

THE IMPACT OF ECONOMIC PILLAR SDGs INDICATORS ON LABOR PRODUCTIVITY IN INDONESIA: A VECM APPROACH

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Article history: received 11 January 2026; revised 22 January 2026; accepted 14 February 2026

DOI: <https://doi.org/10.33751/jhss.v10i1.43>

Abstract. This study aims to examine the effects of Sustainable Development Goals (SDGs) economic pillar indicators—namely the electrification ratio, manufacturing industry growth, income inequality, and Foreign Direct Investment (FDI)—on labor productivity in Indonesia over the period 2015–2024. The research adopts an explanatory quantitative approach using annual time-series data analyzed through a Vector Error Correction Model (VECM). The findings reveal that, in the short run, only the electrification ratio has a statistically significant effect on labor productivity, exhibiting a negative relationship. In the long run, both the electrification ratio and manufacturing industry growth exert negative and significant effects, whereas income inequality shows a positive and significant impact. FDI does not demonstrate a significant effect on labor productivity. Impulse Response Function (IRF) and Forecast Error Variance Decomposition (FEVD) analyses indicate that labor productivity dynamics are predominantly driven by internal factors, with the largest external contribution originating from the manufacturing sector. These findings imply that enhancing labor productivity requires structural transformation, improvements in the quality of energy utilization, and more equitable development. The novelty of this study lies in the application of SDGs economic pillar indicators within a VECM framework and the integration of equity and sustainability perspectives in development analysis.

Keywords: Put your keywords here; keywords are separated by semicolons.

I. INTRODUCTION

Economic development is a multidimensional process that is not only oriented towards economic growth, but also towards improving the welfare and quality of life of the community. In the context of modern development, labor productivity is an important indicator that reflects the efficiency, competitiveness, and quality of economic development. Increased labor productivity is closely related to the quality of human resources, infrastructure, economic structure, and equitable distribution of development outcomes. Empirical research shows that the quality of human capital has a significant effect on labor productivity. (Dirgantara & Santoso, 2024) and (Sairmaly, 2023) found that education, health, and skills have a positive relationship with labor productivity and economic growth. High labor productivity reflects the ability to produce greater *output* with the same input, thereby impacting national welfare and competitiveness (Ningsih, 2024).

Although Indonesia's labor productivity has shown an upward trend in recent years, data from the *International Labor Organization* (2023) shows that Indonesia's productivity level still lags behind other ASEAN countries such as Singapore, Malaysia, and Thailand, and is even beginning to be overtaken by Vietnam, despite relatively stable economic growth (World Bank, 2023). This

phenomenon indicates that the issue of labor productivity in Indonesia is structural and not solely influenced by economic growth. From the perspective of neoclassical and endogenous growth theory, labor productivity is influenced by the quality of human resources, technology, infrastructure, and value-added economic structure. The imbalance between economic growth and productivity indicates that the transmission of growth to the productive sector is not yet optimal. This condition causes labor to be absorbed mostly in low-productivity sectors.

A number of previous studies are still partial in nature. (Kaswinata et al., 2023) emphasizes the role of human resource quality and economic structure but has not directly linked it to the *Sustainable Development Goals* (SDGs) indicators. SDG studies in Indonesia also tend to be descriptive and have not tested their dynamic influence on labor productivity. This indicates a research gap regarding the relationship between economic pillar SDG indicators and labor productivity. The economic pillars of the SDGs, particularly SDG 7 (access to energy), SDG 9 (industrialization), SDG 10 (income inequality), and SDG 17 (FDI), are directly relevant to labor productivity. Although Indonesia's electrification ratio is almost universal, this increase has not been fully accompanied by an increase in labor productivity. Empirical findings from (Mahardika, 2024)

and (Ismiraj et al., 2025) show that the quality and stability of electricity supply are more decisive for productivity than mere availability of access, in line with *Human Capital Theory* (Becker, 1964) and endogenous growth theory (Yunus & Jamar, 2025).

On the other hand, the manufacturing sector as a driver of structural transformation shows moderate and suboptimal growth in labor productivity, as explained in Kaldor's Growth Laws and *structural transformation theory* (Wulandari et al., 2024). Income inequality also has the potential to hinder human capital accumulation and technology diffusion (Bises et al., 2024). Meanwhile, the impact of *Foreign Direct Investment* (FDI) on labor productivity is indirect and highly dependent on domestic absorption capacity (Astuti & Gunawan, 2024).

From an Islamic economic perspective, economic development and labor productivity are seen as part of efforts to achieve justice, benefit, and sustainability in accordance with *maqāṣid al-sharī'ah* (Wulandari et al., 2025). Income inequality, energy access, industrialization, and investment are not only understood as economic phenomena, but also as ethical and social issues. Based on this description, although Indonesia has made progress in various economic development indicators, these achievements are not yet fully reflected in a sustainable increase in labor productivity. Therefore, this study analyzes the influence of SDG indicators in the economic pillar of energy access, the manufacturing sector, income inequality, and foreign investment on labor productivity in Indonesia for the period 2015-2024 using the *Vector Error Correction Model* (VECM) method.

II. RESEARCH METHODS

This study uses a quantitative approach with an explanatory research type to analyze the influence of the *Sustainable Development Goals* (SDGs) economic pillar indicators on labor productivity in Indonesia for the period 2015-2024. The data used is annual time series secondary data, with labor productivity as the dependent variable, and electrification ratio, manufacturing industry growth, Gini index, and *Foreign Direct Investment* (FDI) as independent variables. The data was obtained from official and credible sources, such as the Central Statistics Agency (BPS), national SDGs reports, Bappenas, the World Bank, UNDP, and Satu Data Indonesia. The analysis methods used are *Vector Autoregressive* (VAR) and *Vector Error Correction Model* (VECM) with the help of *EViews* software. VAR is used when there is no *cointegration* between variables, while VECM is used when there is a long-term equilibrium relationship. The analysis stages include the *Augmented Dickey-Fuller* (ADF) *stationarity* test, determination of the optimum lag, Johansen *cointegration* test, VAR/VECM estimation, and *Impulse Response Function* (IRF) and *Forecast Error Variance Decomposition* (FEVD) analysis. Given the limited number of observations ($T = 10$), this study applies efficient lag selection and model stability testing to minimize *small sample problems*. This methodology is in line with economic growth theory, sustainable development, and the principles of justice and sustainability in the perspective of Islamic economics.

III. RESULTS AND DISCUSSION

A. Stationarity Test

The stationarity test method uses a unit *root test* model with the *Augmented Dickey-Fuller* (ADF) at the 5% level with a *test for unit root* in level.

TABLE I
 RESULTS OF THE 2ND DIFFERENCE STATIONARITY TEST

Variable	ADF t-Statistic	Prob*	Description
Electrification Ratio	-13.03319	0.000	Stationary
Manufacturing Industry Growth	-10.53565	0.00	Stationary
Income Inequality (Gini Index)	-10.53565	0.0000	Stationary
Foreign Direct Investment (FDI)	-5.749369	0.0000	Stationary
Labor Productivity	-10.53565	0.0000	Stationary

Source: Eviews 10 processed data

Based on the results of the stationarity test using the *Augmented Dickey-Fuller* (ADF) method at a significance level of 5 percent, it can be concluded that most of the research variables are not stationary at the level. Only the electrification ratio variable is proven to be stationary at the level, while manufacturing industry growth, income inequality (Gini index), foreign direct investment (FDI), and labor productivity still contain unit roots. Testing at the *first difference* level shows that most variables have achieved stationarity, except for the electrification ratio, which is still non-stationary. Therefore, testing was continued at the *second difference* level, and the results show that all research variables are stationary with a probability value below 0.05. These findings indicate that the variables in the model have different integration orders, so that further analysis using the VAR/VECM approach is appropriate in order to capture the dynamic relationships and long-term equilibrium between variables.

B. Cointegration Test

The cointegration test in this study uses the Johansen *Cointegration Test* approach based on *Trace Statistics* and *Maximum Eigenvalue Statistics* to identify the existence of long-term equilibrium relationships between variables that are non-stationary at the level. The basic principle of the cointegration test states that even though variables fluctuate in the short term, a linear combination of variables can move together towards long-term equilibrium. The test results, assuming a linear *deterministic trend* and a lag length of 1–2, show that the *Trace Statistic* values for all hypotheses (None to At most 4) are greater than compared to the critical value at a significance level of 5 percent, with a probability value below 0.05.

These findings indicate the existence of five cointegrating equations between the research variables. Consistent results are also shown by the *Maximum Eigenvalue* test, where all *Max-Eigen Statistic* values exceed the critical value and have a probability of less than 0.05. Thus, it can be concluded that there is a significant long-term equilibrium relationship between labor productivity, electrification ratio,

manufacturing industry growth, income inequality (Gini index), and foreign direct investment (FDI). The existence of this cointegration confirms that the appropriate model used in the study is the *Vector Error Correction* Model (VECM), as it is able to capture both short-term adjustment dynamics and long-term equilibrium relationships between variables.

TABLE II
 COINTEGRATION TEST RESULTS

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized Number of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Probability**
None*	0.551047	401.5854	69.81889	0.0001
At most 1 *	0.500000	309.4890	47.85613	0.0001
At most 2 *	0.500000	229.7771	29.79707	0.0001
At most 3 *	0.500000	150.0652	15.49471	0.0001
At most 4 *	0.457609	70.35325	3.841466	0.0000

Trace test indicates 5 cointegrating equations at the 0.05 level

*Denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Source: Eviews 10 processed data

C. Short-Term VECM Test of Labor Productivity

Based on the results of the long-term estimation analysis, a short-term VECM estimation analysis can be conducted for each variable with a 5% error tolerance (t-statistic > ± 1.9808).

TABLE III
 SHORT-TERM VECM TEST RESULTS FOR LABOR PRODUCTIVITY

Variable	Coefficient	Standard Error	T-Statistic	Description
D(PTK(-2),3)	-0.068591	0.11415	-0.60086	negative and not significantly influential
D(ELECTRIFICATION(-2),3)	-0.187543	0.09260	-2.02538	negative and significantly influential
D(MANUFACTURING RING(-2),3)	-0.001576	0.00080	-1.97093	negative and not significantly influential
D(GINI(-2),3)	0.139107	0.09591	1.45040	positive and not significantly influential
D(FDI(-2),3)	0.000124	0.00196	0.06296	positive and not significantly influential
R-squared	0.717898			
T Table	1.9808			

Source: Eviews 10 processed data

The results of the short-term VECM estimation show that only the electrification ratio has a significant negative effect on labor productivity, while the variables of labor productivity, manufacturing industry growth, income inequality (Gini index), and *foreign direct investment* (FDI) have no significant effect. These findings indicate that in the short term, increased access to electricity has not been utilized productively, while the impact of manufacturing, income distribution, and foreign investment requires time to affect labor productivity. The R-squared value of 0.7179 indicates that the model is able to explain 71.79% of the variation in labor productivity in the short term.

D. Long-Term VECM Test

VECM estimation results can be considered significant if the t-statistic value is > ± [1.9808], indicating data with long-term and short-term trends. From the *Vector Error Correction* Model (VECM) estimation results, long-term and short-term equations can be analyzed.

TABLE III V
 COINTEGRATION TEST RESULTS

Endogenous Variables	Exogenous Variables	Coefficient	Standard Error	t-Statistic	Description
Labor Productivity	C	3.02E-20	-	-	
	Electrification Ratio	-0.434723	0.08749	-4.96885	negative and significantly influential
	Manufacturing Industry Growth	-0.004773	0.00053	-9.02925	negative and significantly influential
	Income Inequality (Gini Index)	0.322448	0.09690	3.32768	Positive and significantly influential
	Foreign Direct Investment (FDI)	0.000287	0.00214	0.13401	negative and not significantly influential

Source: Eviews 10 processed data

The results of the long-term *Vector Error Correction* Model (VECM) estimation show that labor productivity in Indonesia is significantly influenced by the electrification ratio, manufacturing industry growth, and income inequality. The electrification ratio has a negative and significant effect, indicating that increasing access to electricity in the long term has not been fully able to drive an increase in labor productivity, mainly because the use of electrical energy still tends to be consumptive and has not been balanced by improvements in human resource quality, energy use efficiency, and the adoption of productive technologies. The growth of the manufacturing industry also shows a negative and significant effect on labor productivity, reflecting a shift in the industrial structure towards sectors that are increasingly capital and technology intensive, so that the increase in industrial output is not accompanied by a proportional increase in labor productivity.

Conversely, income inequality as measured by the Gini Index has a positive and significant effect on labor productivity in the long term. This finding indicates that productivity gains are more concentrated among certain groups of workers who have higher levels of education, skills, and access to technology, meaning that productivity gains are not distributed evenly. Meanwhile, *Foreign Direct Investment* (FDI) does not show a significant effect on labor productivity, indicating that foreign investment flows during the study period have not been able to produce a strong spillover effect, either in the form of technology transfer, improvement of labor skills, or the creation of productive jobs. Overall, these results confirm that long-term labor productivity growth is not only determined by the availability of infrastructure and industrial growth, but also heavily depends on the quality of energy utilization, an inclusive industrial structure, and equitable distribution of development outcomes. Therefore, integrated and sustainable development policies are needed to support the achievement of SDGs 7, 8, 9, and 10.

E. Impulse Response Function (IRF) Test

Impulse Response Function (IRF) analysis aims to determine how long it takes for a variable to respond to changes in other variables.

The results of the *Impulse Response Function* (IRF) analysis show that the response of labor productivity (PTK) to shocks from itself and variables such as electrification, manufacturing industry, Gini Index, and *Foreign Direct Investment* (FDI) is fluctuating in the early period and begins

to stabilize in the range of the 20th to 25th periods, then fully stabilizes until the end of the observation period. PTK shocks to itself provide a temporary positive response and converge towards long-term equilibrium.

TABLE V
 IMPULSE RESPONSE FUNCTION (IRF) OF LABOR PRODUCTIVITY

Response of D(PTK,2):					
Period	D(PTK,2)	D(ELECTRIFICATION,2)	D(MANUFACTURING,2)	D(GINI,2)	D(FDI,2)
1	0.007626	0.000000	0.000000	0.000000	0.000000
20	0.002718	0.000416	0.001483	-0.000458	-2.11E-05
21	0.002714	0.000412	0.001481	-0.000455	-2.09E-05
22	0.002718	0.000416	0.001484	-0.000458	-2.11E-05
23	0.002716	0.000414	0.001483	-0.000457	-2.10E-05
26	0.002715	0.000414	0.001483	-0.000457	-2.10E-05
27	0.002716	0.000415	0.001483	-0.000457	-2.10E-05
50	0.002716	0.000415	0.001483	-0.000457	-2.10E-05
60	0.002716	0.000415	0.001483	-0.000457	-2.10E-05
130	0.002716	0.000415	0.001483	-0.000457	-2.10E-05
150	0.002716	0.000415	0.001483	-0.000457	-2.10E-05

Source: Eviews 10 processed data

Electrification and manufacturing industry shocks provide a positive response to PTK, albeit with a relatively small and stable magnitude in the long term. Conversely, Gini Index shocks show a negative response to labor productivity, indicating that increased income inequality suppresses productivity, although the impact tends to weaken and stabilize in the long term. Meanwhile, the response of PTK to FDI shocks is very small and negative, indicating that the impact of FDI on labor productivity is relatively weak in dynamic terms. Overall, the IRF results indicate that shocks in the system are temporary and that the Indonesian economy tends to return to long-term equilibrium.

F. Forecast Error Variance Decomposition (FEDV) Test

Variance Decomposition (VD) analysis, also known as Forecast Error Variance Decomposition (FEDV), is used to predict the percentage contribution of each variable's variance due to changes in certain variables in the system.

TABLE VI
 PRODUCTIVITY OF LABOR VARIANCE DECOMPOSITION ANALYSIS

Response of D(PTK,2):						
Period	SE	D(PTK,2)	D(ELECTRIFICATION,2)	D(MANUFACTURING,2)	D(GINI,2)	D(FDI,2)
1	0.007626	100.0000	0.000000	0.000000	0.000000	0.000000
10	0.012992	74.26116	1.475625	22.47018	1.789245	0.003784
20	0.016388	74.23170	1.573751	22.28399	1.906529	0.004032
100	0.032637	74.12134	1.687860	22.13597	2.050487	0.004336
147	0.039156	74.10993	1.699641	22.12073	2.065331	0.004367
148	0.039283	74.10977	1.699814	22.12050	2.065549	0.004368
149	0.039410	74.10960	1.699985	22.12028	2.065764	0.004368
150	0.039536	74.10944	1.700153	22.12007	2.065976	0.004369

Source: Eviews 10 processed data

The results of the variance decomposition analysis show that the variation in labor productivity (PTK) in the early period was entirely influenced by PTK shocks themselves. Over time, the contribution of internal factors continued to dominate with a proportion of around 74 percent to in the final period, while other variables began to make a relatively stable contribution. Among external variables, manufacturing

industry growth was the largest contributor to LPT variation with a contribution of around 22 percent, followed by the Gini Index at around 2 percent and the electrification ratio at around 1.7 percent, while Foreign Direct Investment (FDI) made a very small contribution. These findings indicate that labor productivity dynamics in Indonesia are self-driven and largely determined by internal factors, although the strengthening of the manufacturing sector, income equality, and increased access to energy continue to play a supporting role in driving sustainable labor productivity growth.

Discussion of the research results shows that the relationship between economic development indicators and labor productivity in Indonesia is complex and does not always align with theoretical expectations. The electrification ratio as an indicator of energy infrastructure availability is conceptually expected to increase production efficiency and labor productivity. However, the Vector Error Correction Model (VECM) estimation results show that the electrification ratio has a significant negative effect on labor productivity in the long term. This finding indicates that increased access to electricity during the 2015-2024 period has not been accompanied by an increase in the quality of energy utilization in productive economic activities, so that the benefits of electrification still tend to be consumptive in nature.

This condition reflects the phenomenon of the low productivity trap, where the provision of basic infrastructure has not been able to drive productivity growth when the labor force is still predominantly absorbed in low-productivity sectors. These results are in line with the views of Solow (1956) and Kaldor (1961), who emphasized that productivity growth is not only determined by the availability of physical capital, but also by the quality of labor, technology, and industrial structure. This finding is also consistent with the research by Ningsih (2024) and Latuheru & Gobay (2024), which states that energy acts as an enabling factor, but does not automatically increase productivity without economic structural transformation. From a sharia economics perspective, this condition shows that the achievement of masalah from energy infrastructure development has not been optimal because it has not fully improved the quality of work and community welfare. Therefore, synergy between electrification policies, human resource development, and strengthening the productive sector is needed to be in line with SDG 7 and SDG 8 as well as the principles of maqāsid al-sharī'ah.

Furthermore, the growth of the manufacturing industry, which in theory is seen as the engine of structural transformation and increased labor productivity, shows different results empirically. The VECM estimation results indicate that manufacturing industry growth does not have a significant effect, and even tends to have a negative effect on labor productivity. This finding indicates that manufacturing growth in Indonesia during the study period was still quantitative and not yet qualitative, characterized by the dominance of capital-intensive industries and technologies that did not have a direct impact on aggregate labor productivity improvement. This condition is in line with Kaldor's theory (1961), which emphasizes that the manufacturing sector can only be a major driver of

productivity if it is accompanied by technological innovation and improvements in the quality of human resources.

The results of this study support the findings (Aulia & Nizham, 2023) which show that the characteristics of industrialization have a greater impact on productivity than simply industrial *output* growth. From a sharia economics perspective, manufacturing industry growth should not only be oriented towards *increasing output*, but also towards improving work quality, wage fairness, and social welfare, so that industrialization policies need to be directed towards strengthening high value-added industries and increasing workforce capacity in line with SDG 8 and SDG 9.

The discussion on income inequality shows that income distribution has important implications for labor productivity. The VECM estimation results indicate that income inequality, as measured by the Gini Index, has a positive and significant effect on labor productivity in the long term, but not in the short term. This finding indicates that the increase in national productivity is still largely driven by high-income workers who have greater access to education, training, and technology, so that the impact is only felt in the long term. Theoretically, this finding is in line with the neoclassical view (Solow, 1956) which emphasizes the role of human capital accumulation in increasing productivity, even though excessive inequality has the potential to hamper sustainable development. These results are also consistent with research (Ponto, 2023) which states that productivity gains in Indonesia have not been fully inclusive. From a sharia economics perspective, high income inequality is contrary to the principles of justice (*adl*) and equitable distribution of welfare, thus requiring redistributive policies through the instruments of *zakat*, *infaq*, *sadaqah*, and *waqf* so that productivity gains can be felt more evenly and in line with SDG 10 and the *maqāṣid al-sharī'ah*.

Meanwhile, *Foreign Direct Investment* (FDI) as a source of capital and technology transfer shows different effects in the short and long term. VECM estimation results show that FDI does not have a significant effect on labor productivity in the short term, but has a significant effect in the long term. These findings indicate that the benefits of FDI on labor productivity are cumulative and require time through the process of technology transfer, improvement of labor skills, and adjustment of the production structure. These results are in line with Solow's (1956) neoclassical growth theory of the " " and Kaldor's (1961) industry-based growth theory, and support the findings (Safira & Setyowati, 2025) which confirm that the effectiveness of FDI is highly dependent on the readiness of human resources and linkages with the domestic sector. From a sharia economic perspective, productive and equitable FDI has great *maslahah* value because it encourages the strengthening of the real sector, job creation, and improvement in the quality of the workforce. Therefore, FDI policy needs to be directed towards high value-added investments oriented towards sustainable development in accordance with SDG 8, SDG 17, and the principles of *maqāṣid al-sharī'ah*.

IV. CONCLUSIONS

Based on the results of the study, it can be concluded that the *Sustainable Development Goals* (SDGs) economic pillar indicators have a significant correlation with labor productivity in Indonesia during the 2015-2024 period, both in the short and long term. The estimation results show that in the short term, the electrification ratio is the only variable that has a significant negative effect on labor productivity, indicating that increased access to electricity has not been fully utilized for productive economic activities. Meanwhile, manufacturing industry growth, income inequality, and *Foreign Direct Investment* (FDI) have not shown a significant effect in the short term, reflecting a time lag before their impact on labor productivity can be realized. In the long term, the electrification ratio and manufacturing industry growth have been proven to have a significant negative effect on labor productivity. These findings indicate that improvements in energy infrastructure and industrial *output* growth do not automatically lead to increased productivity if they are not accompanied by improvements in human resource quality, energy use efficiency, and industrial structure transformation towards high value-added sectors. Conversely, income inequality, as measured by the Gini Index, has a positive and significant effect on labor productivity in the long term, indicating that productivity gains are still concentrated among certain groups of workers who have greater access to education, skills, and technology. Meanwhile, FDI does not show a significant effect on labor productivity, indicating that foreign investment flows have not fully resulted in technology spillovers and widespread improvements in labor quality. Based on these findings, the policy implication that can be drawn is the need to shift the focus of development from merely expanding access and quantitative growth to improving the quality of economic resource utilization. The government needs to ensure that electrification policies are directed at strengthening the productive sector, energy efficiency, and improving workforce skills so that energy access can contribute significantly to productivity. In addition, industrialization policies need to be focused on developing innovation- and technology-based manufacturing industries that are capable of absorbing labor productively, not merely increasing *output*. On the other hand, the results of the study emphasize the importance of income distribution policies as a prerequisite for sustainable labor productivity improvement. Strengthening education, vocational training, and improving the quality of the workforce needs to be directed inclusively so that the benefits of increased productivity are not only enjoyed by certain groups. Foreign investment policies also need to be directed at sectors that have strong links to the domestic economy and encourage technology transfer and increased local workforce capacity. From a sharia economic perspective, these findings confirm that increasing labor productivity should not only be oriented towards economic efficiency, but must also reflect the principles of justice, inclusiveness, and benefit as emphasized in *maqāṣid al-sharī'ah*. Therefore, development strategies that integrate economic growth, equitable welfare, and sustainability are key to promoting Indonesia's labor productivity in a

sustainable manner while supporting the achievement of the economic pillar of the SDGs.

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