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RESEARCH ARTICLE

Enhancing the Renewable Energy and GDP Share of Agriculture in Indonesia: Analysis of the Impacts on Agricultural Sector Employment

Hilmy PRİLLİADİ[1]

Abstract

Renewable energy capacity, agricultural sector GDP, and agricultural employment in Indonesia experienced a downward trend from 1990 to 2019. This trend negatively impacts Indonesia's target to utilize renewable energy as its energy source, employment in the agricultural sector, and the importance of agriculture to the Indonesian economy. Based on these issues, this research examined the impact of renewable energy usage and agricultural sector GDP on the employment rate of the agricultural sector by implementing the Autoregressive Distributed Lag (ARDL) model. According to empirical findings, total renewable energy supply improves agricultural sector employment in the short and long run; however, agricultural sector GDP improves employment only in the short run and negatively impacts the long run. It suggests that renewable energy has the potency to enhance agricultural employment. The use of renewable energy is expected to be a solution for the decrease in employment in the agricultural sector along with the GDP decrease. Governments can make sure that all funds allocated to an agroecological program or policy are used to increase agricultural renewable energy use. Renewable energy regulations should be assessed based on their ability to reduce pollution while also ensuring a reliable energy supply for the agricultural sector at an affordable price.

Keywords: Renewable energy, agricultural employment, GDP, ARDL
JEL Codes: *A12, B23, Q52, E24*

Endonezya'da Tarımın Yenilenebilir Enerji ve GSYİH Payının Artırılması: Tarım Sektörü İstihdamı Üzerindeki Etkilerin Analizi

Özet

Endonezya'da yenilenebilir enerji kapasitesi, tarım sektörü GSYİH ve tarım istihdamı 1990'dan 2019'a düşüş eğilimi yaşamıştır. Bu eğilim Endonezya'nın yenilenebilir enerjiyi enerji kaynağı olarak kullanma hedefini, tarım sektöründeki istihdamı ve Endonezya ekonomisi için tarımın önemini olumsuz etkiliyor. Bu konulara dayanarak, bu araştırma, Autoregressive Distributed Lag (ARDL) modelini uygulayarak yenilenebilir enerji kullanımı ve tarım sektörü GSYİH'sının tarım sektörünün istihdam oranı üzerindeki etkisini incelemiştir. Ampirik bulgulara göre, toplam yenilenebilir enerji arzı, kısa ve uzun dönemde tarım sektörü istihdamını iyileştirmektedir; ancak tarım sektörü GSYİH'si istihdamı yalnızca kısa vadede artırır ve uzun vadede olumsuz etkiler. Yenilenebilir enerjinin tarımsal istihdamı arttırma potansiyeline sahip olduğunu öne sürüyor. Yenilenebilir enerji kullanımının GSYİH azalması ile birlikte tarım sektöründeki istihdam azalmasına çözüm olması beklenmektedir. Hükümetler, tarımsal yenilenebilir enerji kullanımını artırmak için bir agroekolojik program veya politikaya tahsis edilen tüm fonların kullanılmasını sağlayabilir. Yenilenebilir enerji politikası, tarım sektörü için uygun fiyata güvenilir enerji arzını sağlarken kirliliği azaltma yeteneklerine göre değerlendirilmelidir.

Anahtar Kelimeler: Yenilenebilir enerji, tarımsal istihdam, GSYİH, ARDL
JEL Kodları: A12, B23, Q52, E24

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[1] Master's degree student, Atatürk University, Faculty of Agriculture, Agricultural Economics Department, Aziziye, Erzurum, 25700, Turkiye. **EMAIL**: hilmy.prilliadi19@ogr.atauni.edu.tr. **ORCID**: 0000-0001-5974-4352.

1. INTRODUCTION

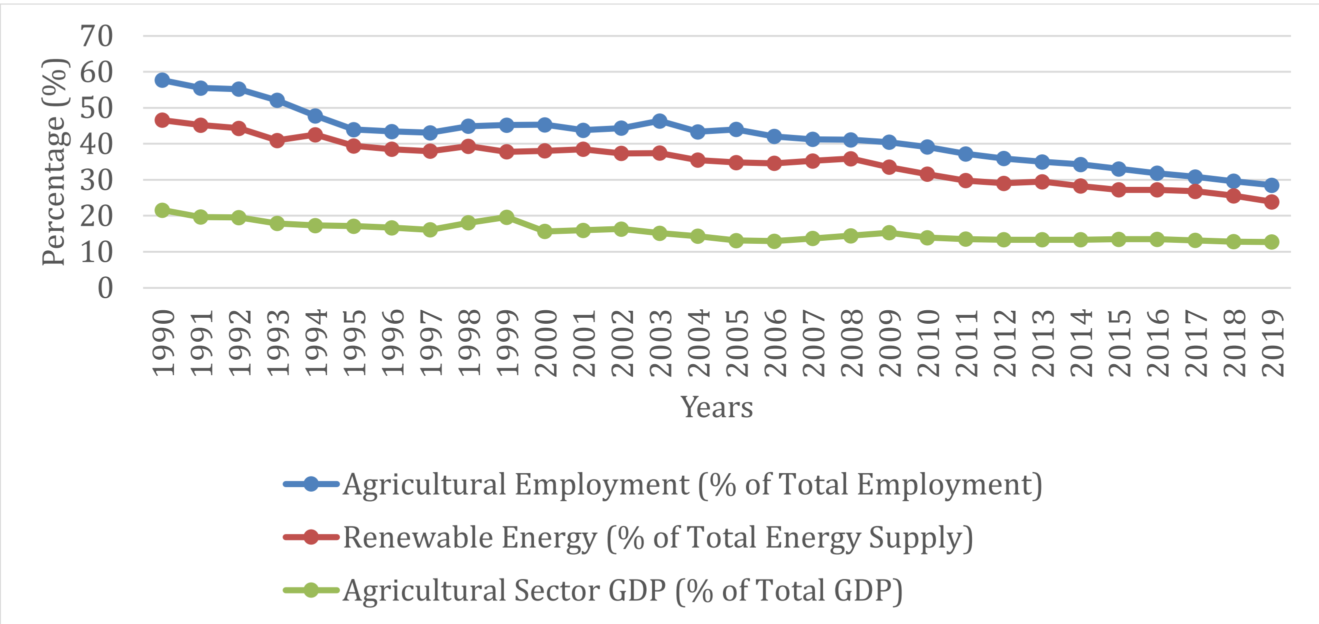
The transformation of developing countries to developed countries occurs in Indonesia. Indonesia's agricultural sector is changing because of the transformation into a developed country through economic development. Economic development cannot instantly change all aspects of the economy. Economic development in the long term brings very essential changes, especially in the structure of the economy. The transition is from a traditional economy centered on agriculture to a modern economy centered on the industrial sector as the primary driver of development. It also contributed significantly to foreign exchange earnings, revenue for the government, and the provision of food for the economy, as well as the supply of input materials to industries. According to this viewpoint, the agricultural sector was heavily reliant on it for growth and development, as well as for providing employment opportunities to the nation's unemployed labour force.

Agriculture's share of GDP and total employment shift as economies develop. Developing countries having a high but decreasing share while developed countries having a low but more stable share of agricultural GDP on their economies. It implies that agricultural sector plays more significant role developing countries, but less significant in developed countries.

Kuznets' (1961, p. 58) statement that as economies grow, the sector-based proportion of output and employment is willing to adjust in favour of non-agricultural sectors becomes almost unassailable. This statement is supported by the finding that most of the poorest regions of the world now show significantly higher GDP and agricultural employment shares. Therefore, the current study's emphasis on agricultural employment rates rather than economic growth is based on the idea that achieving lower rates of unemployment can sometimes be more essential than elevating the level of GDP as an intermediate target in reducing the level of poverty and reducing inequalities.

Figure 1 presents that annual agricultural sector employment shows a negative trend from 1990 to 2019. In 1990 agricultural sector employed 57.67% of Indonesia's total employment and became 28.5% in 2019. This condition is also followed by a negative trend in the agricultural sector's GDP proportion. The agricultural sector proportion of total Indonesian GDP fell from 21.55% in 2019 to 12.71% in 2019.

Figure 1: Indonesia's agricultural employment, GDP, total renewable energy supply



Source: OECD, 2021; World Bank, 2022

In this study, Indonesia's renewable energy usage is also considered an important variable. Nowadays, Indonesia's renewable energy involvement stands at 12%. Fossil fuels are still dominating 88% of the country's electricity production. However, only through switching energy investment toward renewable resources, Indonesia will be able to meet its target. By 2025, Indonesia is projected utilise renewable energy as its source of energy by up to 23% (Indonesian Ministry of Investment, 2021). On the other hand, to accomplish its target, Indonesia still must keep up its renewable energy usage because it shows a negative trend. Indonesia reached 46.57% renewable energy usage in 1990, but this number has decreased to 23.88% by the end of 2019.

The Paris Agreement attempts to reduce global warming to 1.5°C above pre-industrial levels. All country worldwide has used more than a percent of the carbon dioxide spending plan enabling it to keep only within 2°C maximum and that global carbon neutrality should be achieved between 2055 and 2070 to stay within this limit" (UNEP, 2014: 15). Reaching a 1.5°C objective requires a significant effort on the part of both developing and developed countries, which must implement a rapid and significant change in the structure of their energy supply and demand.

Assessing carbon pollution, according to Hamit-Haggar (2012: 359), has become an important aspect of the environment protection political framework. At the moment, a country should have renewable energy sources (such as wave, wind, solar, biomass, geothermal, tidal, and hydro), and these sources must grow in a sustainable and non-polluting manner. The reduction of pollution has emerged as the most important common objective for achieving a sustainable environment. As Emissions of CO_2 and energy consumption have risen, environmental policymakers have shifted their attention to the use of renewable energy rather than traditional energy sources. Many international organizations have recently emphasized the significance of reducing greenhouse gas emissions in both in developing and developed countries.

The most viable approach to reducing the agricultural sector's use of fossil fuels while meeting food productivity goals is the transition to more ecological and to use renewable energy sources. Biofuels, wind energy, hydropower, and solar are all covered. By enhancing the supply of green energies, stakeholders along the value chain of agri-food may be able to produce better quality of food while reducing food waste, thereby improving income levels and livelihoods. In short, renewable energy is essential to long-term climate-friendly agri-food system transformation and food security. Based on the fact that agricultural sector employment continues to decline while GDP contribution increases and Indonesia's capacity to use renewable energy continues to decline, this study looks at how total renewable energy supply and GDP share of agricultural sector affect agricultural sector employment.

1.1 Motivation

The socioeconomic effects of renewable energy consumption, which are also important for creating agricultural sector employment opportunity and reviving local economy, have been widely uninvestigated. This study is conducted due to the fact that the total renewable energy supply, GDP share of agricultural sector, and employment in Indonesian agricultural sector shows negative trend from 1990 to 2019. The decrease of total renewable energy supply will be a friction for Indonesia to accomplish its national target to deploy 23% of total renewable energy supply. Meanwhile, decreasing agricultural GDP share reduced the importance of agricultural sector in Indonesian economy. Furthermore, agricultural employment is significant because it can scale up agricultural sector productivity and contribute to the higher GDP share. Simultaneously, higher total renewable energy supply and GDP share of agricultural sector is expected to create additional employment in agricultural sector.

1.2 Contribution

The result of this empirical study is expected to be critical consideration for academician and government to make regulation about enhancing total renewable energy supply and GDP share of agricultural sector to increase employment in agricultural sector. The renewable energy policy should make sure that this energy is environmentally friendly and can be accessed with affordable price for agricultural sector stakeholders.

2. RELATED WORKS

The study's literature revolves around issues concerning environmentally friendly renewable energy, macroeconomics, and employment. One significant feature of renewable energy is its ability to generate low-emission energy while also having the potential to create new jobs. The macroeconomic aspect of this study is specialized in agricultural sector GDP because it has a correlation with agricultural production and employment (Proença & Fortes, 2020: 5). The model in this study examines whether or not total renewable energy supply and agricultural GDP share have an impact on agricultural employment from 1990 to 2019. These variables are used as reference materials in the literature review for this research, and the related studies are summarized below.

Ghosh (2009) investigates the relationship between power generation, employment, and real GDP in India using an autoregressive distributed lag (ARDL) bounds testing approach to cointegration. For the period 1970–71 to 2005–06, a long-run equilibrium relationship between these variables has been established. The research also demonstrates long- and short-run Granger causality from real GDP and supply of electricity to employment with no feedback effect. Thus, growth in real GDP and supply of electricity are to blame for India's high level of employment. Because there is no causality running from electricity supply to real GDP, electricity demand and supply side measures can be implemented to reduce electricity waste without affecting India's future economic growth.

Lehr, Mönnig, Missaoui, Marrouki, & Salem (2016) examines the economic implications of Tunisia's RE&EE assistance. Tunisia has had RE&EE legislation in place since 2009, with the Tunisian Solar Plan (PST). Energy efficiency in buildings generates the most employment when compared to investments of 100 million Dinars, followed by solar water heating system and PV installations. Wind energy and CSP come next. However, these findings were achieved given a certain import structure of the chosen fields. Solar water heaters were successfully deployed under the PROSOL framework, resulting in the second highest employment rate per 100 million Dinar.

Sari & Akkaya (2016) investigated the types of renewable energy resources and their usage levels across countries in her research. Diverse business areas emerge as a result of the countries' use of renewable energy resources, and the sectorial distribution of business areas is explained using numerical data from the countries. In accordance with these explanations, steps of business areas comprised of renewable energy resources, employment data provided by these steps, and the mechanism of employment because of data in a sustainable manner are also clarified.

Garrett-Peltier (2017) conducted research that presented a method for using Input-Output (I-O) tables to create "synthetic" industries, namely clean energy industries that do not currently exist in I-O tables. This method enables researchers to determine the effects of public and private spending on clean energy to the effects of spending on fossil fuels. They concentrated on the short-to-medium term employment effects and ignore the long-term correlation of operations and maintenance employment. They discover that a $1 million investment in fossil fuels generates 2.65 full-time equivalent (FTE) jobs, whereas the same investment in renewables or energy efficiency generates 7.49 or 7.72 FTE jobs. As a result, every $1 million shifted from brown to green energy creates a net increase of 5 jobs.

Zhao & Luo (2017) investigates the driving forces of environmental quality, policy, and employment on renewable energy generation in China. The findings indicate a quadratic relationship between renewable energy and income. However, when the lagged unemployment rate is included as an explaining variable, the results fail to show that renewable energy generation creates jobs. They considered the labour force, and the results show that employment can promote the development of renewable energy. Renewable energy will benefit greatly from the regulation. The interaction of income and employment demonstrates that as income rises, the impact of employment on renewable energy falls.

Stavropoulos & Burger (2020) performed a meta-analysis of the empirical studies on the net employment effects of renewable energy, and they investigated how much of the reported net employment effects are influenced by the methodology used. They discover that the identified conclusions on net employment effects are largely determined by the methodology used, with computable general equilibrium (CGE) and I/O methods that include induced effects, as well as studies that consider just the near future in their observation period (up to 2020), being less optimistic about net reducing unemployment in the aftermath of the energy transition. Furthermore, they discovered that policy reports are more likely than academic studies to report a positive net employment effect.

Nagatomo, Ozawa, Kudoh, & Hondo (2021)conducts research to determine the socioeconomic impact of rural power plant employment and examines the transition to a low-carbon energy system using a multi-regional MARKet ALlocation (MARKAL) model. The benefit is compensated in order to incorporate it into a cost-cutting criterion, and they concentrate on the impact of value differences on the Japanese energy system and employment. When considering the employment effects of rural power plants, their findings indicate that renewable energy, primarily biomass and solar photovoltaic, will increase to 350 TWh in 2030. Total employment associated with power generation facilities in rural areas will increase by up to 2.28 million person-years over the model period (45 years), with biomass power generation, in particular, playing a significant role in the reinvigoration of local economies due to the large job creation effect during its operational and maintenance phase.

Nasirov, Girard, Peña, Salazar, & Simon (2021)investigates the impact of renewable energy (RE) technologies on employment generation opportunities in Chile. The direct effects on employment in Chile were calculated using three energy scenarios built using the SWITCH-Chile energy model up to 2026. The findings show that renewable energy technologies (solar PV, wind, and hydro) can create more jobs per unit of energy than coal and natural gas. Based on the scenario with the greatest reduction in CO_2 emissions, which includes a significant renewable energies deployment, up to 20,958 jobs in Chile's energy sector could be created by 2026.

Li, Xu, Hui, Cai, & Zhang (2022) investigated how China's investments in renewable energy through the Belt and Road Initiative boosted Pakistan's local economy and employment. They used China's renewable energy investments in Pakistan as a case study in this study to investigate the effects of these investments on the local economy and employment. They discovered through IO table analysis that the 28 renewable power plant projects invested in by China up to now have the potential to provide 8905 jobs and generate around USD 39.8 million in production values in related sectors in Pakistan, including USD 30.7 million from wind power plant development and 9.1 million from solar.

Zaman, Zaman, Zhang, Wang, & Jehan (2022) investigates the relationship between agricultural output, female employment, renewable energy consumption, and carbon dioxide emissions in Pakistan. They used annual data from the World Bank database spanning the years 1991 to 2015. During observational evaluations using the ARDL model and robust analysis, the findings of this study establish an inverse and significant relationship between agricultural production, female employment, consumption of renewable energy, and CO_2 emissions.

3. MATERIALS AND METHOD

The data of Indonesia's total energy supply of renewable energy, agricultural sector GDP, and employment rate of the agricultural sector are used for this study. Each variable consists of 30 observations taken form annual data from 1990 to 2019 that is retrieved from the official website of OECD and The World Bank. Renewable energy encompasses a variety of energy sources that are environmentally friendly and are used repetitively because they cannot be depleted (Deka & Dube, 2021, p. 79). Wave, solar power, wind, hydropower, and tidal are just a few examples of renewable energy sources. Agricultural sector GDP share is expressed as a percentage of total GDP. Meanwhile, the term employment refers to the person who was employed in an activity that involved the production of goods or services for profit. In the agricultural sector, this includes hunting, fishing, and forestry.

Total renewable energy supply and agricultural sector GDP impact on the employment of the agricultural sector in Indonesia is investigated using the ARDL bounds test approach. ARDL model is the framework designed to investigate relationship between variables both in the short-run and long-run and includes lags of the dependent and independent variable. In this study, impacts of total renewable energy supply and GDP share of agricultural sector on employment of agricultural sector occur over time rather than all at once, as implied by distributed lag. This approach is particularly beneficial when the parameters are not integrated in the same order.

The ARDL bounds test model examines relationship level regardless of whether the variables are I[0], I[1], or not mutually cointegrated, so there is no need for pre-testing. Furthermore, the Augmented Dickey-Fuller (ADF) and the Phillips-Peron (PP) unit root test to ensure that no variable are not integrated of order 2 or said as I (2). Meanwhile, if the bounds test model's F-statistic is greater than the lower and upper bounds at all significance level, the Error Correction Mechanism (ECM) and short-run relationship can be indicated; meanwhile, if the F-statistics is less than the lower and upper bounds, only short-run relationship can be identified.

The following model is used to determine the total renewable energy supply and the agricultural sector's GDP share effect on Indonesia's agricultural employment rate. The model will be specified using the ARDL bounds testing approach, with renewable energy supply and agricultural sector GDP share as independent variables and agricultural sector employment as the dependent variable. The following equation expressed long run and short run relationship using the ARDL approach:

$$\Delta lnEmp_t = \alpha_0 + \beta_1 lnEmp_{t-1} + \beta_2 lnRen_{t-1} + \beta_3 lnGDP_{t-1} + \sum_{t=1}^{p} a_1 \Delta lnEmp_{t-1} + \sum_{t=0}^{q_1} a_2 \Delta lnRen_{t-1} + \sum_{t=0}^{q_2} a_3 \Delta lnGDP_{t-1} + \Psi ECM_{t-1} + \varepsilon_t \qquad (1)$$

Eqs. (1) show the statistical representation of the ARDL model to determine the long-run and short-run relationship between renewable energy usage and GDP share of the agricultural sector on its employment in Indonesia. The dependent variable ($lnEmp_{it}$) is expressed by the logarithm of employment. Renewable energy supply is expressed by the logarithm of total energy supply. $lnRen_{it}$ and $lnGDP_{it}$ represents the log of renewable energy and the share of agricultural sector GDP of Indonesia at time t. The coefficient α_i is the constant term, and ε_{it} is the error term. The short-run coefficients the ARDL models are β_1, β_2 and β_3. Meanwhile, α_1, α_2 and α_3 represent long-run relationship of the model. Δ expresses the difference (change) between two values of a variable in successive time periods.

ECM_{t-1} stands for one-period lagged error correction. LN stands for natural logarithm. Ψ is a coefficient that measures the rate of adjustment between long-run and short-run instability and indicates how quickly stability is restored in the event of a system shock. The short-run dynamics of the model are represented by the expression with summation sign. The validity, robustness, and reliability of the model are evaluated using the Breusch–Godfrey serial correlation test, the Breusch–Pagan–Godfrey heteroskedasticity test, and the Jarque–Bera normality tests.

The bounds test for cointegration is based on F-statistic under the null hypothesis stating that long-run relationship between the variables is not exist The joint significance test is used to test the null hypothesis:

$$H_0: \beta_1 = \beta_2 = 0$$

$$H_1: \beta_1 \neq \beta_2 \neq 0$$

The null hypothesis assumes that the long-run equation's coefficients are all exactly equal to zero, indicating that co-integration does not occur, as contrasted to the alternative hypothesis that indicates co-integration is exist. Two critical bounds tests value with the lower bounds denote all regressors are I (0) and the upper bounds assume that all regressors are (1). If The F-statistic for any level of significance chosen is less than the lower bound, only the short-run model is identified. Meanwhile, we can define the ECM if the F-statistic is greater than the upper bound.

The long-run relationship elasticity of all variables in this study will be estimated using the following equation:

$$\Delta lnEmp_t = \alpha_0 + \sum_{t=1}^{p} \theta_1 \Delta lnEmp_{t-1} + \sum_{t=0}^{q1} \theta \Delta lnRen_{t-1} + \sum_{t=0}^{q2} \theta \Delta lnGDP_{t-1} + \varepsilon_t \quad (2)$$

The long-run relationship is represented by Equation 2 above. Each symbol is as described in equation 1, with the exception of the θ, which represents the long-run coefficients.

4. FINDINGS AND RESULTS

4.1. Descriptive statistics and unit root test results

In Table 1 below, descriptive statistics for employment of agricultural sector in Indonesia, total renewable energy supply, and GDP share of the agricultural sector for the period of 1990–2019 are provided. The total sample size for each variable used in this study is 30. During 1990 and 2019, the mean value of agricultural sector employment, renewable energy, and employment in Indonesia's agricultural sector was 41.87% of total employment, 35.1% of national energy supply, and 15.46% of total GDP, respectively. During this period, Indonesia's average GDP share of the agricultural sector was 15.46% which is relatively low when it's compared to industry and services. Furthermore, the standard deviation for Turkey's agricultural sector employment, inflation, and renewable energy is found to be 784.322; 3335.5; and 32.82%, respectively.

Table 1: Descriptive statistic results

Variable	Agricultural Sector Employment (% of Total Employment)	Renewable Energy (% of Total Energy Supply)	GDP Share of Agricultural Sector (% of Total GDP)
Mean	41.87	35.1	15.46
Median	43.21	35.68	14.83
Maximum	57.67	46.57	21.55
Minimum	28.5	23.88	12.71
Std. Dev.	7.51	6.07	2.45
Sum	1256.164	1052.13	463.76
Observations	30	30	30

The unit root test is used to assess the order of variable integration. Variable that is not integrated of order zero produce unspecific results when used for analysis and is not proper to measure short-run analysis. The ADF and the PP unit root test were implemented in this study to determine whether or not the data are stationary at all levels of significance. The results of the unit root test are presented in Table 2 and Table 3 below.

Table 2: ADF unit root test result

Variables	Level Form		First Difference		Order of Integration
	ADF test statistics	1% critical value	ADF test statistics	1% critical value	
Employment	-0.065938	-3.679322	-4.107031	-3.689194	I(1)
Renewable Energy	0.300942	-3.679322	-5.724927	-3.689194	I(1)
GDP	-4.102554	-3.679322	-	-	I(0)

Table 3: PP unit root test result

Variables	Level Form		First Difference		Order of Integration
	PP test statistics	1% critical value	PP test statistics	1% critical value	
Employment	-0.155299	-3.679322	-4.099262	-3.689194	I(1)
Renewable Energy	0.797886	-3.679322	-5.863235	-3.689194	I(1)
GDP	4.137100	-3.679322	-	-	I(0)

The unit root test results in Table 2 and 3 present that Indonesia's agricultural sector employment and renewable energy use both on ADF and PP test are integrated on order one. Meanwhile, the agricultural sector's GDP share is only integrated at the level form. Both the ADF and PP test results for each variable are statistically significant at the 1% significance level, indicating that the variables are a mixture of I (0) and I(1). As a result, the ARDL model can be conducted.

4.2. Lag length selection criteria

The lag length for the autoregressive distributed lag model was calculated using the Akaike Information Criterion (AIC). EViews 12 supports lag length selection automatically. The AIC recommends 5 as the maximum lag length and presented the best ARDL model as shown in Figure 2.

Figure 2: Graph of Akaike Information Criterion-based lag ARDL lag length selection

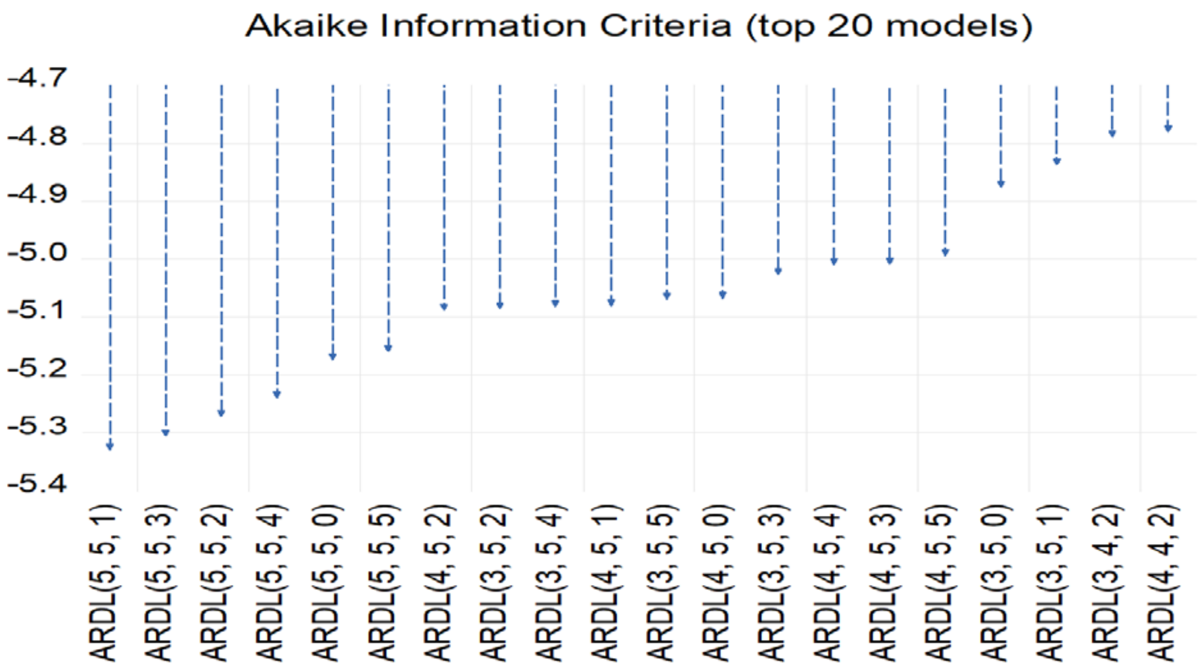


Figure 2 depicts the Autoregressive Distributed Lag (ARDL) model selection. The lag length evaluation resulted in the system automatically selecting ARDL (5, 5, 1) after 20 evaluations.

4.3. ARDL bounds test result

The results of the ARDL bounds test, as well as the short-run and long-run ECM results, are presented in this section of the study. According to the AIC, the best model is ARDL (5, 5, 1) which means lnEMP = 5, lnRen = 5, and lnGDP = 1, selecting the maximum lag value lnEMP = lnRen = lnGDP = 5. Table 4 displays the estimated ARDL ARDL (5, 5, 1) model results.

The bound test method was used to investigate the existence of a long-run relationship between the variables. This is due to the fact that GDP share of agricultural sector variable is integrated of order zero, whereas two others are integrated of order one. Table 4 depicts this output. If the bound test F-statistic is above the upper bound value, the null hypothesis which is stating that no existence of long-run relationship is rejected.

Table 4: ARDL bounds test result

F-statistic: 6.180777			
Significance	**I[0] Bound**	**I[1] Bound**	**Inference**
10%	2.63	3.35	Cointegrated
5%	3.1	3.87	Cointegrated
2.5%	3.55	4.38	Cointegrated
1%	4.13	5	Cointegrated

The F-statistic value is above the upper bound (I [0]) value, as shown in Table 4. It means that the null hypothesis is rejected, and the model's variables have a long-run relationship.

4.4. Estimated long-run model

The long-run model can be estimated after testing the validity of cointegration between variables. Table 5 shows the long-run model estimation results.

Table 5: Long-run coefficients

Dependent variable: Agricultural sector employment (Emp)	Coefficients	Std. Error	t-Statistic	Prob.
Renewable Energy	1.34	0.15	9.2	0.02**
GDP Share of Agricultural Sector	-0.43	0.16	-2.72	0.00*
C	0.12	0.25	0.47	0.01

As shown in Table 5, total renewable energy supply has statistically significant and positive relationship with agricultural sector employment in the long run. It stated unequivocally that every 1% total renewable energy supply improvement will increase agricultural sector employment by 1.34%. This outcome is consistent with Adelaja & Hailu (2008: 13) who indicated that land lease payments for wind turbine siting are estimated to contribute $50 million annually over time, posing an impact on agricultural viability. Furthermore, OECD (2017: 5) also supported the result by stating that green agriculture is one of the example sectors with the potential to create green jobs. Up to 20 million new jobs would be created globally by 2030 where 12 million in agriculture and industry related to biofuels take place (OECD, 2017: 8).

According to the long-run coefficients result, the GDP share of the agricultural sector has a statistically significant and negatively impact on agricultural sector employment. This result shows that agricultural sector employment will be increased by 0.43% with every 1% of GDP increase in the agricultural sector. This output is following Arendonk (2015: 27) who indicated that agriculture's share of GDP decreases as economic development progresses. Agricultural production will rise as the implication of technology application and scientific advancements. Growth in agricultural production will be accelerated in conjunction with divergence and specialization. This fact proves that increases in agricultural productivity enable the country to shift the agricultural sector's labour to a variety of other economy's sectors (Gollin, Parente, & Rogerson, 2002: 4). According to this point of view, productivity of agricultural labour is lower than productivity of industrial one, necessitating labour in agricultural sector mobility into the non-agricultural sector (Diao, Hazell, Resnick, & Thurlow, 2007). It implicates that without reducing agricultural output, agricultural labours can be transferred to industry.

4.5. Short-run error correction model

The ECM represents the short-run relationship between variables. Table 6 depicts the ARDL (5, 5,1) short-run error correction model.

Table 6: Estimated short-run model result

Variables	Coefficients	Std. Error	t-Statistic	Prob
D(EMP(-1))	0.32	0.1	3.12	0.0098
D(EMP(-2))	0.43	0.11	3.91	0.0024
D(EMP(-3))	-0.35	0.1	-3.59	0.0043
D(EMP(-4))	-0-.24	0.08	-2.81	0.0171
D(GDP)	-0.13	0.06	-2.25	0.0463
D(GDP(-1))	0.02	0.05	0.48	0.6373
D(GDP(-2))	0.003	0.05	0.07	0.9476
D(GDP(-3))	-0.11	0.06	-1.94	0.0485
D(GDP(-4))	0.32	0.05	6.11	0.0001
D(REN)	0.28	0.1	3.09	0.0102
ECM(-1)	-0.47	0.08	-5.61	0.0002

According to the examined short-run model result in Table 6, the first difference of all variables except the first and second year lags of GDP is statistically significant with less than 5% significance level to have an impact on agricultural sector employment, despite having positive coefficients. Furthermore, the GDP share of the agricultural sector affects negatively significant to agricultural sector employment in the short run where a 1% increase in GDP will decrease the employment by 0.13%. Meanwhile, agricultural sector GDP is positively significant at the fourth-year lag where a 1% increase in GDP will also increase the agricultural sector employment. This result is supported by Ogbanga (2018, p. 19) that revealed GDP contributes to the growth of employment which on average, a 1% increase in the gross domestic product leads to a 32% creation of jobs in Nigeria.

Table 6 shows renewable energy supply significantly contributes to the agricultural sector employment in the short run. Its coefficient indicates that a 1% increase in renewable energy use will lead to 0.28% additional employment in the agricultural sector. This condition is consistent with the findings of a study conducted by Proença & Fortes (2020: 585), who found that significantly improvement of total renewable energy supply will have a statistically significant and positive impact on increasing employment opportunities. The result agrees with Hillebrand et al. (2006: 3) who concluded that renewable energy investment will cause an output increase, resulting in higher employment of up to 35,000 jobs annually in Germany. Pestel (2019: 5) conducted research that supports this conclusion, stating that the decisive total effect employment from total renewable energy source investments should always be positive: advancement in renewable technology facilities generate additional demand for goods and services across industries and supply chains. This increases the demand for workers in fields such as R&D, production, installation and maintenance of green power plants. These findings suggest that Indonesia should implement policy support in order to achieve a positive impact on Indonesian society, such as contributing to improve agricultural employment, that has significant implication for citizens. Furthermore, prospective Indonesian implementation related to the country's target of using renewable energy as its primary source of energy by 2025 will be completed.

At the 1% significance level, the presence of a statistically negative and significant lagged error term ECM (-1) validates the presence of a long-run correlation. -0.47 is the error correction coefficient. This output defines the model and displays the long-run equilibrium adjustment speed. This means that the long-run deviation equilibrium is adjusted at 47% rate per year, which is less than 50%, indicating that the equilibrium adjustment rate is slow.

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4.6. Residual diagnostic and stability test results

To avoid misspecification errors, the Breusch-Godfrey Serial Correlation LM test, Jarque-Bera Normality test, Breusch-Pagan-Godfrey Heteroskedasticity diagnostic tests, as well as dynamic stability CUSUM and CUSUM of square tests are implemented in this study.

Breusch-Godfrey LM test

The serial correlation trend in the error term is investigated using the Breusch-Godfrey Serial Correlation LM Test. Table 7 shows the output of the test.

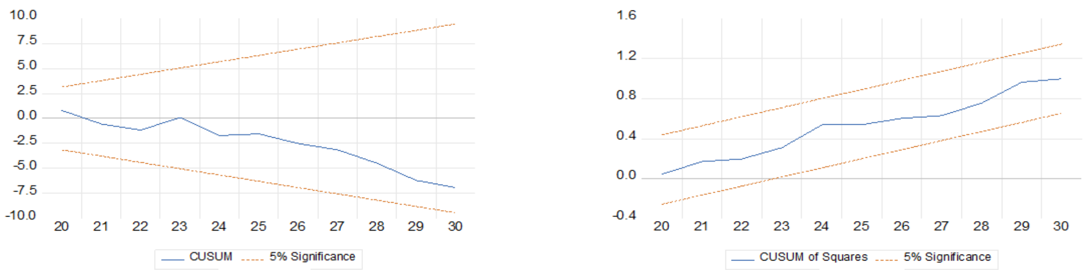
Table 7: Residual diagnostic test results

Test Series		
Breusch-Godfrey Serial Correlation LM Test	Obs*R-Squared	2.34567
	Prob. Chi-Square (2)	0.3095
Jarque-Bera Normality Test	Jarque-Bera	1.222647
	Probability	0.542632
Breusch-Pagan-Godfrey Heteroskedasticity Test	Jarque-Bera	1.222647
	Probability	0.542632

The results of the LM test above indicate that the null hypothesis which states there is no serial correlation cannot be rejected since the Obs*R-Squared value is not significant because it is greater than the Prob value. Chi-Square (2). Furthermore, The Jarque-Bera normality test shows the Jarque-Bera value of 1.222647 and is not significant because it has a probability value of 0.51. Therefore, it can be concluded that the null hypothesis which states that the residuals are normally distributed cannot be rejected. Moreover, The Breusch-Pagan-Godfrey Heteroskedasticity test shows that the Obs*R-squared value has an insignificant Chi-square probability value. Thus, the null hypothesis that the homoscedasticity model cannot be rejected.

The model's stability was evaluated using the CUSUM and CUSUM of Squares tests. These tests attempt to refuse the model hypothesis's stability if the middle blue line crosses the patterned red border lines; otherwise, the model is said to be stable. The model's stability is the null hypothesis for the test.

Figure 3: The plot of (a) CUSUM and (b) CUSUM of squares



(a) (b)

Figure 3 depicts the parameter stability test plots: Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMSQ). The null hypothesis of parameter stability cannot be rejected because the CUSUM plot is placed inside the critical bound of 5%. The CUSUMQ plot also falls inside the critical bound of 5%. It means that the estimated variables are constant or stable within the sample considered because they do not exhibit structural instability throughout the study.

5. CONCLUSION

This study estimated the impact of total renewable energy supply and agricultural GDP share on creating employment in the Indonesian agricultural sector. According to the estimation results, total renewable energy supply statistically significant and has a positive relationship with agricultural employment rate in both the short and long-run. Meanwhile, the agricultural sector GDP share is statistically significant and positive relationship with agricultural sector employment in the short-run but statistically significant and has a negative relationship in the long run.

Agriculture's GDP and employment contributions are declining. Taking everything into consideration, this seems to be primarily resulted of increased agricultural output. Therefore, agriculture has a lower relative value. Agriculture is losing importance in the country's economy, but agribusiness benefit of the entire accounts for much larger economy proportion. While agriculture's value added to agribusiness is improving, agribusiness's share of GDP is decreasing.

The results of this study indicate a promising opportunity for Indonesia to realize the wider use of renewable energy by 2025. The positive impact of renewable energy is also exploited by the growth of new jobs in the agricultural sector. This positive direct employment effect implies that expansions in renewable technology facilities create extra labour supply in agricultural sectors along their value chain. This increases the supply of workers in fields such as research and development, manufacturing, construction, and green energy system maintenance.

Many countries are shifting to a low-carbon green economy to meet political goals for climate change mitigation and provide new employment, especially for the agricultural sector. Prospective job creation is an argument used by both proponents and detractors of renewable energy regulations. As Indonesia strives to transform the economy to alleviate the country's alarming unemployment, policymakers in charge of agricultural output must provide adequate renewable energy for agricultural practices, particularly nowadays when agricultural sector is significant for economic revitalization. Energy policy changes may increase total employment by establishing more environmentally friendly agricultural employment, however they can also eliminate investment-driven employment in non-green sectors. Subsidies for renewable energy sources are typically included in this policy shift, raising the cost of energy for businesses and private households.

Given that the agricultural sector's GDP contribution and employment rate are declining; the use of renewable energy provides an important opportunity to create new jobs while increasing agricultural output. Policymakers should consider making every initiative to guarantee that each investment given to an agroecological scheme or policy is fully utilized for enhancing agricultural renewable energy use. Each scheme and policy should be carefully monitored to ensure that its specific policy objectives are met in order to create more jobs. As a result, more farmers must be educated on the advantages of mechanized farming. This will contribute to dispelling the myth that crop production is a seasonal occupation. It should result in more opportunities for educated workers in the agricultural sector.

The empirical evidence, particularly in the Indonesia case, shows that renewable energy policies have positive effects, and the agricultural sector's GDP share is a negative impact on employment. In addition, renewable energy policies should be judged on their ability to minimize the pollutants into the atmosphere while also ensuring a reliable supply of energy for agricultural production at a reasonable cost.

REFERENCES

Adelaja, S., & Hailu, Y. G. (2008). Renewable Energy Development and Implications to. *Director*, 1–15. Retrieved from http://ageconsearch.umn.edu/bitstream/6132/2/470566.pdf

Arendonk, A. van. (2015). The development of the share of agriculture in GDP and employment: A case study of China, Indonesia, the Netherlands and the United States. Retrieved from https://edepot.wur.nl/342795

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

Diao, X., Hazell, P., Resnick, D., & Thurlow, J. (2007). The role of agriculture in development: Implications for Sub-Saharan Africa. In *Research Report of the International Food Policy Research Institute*. https://doi.org/10.2499/9780896291614rr153

Dickey, D. A., & Fuller, W. A. (2012). Journal of the American Statistical Association Distribution of the Estimators for Autoregressive Time Series with a Unit Root Distribution of the Estimators for Autoregressive Time Series With a Unit Root. July 2015, 37–41. https://doi.org/10.1080/01621459.1979.10482531

Garrett-Peltier, H. (2017). Green versus brown: Comparing the employment impacts of energy efficiency, renewable energy, and fossil fuels using an input-output model. *Economic Modelling*, *61*(November 2016), 439–447. https://doi.org/10.1016/j.econmod.2016.11.012

Ghosh, S. (2009). Electricity supply, employment and real GDP in India: evidence from cointegration and Granger-causality tests. *Energy Policy*, *37*(8), 2926–2929. https://doi.org/10.1016/j.enpol.2009.03.022

Gollin, D., Parente, S., & Rogerson, R. (2002). The Role of Agriculture in Development. *The New Palgrave Dictionary of Economics*, *92*(2), 142–149. https://doi.org/10.1057/9780230226203.0037

Hamit-Haggar, M. (2012). Greenhouse gas emissions, energy consumption and economic growth: A panel cointegration analysis from Canadian industrial sector perspective. *Energy Economics*, *34*(1), 358–364. https://doi.org/10.1016/j.eneco.2011.06.005

Hillebrand, B., Buttermann, H. G., Behringer, J. M., & Bleuel, M. (2006). The expansion of renewable energies and employment effects in Germany. *Energy Policy*, *34*(18), 3484–3494. https://doi.org/10.1016/j.enpol.2005.06.017

Kuznets, S. (1961). Economic growth and the contribution of agriculture: notes on measurement (No. 979-2016-77077).

Lehr, U., Mönnig, A., Missaoui, R., Marrouki, S., & Salem, G. Ben. (2016). Employment from Renewable Energy and Energy Efficiency in Tunisia – New Insights, New Results. *Energy Procedia*, *93*(March), 223–228. https://doi.org/10.1016/j.egypro.2016.07.174

Li, R., Xu, L., Hui, J., Cai, W., & Zhang, S. (2022). China's investments in renewable energy through the belt and road initiative stimulated local economy and employment: A case study of Pakistan. *Science of The Total Environment*, *835*(April), 155308. https://doi.org/10.1016/j.scitotenv.2022.155308

Ministry of Investment. (2021). Harnessing renewable energy investment sector in Indonesia. Retrieved from Ministry of Investment: https://bit.ly/3yo08RJ

Nagatomo, Y., Ozawa, A., Kudoh, Y., & Hondo, H. (2021). Impacts of employment in power generation on renewable-based energy systems in Japan— Analysis using an energy system model. *Energy*, *226*, 120350. https://doi.org/10.1016/j.energy.2021.120350

Nasirov, S., Girard, A., Peña, C., Salazar, F., & Simon, F. (2021). Expansion of renewable energy in Chile: Analysis of the effects on employment. *Energy*, *226*. https://doi.org/10.1016/j.energy.2021.120410

OECD. (2017). Employment Implications of Green Growth: Linking jobs, growth, and green policies. OECD Report for the G7 Environment Ministers. *Oecd*, (June), 1–24. Retrieved from https://www.oecd.org/environment/Employment-Implications-of-Green-Growth-OECD-Report-G7-Environment-Ministers.pdf

OECD. (2021, October 28). Renewable Energy. Retrieved December 2021, from OECD: https://data.oecd.org/energy/renewable-energy.htm

Ogbanga, A. (2018). Agricultural Development and Employment Generation in Nigeria. *Allwell International Journal of Advanced Studies in Ecology*, *5*(1), 1–22. Retrieved from http://internationalpolicybrief.org/journals/international-scientific-research-consortium-journals/

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics, 16(3), 289–326. https://doi.org/10.1002/jae.616

Pestel, N. (2019). Employment effects of green energy policies. *IZA World of Labor*, (July 2014), 1–11. https://doi.org/10.15185/izawol.76.v2

Peter C. B. Phillips, & Perron, P. (1988). Testing for a Unit Root in Time Series Regression. Biometrika, 75(2), 335–346. https://doi.org/10.2307/2336182

Proença, S., & Fortes, P. (2020). The social face of renewables: Econometric analysis of the relationship between renewables and employment. *Energy Reports*, *6*, 581–586. https://doi.org/10.1016/j.egyr.2019.09.029

Sari, A., & Akkaya, M. (2016). Contribution of Renewable Energy Potential to Sustainable Employment. *Procedia - Social and Behavioral Sciences*, *229*, 316–325. https://doi.org/10.1016/j.sbspro.2016.07.142

Stavropoulos, S., & Burger, M. J. (2020). Modelling strategy and net employment effects of renewable energy and energy efficiency: A meta-regression. *Energy Policy*, *136*(August 2019), 111047. https://doi.org/10.1016/j.enpol.2019.111047

The World Bank. (2021, January 29). Employment in agriculture (% of total employment) (modeled ILO estimate) - Turkey. Retrieved December 2021, from The World Bank: https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=TR

The World Bank. (2022, April 27). Agriculture, forestry, and fishing, value added (% of GDP). Retrieved from The World Bank: https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS

UNEP. (2014). United Nations Environment Assembly of the United Nations Environment Programme. In United Nations Environment Programme. Nairobi. Retrieved from https://papersmart.unon.org/resolution/uploads/k1900699.pdf

Zaman, S., Zaman, Q. uz, Zhang, L., Wang, Z., & Jehan, N. (2022). Interaction between agricultural production, female employment, renewable energy, and environmental quality: Policy directions in context of developing economies. *Renewable Energy*, *186*, 288–298. https://doi.org/10.1016/j.renene.2021.12.131

Zhao, X., & Luo, D. (2017). Driving force of rising renewable energy in China: Environment, regulation and employment. *Renewable and Sustainable Energy Reviews*, *68*(January 2016), 48–56. https://doi.org/10.1016/j.rser.2016.09.126