, FDI, and renewable energy consumption. Future research should aim to address these limitations by incorporating additional variables beyond those included in the current model.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

The authors confirm that they did not use Artificial Intelligence (AI) technologies when creating the current work.

Abbreviations

**ADF** : Augmented Dickey-Fuller

**ARDL** : Definition for the term Autoregressive Distributed Lag

ASEAN : Association of Southeast Asian Nations

BLUE : Best Linear Unbiased Estimator

COVID-19 : Corona Virus Disease 2019

CUSUM : Cumulative Sum

CUSUMQ : Cumulative Sum of Squares of Recursive Residuals

Eviews : Econometric Views

FDI : Foreign Direct Investment

GDP : Gross Domestic Product

ILO : International Labour Organization

IMF : International Monetary Fund

PHK : Pemutusan Hubungan Kerja/ Mass Layoffs

RUEN : Rencana Umum Energi Nasional/ National Energy Master Plan

SIC : Scwartz Information Criterion

UMKM : Usaha Mikro, Kecil, dan Menengah/ Micro, Small, and Medium Enterprises

USD : United States Dollar

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