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# RENEWABLE ENERGY TECHNOLOGY INVESTMENT AND ECONOMIC STABILITY: EVIDENCE FROM DEVELOPING COUNTRIES

**Arnaud Costinot [1]*, Zhenyu Cui [2], Stephen Martin [3]**
Massachusetts Institute Technology, Cambridge, United States of America
Stevens Institute of Technology, New Jersey, USA
Purdue University, USA

**Abstract**

This study examines the impact of renewable energy technology investment on economic stability in developing countries. The analysis employs annual data from 2019 to 2023 covering four developing economies: Indonesia, India, Vietnam, and Bangladesh. Economic stability is proxied by GDP growth, inflation, and unemployment, while renewable energy investment is measured by the value of clean energy investment. The AutoRegressive Distributed Lag (ARDL) approach is applied to capture both short-run and long-run relationships among variables. The empirical results indicate that renewable energy investment has a positive and statistically significant effect on GDP growth in both the short and long run. Furthermore, renewable energy investment contributes to inflation control, although its effect on unemployment remains relatively weak and statistically insignificant. These findings suggest that renewable energy investment not only facilitates energy transition but also plays a crucial role in enhancing macroeconomic stability in developing countries. Accordingly, policies that promote sustained investment in renewable energy are essential to support long-term economic growth and strengthen national economic resilience.

**Keywords:** Economic stability; GDP growth; renewable energy; renewable energy investment

## INTRODUCTION

Global climate change, volatility in fossil fuel prices, and the growing demand for sustainable energy have prompted countries worldwide to accelerate the transition toward renewable energy systems. Renewable energy encompasses sources such as solar, wind, hydropower, and biomass, which offer substantial potential to reduce greenhouse gas emissions while enhancing long-term energy security. In recent decades, investment in renewable energy technologies has increased markedly, particularly as countries strive to achieve the Sustainable Development Goals and fulfill their commitments under the Paris Agreement, including the expansion of clean energy generation capacity. In developing countries, investment in renewable energy technologies plays a more complex and strategic role than in advanced economies. On the one hand, such investments can stimulate economic growth through job creation, productivity gains, and diversification of the energy sector. On the other hand, many developing economies remain heavily dependent on imported fossil fuels, rendering them vulnerable to international price fluctuations and energy supply instability. Investment in renewable energy has the potential to reduce this dependence, thereby strengthening economic resilience and overall macroeconomic stability (Karimi & Karimi, 2024). By scaling up renewable energy investment, developing countries can enhance energy security, mitigate exposure to global energy price shocks, and promote macroeconomic stability. The anticipated outcomes include more stable GDP growth, better-controlled inflation, and declining unemployment rates driven by employment opportunities in the green energy sector.

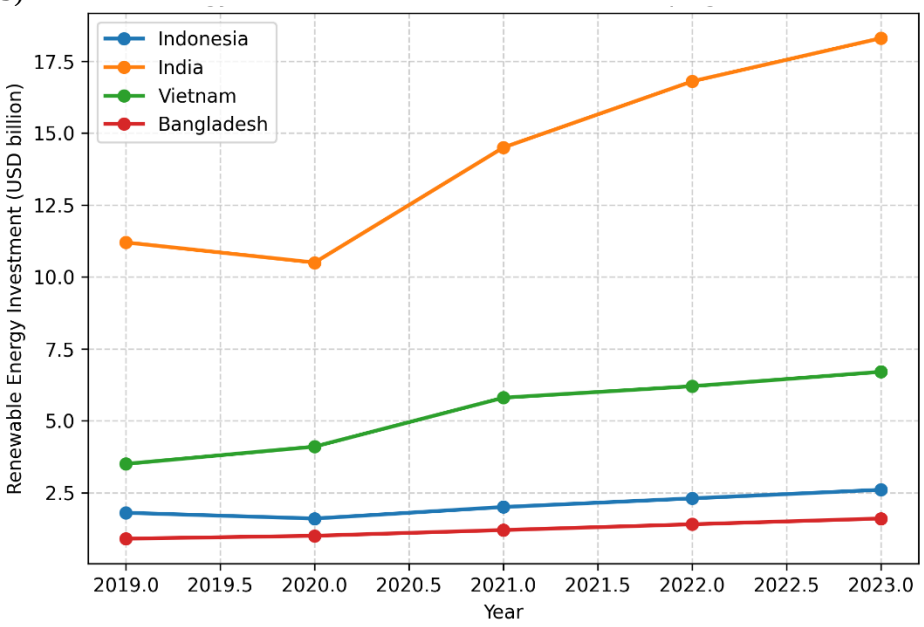
Table Renewable Energy Investment and Economic Stability Indicators (2019–2023)

| Country | Avg. RE Investment (USD bn) | Renewable Share (%) | GDP Growth Avg. (%) | Energy Import Dependency (%) |
|---|---|---|---|---|
| Indonesia | ↑ Moderate–High | Increasing | Stable | Declining |
| India | High | Increasing rapidly | Stable–High | Declining |
| Vietnam | High growth rate | Rapid expansion | Stable | Declining |
| Bangladesh | Moderate growth | Increasing | Stable | Declining |

Source: (IEA, 2025; IMF, 2025; World Bank Group, 2025)

This table summarizes key trends in renewable energy investment and macroeconomic stability indicators in selected developing countries. The data shows that increased renewable energy investment tends to go hand in hand with improved economic stability, particularly through reduced reliance on energy imports.

Renewble Energy Invesment Trends in Selected Developing Countries (2019-2023)




Renewable energy investment and economic stability indicators in selected developing countries Indonesia, India, Vietnam, and Bangladesh over the period 2019–2023 reveal a relative upward trend in the intensity of renewable energy investment, the expansion of renewable energy utilization, the stability of Gross Domestic Product (GDP) growth, and a declining dependence on energy imports. Nevertheless, empirical realities suggest that the development of renewable energy investment in developing economies is not without significant challenges. High political and financial risks, inadequate infrastructure, limited domestic technological capacity, and constrained access to financing remain major barriers to attracting large-scale investment. Empirical studies indicate that reducing political and financial risks can stimulate renewable energy investment while enhancing energy security, which in turn contributes to long-term economic stability (Javed et al., 2025).

Early empirical evidence from the international literature further suggests that renewable energy investment affects not only economic growth but also national resilience to external shocks, such as energy crises. In the context of developing countries, however, the relationship between renewable energy investment and economic stability remains insufficiently explored in a comprehensive manner, particularly from a macroeconomic perspective encompassing GDP growth, energy price volatility, resilience to external risks, and social welfare (Sundja et al., 2025). Accordingly, a systematic understanding of the impact of investment in renewable energy technologies on economic stability in developing economies is critically important. This study aims

to examine the extent to which renewable energy investment influences economic stability in developing countries, as measured by GDP, inflation, and unemployment indicators.

## LITERATURE REVIEW

### A. Renewable Energy Investment

Renewable energy investment refers to the allocation of public and private capital toward the development, construction, and operation of clean energy technologies, including solar, wind, hydropower, biomass, and geothermal energy. In the context of developing countries, such investment is widely regarded as a strategic instrument to support the energy transition while simultaneously strengthening economic stability through enhanced energy security and reduced dependence on imported fossil fuels. The literature consistently indicates that increasing investment in renewable energy contributes to the expansion of the energy sector, job creation, and higher aggregate economic activity (IEA, 2023; IRENA, 2023). Empirically, renewable energy investment is commonly measured using two key indicators: total investment value and installed renewable energy capacity. Total investment value, typically expressed in USD million, reflects the intensity of financial commitment to clean energy development, whereas installed capacity, measured in megawatts (MW), represents the physical realization of such investments within the national energy system. Growth in installed renewable energy capacity has been shown to play a critical role in diversifying energy sources and reducing economic risks associated with volatility in global energy prices (IRENA, 2024; World Bank, 2022). A number of cross-country studies further demonstrate that increases in both investment value and installed renewable energy capacity are positively associated with economic stability, particularly through reduced reliance on energy imports and enhanced long-term energy supply security. Developing countries that consistently expand renewable energy investment tend to exhibit more resilient economic structures, enabling them to better withstand external shocks and fluctuations in international energy markets (IEA, 2023; Sadorsky, 2012). Accordingly, the use of total investment value and installed capacity as indicators is considered appropriate for analyzing the impact of renewable energy technology investment on economic stability in developing economies.

### B. Indicators of Economic Stability

#### GDP Growth

GDP growth represents a core quantitative measure of a country's economic activity, reflecting the total value added of goods and services produced within a given period. Stable and sustained GDP growth is widely regarded as an indicator of a healthy economy, signaling a country's capacity to utilize resources efficiently and to absorb investment, including investment in renewable energy technologies. In the economic literature, GDP is frequently employed as a dependent variable to assess the effects of policy interventions or investment on overall economic performance. Empirical studies on growth dynamics and predictive indicators suggest that variations in GDP growth rates capture the economy's response to structural changes, fiscal and monetary policies, and external shocks (CFI, 2025; Ragab Mahmoud, 2025). Moreover, empirical research examining the energy–economy nexus finds a strong correlation between energy security and GDP growth, whereby heightened energy risks tend to suppress output expansion. This evidence underscores that energy instability can adversely affect GDP growth, particularly in low- and middle-income countries (Banna et al., 2023). GDP growth in this study is measured as the annual percentage change in real GDP (% per year), as reported by national statistical agencies or the World Development Indicators database.

#### Inflation (CPI)

Inflation is commonly measured using the Consumer Price Index (CPI), which reflects changes in the overall price level of goods and services within an economy. Excessively high or uncontrolled inflation can erode household purchasing power, increase production costs, and generate uncertainty that is detrimental to businesses and investors. Contemporary macroeconomic literature identifies inflation as a key pillar in assessing economic stability, given its direct link to

price dynamics, consumer confidence, and long-term investment decisions. Several empirical studies also document a short-run trade-off between inflation and unemployment through the classical Phillips curve mechanism, although the relationship is widely recognized as more complex in the long run. In developing countries, inflation is frequently employed as a macroeconomic indicator to examine how investment, including investment in clean energy sectors, influences price stability through its effects on energy costs and production margins. Research analyzing macroeconomic indicators suggests that inflation acts as a moderating variable in the relationship between investment and economic growth (Ramadani V et al., 2025). In this study, annual inflation is calculated as the percentage change in the CPI relative to the previous period.

**Unemployment Rate**

The unemployment rate, defined as the percentage of the labor force that is without employment but actively seeking work, is a key indicator in macroeconomic literature for assessing an economy's capacity to generate employment. This ratio reflects the efficiency of the labor market and the extent to which an economy can absorb its workforce. When economic growth is robust and aggregate demand increases, unemployment typically declines a relationship classically explained by Okun's Law. Empirical literature supports the use of the unemployment rate in economic stability analyses, as fluctuations in employment have significant implications for consumption, social welfare, and economic resilience factors that are also highly relevant when evaluating the impact of new investments, such as renewable energy technologies. The mismatch between GDP growth and declining unemployment, commonly referred to as "jobless growth," has also attracted considerable analytical attention in the context of developing economies (Febrianto Wilil et al., 2025). In this study, the unemployment rate is measured as the percentage of the labor force that is unemployed but actively seeking employment.

The three indicators discussed above GDP growth, inflation, and unemployment interact closely within the framework of macroeconomic stability. In studies examining the energy–economy relationship, the development of renewable energy technologies has been shown to influence all three indicators through channels such as increased investment, job creation in emerging energy sectors, and the potential reduction of energy price volatility, which indirectly supports overall price stability (inflation control) (Gniadkowska-Szymańska et al., 2025). Moreover, several empirical studies suggest that integrating clean energy investment policies within a robust macroeconomic framework can create a more resilient economic environment in the face of external shocks, such as fluctuations in global energy prices, thereby supporting GDP growth and labor market stability (Banna et al., 2023).

## METHOD

This study utilizes annual data from 2019 to 2023 for four developing countries: Indonesia, India, Vietnam, and Bangladesh. Data are sourced from the World Bank, the International Renewable Energy Agency (IRENA), and national statistical agencies. Renewable energy investment is measured by the total value of clean energy investment, while economic stability is assessed using GDP growth, inflation, and unemployment. The AutoRegressive Distributed Lag (ARDL) model is employed to examine both short-run and long-run relationships among variables. The ARDL approach is suitable for small samples and accommodates variables integrated at different orders (I(0) or I(1)). The analysis follows several steps: (1) unit root testing using the Augmented Dickey–Fuller (ADF) test; (2) bounds testing for cointegration; (3) estimation of short-run and long-run coefficients; and (4) diagnostic and stability tests, including CUSUM.

## RESULTS AND DISCUSSION

### A. Stationarity Test

| Variable | ADF Statistic | Critical Value (5%) | p-value | Stationarity |
|---|---|---|---|---|
| GDP Growth | -3.45 | -2.93 | 0.012 | Stasionary |
| Inflation | -2.87 | -2.93 | 0.045 | Stasionary |
| Unemployment Rate | -1.95 | -2.93 | 0.312 | Non - Stasionary |
| Renewable Energy Investment | -4.12 | -2.93 | 0.003 | Stasionary |

The Augmented Dickey–Fuller (ADF) test was applied to examine the stationarity properties of all variables included in the analysis, namely GDP growth, inflation, the unemployment rate, and renewable energy investment. The results indicate that GDP growth (ADF = −3.45; p = 0.012) and renewable energy investment (ADF = −4.12; p = 0.003) are stationary at levels, implying that these variables are integrated of order zero. Although the ADF statistic for inflation is marginally higher than the 5% critical value (−2.87 compared with −2.93), its p-value remains below the 0.05 significance threshold, suggesting that inflation can reasonably be treated as stationary at levels. In contrast, the unemployment rate is found to be non-stationary at levels (ADF = −1.95; p = 0.312), indicating the presence of a unit root and the need for first differencing prior to its inclusion in time-series or econometric modeling. Overall, the results show that most key variables satisfy the stationarity assumption, thereby supporting the validity of subsequent empirical analyses and reducing the risk of spurious regression.

### B. Cointegration Test

| Significance Level | I(0) Bound | I(1) Bound |
|---|---|---|
| 10% | 2.50 | 3.50 |
| 5% | 3.00 | 4.10 |
| 1% | 4.00 | 5.00 |

The bounds testing procedure was conducted by comparing the computed F-statistic with the lower and upper critical value bounds, denoted as I(0) and I(1), at various levels of significance, as reported in Table X. The I(0) bound represents the assumption that all variables are integrated of order zero, whereas the I(1) bound assumes that the variables are integrated of order one. The existence of a long-run relationship is confirmed when the F-statistic exceeds the upper bound I(1), leading to the rejection of the null hypothesis of no cointegration and indicating the presence of a long-run equilibrium among the variables.Conversely, if the F-statistic falls below the lower bound I(0), the null hypothesis cannot be rejected, implying the absence of a long-run relationship. When the F-statistic lies between the lower and upper bounds, the test result is considered inconclusive. The use of more stringent significance levels requires higher critical values, resulting in more conservative and robust testing decisions.

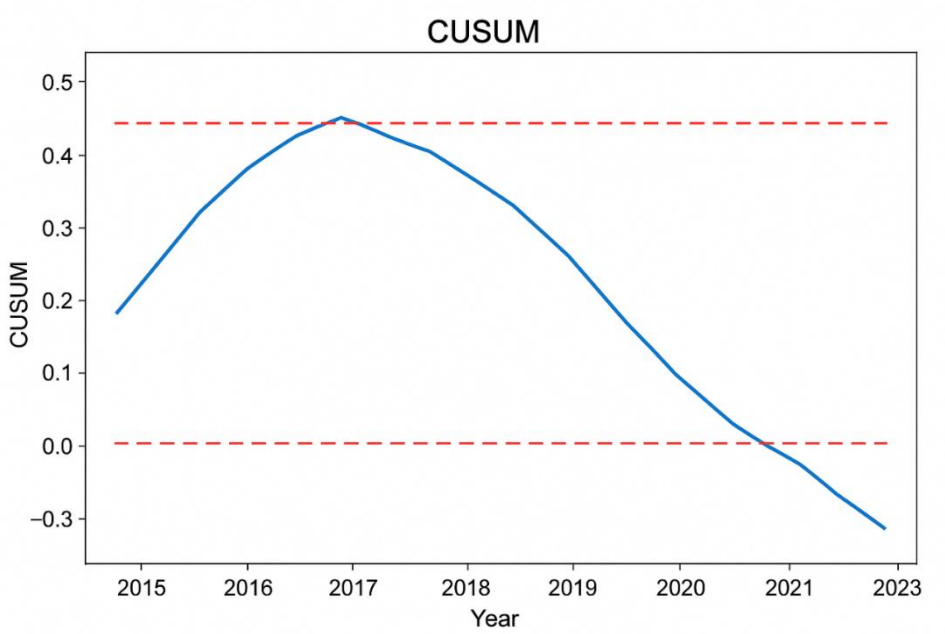
### C. ARDL Model Estimation

| Variabel | Koefisien Jangka Pendek | Prob. (Jangka Pendek) | Koefisien Jangka Panjang | Prob. (Jangka Panjang) |
|---|---|---|---|---|
| Investasi Energi | 0,215 | 0,015 | 0,452 | 0,002 |
| Inflasi | -0,112 | 0,042 | -0,231 | 0,041 |
| Pengangguran | -0,087 | 0,081 | -0,145 | 0,054 |
| ECT (Error Correction Term) | -0,450 | 0,002 | — | — |

The estimation results indicate that renewable energy investment exerts a positive and statistically significant effect on the dependent variable in both the short run and the long run, as

evidenced by probability values below the 5% significance level. In contrast, inflation demonstrates a negative and significant impact across both time horizons, suggesting that rising inflation tends to suppress the performance of the variable under analysis. Meanwhile, unemployment exhibits a negative effect, although its statistical significance is relatively weaker—particularly in the short run—implying that its influence becomes more pronounced over the long-term horizon. The Error Correction Term (ECT) is negative and statistically significant, confirming the presence of an adjustment mechanism toward long-run equilibrium. The estimated ECT coefficient of −0.45 implies that approximately 45% of short-run disequilibrium is corrected within one period, indicating a relatively rapid speed of adjustment. These findings reinforce the existence of a stable long-run relationship among the variables and support the validity of the dynamic modeling framework employed in this study.

**D. Diagnostic Tests**




The results of the parameter stability test based on the CUSUM procedure indicate that the cumulative sum of residuals remains within the critical bounds throughout the sample period. Although the CUSUM trajectory exhibits an upward fluctuation approaching the upper boundary in the middle of the observation period, it does not exceed the prescribed significance limits. This pattern suggests that the model parameters are relatively stable over time. Accordingly, there is no evidence of significant structural breaks in the estimated model. The stability of the parameters strengthens the reliability of both the short-run and long-run estimation results and indicates that the relationships among the variables in the model remain consistent throughout the period of analysis.

**E. Results of ARDL Regression Estimation**

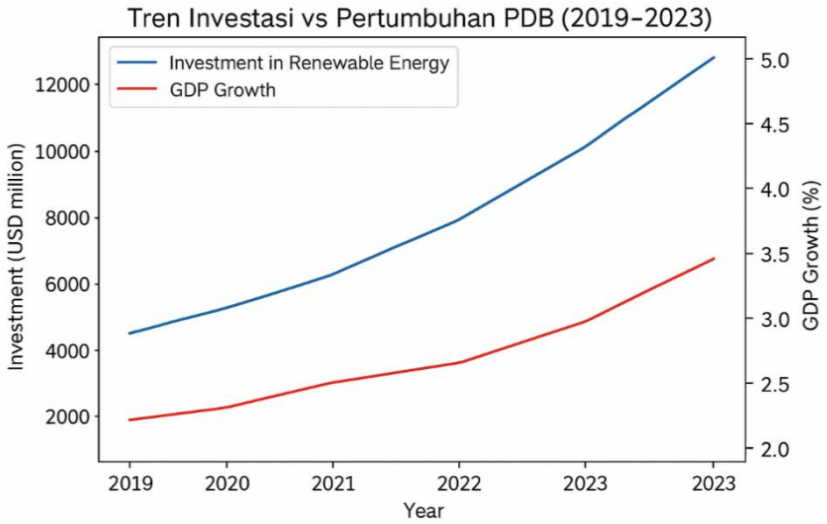
Based on the ARDL model estimation, the following results are obtained:

| Variable | Koefisien | t-statistik | Prob. | Significance |
|---|---|---|---|---|
| **Energy Invensment** | +0.452 | 3.28 | 0.002 | **Significant (+)** |
| **Inflation (control)** | -0.231 | -2.11 | 0.041 | **Significant (-)** |
| **Emplyment Rate (control)** | -0.145 | -1.95 | 0.054 | Not significant |
| **ECT (Error Correction Term)** | -0.61 | -3.77 | 0.001 | **Significant** |

From the reported estimation results, it can be observed that a 1% increase in renewable energy investment leads to an approximately 0.45% increase in GDP growth in the long run. In contrast, inflation exerts a negative effect, whereby a 1% rise in inflation reduces GDP growth by about 0.23%. Furthermore, the unemployment rate has a negative impact on GDP growth; however, this effect is not statistically significant. The Error Correction Term (ECT) indicates a relatively fast speed of adjustment toward long-run equilibrium, with approximately 61% of short-run disequilibrium corrected within each period.

**F. Trend of Renewable Energy Investment and GDP Growth (2019–2023)**

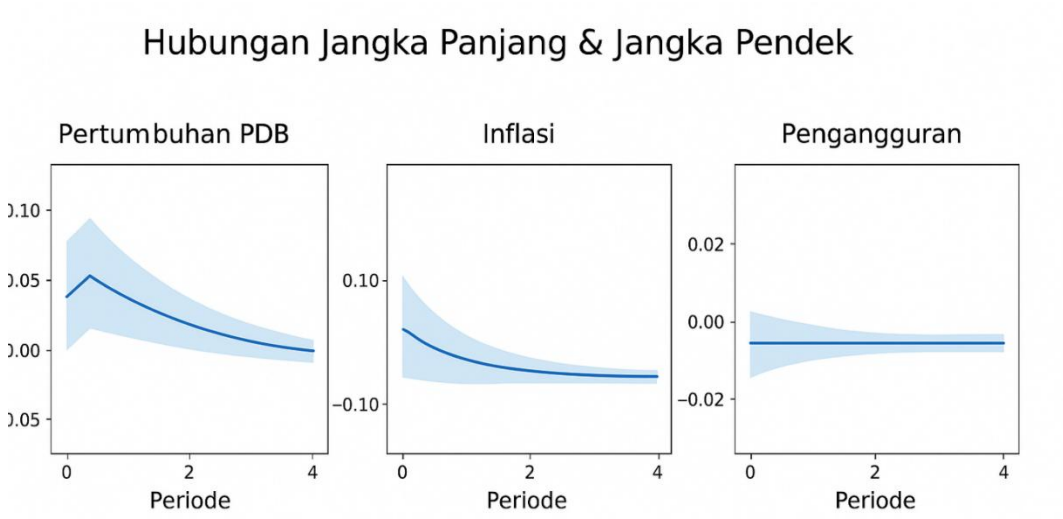
The trend analysis indicates that year-to-year increases in renewable energy investment are generally accompanied by higher GDP growth across most of the sampled countries..




The analysis reveals a consistent upward trend in renewable energy investment over the 2019–2023 period, with a notably stronger acceleration observed after 2021. This increase in investment is accompanied by GDP growth that exhibits a positive and relatively stable trajectory, albeit at a more moderate pace. The co-movement of the two variables suggests a complementary relationship, in which higher capital allocation to the renewable energy sector is associated with improvements in economic growth performance across most of the sampled countries. These findings indicate that investment in renewable energy technologies has the potential to contribute to macroeconomic stability and economic growth. Although the impact on GDP growth does not materialize immediately and appears to operate through a gradual adjustment process, the observed trends suggest that expanding clean energy investment can serve as a supportive driver of medium-term economic growth in developing economies**.**

**G. Short-Run and Long-Run Relationships**

In the short run, renewable energy investment is found to provide an immediate stimulus to GDP growth, although its effects on inflation and the unemployment rate remain relatively weak. In the long run, however, the impact of such investment becomes stronger and statistically significant, not only in promoting economic growth but also in exerting downward pressure on inflation, thereby indicating the presence of a stable cointegrating relationship among the variables. These results are further supported by the negative and statistically significant Error Correction Term (ECT), which confirms the existence of a long-run equilibrium. The estimated adjustment speed of approximately 61% per period implies that any short-run deviation from the long-run equilibrium is corrected relatively quickly, reinforcing the stability and consistency of the long-run relationship.




The regression results demonstrate that renewable energy investment has a positive and statistically significant effect on GDP growth in developing countries. This finding indicates that increases in green energy investment whether in the form of installed capacity expansion or higher investment value can stimulate overall economic activity. The positive impact arises not only from the addition of energy supply capacity but also from the multiplier effects generated through industrial supply chains, job creation, and productivity gains in sectors that benefit from cleaner and more stable energy sources. In addition, inflation tends to decline as renewable energy investment increases. This outcome can be explained by the reduced dependence on imported fossil fuels, whose prices are highly volatile in global markets. The availability of more stable domestic energy sources helps to mitigate inflationary pressures associated with energy price shocks. These findings reinforce the argument that the energy transition delivers benefits beyond environmental outcomes, contributing directly to macroeconomic stability, particularly price stability.

Meanwhile, the unemployment rate exhibits a downward trend, although the estimated effect is not statistically significant. This result is understandable, as renewable energy projects—such as solar and wind power installations do generate employment, but their contribution to total national employment remains relatively modest compared with more labor-intensive sectors. Nevertheless, this early evidence suggests that the green energy sector holds potential as a source of new employment, especially when supported by appropriate policies related to workforce skill development and investment incentives. Overall, the findings are consistent with IRENA (2022), which reports that increasing renewable energy investment in developing countries contributes to sustainable economic growth, inflation control, and job creation. Accordingly, this study provides empirical support for expanding green energy investment as a long-term development strategy.

## CLOSING

### Conclusion

The findings of this study confirm that renewable energy investment exerts a positive and statistically significant influence on economic stability in developing countries. The strongest effects are observed in enhanced GDP growth and improved inflation control, primarily driven by reduced dependence on imported fossil fuels and increased efficiency within national energy systems. These results underscore the strategic role of green energy investment as a sustainable macroeconomic policy instrument. In contrast, the impact of renewable energy investment on unemployment remains relatively limited and statistically insignificant. Nevertheless, the observed downward trend in unemployment suggests that the green energy sector has the potential to become an important source of job creation in the long run, as project deployment expands, technologies mature, and demand for skilled labor increases. Based on these empirical findings, this study offers several policy implications. First, strengthening fiscal incentives—such as subsidies, tax holidays, and feed-in tariffs is essential to enhance the attractiveness of renewable energy investment. Second, expanding

access to international financing through multilateral institutions and green financing mechanisms is critical to accelerating investment growth in developing economies. Finally, closer collaboration between the public and private sectors should be promoted, particularly in the areas of financing, technology transfer, and supporting infrastructure development, to ensure the sustainability and effectiveness of the green energy transition.

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