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Effects of Workforce, Tax Revenue, Unemployment, and Technological Advancement on Indonesia's Economic Development

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ABSTRACT

Inflation and unemployment are trade-offs for economic growth, and prolonged unemployment lowers GDP. With a GDP growth of 5.05% in 2023, Indonesia showed its resilience and strategic adaptability in the face of global economic uncertainty. This research examined factors influencing Indonesia's economic growth using macroeconomic indicators and time series data from 1974 to 2023. Stationarity tests (ADF and PP unit roots) and Johansen's cointegration confirmed long-term relationships among eight variables. The ARDL model investigated short and long-term dynamics, including CUSUM/CUSUMQ plots, SMPAE, and U-Theil inequality to assess causal relationships and model stability. ARDL results revealed that labor force participation, tax revenue, trade openness, urban population, unemployment, and technological advancement significantly impacted Indonesia's economic growth. Tax revenue, trade openness, foreign direct investment, and technological advancement positively influenced short-term growth. Short-run dynamics showed immediate economic adjustments affecting macroeconomic indicators and growth. The research determined that labor force participation, tax revenue, trade openness, urbanization, unemployment, foreign direct investments, and technological advancement were crucial for Indonesia's economic growth. The study suggests allocating resources to training, education, and skill development programs to boost workforce efficiency. The government should promote domestic production of tradable commodities, employ strategic tariffs and subsidies, and promote competitive sectors. The administration should nurture innovation, enhance access to technology, and invest in education. The government should improve tax collection, expand the tax base, and direct revenue toward growth-stimulating projects. Studi about interaction on macroeconomic indicators supporting agriculture development strategy.

Keywords: *GDP per capita, government expenditure, income, trade openness, urbanization*

BACKGROUND

The slowdown in worldwide economic growth occurred in 2024, with GDP expansion based on Purchasing Power Parity expected to reach 2.9%, down from the 3.2% estimate for 2023. This anticipated economic cooling is largely due to developed nations implementing stricter monetary

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measures and scaling back fiscal assistance (de Jesus & Correia, 2016). In macroeconomics, the GDP is one of the key metrics for assessing a nation's output and performance, calculated using production, income, and expenditure. The GDP calculations include financial flow and international trade activities in an open economy. The expenditure approach covers consumption, investment, government spending, and international trade (Gizaw et al., 2024; Hossain et al., 2024)

Rising global demand and competition for tradable goods and services enhance trade openness, boosting GDP through increased production and exports. Imports of goods and services also stimulate economic growth, with the impact influenced by the trading partner's economic standing in both developed and developing countries worldwide (Karedla et al., 2021; Yaqin & Sulistyono, 2024). Natural resources and labor availability represent economic complexity and factors leveraging GDP in emerging economies across the globe (Hung et al., 2024). Not only does fiscal policy stimulate businesses through incentives or tax management, affecting spending and investment (Hayati et al., 2024; Romadhian et al., 2024) but monetary policy also manages inflation and maintains price stability within an emerging economy by influencing interest rates and the money supply, ultimately achieving economic stability (Al-Farabi et al., 2024). In addition, labor force participation also reflects a country's production capacity and is key to economic policy (Ogbuabor et al., 2025). The Solow Growth Theory suggests that both affluent and impoverished regions can generate unemployment, reducing GDP. The Endogenous Growth Theory links technological disparities to GDP variations, with unemployment and technology as key factors (Suparman & Muzakir, 2023)

Economic growth faces a trade-off between inflation and unemployment, while long-term unemployment harms GDP. Despite global economic uncertainties in 2023, Indonesia demonstrated its resilience and ability to adapt strategically, recording a GDP growth of 5.05%. While this figure was slightly lower than the 5.31% growth seen in the previous year, it remains impressive given the widespread economic difficulties faced worldwide (Saliu, 2024). Policies promoting labor absorption and management enhance workforce and capital accumulation, boosting GDP growth in Indonesia (Nasir & Syuib, 2021; Suharti et al., 2021). Improvements in economic structure and reduced unemployment reflect macroeconomic policies that positively contribute to GDP growth in an emerging country like Indonesia (Al-Wahhab et al., 2023).

Despite ongoing economic growth in Indonesia, the urbanization rate continues to increase, suggesting uneven distribution of benefits across regions and inefficiencies in structural economic policies. Urbanization influences unemployment and affects GDP growth, with different short-term and long-term consequences. Although the COVID-19 pandemic caused GDP growth to drop into negative territory (Indrawati et al., 2024), Indonesia aims to maintain a growth trajectory. Through economic stimulus measures, the country has improved its growth figures during the post-pandemic "new normal" period.

Indonesia has experienced fluctuations in tax revenue and international trade, while unemployment rates, which rose during the pandemic, have since decreased. Indonesia's economic growth is significantly influenced by its workforce, enhancing productivity and national income. Research shows a large informal labor sector, high youth joblessness, and discrepancies between education and industry needs (Hossain et al., 2024; Hung et al., 2024; Yaqin & Sulistyono, 2024). Indonesia's tax-to-GDP ratio is lower than comparable emerging economies in Southeast Asia (Mujahid & Siddiqui, 2019). While initiatives aim to enhance tax collection, obstacles persist. The

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relationship between regional tax disparities and local economic growth is understudied. Indonesia's unemployment rate fluctuates due to economic disruptions, labor market inflexibility, and structural issues. The country is investing in digital transformation, Industry, and intelligent infrastructure, with studies on digital transformation's impact on traditional sectors still in the early stages. The impact of Indonesia's informal workforce on economic growth, tax collection, and social welfare is not well understood. Addressing these gaps can provide insights into policymakers and lead to more effective economic strategies for sustainable growth.

This research integrates four elements to analyze their collective influence on Indonesia's economic growth, acknowledging their interconnected effects. Conventional models often rely on Western economies or generalized theories. However, Indonesia, an emerging market with distinct labor dynamics, tax policies, and technology adoption patterns, requires a tailored approach. This investigation will yield country-specific policy recommendations based on Indonesia's economic structure, labor market, and technological landscape. It examines the impact of technological advancement, unemployment, tax revenue allocation, and innovation on economic productivity, addressing gaps in fiscal policy analysis. The research will employ Autoregressive Distributed Lag (ARDL) models to examine complex interdependencies. This methodology captures causal relationships and feedback loops among the workforce, tax revenue, unemployment, and technology. This research emphasizes long-term sustainability and inclusive growth. The study's novelty lies in its integrated analysis of how workforce, taxation, unemployment, and technology shape Indonesia's economic development, offering a framework for guiding future growth. It would provide recommendations on workforce skill enhancement, taxation efficiency, unemployment reduction, and technology-driven productivity gains tailored to Indonesia's objectives. This study seeks to determine the impact of those macroeconomic indicators on economic growth in Indonesia. Hypothesis on this research is labour force, tax revenue, unemployment and techologycal advancement influence economic growth in Indonesia. The research questions of the study include:

a) How was Indonesia's labor force influence its long-term economic expansion?
b) How does the amount of tax revenue collected relate to Indonesia's economic development?
c) What effects does unemployment among young people have on Indonesia's long-term economic progress?
d) In what manner does the advancement of technology enhance productivity and foster economic growth in Indonesia?

The study is organized into four main parts. The initial segment provides context, outlines the issues, and states the research goals. The second part details the methodological approach. The third section presents the outcomes and findings of the research. The final segment concludes the study and explores its implications for policymaking based on the result that explain how determinan growth factors influence GDP of Indonesia.

RESEARCH METHODS

Data and data source

The research utilized empirical secondary data from 1974 to 2023. GDP per capita was the dependent variable, while labor force participation, tax revenue, trade openness, urban population,

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foreign direct investments, inflation, unemployment, and technological advancement were independent variables. These indicators were sourced from the World Bank Indicators website.

Table 1. Description and measurement of macroeconomic indicators used in the ARDL model

Variable	Description	Measurement unit	Data source
GDP	Gross domestic product per capita	Constant 2015 US$	WDI
LFP	Labor force participation	% of total labor force	WDI
TAX	Tax revenue	% of GDP	WDI
TRA	Trade	% of GDP	WDI
URB	Urban population	% of total population	WDI
FDI	Foreign direct investments	% of GDP	WDI
INF	Inflation	annual %	WDI
UNE	Unemployment rate	% of the total labor force	WDI
TEC	Technological advancement	Patent applications, non-residents	WDI(Salisu, 2022)

Source: World Bank Indicators

Theoretical model for economic growth

This study employs production function theory as its conceptual framework, investigating how different factors of production interact to generate economic output. The research incorporates the Solow growth model, a macroeconomic theory that elucidates long-term economic expansion through the accumulation of capital, labor, and technological advancements. This model centers on four key variables: output (Y), capital (K), labor (L), and knowledge or effective labor (A) (Romer, 2012). The fundamental principle posits that economies create output by combining available capital, labor, and knowledge. While the Solow growth model encompasses production function, capital accumulation, and steady-state growth (Aniket, 2021), this investigation focuses exclusively on the production function component. The study applies the Cobb-Douglas production function model that extended in Endogen Growth Model:

$$Y(t) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha} \quad (1)$$

Where $Y\ (t)$ = total output (GDP), t denotes time, $K =$ capital, $L =$ labor, $A =$ technology level, and $\alpha =$ output elasticity of capital $(0 < \alpha < 1)$. To avoid the use of differences in measurement, the natural logarithm is used for the data analysis. This natural logarithm transformation was applied to normalize the data, reduce heteroscedasticity, and interpret the coefficients as elasticities, and the equation is specified as follows:

$$lnGDP_t = \beta_0 + \beta_1 lnLFP_t + \beta_2 lnTAX_t + \beta_3 lnTRA_t + \beta_4 lnURB_t + \beta_5 lnFDI_t + \beta_6 lnINF_t + \beta_7 lnUNE_t + \beta_8 lnTEC_8 + \varepsilon_t \quad (2)$$

Where: β_0 is the Intercept or constant, $\beta_1 - \beta_8$: Coefficient of the explanatory variables, GDP_t; GDP measured in millions of USD, LFP_t: labor force participation, TAX_t: Tax revenue, TRA_t: Trade openness, URB_t: Urban population, FDI_t: Foreign direct investments, INF_t: Inflation, UNE_t: Unemployment, TEC_t: Technological advancement, ε_t : Error term.

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Specification of the econometric model

Unit root tests

This research examined the stationarity of economic variables using unit root tests, ensuring their appropriateness for policy-related decisions and avoiding unit root problems. The analysis employed the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) tests proposed by Philips and Perron (1988) and Dickey and Fuller (1979). The basic equations for the ADF unit root test are represented by the following formula:

$$\Delta Y_t = \mu + \rho Y_{t-1} + \gamma_t + \varepsilon_t \quad (3)$$

Where Y_t is the time t, Δ is the difference operator, μ, γ and β_t are estimated parameters, and ε_t is the error term.

Cointegration test

The Johansen cointegration method, introduced by Johansen & Juselius (1990), evaluates the number of cointegration vectors within an unconstrained vector autoregression framework. This approach employs a specific equation to examine cointegration relationships in the context of vector autoregression modeling:

$$\Delta X_t = \beta_1 + \beta_2 T + \Pi X_{t-1} + \sum_{k=1}^{m-1} \Gamma_i \Delta X_{t-k} + \Phi D_t + \varepsilon_t \quad (4)$$

Where $\pi = \sum_{k=1}^{m} A_k = I$ and $\Gamma_k = -\sum_{l=k+1}^{m} A_l$, X_t is a $(X \times 1)$ is a dimensional vector representing variables and $I\ (1), \Pi, \Gamma_k$ and Φ are parameter matrices to be estimated, D_t is a vector containing deterministic components and ε_t is an error term.

ARDL model

The study employed the Autoregressive Distributed Lag (ARDL) method to examine the determinants affecting Indonesia's sustainable economic growth. The primary justification for choosing the ARDL estimation technique was its capacity to manage variables with differing integration orders and to concurrently estimate both short-term and long-term relationships, making it particularly suitable for this investigation (Pesaran & Shin, 1998). The model is expressed as:

$$\begin{aligned}\Delta InGDP_t = {} & \beta_0 + \sum_{i=1}^{\rho} \beta_1\, \Delta InGDP_{t-i} + \sum_{i=1}^{\rho} \beta_2 \Delta InLFP_{t-i} + \sum_{i=1}^{\rho} \beta_3\, \Delta InTAX_{t-i} \\ & + \sum_{i=1}^{\rho} \beta_4 \Delta InTRA_{t-i} + \sum_{i=1}^{\rho} \beta_5\, \Delta InURB_{t-i} \\ & + \sum_{i=1}^{\rho} \Delta\beta_6 \Delta InFDI_{t-i} + \sum_{i=1}^{\rho} \beta_7 \Delta InINF_{t-i} + \sum_{i=1}^{\rho} \beta_8\, \Delta InUNE_{t-i} + \sum_{i=1}^{\rho} \beta_9 \Delta InTEC_{t-i} \\ & + \lambda_1 InGDP_{t-1} + \lambda_2 InLFP_{t-1} + \lambda_3 InTAX_{t-1} + \lambda_4 InTRA_{t-1} + \lambda_5 InURB_{t-1} \\ & + \lambda_6 InFDI_{t-1} + \lambda_7 InINF_{t-1} + \lambda_8 InUNE_{t-1} + \lambda_9 InTEC_{t-1} \\ & + \varepsilon_t \quad (5)\end{aligned}$$

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where β_0 represents the drift component, Δ indicates the first difference, ε_t means the white noise error term.

Error correction model

Upon verification of cointegration, an error correction model is utilized to assess the rapidity with which long-run equilibrium is restored. The error correction term's coefficient (λ), when negative and significant, indicates the pace at which the system returns to its long-term equilibrium after a short-term disturbance. A larger absolute value of this coefficient suggests a faster return to equilibrium. The error correction model is typically represented as:

$$\Delta InGDP_t = \beta_0 + \sum_{i=1}^{\rho} \beta_1 \Delta InGDP_{t-i} + \sum_{i=1}^{\rho} \beta_2 \Delta InLFP_{t-i} + \sum_{i=1}^{\rho} \beta_3 \Delta InTAX_{t-i} + \sum_{i=1}^{\rho} \beta_4 \Delta InTRA_{t-i} + \sum_{i=1}^{\rho} \beta_5 \Delta InURB_{t-i} + \sum_{i=1}^{\rho} \beta_6 \Delta InFDI_{t-i} + \sum_{i=1}^{\rho} \beta_7 \Delta InINF_{t-i} + \sum_{i=1}^{\rho} \beta_8 \Delta InUNNE_{t-i} + \sum_{i=1}^{\rho} \beta_9 \Delta InTEC_{t-i} + \lambda ECM_{t-1} + \varepsilon_t \quad (6)$$

Where Δ represents the first difference, λ is the coefficient of the error correction term (ECM_{t-1}), this indicates the rate at which long-term equilibrium is restored following a short-term disruption.

ARDL bound cointegration test

The bound cointegration test is applicable in cases where several integrated variables of varying orders $I(1)$, $I(0)$ are accessible. The bound cointegration model is specified as:

$$\Delta Y_t = \delta_1 Y_{t-1} + \delta_2 X_{t-1} + \sum_{k=1}^{m} \alpha_i \Delta y_{t-k} + \sum_{l=0}^{n-1} \beta_l \Delta x_{t-l} + \pi_0 + \pi_t + \varepsilon_t \quad (7)$$

The study hypotheses are formulated as:

$$H_0: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = \delta_7 = \delta_8 = 0$$

$$H_1: \delta_1 \neq \delta_2 \neq \delta_3 \neq \delta_4 \neq \delta_5 \neq \delta_6 \neq \delta_7 \neq \delta_8 \neq 0$$

If the computed F-statistic falls between the lower and upper bounds, the outcome is indeterminate, requiring further examination to determine the presence of cointegration. When the F-value surpasses the upper bound threshold, cointegration is established. On the other hand, if the F-value is less than the upper bound limit, cointegration is absent (Salisu, 2022).

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RESULT AND DISCUSSION

Descriptive statistics

This section presents the estimated results of Indonesia's economic growth and labor force participation, tax revenue, trade openness, urban population, foreign direct investments, inflation, unemployment, and technological advancement. Table 2 provides descriptive results of the dependent and independent variables employed in the econometric analysis.

Table 2. Descriptive statistics of macroeconomic indicators for Indonesia's economic growth

	GDP	LAF	TAX	TRA	URB	FDI	INF	UNE	TEC
Mean	2,095	57.464	14.388	51.056	38.993	1.134	10.000	4.120	3,491
Maximum	4,193	89.028	21.946	96.186	58.572	4.241	58.451	8.060	8,538
Minimum	801	0.000	8.310	32.972	18.793	-2.757	1.560	1.290	475
Std. Dev.	982	39.890	3.467	10.304	12.806	1.243	9.484	1.838	2,725
Skewness	0.601	-0.761	0.317	1.765	-0.087	-0.573	3.420	0.529	0.418
Kurtosis	2.214	1.594	2.199	8.803	1.619	4.300	16.565	2.236	1.850
Jarque-Bera	4.306	8.940	2.171	96.134	4.032	6.258	480.851	3.548	4.211
Probability	0.1161	0.001	0.337	0.000	0.133	0.044	0.000	0.169	0.122
Observations	50	50	50	50	50	50	50	50	50

Source: Authors' computation (2025)

The research indicates that Indonesia's average GDP per capita from 1974 to 2023 was $2,095, with a $982 standard deviation. The mean labor force participation stood at 57.46% of the total workforce, while the average tax revenue during the study period was 51.06% of the GDP. The urban population averaged 38.99% of the total population. Foreign direct investments averaged 1.13% of GDP, inflation had a mean of 10%, unemployment averaged 4.12% of the total labor force, and technological advancement showed a mean value of 3,491. Most economic indicators displayed a rightward skew. Jarque-Bera test results showed normal distribution for GDP, tax revenue, urban population, unemployment, and technological advancement. However, labor force participation, trade openness, foreign direct investment, and inflation were not normally distributed.

The analysis of Indonesia's macroeconomic indicators from 1974 to 2023 reveals important structural characteristics and patterns in the economy. The average GDP per capita of $2,095, accompanied by a high standard deviation, reflects significant economic fluctuations over time. This volatility suggests periods of both growth and instability, which are crucial for understanding long-term development dynamics. The labor force participation rate averaged 57.46%, but its non-normal distribution indicates irregular trends, potentially influenced by demographic shifts, policy changes, or external shocks. This has implications for assessing labor market flexibility and the effectiveness of employment policies. A notably high average tax revenue—51.06% of GDP—if accurate, suggests an extensive fiscal capacity and strong state involvement in the economy. Its normal distribution implies relative stability in government revenue mobilization across the observed period. Urbanization progressed steadily, with 38.99% of the population living in urban areas on average. The normal distribution of this variable reflects a consistent demographic transition that likely affects broader economic planning, infrastructure development, and labor mobility. Foreign direct investment (FDI), averaging 1.13% of GDP, was right-skewed and non-normally distributed, pointing to episodic capital inflows. Such volatility can have implications for macroeconomic stability,

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especially in sectors reliant on foreign investment. Similarly, inflation averaged 10% and was also non-normally distributed, indicating frequent price instability that can undermine economic predictability and investor confidence. Unemployment remained relatively low at 4.12% and followed a normal distribution, suggesting a stable labor absorption capacity over time. Technological advancement, though not specified in units, also exhibited normal distribution, implying steady progress in innovation or infrastructure development. The results of the Jarque-Bera normality tests reinforce the importance of tailored econometric approaches. Variables with normal distributions support conventional modeling techniques, while non-normal variables require transformation or robust statistical methods to ensure valid inference and accurate policy insights. Overall, these findings highlight the structural diversity and evolution of Indonesia's economy over five decades, informing both empirical modeling and macroeconomic policy analysis

Correlation Analysis

Table 3 presents the correlation matrix of the ARDL model, indicating the relationships between Indonesia's sustainable economic growth (GDP) and labor force participation, tax revenue, trade openness, urban population, foreign direct investments, inflation, unemployment, and technological advancement. The results reveal varying degrees of positive and negative correlations between these variables and GDP.

Table 3. Correlation Matrix of Macroeconomic Indicators

	lnGDP	lnLFP	lnTAX	lnTRA	lnURB	lnFDI	lnINF	lnUNE	lnTEC
lnGDP	1								
lnLFP	0.811	1							
lnTAX	-0.875	-0.673	1						
lnTRA	-0.231	0.185	0.338	1					
lnURB	0.975	0.868	-0.877	-0.074	1				
lnFDI	0.323	0.195	-0.335	-0.438	0.224	1			
lnINF	-0.690	-0.384	0.627	0.593	-0.619	-0.212	1		
lnUNE	0.514	0.695	-0.505	0.437	0.669	-0.049	-0.121	1	
lnTEC	0.953	0.901	-0.850	-0.081	0.966	0.299	-0.591	0.641	1

Source: Authors' computation (2025)

The research results suggest that various economic indicators, such as workforce participation, urban population growth, joblessness rates, international capital inflows, and technological progress, show a positive association with gross domestic product. This implies that enhancements in these areas could potentially boost economic development. On the other hand, factors like tax income, trade liberalization, and inflation exhibit an inverse relationship with GDP. These findings point to Indonesia's challenges in generating sufficient tax revenue, the presence of numerous trade obstacles, and low inflation rates, all of which impede the country's economic expansion(Saliu, 2024) (Iballi et al., 2022).

Stationarity test

The study adopted has two lag orders while estimating the ARDL bound test. The current empirical study checks the stationarity of the dataset through the Augmented Dickey-Fuller (ADF) and Philips-Perron (PP) unit root tests. The results are presented in Table 4.

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Table 4. Stationarity test results

	ADF		PP		
Variables	Levels	1st Differences	Levels	1st Differences	I
lnGDP	-2.845271	-5.240152***	-2.303531	-5.213063***	I (1)
lnLFP	-1.583968	-6.910619***	-1.61678	-6.911228***	I (1)
lnTAX	-3.844722**	-7.129347***	-3.429694**	-7.802913***	I (0)
lnTRA	-2.817142	-9.179071***	-2.675238	-10.75976***	I (1)
lnURB	-1.416671	-5.949390***	-2.079069	-5.950504**	I (1)
lnFDI	-3.266874*	-8.530136***	-3.332060*	-8.377643***	I (0)
lnINF	-5.300238***	-9.711244***	-5.279296***	-19.35477***	I (0)
lnUNE	-0.625288	-7.124432***	-0.733262	-7.125282***	I (1)
lnTEC	-2.831506	-8.506613***	-2.831506	-9.767286***	I (1)

Source: Authors' computation (2025). Note: *, **, and *** are significant at 10%, 5% and 1% significance level.

The results in Table 4 indicated that tax revenue, foreign direct investments, and inflation are stationary at levels I (0), while GDP per capital, labor force participation, trade openness, urbanization, unemployment, and technological advancement are stationary at first differences I (1). The ADF and PP results indicate all variables exceed their p-values, rejecting the null hypothesis of a unit root at their respective integration levels (Philips & Perron, 1988).

Lag order selection

After inspecting the integration of the series, the next step is selecting the appropriate lag order of variables for ARDL estimation. The study used the optimal lag order of the vector autoregressive (VAR) model, employing LogL, likelihood ratio (LR) statistic, final predictor error (FPE), Akaike information criterion (AIC), Schwarz information criterion (SC), and Hannan-Quin information criterion (HQ). The estimated outcomes are presented in Table 5.

Table 5. Lag order selection criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-66.82819	NA	1.91e-10	3.159508	3.510358	3.292095
1	325.2324	663.5126	1.53e-16	-10.92635	-7.417848*	-9.600482
2	487.1929	163.0772*	2.32e-17*	-13.17470*	-6.508549	-10.65555*

Source: Authors' computation (2025). Note * indicates lag order selected by the criterion, LR= Likelihood Ratio, FPE= Final prediction error, AIC= Akaike information criterion, SC= Schwarz information criterion, and HQ=Hannan-Quin information criterion

The results displayed in Table 5 indicate that the second lag order exhibits better performance, as evidenced by lower values across all three criteria: AIC (-13.17470), SC (-7417848), and HQ (-10.65555). These outcomes suggest that lag order 2 outperforms lag order 1 when assessed using the AIC, SC, and HQ metrics. As a result, this implies that the model employing lag order 2 provides greater efficiency and a more precise representation of the data in comparison to the model using lag order 1.

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Johansen Cointegration Test

The study explores the long-run linkage among the variables using Johansen & Juselius (1990) cointegration method. The estimated outcomes are presented in Table 6.

Table 6. Cointegration test results (trace statistic)

Hypothesized No. of CE (s)	Eigenvalue	Trace statistic	0.05 Critical value	Probability
None*	0.890192	314.8093	197.3709	0.0000
At most 1*	0.651620	208.7761	159.5297	0.0000
At most 2*	0.599286	158.1619	125.6154	0.0001
At most 3*	0.531072	114.2655	95.75366	0.0015
At most 4*	0.446008	77.91484	69.81889	0.0098
At most 5*	0.364341	49.56581	47.85613	0.0342
At most 6	0.273464	27.81737	29.7907	0.0832
At most 7	0.183068	12.48297	15.49471	0.1352
At most 8	0.056220	2.777393	3.841465	0.0956

Source: Authors' computation (2025). Trace test indicates 6 cointegrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level; *MacKinnon-Haug-Michelis (1999) p-values.

The Trace statistic results in Table 6 indicate up to six cointegrating vectors among the chosen variables at 5% significance. The hypothesis of "at most five cointegrating vectors" is not accepted as the Trace value of 49.566 exceeds the critical value of 47.856, with a p-value of 0.0342. This evidence strongly supports the existence of long-term relationships between these variables.

Table 7. Cointegration test results (Max-eigenvalue statistic)

Hypothesized No. of CE (s)	Eigenvalue	Max-Eigen statistic	0.05 Critical value	Probability
None*	0.890192	106.0333	58.43354	0.0000
At most 1	0.651620	50.61411	52.36261	0.00747
At most 2	0.599286	43.89639	46.23142	0.0872
At most 3	0.531072	36.35070	40.07757	0.1240
At most 4	0.446008	28.34903	33.87687	0.1979
At most 5	0.364341	21.74845	27.58434	0.2336
At most 6	0.273464	15.33440	21.13162	0.2661
At most 7	0.183068	9.705574	14.26460	0.2320
At most 8	0.056220	2.777393	3.841465	0.0956

Source: Authors' computation (2025). Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level; * denotes rejection of the hypothesis at the 0.05 level; *MacKinnon-Haug-Michelis (1999) p-values.

The cointegration is confirmed by the Maximum Eigenvalue findings in Table 7. The hypothesis of "none cointegrating equation" is dismissed, as the Max-eigen statistic (106.033) exceeds its critical value (58.434), with a p-value of 0.0000.

ARDL long-run estimation results

These results confirm long-run relationships between GDP and non-traditional crops and validate the ARDL model's application to analyze both short- and long-run dynamics in subsequent sections.

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Table 8. Long-run estimation results

Variable	Coefficient	Standard error	t-Statistic	Prob.
lnLFP	-0.013312*	0.007228	-1.841734	0.0748
lnTAX	0.537477***	0.092942	5.782916	0.0000
lnTRA	-0.640787**	0.116969	-5.478250	0.0000
lnURB	1.247055***	0.103455	12.05409	0.0000
lnFDI	-0.000328	0.008984	-0.036473	0.9711
lnINF	-0.009345	0.022013	-0.424496	0.6740
lnUNE	-0.015086**	0.007334	-2.056922	0.0479
lnTEC	0.161127***	0.028832	5.588426	0.0000
Constant	3.045804***	0.462187	6.589978	0.0000

Source: Authors' computation (2025). Note: *, **, and *** are significant at 10%, 5%, and 1% significance level.

The findings indicate that labor force participation negatively impacts Indonesia's economic growth at a 10% significance level in the long run. A 1% rise in labor force participation is associated with a $ 0.01 decrease in economic growth, suggesting the increase might be driven by low productivity or low-wage employment. A significant increase in people taking up part-time or informal employment could raise participation rates without substantially increasing overall GDP. The result is consistent with research by Thaddeus et al. (2022) indicated that increased female participation in the workforce had a detrimental effect on economic growth in Sub-Saharan African countries.

Tax revenue exhibits a positive and significant influence on Indonesia's economic growth at 1% in the long term. A 1% increase in tax revenue corresponds to a $ 0.54 rise in economic growth, enabling the government to fund economic activities. Tax revenue enhances economic growth in developing nations like Indonesia due to trade openness and the tax system structure. The study's results align with the conclusions of Yossinomita et al. (2024) and Samudro (2024), which indicated that increased tax revenue contributes positively to economic growth in Indonesia.

Trade openness demonstrates a negative and significant effect on economic growth at a 1% significance level in the long run. An increase of 1% in trade openness correlates with a reduction of $ 0.64 in Indonesia's economic growth, holding all other variables constant. This negative relationship may be explained by heightened market competition, which could potentially harm local industries, or by trade imbalances that contribute to economic instability. The findings suggest that poorly designed trade policies, overreliance on specific imported goods, or underlying structural economic challenges might render trade liberalization counterproductive in the long run. Research by Rasoanomenjanahary et al. (2022) revealed that in Madagascar, increased trade openness negatively impacts economic growth, attributed to reduced trade barriers and inferior product quality.

In Indonesia, urban population growth shows a significant positive influence on economic development, with a 1% significance level long-term. Each 1% increase in urban population corresponds to a $1.25 rise in economic growth. This beneficial relationship stems from economies of scale, as urban centers provide enhanced efficiency through population concentration, access to skilled labor, and resource availability. The research findings are consistent with the findings of (Hana & Pujiati, 2023; Hassan & Pitoyo, 2017; Saputra & Darmawan, 2023) urbanization positively increased economic growth in Indonesia. Conversely, the unemployment rate demonstrates a significant negative impact on Indonesia's economic growth, also at a 1% significance level long-

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term. A 1% rise in unemployment results in a $0.02 decline in economic growth. This inverse relationship is expected, as higher unemployment signifies labor market inefficiencies, reduced consumer expenditure, and decreased productivity. Elevated joblessness suggests underperformance in certain sectors, weakening aggregate demand and discouraging investment. Higher unemployment rates in Indonesia may be attributed to skill mismatches, insufficient job creation, or economic disruptions. This result aligns with the conclusions drawn by (Suparman & Muzakir, 2023) who observed that in Indonesia, increased unemployment leads to a decrease in economic growth over the long term.

Technological advancement exhibits a significant positive effect on Indonesia's economic growth, with a 1% significance level in the long-term. For every 1% increase in technological progress, economic growth rises by $0.16, assuming other factors remain constant. This correlation is logical, as technological improvements typically lead to productivity gains, efficient production processes, and innovation, contributing to enhanced economic performance. The finding suggests that investments in technology, such as automation, digital infrastructure, or research and development in sectors like agriculture, healthcare, and manufacturing, are likely to boost Indonesian growth by enabling businesses to operate more efficiently and potentially creating new markets. The findings were confirmed by Gultom et al. (2024) and Hindrayani et al. (2024) who found that technological advancement influenced Indonesia’s economic growth positively.

ARDL short-run estimation (error correction) results

Table 9 illustrates the findings of ARDL short-run estimation results. The Error Correction Term (ECT) coefficient, denoted as D (GDP (-1)), has a value of -0.539486 and is statistically significant at the 1% level (p> 0.01). This coefficient is applied to compute the rate of adjustment from short-run fluctuations to long-run equilibrium, and it shows that the yearly rate of adjustment is 53.95%. The estimation results further indicate that the explanatory variables, including tax revenue (TAX), trade openness (TRA), foreign direct investments (FDI), and technological advancement (TEC), have significant long-run effects on Indonesia’s economic growth development (GDP).

Table 9. Short-run estimation results (Error correction)

Variable	Coefficient	Standard error	t-Statistic	Prob
Dln(TAX)	0.230348***	0.030845	7.467954	0.0000
Dln(TRA)	-0.163816***	0.020203	-8.108350	0.0000
Dln(TRA(-1))	0.106285***	0.020691	5.136797	0.0000
Dln(FDI)	0.010434***	0.002711	3.849285	0.0005
Dln(FDI(-1))	0.004178***	0.002358	1.771318	0.0860
Dln(TEC)	0.049374***	0.009778	5.049538	0.0000
Cointegration Eq (-1)*	-0.539486***	0.034405	-15.68061	0.0000
R-squared	0.781299	Mean dependent var	0.034007	
Adjusted R-squared	0.749294	S.D. dependent var	0.033194	
S.E. of regression	0.016620	Akaike info criterion	-5.222356	
Sum squared resid	0.011325	Schwarz criterion	-4.949472	
Log-likelihood	132.3365	Hannan-Quinn criterion	-5.119233	
Durbin-Watson stat	2.074840			

Source: Authors’ computation (2025). Note: *, **, and *** are significant at 10%, 5% and 1% significance level

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In the short term, tax revenue significantly and positively impacts economic growth at the 1% significance level. A 1% rise in tax revenue corresponds to a $0.23 increase in economic growth, ceteris paribus. This positive influence on short-term economic growth in Indonesia indicates that the government's tax collection is crucial in fostering economic activity. This highlights the significance of fiscal policy in promoting growth, as increased tax revenue allows the government to finance investments that enhance productivity and generate employment opportunities, particularly for youth facing high unemployment rates. Tax revenue enables the government to fund infrastructure projects, social initiatives, and other public goods essential for economic expansion. The findings confirm the findings of Samudro (2024) that regional tax increases economic growth in Indonesia. Indonesia's economic growth was significantly and positively influenced by trade openness at a 1% significance level. The analysis revealed that a 1% rise in trade openness corresponded to a $0.11 increase in economic growth, assuming all other factors remained constant. This suggests that expanding international trade opportunities, such as reducing trade restrictions or boosting exports, has a favorable short-term impact on Indonesia's economic performance. These findings support the notion that adopting more liberal trade policies, enhancing access to global markets, and cultivating international collaborations can contribute to Indonesia's increased economic output, as reported by (Elfaki et al., 2021; Nursini, 2017).

In Indonesia, foreign direct investments (FDI) significantly impacted short-term economic growth at a 1% significance level. A 1% rise in FDI led to a $0.01 increase in economic growth, assuming other factors remained constant. This correlation stems from benefits like capital influx, technological advancements, improved management expertise, and better access to global markets, boosting productivity and economic expansion. Indonesia could enhance short-term growth by attracting foreign investment through tax benefits, streamlined regulations, or dedicated economic zones. Additionally, FDI can reduce high unemployment rates by creating job opportunities directly and indirectly through new enterprises, industry growth, and supply chain development. The study findings align with the findings of Ifa & Yahdi (2020) and Yaqin & Sulistyono (2024), who reported that FDI positively influenced Indonesian economic growth.

In Indonesia, technological progress demonstrated a positive and statistically significant impact on economic growth in the short term, with a significance level of 1%. Specifically, a 1% rise in technological advancement resulted in a $0.05 increase in economic growth, with all other factors remaining constant. During short-term periods, technological improvements boost productivity across industries, including manufacturing, services, and agriculture, as these sectors depend on innovation and efficiency. The enhancements in productivity and output often lead to rapid economic growth, as confirmed by Hindrayani et al. (2024).

ARDL bound cointegration test results

Table 10 presents the estimated results of ARDL bounds test results, confirming a long-run co-integration between economic growth (GDP) and macroeconomic indicators for Indonesia. The results of ARDL bounds testing reveal that the calculated F-statistic for model 19.19076 is greater than the critical value of the upper bound (3.77) at a 1% significance level. It indicates that labor force participation, tax revenue, trade openness, foreign direct investments, inflation, urbanization, unemployment, and technological advancement have a long-term cointegration relationship with

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Indonesia's economic growth development. Therefore, the null hypothesis assumption of no cointegration in the model is rejected at the 1% significance level.

Table 10. Bounds test results

Test Statistic	Value	Significant	I (0)	I (1)
F-statistic	19.19076	10%	1.85	2.85
K	8	5%	2.11	3.15
		2.5%	2.33	3.42
		1%	2.62	3.77

Source: Authors' computation (2025)

Diagnostics test results

The study employs a normality test, serial correlation, heteroscedasticity, and regression specification error test to check the reliability and validity of macroeconomic indicators affecting Indonesia's economic growth development, and the results are shown in Table 11.

Table 11. Diagnostics test results on macroeconomic indicators

Classical Assumption	**Type of Test**	**F-Statistic**	**Probability**	**Conclusion**
Normality	Jarque Bera	5.556522	0.062146	Data not normally distributed
Serial correlation	Breusch-Godfrey Serial Correlation LM	1.881808	0.1699	No serial correlation was detected in the analysis
Heteroskedasticity	Breusch Pagan-Godfrey	1.404047	0.2044	No Heteroskedasticity was detected in the analysis
Regression Specification Error	Ramsey RESET	1.108226	0.3006	No Specification error was detected in the analysis

Source: Authors' computation (2025)

The diagnostic tests were conducted to check normality, homoskedasticity, serial correlation, heteroskedasticity, and regression specification error for the error term, and the outcomes of the study are displayed in Table 6. The results indicate that the dataset is not normally distributed, and no issues of homoscedasticity, serial autocorrelation, or specification errors were detected.

Stability tests

The study used the Cumulative sum (CUSUM) of recursive residuals, the cumulative sum square (CUSUMSQ) of recursive residuals, the Theil inequality coefficient, and the Symmetric Mean Absolute Percentage Error (SMAPE) to check the stability of the ARDL model

CUSUM and CUSUMQ

The cumulative sum and cumulative sum of squares outcomes are illustrated in Figures 1 and 2. To evaluate the ARDL model's fit, CUSUM and CUSUMQ tests were conducted, as suggested by Brown et al. (1975). The graphs remained within the 5% significance level's critical bounds after

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confirming the cointegration link between economic growth and labor force participation, tax revenue, trade openness, urban population, unemployment, foreign direct investments, inflation, and technology advancement. This outcome demonstrates the stability of the ARDL model's coefficients and confirms the model's overall satisfactory fit.

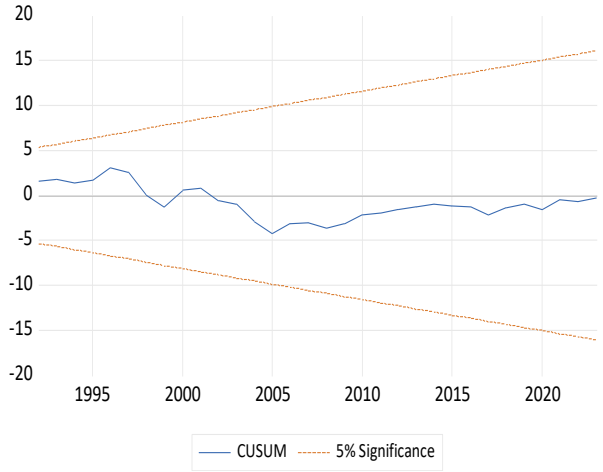

Figure 1. Cumulative sum (CUSUM) of recursive residuals

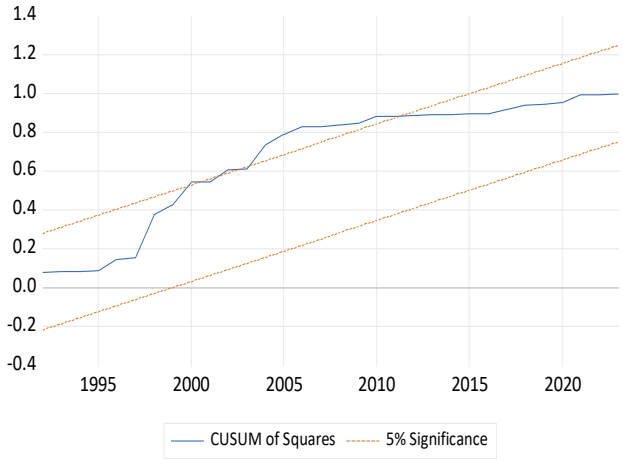

Figure 2. Cumulative sum squares (CUSUMSQ) of recursive residuals

Theil Inequality Coefficient and Symmetric Mean Absolute Percentage Error (SMAPE)

We evaluated the ARDL model's forecasting accuracy for economic growth from 1974 to 2023 using static forecasting charts, Theil inequality coefficients, and Symmetric Mean Absolute Percentage Error (SMAPE). The results are in Figure 3. Among all models, the ARDL model showed superior performance, with the lowest Root Mean Square Errors and Theil Inequality coefficient. The ARDL model achieved a Root Mean Squared Error of 0.015662 for predicting economic growth, demonstrating high accuracy. Its Theil Inequality coefficient of 0.001032, approaching zero, highlights its outstanding performance and minimal prediction error. The Symmetric MAPE value of 0.158053 indicates an average absolute percentage prediction error of 15.8% within an acceptable forecasting range.

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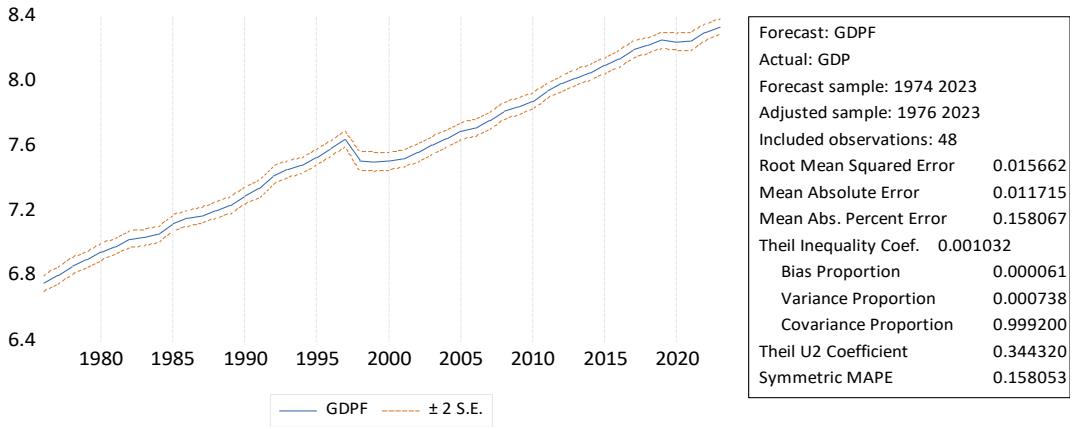

Figure 3. Theil Inequality Coefficient and Symmetric Mean Absolute Percentage Error (SMAPE)

CONCLUSION AND SUGGESTION

The ARDL model results revealed that several factors, including labor force participation, tax revenue, trade openness, urban population, unemployment, and technological advancement, had a significant long-term impact on Indonesia's economic growth. In contrast, tax revenue, trade openness, foreign direct investment, and technological advancement positively influenced the country's economic growth in the short term. The short-run dynamics demonstrated immediate economic adjustments that triggered macroeconomic indicators, with some showing varying effects on economic growth. The research determined that labor force participation, tax revenue, trade openness, urbanization, unemployment, foreign direct investments, and technological advancement played crucial roles in shaping Indonesia's economic growth.

The research suggests that Indonesia's government allocates more resources to vocational training, tertiary education, and skill development programs to boost workforce efficiency. Policies supporting flexible work arrangements could increase labor force participation, especially among women and older workers that often used in agricultural sector. The administration should promote the domestic production of high-value goods, employ strategic tariffs and subsidies to safeguard emerging industries, and promote competitive sectors. Enhancing economic ties with neighboring nations could reduce reliance on unpredictable global markets. Indonesia should focus on nurturing innovation, enhancing access to technology, and investing in education. The government should improve tax collection efficiency, expand the tax base, and direct revenue toward growth-stimulating projects. Further, liberalize trade, reduce barriers for international businesses, attract more foreign direct investment, and ensure equitable distribution of trade benefits. Boost public investment in infrastructure, renewable energy, and technology sectors to create jobs and offer incentives to foster entrepreneurship. This study also becomes lesson learned for formulating agricultural development strategy based on macroeconomic indicators.

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