International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2025, 15(5), 539-546.

# How does Financial Stability Affect Renewable Energy Investment?

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**Received:** 09 May 2025 **Accepted:** 06 August 2025 **DOI:** https://doi.org/10.32479/ijeep.20905

**ABSTRACT**

There is no doubt that financial stability is crucial for the sustainable economic growth of a nation. Nevertheless, whether it has any role in aiding renewable energy investment is an empirical question that has not received much consideration in the past. Therefore, our primary goal is to examine the role of financial stability in promoting renewable energy investment in top-polluting economies from different regions of Asia, Africa, America, and Europe. To that end, our selected estimation technique is CS-ARDL. Our long-run results reveal that financial stability and GDP cause renewable energy investment to rise in all regions except Africa. On the other hand, carbon emissions and ICT favorably influence renewable energy investment in all regions. The short-run estimates are insignificant in most instances. Since financial stability is crucial for promoting renewable energy investment, policymakers must focus on a more stable financial sector, and financial stability should be part and parcel of any policy design to promote renewable energy investment.

**Keywords:** Financial Stability, Renewable Energy Investment, CS-ARDL
**JEL Classifications:** O44, Q20, Q40, Q57

## 1. INTRODUCTION

The rise in greenhouse gas (GHG) emissions due to anthropogenic activities has contaminated the world's environment, making environmentalists and policymakers worried about the future of humanity on Earth (Dryzek, 2022). In this regard, the most feasible option for the world is to follow the path of sustainable development, in which economic and environmental goals are given equal consideration. However, walking on the path of sustainability is not easy, and the economy must require dependable, cost-effective, economically feasible, and socially suitable energy sources (Kaygusuz, 2012). Investing in renewable energy technologies can increase the generation of clean energy that would enlarge the energy mix, protect the environment from further degradation, and improve energy availability (Dincer, 2000; Erdogan et al., 2023). Similarly, economists have confirmed that the increased use of renewable energy sources can restrict $CO_2$ emissions (Cantarero, 2020). Since renewable energy is the best option to deal with the problems of environmental degradation and energy poverty; hence, many nations have invested heavily in their energy sector to increase the generation of renewable energy with the help of feed-in tariffs and renewable portfolio standards policies. However, despite all these struggles, non-hydro-renewable energy sources only amounted to 5.8% of total energy generation by 2013 (REN21, 2014). The lack of renewable energy production in most economies is linked to its high initial cost, information cost, and precision of assets.

One of the main hurdles that have obstructed renewable energy generation is its high start-up cost. This is because the energy sector, compared to other sectors, is capital-intensive and requires much more investment before production starts (Peng and Liu, 2018). Another reason behind the lack of renewable energy generation is that investment in renewable energy sources provides a lower rate of return than non-renewable energy ventures. The pay-back period for clean energy projects is too long and needs massive financial resources. In addition to the high initial cost, information cost is another hurdle in generating renewable energy projects, particularly the cost of doing research and gathering data. The history of deploying renewable projects is not long enough; hence, inadequate data collection has created great doubts (Hanke et al., 2021). Consequently, it seems that asymmetry in the information develops between the firms and the investors. Hence, the lack of investment in renewable energy production is also because of the information cost usually endured by the financers. Moreover, the energy infrastructure is highly specific in nature. For instance, the services provided by the energy plants make the energy assets highly specific because such services are only related to specific domestic markets. These assets do not hold higher cash value in the markets and can not provide much cash benefits in the case of bankruptcy, which is the main reason behind the rise in exterior sponsoring costs of renewable energy (Guelpa et al., 2019). Hence, to conclude, we can say that the low generation of renewable energy is due to the following three reasons: high start-up costs, information asymmetry, and the specific nature of assets. These three reasons justify the provision of expensive funds by investors for renewable projects, thereby stemming the deployment of renewable energy.

Therefore, stability and well-functioning are vital for developing renewable energy technologies because they can facilitate the provision of debt and equity financing (Lei et al., 2022). The economic concepts based on the ideas of modern contracts recommend that to resolve problems such as moral hazards and adverse selection, a well-functioning financial market can play a significant role, which would ultimately reduce the firms' external financial costs. Hence, a dynamic and vibrant financial sector is more likely to facilitate renewable energy production, particularly projects that require massive investment (Alsagr, 2023).

The main objective of this analysis is to examine how financial stability affect renewable energy investment in top polluting economies. Several studies have investigated the relationship between financial development and environmental quality. Tamazian et al. (2009) collected the data for the BRICS economies and observed that financial development is highly recommended for mitigating $CO_2$ emissions. Along the same lines, Tamazian and Rao (2010) collected data for 24 transitional economies and established that financial development can contribute to environmental protection strategies via controlling $CO_2$ releases. They also suggest that financial development is key in promoting environment-related technologies at an affordable cost and enhancing environmental quality. Also, Jalil and Feridun (2011) confirmed that financial sector development is crucial in mitigating environmental pollution. According to Baloch et al. (2018), financial instability may increase environmental pollution because the weak financial structure can't provide the required investment for the development of renewable energy technologies due to increased information asymmetry. Several studies (Safi et al., 2021; Ashraf, 2022) have investigated the positive influence of financial stability on the environment in E-7, belt and road initiative countries, and India. However, these studies have overlooked the crucial connection between financial stability and renewable energy investment.

Even though the relationship between financial stability and $CO_2$ emissions has been widely investigated, none of the past studies have investigated how the financial sector affects environmental quality. This study is an effort to explore the channel that helps the financial sector to promote environmental quality in top polluting economies, which is an investment in renewable energy projects. This is the first-ever study that tries to investigate the impact of financial stability on renewable energy investment in top-polluting countries' economies. For this purpose, we have employed the novel CS-ARDL model proposed by Chudik and Pesaran (2015) that can help estimate both the short and long-run effects on renewable energy investment. The top polluting economies have become the key international players due to their contribution to global GDP. Moreover, the top polluting economies are among the top energy consumers and the top emitters of GHG. In light of the Paris Agreement goals, top-polluting economies have shifted their focus toward investment in renewable energy. Therefore, it is appropriate to investigate the relationship in the context of top-polluting economies. The findings of this study carry substantial industrial significance, particularly for stakeholders involved in energy finance, policy formulation, and sustainable infrastructure development. By demonstrating that financial stability enhances investment in renewable energy, this research offers actionable insights for financial institutions, investors, and policymakers aiming to align financial sector reforms with environmental targets. In the era of carbon neutrality and green transitions, understanding this linkage is crucial for designing resilient financial systems that can support renewable energy development.

## 2. THEORETICAL FRAMEWORK AND EMPIRICAL MODEL

The theoretical base of this topic is derived from the link between finance and energy consumption. According to Sadorsky (2011), there are three mechanisms through which finance can influence energy consumption. These three mechanisms include direct, business, and wealth effects. The direct effect of financial development suggests that a more developed and stable financial sector significantly boosts energy consumption (Anton and Nucu, 2020; Chiu and Lee, 2022). This is because a well-developed and stable financial sector provides more funds to individuals at a reasonable price, which allows them to buy more energy-intensive goods. On the other hand, business effects in the context of financial development offer businesses and firms loans and financial capital at the most affordable rates and help them deploy plants and machinery that consume higher levels of energy. Lastly, the wealth effects come into play after the overall rise in economic activities due to a developed and stable financial sector, leading to an increase in energy consumption (Eren et al., 2019). In recent times, renewable energy has become an integral part of the energy mix of most developed and developing economies; therefore, the higher energy demand is to be fulfilled by clean and green energy sources instead of dirty and traditional ones. As far as the link between financial stability and renewable energy is concerned, financial stability may impact renewable energy investment via stable and well-established financial institutions and capital markets, which are crucial in providing funds and capital for green energy projects (Boute, 2020). Moreover, a stable financial setup offers incentives for firms and individuals, like simplicity and cost-effectiveness. As such, it warrants inexpensive funding for ecologically conscious economic firms and their eco-friendly commercial activities (Anton and Nucu, 2020). This research examines the effect of financial stability on renewable energy investment. Based on the findings of Nasreen et al. (2017) and Alzakri (2023), we have formulated the following function to assess renewable energy investment in pursuit of our goal:

$$REI_{it} = \delta_0+\delta_1 FS_{it}+\delta_2 GDP_{it}+\delta_3 CO_{2it}+\delta_4 ICT_{it}+\delta_5 FG_{it}+\varepsilon_{it} \quad (1)$$

Where renewable energy investment (REI) is a function of financial stability (FS), gross domestic product (GDP), carbon dioxide emissions ($CO_2$), information and communications technology (ICT), financial globalization (FG), and error term (). The anticipated signs of our regressors are as follows: Financial stability is crucially linked to a nation's economic stability and prosperity. As the country becomes more financially stable the financial institutions strengthen and become more responsible. Thus, providing and allocating more resources for the green transformation of the economy, particularly for REI. GDP per capita represents the purchasing power of the individuals in the economy. The higher the GDP per capita the more affluent the people will be and more ready to invest in renewable energy. $CO_2$ emissions cause REI to rise because higher $CO_2$ emissions represent a low standard of environmental quality which demands more investment in renewable energy. ICT may increase the REI because it eases the incorporation of renewable energy into smart grids and thus promotes energy efficiency and a conducive environment for REI. Financial globalization means integration of the financial institutions across borders; thus, it can even gather funds from different nations to invest in renewable energy. Thus, the expected outcomes of these variables show a positive impact on REI.

## 3. MATERIALS AND METHODS

### 3.1. CSD and Homogeneity Tests

Inspecting cross-sectional dependence (CSD) is necessary for the panel data. Thus, it is essential to test CSD because it will make inefficient coefficients if ignored. Furthermore, CSD guides which type of unit root test generation (1st or 2nd) is suitable for investigation. The 2nd generation unit root tests are required to be employed in CSD. However, 1st generation unit root tests are applied when no CSD exists. The CSD is also the 1st step toward unit root investigation. The present study uses the Pesaran CSD test (Pesaran, 2021), which is employed to investigate CSD. The test equation is given as:

$$CSD_{test} = \sqrt{\frac{2T}{N(N-1)}}\left(\sum_{i=1}^{N-1}\sum_{k=i+1}^{N}\hat{\tau}_{ik}\right) \quad (2)$$

Slope heterogeneity between cross-sections, along with CSD, is a crucial aspect of panel data. Therefore, this research focused on the Pesaran and Yamagata (2008) test to determine whether the slope is homogeneous or heterogeneous. The following equations test slope coefficients:

$$\tilde{\Delta}_{HPY} = (N)^{\frac{1}{2}}(2k)^{-\frac{1}{2}}\left(\frac{1}{N}\tilde{S}-k\right) \quad (3)$$

$$\tilde{\Delta}_{ASH} = (N)^{\frac{1}{2}}\left(2k\left(\frac{T-k-1}{T+1}\right)^{-\frac{1}{2}}\left(\frac{1}{N}\tilde{S}-2k\right)\right) \quad (4)$$

### 3.2. Unit Root Tests

The unit root tests are applied to verify whether the variable is stationary. Whenever there are no symbols of the CSD, 1st generation unit root tests are employed. Hence, in the CSD presence, these tests commit misleading results. This is because the null hypothesis and data size properties issues are rejected in deceiving behaviour. Therefore, if the CSD occurs in the data, 2nd generation unit root tests, i.e., the CIPS is applied. Pesaran (2007) proposed the CIPS unit root test, which is recognized as a 2nd generation unit root test employed for stationarity detection. This test has the capability to address both CSD and heterogeneity and uses the preceding equations:

$$\Delta V_{i,t} = \alpha_i + \alpha_i X_{i,t-1} + \alpha_i Y_{t-1} + \sum_{l-0}^{p}\alpha_{il}\Delta\overline{V_{t-1}} + \sum_{i-1}^{p}\alpha_i \Delta Y_{i,t-1} + \mu_{it} \quad (5)$$

Equation (5) shows the cross-sectional averages ($\overline{V_{t-1}}$). Equation (5) leads to the CADF approach, which also forms the basis for the CIPS level.

$$\widehat{CIPS} = \frac{1}{N}\sum_{i=1}^{n} C_{ADF}^{i} \quad (6)$$

### 3.3. Cointegration Test

There are several testing methods for investigation, including those suggested by Kao (1999) and Pedroni (2004). In this investigation, we employ the two tests to assess the cointegrating relationship between concern variables. Pedroni (1999, 2004) introduces various statistics based on the Engle and Granger (1987) cointegration for testing in heterogeneous panels. Pedroni's proposed numerous types of statistics. These statistics are based on the average autoregressive coefficients linked to unit root tests of residuals for each cross-sectional unit, utilizing estimated residuals from the long-run model.

$$Y_{it} = \alpha_i + \lambda_i t + \sum_{j=i}^{m}\beta_{ji}X_{jit} + \varepsilon_{it} \quad (7)$$

In eq. (7), N, T, and m represent the quantity of cross-sectional units, observations, and regressors. Furthermore, it is assumed that both Y and X are integrated of order one. The configuration of the estimated residuals is outlined as follows in eq. (8):

$$\varepsilon_{it} = \rho_i \varepsilon_{it-1} + \mu_{it} \quad (8)$$

Under the null hypothesis (H0), all tests consistently demonstrate the absence of cointegration, while the alternative hypothesis (H1) is defined. The distribution of the seven statistics follows a normal distribution. Upon comparing these statistics to pertinent critical values, the null hypothesis of no cointegration is rejected if the critical values are exceeded. This rejection implies the existence of a long-run relationship among the variables. Kao's (1999) test follows a similar approach to the Pedroni (1999, 2004) test but introduces specific characteristics. The test involves conducting the first-stage regression as outlined in Eq. (9), with a requirement for heterogeneous intercepts and homogeneous slope coefficients across cross-sections. The null and alternative hypotheses in Kao's test align closely with those in Pedroni's test.

### 3.4. CS-ARDL

The CS-ARDL proposed by Chudik and Pesaran (2015) was employed in the further step to attain coefficient estimates of the short run (SR) and long run (LR). This method is related to the PMG-ARDL given by Pesaran et al. (2015). It has several features with numerous advantages and additional characteristics. For example, the CS-ARDL is a constant estimator, although the variables chosen for the estimation are in various integration orders, such as 1(0) or 1(1). In addition, in the existence of CSD, the estimates cannot be accurate. Nevertheless, this issue may be resolved as the method of analysis is CS-ARDL. Additionally, the CS-ARDL is a mean group method with diverse slope coefficients. As we repeat the lagged dependent variable, a weak exogeneity problem appears, which may be determined by employing the CS-ARDL. Furthermore, the endogeneity problem's resolution is asserted by including lagged cross-sectional averages (Erdogan et al., 2024). The ARDL method employs the ECM, which is not limited by the consequences of fundamental ARDL estimation, to distinguish between SR and LR dynamics. Hence, we constructed a basic model as shown following:

$$\Delta REI_{i,t} = \varnothing_i + \sum\nolimits_{l=1}^{p} \theta_{il} \Delta REI_{i,t-l} + \sum\nolimits_{l=0}^{p} \theta_{il}^{'} X_{i,t-l} + \sum\nolimits_{l=0}^{1} \theta_{il}^{'} \bar{W}_{i,t-l} + \varepsilon_{i,t} \quad (9)$$

Where $\bar{W}_t = (\overline{REI_t} \; . \; \overline{X_t})$ and $X_{it} = (FS_{it} + GDP_{it} + CO_{2it} + ICT_{it} + FG_{it})'$, and $X$ is the vector of independent variables. To enhance our analysis, we employed the PMG-ARDL method developed by Pesaran et al. (1999), which uses the PMG estimator. This technique reduces autocorrelation in residuals by combining data across different units, effectively leveraging both cross-sectional and time series data. In the PMG-ARDL model, lagged dependent variables serve as predictors, helping to address endogeneity by reflecting the impact of past values on current outcomes (Elhaj et al., 2024). Additionally, this method accommodates variables with mixed integration orders (I(0) and I(1)) and offers insights into both SR and LR effects.

## 4. DATA AND DESCRIPTIVE ANALYSIS

The current study examines the impact of financial stability on renewable energy investment in top polluting economies. For this, the study covers 55 top polluting economies over the period 2000-2021. The selection of economies is made based on data availability. In this study, renewable energy investment is used as a dependent variable. Renewable energy investment refers to the production of total renewables from nuclear, renewables, and other in quad Btu. The data on REI is derived from the EIA. Our focused variable is financial stability (FS), which is proxied through the Bank Z-score. Data on financial stability is attained from the global financial development database. GDP per capita (GDP) is an important determinant that plays a significant role in determining renewable energy investment. A higher GDP per capita indicates greater economic prosperity and purchasing power. As a result, countries with higher GDP levels tend to have more resources for renewable energy projects (Bamati & Raoofi, 2020). This study uses GDP per capita series constant at 2015 US$ and the data is derived from the WDI. Carbon dioxide ($CO_2$) emissions have a significant impact on renewable energy investment by creating environmental pressures. Our third control variable is ICT. ICT enhances renewable energy investment by providing easy access (Chang et al. 2022). Data for ICT is derived from the WDI, which is measured by total users of the internet as a percent of total population. Other control variable is financial globalization (FG). Financial globalization (FG) has a significant impact on REI by altering the dynamics of capital flows and investment opportunities in the energy sector. Financial globalization facilitates cross-border investment, allowing capital to flow to regions with favorable renewable energy conditions and policies (Chen and Zhang 2023). Data for the financial globalization index is derived from the KOF. Table 1 reports the summary statistics of the variable along with a detailed description of the data. The mean scores for REI, FS, GDP, $CO_2$, ICT, and FG are 1.184, 2.534, 9.279, 11.83, 3.478, and 4.146, respectively. The highest score is reported for REI (24.91), while the minimum score is reported for ICT (−2.189).

**Table 1: Variables and summary statistics**

| Variables | Symbol | Definitions | Sources | Mean | Median | Max | Min | Std. dev. |
|---|---|---|---|---|---|---|---|---|
| Renewable energy investment | REI | A proxy of total renewable energy production from nuclear, renewables, and other (quad Btu) | EIA | 1.184 | 0.258 | 24.91 | 0.001 | 2.945 |
| Financial stability | FS | Bank Z-score | Global financial development database | 2.534 | 2.614 | 3.929 | 0.080 | 0.615 |
| GDP per capita | GDP | GDP per capita (constant 2015 US$) | WDI | 9.279 | 9.212 | 11.39 | 6.471 | 1.229 |
| $CO_2$ emissions | $CO_2$ | $CO_2$ emissions (kt) | WDI | 11.83 | 11.58 | 16.22 | 9.695 | 1.273 |
| Information and communications technology | ICT | Individuals using the Internet (% of population) | WDI | 3.478 | 3.951 | 4.595 | −2.819 | 1.224 |
| Financial globalization | FG | Financial globalization index | KOF | 4.146 | 4.232 | 4.591 | 2.698 | 0.351 |

Source: Author's calculation

## 5. EMPIRICAL RESULTS AND DISCUSSIONS

To evaluate the multicollinearity among the explanatory variables, values of VIF are shown in Table 2. Values of VIF lie in the range of 1.01-3.13, revealing the absence of multicollinearity. The mean VIF is 2.00 which is <5 and confirms the no multicollinearity. Additionally, all values of 1/VIF are >0.30. CSD among cross sections is checked through Pesaran's test and Friedman's test and findings are given in Table 3. Results show that all the variables have significant values, which are calculated using Pesaran and Friedman tests. In Pesaran's test for CSD, all variables have significant values with 1% significance level while in Friedman's test FS is significant with 10% and $CO_2$ is significant with 5% significance level. Overall, both tests validated the existence of cross-sectional dependence, which is that changes in a variable are associated with changes in the same variable in other economies. Furthermore, significant values of delta (2.227) and adjusted delta (2.697) with 5% and 1% significance level, depict the presence of slope heterogeneity (Table 4).

In the presence of CSD, CIPS and CADF unit root tests are considered more appropriate. The outcomes of both unit root tests are given in Table 5. The dependent variable REI is stationary at first difference estimated in both tests. While all explanatory variables are stationary with a mix of level and first difference. FS, ICT, and FG are stationary at a level with 1% significance. GDP and $CO_2$ are stationary at the first difference with 1% significance level.

Before conducting regression analysis, the study applies a cointegration test to assure the presence of long-run linkages among the model variables. Results of Kao and Pedroni cointegration tests are presented in Table 6 including four statistics of Kao test and three of Pedroni test. All seven statistics are significant with 1% significance level. Four statistics of the Kao test are modified DF-t (7.938), DF-t (12.98), ADF-t (9.921), unadjusted modified DF (7.851), and unadjusted DF-t (12.56). Pedroni test statistics include modified PP-t (7.012), PP-t (−6.533), and ADF-t (−7.610).

The results of analysis are given in Table 7. These findings cover a full sample of 55 global economies consisting of Asia (17), Africa (6), America (9), and Europe (23). Initially, the CS-ARDL method is used and to evaluate the robustness of findings of the CS-ARDL approach, the PMG-ARDL method is estimated. Long-run outcomes of the CS-ARDL method reveal a positive link between FD and REI that 1% rise in FS leads 0.97% uplift in REI (5% significance level) for a full sample of economies. The coefficient values of FS in sub-regions are 0.747 (Asia), 0.284 (Africa), 1.152 (America), and 1.116 (Europe). However, in the case of Africa, the linkage of FS with REI is insignificant. The robustness test also shows a similar positive linkage between FS and REI. This finding is consistent with Safarzyńska and van den Bergh (2017), who noted that financial stability significantly reduces investment risks associated with renewable energy projects. Given the predictable policies and lower financial volatility, investors are more inclined to require capital in stable financial environments. The result also infers that a stable financial market provides a favorable atmosphere for long-term investments, essential for the capital-intensive nature of renewable energy initiatives. Moreover, financial stability plays a significant role in improving access to capital for renewable energy investments. Banks and financial institutions are more willing to offer loans and financing in economically stable conditions, thus alleviating financial barriers faced by renewable energy developers. The studies of Polzin et al. (2017) and Boute (2020) supported these empirical inferences. They noted that access to affordable capital is a key factor influencing the expansion of renewable energy initiatives (Luthra et al., 2015). Furthermore, financial stability is closely related to supportive renewable energy projects. The study by Alzakri (2023) supported our results and infers that

**Table 2: VIF results**

| Variables | VIF | 1/VIF |
|---|---|---|
| GDP | 3.13 | 0.320 |
| FG | 2.79 | 0.358 |
| ICT | 1.97 | 0.507 |
| FS | 1.07 | 0.936 |
| $CO_2$ | 1.01 | 0.988 |
| Mean VIF | 2.00 | |

Source: Author's calculation

**Table 3: CSD results**

| Tests | REI | FS | GDP | $CO_2$ | ICT | FG |
|---|---|---|---|---|---|---|
| Pesaran's test | 20.64*** | 6.342*** | 29.64*** | 8.312*** | 34.87*** | 12.95*** |
| Friedman's test | 142.2*** | 67.17* | 201.8*** | 74.05** | 181.7*** | 96.30*** |

Source: Author's calculation

**Table 4: Slope homogeneity results**

| Tests | Delta | P-value |
|---|---|---|
| $\hat{\Delta}$ | 2.227** | 0.026 |
| $\hat{\Delta}_{adjusted}$ | 2.697*** | 0.007 |

Source: Author's calculation

**Table 5: Unit root tests**

| Variables | CIPS | | CADF | |
|---|---|---|---|---|
| | I (0) | I (1) | I (0) | I (1) |
| REI | −0.844 | −4.817*** | 2.194 | −29.63*** |
| FS | −2.411*** | | −7.345 | |
| GDP | −1.563 | −3.844*** | −0.513 | −20.53*** |
| $CO_2$ | −0.726 | −4.456*** | 2.088 | −25.38*** |
| ICT | −5.094*** | | −9.252*** | |
| FG | −1.912*** | | −3.364 | |

Source: Author's calculation

**Table 6: Kao and Pedroni test for cointegration**

| Tests | Test statistics | Statistic | P-value |
|---|---|---|---|
| Kao test | Modified DF-t | 7.938*** | 0.000 |
| | DF-t | 12.98*** | 0.000 |
| | ADF-t | 9.921*** | 0.000 |
| | Unadjusted modified DF | 7.851*** | 0.000 |
| | Unadjusted DF-t | 12.56*** | 0.000 |
| Pedroni test | Modified PP-t | 7.012*** | 0.000 |
| | PP-t | −6.533*** | 0.000 |
| | ADF-t | −7.610*** | 0.000 |

Source: Author's calculation

**Table 7: Results estimates of REI**

| Variables | CS-ARDL | | | | | PMG-ARDL (robustness) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Full sample | Asia | Africa | America | Europe | Full sample | Asia | Africa | America | Europe |
| Long-run | | | | | | | | | | |
| FS | 0.974** | 0.747* | 0.284 | 1.152** | 1.116*** | 0.074*** | 0.076*** | 0.002 | 0.093** | 0.018*** |
| | 0.391 | 0.402 | 0.344 | 0.472 | 0.247 | 0.013 | 0.023 | 0.015 | 0.044 | 0.005 |
| GDP | 1.151** | 1.601** | 0.123 | 1.686* | 1.363* | 0.891*** | 1.375*** | 0.096*** | 0.073 | 0.064*** |
| | 0.452 | 0.857 | 0.305 | 1.006 | 0.683 | 0.076 | 0.067 | 0.034 | 0.111 | 0.015 |
| $CO_2$ | 1.892** | 1.094** | 0.727* | 1.165** | 1.118* | 0.072*** | 0.518*** | 0.057*** | 0.245** | 0.141*** |
| | 0.913 | 0.517 | 0.383 | 0.537 | 0.627 | 0.023 | 0.043 | 0.022 | 0.121 | 0.009 |
| ICT | 1.571*** | 0.394** | 0.488*** | 0.497*** | 0.313*** | 0.034** | 0.051*** | 0.012*** | 0.164*** | 0.043*** |
| | 0.316 | 0.162 | 0.079 | 0.083 | 0.046 | 0.016 | 0.015 | 0.003 | 0.03 | 0.007 |
| FG | 1.001** | 0.329 | 0.075 | 0.211 | 1.169 | 0.213*** | 0.083 | 0.051* | 0.163*** | 0.108*** |
| | 0.491 | 0.417 | 0.069 | 0.506 | 1.266 | 0.056 | 0.061 | 0.026 | 0.051 | 0.026 |
| Short-run | | | | | | | | | | |
| D (FS) | 0.045* | 0.253 | 0.716 | 0.252 | 0.116 | 0.056* | 0.059 | 0.023 | 0.202 | 0.012 |
| | 0.024 | 0.502 | 0.844 | 0.472 | 0.247 | 0.032 | 0.067 | 0.022 | 0.147 | 0.013 |
| D (GDP) | 0.422*** | 1.042 | 1.062 | 1.004 | 0.237 | 0.564*** | 0.850 | 0.022 | 1.004 | 0.242 |
| | 0.144 | 1.128 | 0.844 | 1.212 | 1.081 | 0.219 | 0.544 | 0.041 | 0.714 | 0.194 |
| D ($CO_2$) | 0.886 | 1.032 | 1.083 | 0.837 | 0.503 | 0.579** | 1.228* | 0.027 | 0.463 | 0.213* |
| | 0.759 | 1.275 | 1.167 | 1.641 | 0.527 | 0.236 | 0.711 | 0.036 | 0.323 | 0.115 |
| D (ICT) | 1.121 | 0.555 | 0.096 | 1.289 | 0.079 | 0.032 | 0.084 | 0.051 | 0.316** | 0.039 |
| | 0.693 | 0.652 | 0.129 | 1.227 | 0.564 | 0.075 | 0.195 | 0.007 | 0.158 | 0.037 |
| D (FG) | 1.298 | 0.674 | 0.157 | 0.851 | 0.225** | 0.103 | 0.139 | 0.029* | 0.021 | 0.353 |
| | 1.283 | 0.917 | 0.977 | 0.676 | 1.325 | 0.154 | 0.151 | 0.015 | 0.099 | 0.354 |
| C | | | | | | 1.015*** | 0.383*** | 1.042*** | 1.420* | 0.834*** |
| | | | | | | 0.260 | 0.127 | 0.326 | 0.736 | 0.201 |
| ECM(−1) | | | | | | −0.363*** | −0.247** | −0.219** | −0.253* | −0.442*** |
| | | | | | | 0.037 | 0.063 | 0.101 | 0.131 | 0.111 |
| Number of countries | 55 | 17 | 6 | 9 | 23 | 55 | 17 | 6 | 9 | 23 |

Standard errors below estimates. ***P<0.01, **P<0.05, *P<0.1. Source: Author's calculation

financial stability reduces uncertainty and positively influences renewable energy investment. These findings also support the financial theory of stability (Crockett, 1996). The results also suggest that financial stability attracts both domestic and foreign investors, driving further renewable energy growth. Our finding is also reliable with Raberto et al. (2019), who noted that financial stability facilitates access to capital, boosts investor confidence, and promotes technological innovation that ultimately enhances renewable energy investment.

The impact of GDP on REI is also positive with coefficient values for the full sample (1.151), Asia (1.601), Africa (0.123), America (1.686), and Europe (1.363). All coefficients are significant except Africa. PMG-ARDL method also confirms the positive significant effect of GDP on REI with 0.891 coefficient values for the full sample with 1% significance level but insignificant in the case of America. The results reveal that 1% rise in $CO_2$ emissions brings an increase in REI by 1.89% for the full sample, 1.09% for Asia, 0.73% for Africa, 1.165% for America, and 1,118% for Europe. PMG-ARDL shows positive coefficients as 0.072, 0.518, 0.057, 0.245, and 0.141 for the same sequence of coefficients. ICT positively influences REI for the full sample and all sub-regions in both regression methods. The study found coefficient values of CS-ARDL for the impact of ICT on REI as 1.571 (whole panel), 0.394 (Asia), 0.488 (Africa), 0.497 (America), and 0.313 (Europe). Likewise, PMG-ARDL validates the robustness of GDP-REI linkage and shows positive coefficients 0.034 (full sample), 0.051 (Asia), 0.012 (Africa), 0.164 (America), and 0.043 (Europe). The impact of FG on REI is significant and positive (1.001) for the full sample but insignificant for all individual sub-regions. However, in PMG-ARDL outcomes, this linkage is significant for the full sample (0.213), Africa (0.051), America (0.163), and Europe (0.108). Short-run estimates of CS-ARDL reveal that FS and GDP positively impact REI while PMG-ARDL shows that FS, GDP, and $CO_2$ have a significant association with REI. All other independent variables including ICT and FG have insignificant linkage with REI in the short-run. Value ECM was found to be significant for the full sample and all sub-regions in the PMG-ARDL method. This confirms the presence of short-run equilibrium in the model. Convergence towards the equilibrium in the short-run is 36% (full sample), 25% (Asia), 22% (Africa), 25% (America), and 44% (Europe).

## 6. CONCLUSION AND POLICY IMPLICATIONS

Energy is recognized as the driver of the global economy and demand for energy resources is continuously growing. Its energy consumption has an unfavorable impact on the environment but also causes health risks. This environmental pressure motivates investment in renewable energy. Financial stability is a key role play in renewable energy investment. The prior literature has overlooked the financial stability and investment nexus. Motivated by the rising environmental concerns and lack of literature, this study explores the impact of financial stability on renewable energy investment using the CS-ARDL method. In this regard, we collected data on polluted economies in countries from 2000 to 2021. Our long-run results reveal that financial stability and GDP are significant encourages renewable energy investments in all regions except Africa. While, carbon emissions and ICT favorably influence renewable energy investment in all regions. The short-run estimates are insignificant in most regions.

Based on empirical outcomes, our study suggests the following policy suggestions. Firstly, the establishment of clear regulatory frameworks is paramount to provide investors with transparency and consistency in areas. Incentivizing renewable energy investments through financial stability mitigates risks and creates a favorable investment climate. Access to finance must be facilitated through specialized funds or lending programs in collaboration with financial institutions. Risk mitigation mechanisms, such as insurance programs or guarantees, further protect investors from uncertainties. Capacity-building programs and knowledge transfer initiatives are crucial to encourage local expertise and foster innovation in renewable energy technologies. Encouraging public-private partnerships leverages resources efficiently, accelerating project development and enhancing overall financial stability. Investment promotion agencies dedicated to renewable energy can actively market opportunities and bridge communication between governments and the private sector. Regular policy reviews ensure adaptability to market changes and technological advancements. Strengthening infrastructure is imperative for the continuous rise of renewable energy sources. Facilitate access to finance for renewable energy projects by working with financial institutions to create specialized funds or lending programs. This can ease the financial burden on investors and promote a more stable investment structure. Initiating green financing programs targeted specifically at renewable energy projects, in collaboration with financial institutions, can provide investors with favorable terms and incentivize a diverse range of stakeholders. Moreover, directing resources toward RandD in renewable energy technologies fosters innovation. Lastly, the encouragement of international collaboration facilitates the exchange of best practices.

## FUNDING

This work was supported and funded by the Deanship of Scientific Research at Imam Mohammad Ibn Saud Islamic University (IMSIU) (grant number IMSIU-DDRSP2502).

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