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(3), 374-382.

Empowering Clean Energy Justice: The Role of Logistic Performance, Digital Finance, and Political Stability

Eias Al Humdan[1]*, Ousama Ben-Salha[2], Hassen Soltani[3], Sana Ullah[4,5]

[1]Rabdan Academy, Faculty of Resilience, Abu Dhabi, UAE, [2]Humanities and Social Research Center, Northern Border University, Arar 91431, Saudi Arabia, [3]Department of Business Administration, Business College, University of Bisha, Saudi Arabia, [4]Faculty of Economics and Administrative Sciences, Department of Economics, Near East University, TRNC, Nicosia, Turkey, [5]Advanced Research Centre, European University of Lefke, Lefke, Northern Cyprus, TR-10, Mersin, Turkey. *Email: Eias.alhumdan@gmail.com

Received: 25 December 2024 **Accepted:** 28 March 2025 **DOI:** https://doi.org/10.32479/ijeep.19398

ABSTRACT

The SGD 7 underscores the significance of affordable and clean energy for all. As a result, clean energy justice has gained a lot of attention from academics and policymakers. Due to its significance for the world's sustainable future, finding the factors of clean energy justice has become crucial. This analysis aims to examine the influence of logistic performance, digital finance, and political stability on clean energy justice in 70 developing economies. Empirical analysis is performed via the use of two-stage least squares (2SLS), system generalized method of moments (SGMM), and smoothed instrumental variable quantile regression (SIVQR) techniques. The outcomes of the study highlight that logistics performance, digital finance, and political stability help foster clean energy justice. In addition, the GDP, globalization, ICT, and FDI contribute to clean energy justice, while natural resource rent proves detrimental to clean energy justice. In light of these findings, we suggest that policymakers formulate a policy for the fair and equitable distribution of clean energy with improved logistics performance, digitalization of the financial sector, and political stability as the main ingredients.

Keywords: Clean Energy Justice, Logistic Performance, Digital Finance, Political Stability, Sustainable Development Goal 7
JEL Classifications: F36; P48; O13

1. INTRODUCTION

The role of energy is widely recognized as a crucial factor in raising the lifestyles of the general public. The rising population in urban and rural regions has been the primary reason behind the surge in energy demand. The sustainable and clean energy supply is essential not only for fulfilling the energy demand for household use but also for the production of agricultural and industrial goods, which are essential for boosting total productivity and improving human well-being (Alegre-Bravo and Anderson, 2023). Along with the significance of climate change and energy security issues, achieving energy justice has become crucial for fostering sustainable development. In order to enhance worldwide access to clean energy sources, the year 2030 was set by the United Nations as a cut-off year; however, as per the statistics of the International Energy Agency still, a lot of work has to be done in this regard as a good number global population don't have access to electricity and cooking fuels (Kaygusuz, 2012). This situation is a serious threat to achieving energy justice and sustainable development. The developing economies are more susceptible to the problems and issues hindering equal access to energy resources for all segments of society in both rural and urban areas. Several rural families have to rely on dirty fossil fuels to fulfill their energy demands, and noticeable regional disparities in energy access underscore the significance of clean energy justice. Given the significance of clean energy justice, it is crucial to find the determinants of clean energy justice. The primary objective of this analysis is to investigate the impact of logistics performance, digital finance, and political stability on clean energy justice.

The significance of logistics in generating jobs and promoting economic growth has made it a new field of study (Saidi et al., 2020). Due to globalization, the present global economic competition has increased, which enhances the importance of logistics in terms of business success. In the supply chain, logistics is the most important component. It affects customer satisfaction by practically connecting upstream suppliers with downstream customers. Research shows that logistics increase productivity and service quality, which boosts a nation's ability to produce (Le et al., 2020). The functioning of the supply chain is impacted by logistics, which influences a number of factors, including wrapping, storing, communication, and delivery. According to Zhao et al. (2023), the logistics sector is the national economy's backbone and most important sector. In order to achieve net zero emissions, green logistics is a crucial requirement as it significantly reduces carbon footprints attached to logistics. Green logistics also contribute to the SGD7, which stresses the significance of "affordable and clean energy" for all. According to Tercan and Özdemir (2024), the logistics industry has the opportunity to address the increasing demand for sustainable energy via infrastructure development, product distribution, and effective transportation management. However, this research attempts to answer this question by investigating the impact of logistics performance on clean energy justice.

In addition to logistics performance, a well-functioning financial system helps in efficient resource allocation, which is essential to attaining maximum energy justice. The growth of the financial sector has the ability to substantially influence electricity accessibility by enhancing "energy affordability, financial inclusion, and infrastructure investment" (Shahbaz et al., 2024). Financial institutions supply vital financial funding for developing power plants and effective energy distribution networks. Financial obstacles are considered the biggest hurdles in developing clean energy projects due to high upfront costs and long payback periods (Manju and Sagar, 2017). A well-developed financial sector can overcome this hurdle by enhancing access to loans and microfinance for people and enterprises, hence augmenting investment in clean and green energy projects (Raghutla et al., 2021), which is crucial for promoting energy justice regarding clean energy. Digital finance has become an essential component of the financial system due to its ability to overcome the issue of information asymmetry. Consequently, the trust deficit between borrowers and lenders is significantly reduced, borrowing costs are lowered, and the accessibility to financial services and banks significantly increases, ultimately reducing the financing disparities. Digital finance is not a separate financial system; it is a part of the main financial system and plays a crucial role in enhancing the efficiency of the traditional financial sector (Gomber et al., 2017). This helps the investors make an informed decision regarding the investment in clean energy technologies. The empirical literature has not clarified the link between digital finance and clean energy justice.

Political scientists underscore the significance of political policies and actions in transforming the energy framework of a nation (Newell, 2021). A nation's transition to carbon-free energy sources cannot only be credited to environmental and economic considerations; thus, political action is essential. Ensuring robust political and national stability is essential for clean and green energy and attaining sustainable development (Qamruzzaman and Karim, 2024). An unstable political climate is the main contributor to triggering considerable uncertainty, resulting in economic consequences. Political instability often results in law and order challenges and political movements that may lead a country toward anarchy. Consequently, the government must alter its spending on clean and green projects to improve the situation of law and order and address terrorism and violence, leaving minimal funds for investment in renewable energy projects and development purposes. Furthermore, political instability adversely affects innovation-related activity (Krammer and Kafouros, 2022). Given the unpredictable economic climate in a politically volatile environment, politicians are less inclined to secure investment in high-risk green and alternative energy initiatives. Consequently, political stability is essential for promoting renewable energy development (Wang et al., 2024).

Energy justice is becoming more and more popular, although the majority of research on energy justice focuses on its definition and how it fits within a clean and green economic framework (Heffron and McCauley, 2017; Munro et al., 2017). On the other hand, the literature on the factors that influence energy justice is still in its early stages. Specifically, no empirical research has ever been done on how logistics performance, digital finance, and political stability affect clean energy justice. Thus, a significant gap exists in the literature on clean energy justice, and this analysis aims to fill the above-stated gaps. Against this backdrop, the research adds the following new points to clean energy justice. First, this research is novel as it is the initial effort to disclose the effect of logistics performance on clean energy justice. Second, the study extends the literature by estimating the influence of digital finance on clean energy justice. Third, analyzing the role of political stability in fostering clean energy justice is another novel contribution to the analysis. Fourth, this is the first effort to investigate the impact of economic and non-economic factors on clean energy justice. Fifth, the research uses novel econometric techniques 2SLS, SGMM, SIVQR to estimate the connection between the variables. Lastly, the study findings also prove crucial in providing policy suggestions to enhance clean energy justice.

2. THEORETICAL FRAMEWORK AND MODEL

Theoretically, efficient logistics networks are essential for the equal distribution of renewable energy technology and resources. Improved logistics services are helpful in facilitating the transportation and delivery of clean energy resources like solar panels, wind turbines, and batteries across the globe, particularly in far-flung areas and underdeveloped regions (Tercan and Özdemir, 2024). The affordability of clean energy largely relies on efficient transportation and storage systems, which are efficient by significantly lowering the delays in supply and costs of renewable energy sources and enhancing everyone's accessibility to clean energy sources. Reliable logistics also plays an important role in encouraging the fair distribution of clean energy to people living in rural and underdeveloped regions (Górecka et al., 2021) by bridging the gap between developed and developing regions. Improved and modern logistic systems, relying on fast routes and state of the art technologies, can help mitigate transportation's environmental consequences and contribute to superior environmental quality (Li et al., 2021). Last but not least, better and modern logistics help foster global partnerships in clean energy by facilitating the exchange of technology and best practices in clean energy transitions across nations. To conclude, we believe that improved logistics performance is crucial in fostering a fair and equitable transition to clean energy systems, ensuring the availability of clean energy sources for every faction of society.

Digital finance encourages investment in clean and green ventures and initiatives by enhancing access to financial products and services. With the advent of digital finance, mobile and internet banking become popular, allowing individuals living in rural areas to avail financial services, such as loans and a saving account, without any hassle and visiting the bank (Hasan et al., 2022). This enables households and small enterprises to finance renewable energy solutions like solar home systems or energy-efficient appliances. In addition, digital finance has made the accumulation of funds for investment in clean energy possible with the help of crowdfunding and other online sources, thereby enhancing community access to clean energy (Wei et al., 2023). Further, digital financial methods are more transparent, help reduce corruption, and guarantee equitable use of money. Digital finance also has a crucial role in providing a due share of clean energy to poor people and reducing energy inequality within society by providing broader access to financial instruments to every faction (Dong et al., 2024). It generates chances for everybody to benefit from a more sustainable and equitable energy future. Therefore, we believe that digital finance helps improve clean energy justice.

In addition to logistics performance and digital finance, the equal distribution of clean energy relies on political stability. A politically stable government can formulate long-term policies and action plans crucial for the equal distribution of clean energy sources to marginalized people and regions (Acheampong et al., 2023a). Political stability helps attract investment in renewable energy initiatives, facilitating infrastructure development such as solar farms or wind power plants in far-flung regions. As a result of transparent and uniform regulations, equal distribution of energy and other resources within society becomes possible by ensuring affordable prices for all people. Stable governments can oversee and mitigate corruption more effectively, ensuring that renewable energy initiatives benefit the most deserving people (Shittu et al., 2024). Moreover, a politically stable and democratic government involves the people in decision-making and policy formulation, allowing people to influence choices that impact their lives. Thus, we hypothesize that a politically stable government is vital in fostering clean energy justice. In this context, the baseline model is formulated to detect the impact of logistics performance, digital finance, and political stability on clean energy justice.

$$CEJ_{it} = \varkappa_0 + \varkappa_1 LP_{it} + \varkappa_2 DFI_{it} + \varkappa_3 PS_{it} + \varkappa_{4i} X_{it} + \partial_i + \epsilon_{it} \quad (1)$$

In the above model (1), CEJ_{it} refers to clean energy justice and is determined by the logistics performance (LP), digital financial inclusion (DFI), political stability (PS), and a set of control variables (X), which comprises ICT, GDP, globalization, natural resources, FDI. The anticipated sign of logistics performance is positive. The positive impact of logistics performance on CEJ due to efficient supply chain management, reduction in cost of energy distribution, and economic accessibility. Digital financial inclusion fosters clean energy justice by enhancing household access to clean energy. The expected impact of political stability on clean energy justice is also favourable. Political stability can play a crucial role in shaping clean energy justice, ensuring fair and equitable energy transitions in rural-urban areas.

3. ECONOMETRIC METHODOLOGY, DATA AND DESCRIPTIVE ANALYSIS

Combining data across countries and time, also known as panel data, has benefits in the form of more observations, variety, and information. Despite some notable benefits, panel data usually has some limitations if handled with OLS, such as "measurement error, individual heterogeneity, selection bias, and serial correlation" (Browning and Collado, 2007). In order to make sure that our estimates are resistant to these biases, we use the instrumental variable (IV) approaches as alternatives to the traditional approaches, including the OLS. These methods allow endogeneity to be controlled (Blundell and Bond, 2023). One of the most famous IV approaches is the 2SLS of Cumby et al. (1983), an upgraded form of the OLS with the ability to overcome issues beyond the scope of the OLS. The OLS basically relies on two assumptions: Homoscedasticity and independence of the error term, which is violated in the case of panel data (Wooldridge, 2010). Justifying its name, the 2SLS resolves these issues in two steps. In the first step, the endogenous regressor is regressed on instrumental and other regressors to obtain the estimated values, which are then replaced in place of these endogenous variables in the original model and help us obtain the estimates that are free from the endogeneity concerns (Chen and Majeed, 2024). In contrast to other approaches, locating the appropriate instrument for every situation is sometimes very difficult and demanding, especially in 2SLS. The GMM of Arellano and Bover (1995); Blundell and Bond (1998) resolves this problem as it allows the inclusion of all the regressors as instruments. However, GMM may give rise to different problems, including "estimator instability, serial correlation, and weak instruments", leading to overidentification within the given framework. The limitations mentioned above were noticed and resolved by the Arellano and Bover (1995), by developing the system GMM with onwards orthogonal divergences serves as the foundation for this approach. Lags are allowed to be included at both levels and differences, and endogeneity in regressors and outcome variables can be handled independently. Since it is more effective for panel data gathered over a short period of time, this study employs the two-step estimate technique proposed by Roodman (2009). This approach minimizes information loss by using instruments in different stages. To further investigate the issue of overidentification, Roodman et al. (2009) recommended applying the Sargan and

Hansen tests to see whether there are any extra instruments. The Hansen test, however, is the recommended approach for analyzing overidentification in a two-step system for GMM. Following is the baseline system GMM equation with the inclusion of our variables:

$$CEJ_{it} = \varkappa_0 + \lambda_1 CEJ_{it-1} + \varkappa_1 LP_{it} + \varkappa_2 DFI_{it} + \varkappa_3 PS_{it} + \varkappa_{4i} X_{it} + \partial_i + \epsilon_{it} \quad (2)$$

We also utilize SIVQR, a supplementary econometric approach used in this study that integrates quantile regression with the instrumental variable technique. In order to address the endogeneity within the quantile regression approach, Chernozhukov and Hansen (2008) created the IVQR approach, which combines the IV and quantile regression (QR) techniques. Nevertheless, the IVQR technique can handle only one endogenous regressor, which Kaplan (2022) resolved by offering a SIVQR, which can handle more than endogenous regressors.

Data for 70 developing economies have been collected for the period 2007-2022. Clean energy justice (CEJ) is the dependent variable, which is measured by rural-urban equality in access to clean fuels and technologies for cooking. The author constructed the CEJ data series. The trend of CEJ is presented in Figure 1. Logistics performance (LP), digital financial inclusion (DFI), and political stability (PS) are major focused variables. Data for logistics performance is measured via an index that ranges between 1 and 5. DFI is assessed through number of ATMs per 100,000 adults. Political stability and absence of violence and terrorism estimates are used to measure political stability. The data series for LP, DFI, and PS are collected from the WDI. Our study used ICT, GDP, globalization, natural resource rents, and foreign direct investment as control variables. Literature documented that ICT development enhances access to clean energy by facilitating awareness. Digital platforms improve service delivery, enabling rural areas to access clean fuels and technologies (Wang et al., 2022). ICT index is used to measure this variable, which the author constructs. This index is composed of four determinants, namely, internet users, fixed telephone subscriptions, fixed broadband subscriptions, and mobile cellular subscriptions. Higher GDP provides governments with greater resources to invest in clean energy technologies by fostering energy justice (Sen et al., 2024). GDP series is measured at current US$. Globalization promotes CEJ by facilitating the transfer of clean energy to rural areas. Globalization index is used to asses this variable, which the KOF constructs. Following the resources curse or blessing hypothesis, natural resources can positively and negatively impact CEJ. Natural resource rents are measured as percent of GDP. Lastly, FDI brings technology for clean energy projects, contributing to equitable energy access across rural and urban areas (Nguea et al., 2022). Net inflows of FDI as a percent of GDP are used to measure this variable. WDI is the source of data collection for GDP, NRR, and FDI. Description of all variables and data collection sources are given in Table 1.

Figure 1: Trend of clean energy justice

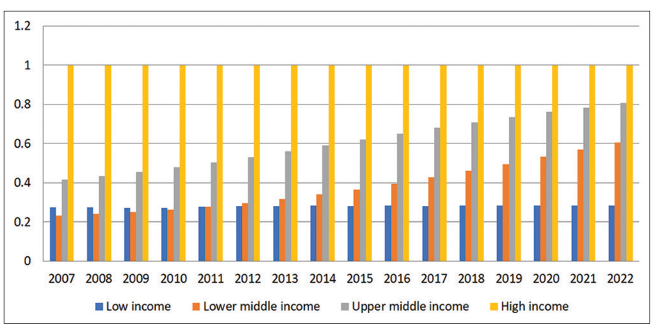

Table 2 presents the summary statistics. The mean scores for CEJ, LP, DFI, PS, ICT, GDP, GLOB, NRR, and FDI are 0.508, 2.650, 2.879, −0.492, 2.339, 24.68, 4.047, 1.113, and 0.846, respectively. The S.D scores for CEJ, LP, DFI, PS, ICT, GDP, GLOB, NRR, and FDI are 0.346, 0.361, 1.349, 0.775, 1.213, 1.893, 0.184, 1.551, and 1.056, respectively. The skewness values reveal that CEJ, LP, and, GDP exhibit negative skewness and DFI, PS, ICT, GLOB, NRR, and FDI show positive skewness. The Jarque-Bera (J-B) confirms all variables are significant at 1%, indicating a non-normal distribution. In Table 3, the VIF values of all selected variables are below 5, which is the commonly accepted threshold level. Additionally, the mean VIF is 2.73, indicating that the model is free from multicollinearity problems.

4. EMPIRICAL RESULTS

Table 4 shows the results of POLS, 2SLS, and SGMM methods. The results reported that LP exhibits a significantly positive effect on CEJ in 2SLS and SGMM models, representing an increasing effect of LP on CEJ in selected global economies. A 1% upsurge in LP documents a 0.085% upsurge in CEJ in 2SLS and 0.008% in SGMM. Nexus between LP and CEJ is documented as insignificant in POLS. This result is parity supported by Tercan and Özdemir (2024), who noted that logistics performance enhances energy

Table 1: Variables description and sources

Variables	Definitions	Sources
Clean energy justice (CEJ)	Rural-urban equality in access to clean fuels and technologies for cooking	Authors' calculations
Logistics performance (LP)	Logistics performance index: Overall (1=low-5=high)	WDI
Digital financial inclusion (DFI)	A proxy of ATMs per 100,000 adults	WDI
Political stability (PS)	Political stability and absence of violence/terrorism: estimate	WDI
Information and communications technology (ICT)	ICT index (individuals using the internet [% of population], fixed broadband subscriptions [per 100 people], mobile cellular subscriptions [per 100 people], fixed telephone subscriptions [per 100 people])	Authors' calculations
Gross domestic product (GDP)	GDP (current US$)	WDI
Globalization (GLOB)	Globalization index	KOF
Natural resources rents (NRR)	Total natural resources rents (% of GDP)	WDI
Foreign direct investment (FDI)	FDI, net inflows (% of GDP)	WDI

Table 2: Summary statistics

Variables	Mean	Median	Max	Mini	Standard deviation	Skewness	Kurtosis	J-B [Prob.]
CEJ	0.508	0.464	1.173	0.003	0.346	0.115	1.428	0.000
LP	2.650	2.600	3.775	1.210	0.361	0.415	3.728	0.000
DFI	2.879	3.209	5.912	−2.401	1.349	−0.654	3.298	0.000
PS	−0.492	−0.439	1.201	−2.810	0.775	−0.418	3.234	0.000
ICT	2.339	2.687	4.147	−1.457	1.213	−0.769	2.729	0.000
GDP	24.68	24.44	30.51	20.49	1.893	0.360	2.781	0.000
GLOB	4.047	4.083	4.395	3.427	0.184	−0.731	3.199	0.000
NRR	1.113	1.246	3.995	−6.049	1.551	−1.700	8.354	0.000
FDI	0.846	0.944	3.782	−6.089	1.056	−1.089	6.676	0.000

Table 3: VIF test

Variable	VIF	1/VIF
DFI	4.74	0.211
ICT	4.43	0.226
GLOB	3.34	0.299
GDP	3.04	0.329
LP	2.03	0.494
PS	1.79	0.558
FDI	1.29	0.775
NRR	1.21	0.828
Mean VIF	2.73	

justice in China. The possible reason is that efficient logistics supply chain networks are essential for delivering renewable energy technologies to rural areas that enhance energy equity. Rafique et al. (2017) noted that developed logistics systems bridge the gap between energy producers and consumers, ensuring equitable access to clean energy in remote areas. John et al. (2024) pointed out that effective logistics supply chain systems mitigate risks and enable energy transition in rural areas.

Meanwhile, DFI and PS report a significantly positive association with CEJ in all three models, indicating that digital finance and political stability are significant determinants of CEJ in selected global economies. A 1% increase in DFI brings a 0.019% upsurge in CEJ in POLS, 0.033% in 2SLS, and 0.002% in SGMM. On the other side, a 1% increase in PS enhances CEJ by 0.014%, 0.021%, and 0.007% (respectively) in the POLS, 2SLS, and SGMM models. This finding is also backed by Peng et al. (2024), who emphasized that DFI enhances access to financial resources in rural communities and fosters equitable energy transitions. DFI also plays a critical role in bridging the urban-rural energy divide. Wang et al. (2022) revealed that digital finance ensures energy supply to rural and remote areas by promoting equitable energy distribution. The literature noted that digital finance supports renewable energy adoption and improves energy accessibility. Li (2024) found that digital platforms encourage investments in clean energy projects. For instance, digital applications can connect local communities with green energy markets, enabling them to buy renewable energy resources. This not only promotes fair distribution but also enhances energy sustainability and energy poverty in rural areas. The PS result is also supported by Acheampong et al. (2023a), who stated that political stability facilitates the clean energy infrastructure in rural communities. This also helps bridge the energy access gap by fostering equity in energy distribution. Furthermore, political stability can mitigate the negative impacts of corrupt practices that hinder energy access. Rehman et al. (2012) emphasized that by curbing corruption, political stability creates an environment favorable to implementing effective energy transition policies, thereby advancing energy justice in rural-urban areas. Acheampong et al. (2023b) argued that stable democratic systems enhance public service provision, including rural access to clean energy technologies.

Among control variables, ICT reports a positive significantly connection with CEJ in all models except Model 2. Whereas, GDP shows a strong positive connection with CEJ in all nine models, as all the coefficient estimates are statistically significant. GLOB is significantly and positively attached with CEJ only in POLS and SGMM models. All estimates of GLOB are insignificant in 2SLS models. In contrast, NRR exhibits a significant and negative effect on CEJ in all POLS and SGMM models, but the estimates are insignificant in the 2SLS models. FDI and CEJ are significantly and positively associated only in POLS models in our analysis. Lastly, all L.CEJ estimates are significantly positive in SGMM models, depicting that the current level of CEJ is positively affected by the lag level of CEJ. The Hansen test confirms instrument validity, and the AR(2) test shows no autocorrelation in CEJ models.

The SIVQR robustness results are reported in Table 5 to address the endogeneity and non-normal distribution. In OLS regression, LP and PS exhibit a significantly positive influence on CEJ, whereas DFI shows an insignificant effect on CEJ. Specifically, a 1% rise in LP and PS enhances CEJ by 0.020% and 0.038%, respectively. In the case of control variables, ICT, GDP, and FDI bring significant and positive increases in CEJ while GLOB and NRR report insignificant influence on CEJ in the OLS. The estimates of ICT, GDP, and FDI are 0.205, 0.008, and 0.018, respectively. These estimates depict that a 1% rise in ICT, GDP, and FDI tends to enhance CEJ by 0.205%, 0.008%, and 0.018%, respectively. The SIVQR results are reported for lower, medium, and higher quantiles (i.e., 0.25^{th} quantile, 0.50^{th} quantiles, 0.75^{th} quantile). The linkage between LP and CEJ is found significantly positive at all quantiles with estimates 1.021 at lowest quantile, 0.800 at medium quantile, and 0.741 at highest quantile. Similarly, the relationship between DFI and CEJ is found significantly positive across all quantiles, with estimated coefficients of 0.060, 0.084, and 0.053 at the lowest, medium, and highest quantiles. PS also shows a significantly positive association with CEJ across all quantiles, with coefficients of 0.455 at the lower quantile, 0.494 at the middle quantile, and 0.397 at the upper quantile. ICT and GDP exhibit significantly positive effect on CEJ, where ICT is positively associated

Table 4: CEJ estimates (POLS, 2SLS, SGMM)

Variables	POLS			2SLS			SGMM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LP	0.010			0.085***			0.008***		
	(0.012)			(0.024)			(0.002)		
DFI		0.019***			0.033*			0.002**	
		(0.006)			(0.018)			(0.001)	
PS			0.014**			0.021*			0.007**
			(0.006)			(0.011)			(0.003)
ICT	0.013**	0.003	0.012**	0.079***	0.087***	0.084***	0.003**	0.004***	0.002*
	(0.006)	(0.007)	(0.006)	(0.021)	(0.026)	(0.022)	(0.001)	(0.001)	(0.001)
GDP	0.081***	0.075***	0.078***	0.428***	0.497***	0.420***	0.008***	0.007***	0.007***
	(0.009)	(0.009)	(0.009)	(0.069)	(0.098)	(0.067)	(0.002)	(0.002)	(0.002)
GLOB	0.304***	0.251***	0.305***	0.135	0.222	0.163	0.019*	0.013*	0.018*
	(0.062)	(0.067)	(0.062)	(0.133)	(0.167)	(0.136)	(0.011)	(0.007)	(0.010)
NRR	−0.012***	−0.012***	−0.011***	−0.001	−0.004	−0.004	−0.008***	−0.005***	−0.003**
	(0.003)	(0.003)	(0.004)	(0.007)	(0.007)	(0.006)	(0.000)	(0.000)	(0.000)
FDI	0.007**	0.005*	0.007**	0.001	0.003	0.002	0.0001	0.0001	0.0002
	(0.003)	(0.003)	(0.003)	(0.005)	(0.006)	(0.005)	(0.0004)	(0.0003)	(0.0004)
L.CEJ							1.008***	1.005***	1.008***
							(0.005)	(0.005)	(0.005)
Constant	2.721***	2.426***	2.669***	9.105***	10.57***	9.001***	0.281	0.101	0.261
	(0.301)	(0.324)	(0.300)	(1.337)	(1.959)	(1.317)	(0.291)	(0.300)	(0.290)
Observations	1,120	1,110	1,120	1,120	1,110	1,120	980	972	980
Number of countries	70	70	70	70	70	70	70	70	70
AR (2) (P-value)							0.256	0.279	0.312
Hansen test (P-value)							0.544	0.573	0.457

Standard errors in parentheses
***P<0.01, **P<0.05, *P<0.1

Table 5: CEJ estimates (OLS & SIVQR)

Variables	SIVQR			
	OLS	(0.25)	(0.50)	(0.75)
LP	0.020*	1.021***	0.800*	0.741***
	(0.011)	(0.383)	(0.416)	(0.165)
DFI	0.005	0.060*	0.084**	0.053*
	(0.011)	(0.035)	(0.039)	(0.030)
PS	0.038***	0.455*	0.494*	0.397*
	(0.012)	(0.246)	(0.274)	(0.239)
ICT	0.205***	0.070	0.093*	0.114***
	(0.012)	(0.069)	(0.055)	(0.044)
GDP	0.008**	0.479**	0.511*	0.402
	(0.004)	(0.218)	(0.295)	(0.350)
GLOB	0.076	1.107	1.393	1.204
	(0.069)	(0.691)	(1.174)	(1.189)
NRR	−0.006	−0.122**	−0.137*	−0.119*
	(0.004)	(0.056)	(0.080)	(0.071)
FDI	0.018**	0.059**	0.080**	0.091**
	(0.007)	(0.029)	(0.034)	(0.045)
Constant	−0.395	−4.542	−3.987	−2.239
	(0.244)	(3.172)	(3.545)	(2.895)
Observations	1,110	1,110	1,110	1,110
Number of countries	70	70	70	70

Standard errors in parentheses
***P<0.01, **P<0.05, *P<0.1

at medium and highest quantiles, while GDP at lowest and medium quantiles. Conversely, GLOB reports an insignificant association with CEJ across all quantiles. However, NRR and FDI are significantly associated with CEJ across all quantiles. However, NRR effect remains negative and FDI effect remains positive throughout all quantiles.

For regional analysis, the study uses SGMM regression method. Table 6 reports the estimates for Asian, American, and African developing regions. L.CEJ estimates are significantly positive in all nine models, depicting that the current level of CEJ is affected by the previous level of CEJ in Asian, American, and African developing regions. The linkage between LP and CEJ is found to be positive in all regions; however, the nexus remains significant only in Asian and American regions. A 1% upsurge in LP documents 0.008% upsurge in Asian region and 0.007% in the American region. DFI documents a positive significant influence on CEJ in all three regions, with estimated coefficients 0.006, 0.002, and 0.005. It demonstrates that a 1% increment in DFI enhances CEJ by 0.006% in Asia, 0.002% in America, and 0.005% in Africa. On the other hand, PS impact on CEJ is found significantly positive in Asian and American regions only. In our analysis, a 1% increase in PS reports 0.002% rise in CEJ in Asia and 0.003% rise in America. ICT demonstrates a positive significant association with CEJ across eight regional models, while GDP reports a significantly positive linkage with CEJ across seven regional models. On the other hand, GLOB shows a significantly positive association with CEJ across all regional models. Conversely, NRR exhibits significantly negative relationships with CEJ across all Asian and American models. The linkage between NRR and CEJ is found insignificant across all African models. Lastly, FDI maintains a significantly positive effect across eight regional models. The Hansen test confirms instrument validity, and the AR(2) test shows no autocorrelation in all regions.

Table 6: CEJ estimates (region-wise)-SGMM

Variables	Asia			America			Africa		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
L.CEJ	1.012***	1.012***	1.011***	1.067***	1.063***	1.065***	1.058***	1.053***	1.048***
	(0.002)	(0.002)	(0.002)	(0.007)	(0.007)	(0.007)	(0.018)	(0.018)	(0.019)
LP	0.008***			0.007**			0.004		
	(0.001)			(0.002)			(0.003)		
DFI		0.006***			0.002**			0.005*	
		(0.000)			(0.001)			(0.003)	
PS			0.002***			0.003***			0.001
			(0.000)			(0.001)			(0.003)
ICT	0.014***	0.009***	0.014***	0.001**	0.003***	0.001	0.005**	0.005*	0.006**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.002)	(0.003)	(0.002)
GDP	0.0037***	0.0006	0.0018*	0.0043**	0.0029*	0.0040**	0.0081	0.0072*	0.0097*
	(0.0010)	(0.0010)	(0.0010)	(0.0018)	(0.0017)	(0.0018)	(0.0054)	(0.0042)	(0.0053)
GLOB	0.067***	0.102***	0.072***	0.042***	0.039***	0.040***	0.128***	0.137***	0.125***
	(0.005)	(0.006)	(0.005)	(0.010)	(0.010)	(0.010)	(0.029)	(0.034)	(0.029)
NRR	−0.0016***	−0.0018***	−0.0019***	−0.0011**	−0.0009*	−0.0011**	0.0002	0.0005	0.0005
	(0.0003)	(0.0003)	(0.0003)	(0.0005)	(0.0005)	(0.0005)	(0.0018)	(0.0017)	(0.0017)
FDI	0.0011***	0.0013***	0.0008***	0.0011***	0.0012***	0.0010**	0.0018*	0.0015	0.0017*
	(0.0002)	(0.0002)	(0.0002)	(0.0004)	(0.0004)	(0.0004)	(0.0011)	(0.0010)	(0.0010)
Constant	1.807***	1.880***	1.849***	0.697**	0.768**	0.696**	−0.898	−0.975	−0.865
	(0.158)	(0.165)	(0.160)	(0.287)	(0.305)	(0.285)	(0.739)	(0.763)	(0.733)
Observations	378	374	378	182	179	182	364	363	364
Number of countries	27	27	27	13	13	13	26	26	26
AR (2) (P-value)	0.324	0.387	0.298	0.418	0.378	0.324	0.412	0.458	0.529
Hansen test (P-value)	0.515	0.487	0.458	0.541	0.564	0.412	0.495	0.545	0.658

Standard errors in parentheses
***P<0.01, **P<0.05, *P<0.1

5. CONCLUSION AND POLICY RECOMMENDATIONS

Clean energy justice has become a central pillar in achieving global energy goals. In this context, understanding the factors that drive clean energy justice is critical. Among these factors, logistics performance, digital finance, and political stability play significant roles in promoting energy transitions. Although these factors have been limited explored in the clean energy justice context. This study fills this gap by examining how logistics performance, digital finance, and political stability affect clean energy justice in developing countries from 2007 to 2020. POLS, 2SLS, and SGMM techniques have been used as baseline models for global analysis, while OLS and SIVQR techniques are used for sensitivity analysis. SGMM technique is used for regional investigation. The global findings reveal that LP significantly enhances CEJ in 2SLS and SGMM models but is insignificant in POLS, while DFI and PS show consistent positive effects on CEJ across all models. Among control variables, ICT, GDP, GLOB, and FDI positively influence CEJ, whereas NRR negatively affects CEJ in most models. Robustness models report consistent results. The regional analysis reveals that LP and PS positively influence CEJ in Asia and America, while LP positively affects CEJ in Asia, America, and Africa. ICT, GDP, GLOB, and FDI show positive associations with CEJ across most models. NRR exhibits negative effects in Asia and America but remains insignificant in Africa.

The findings help us derive some important practical suggestions for the concerned stakeholders. First, logistics performance is crucial for fair and equitable distribution of clean energy. Therefore, the government must focus on improving the logistic aspects of the supply chain within the renewable energy sector. In this regard, the government should invest in building logistics infrastructure, such as roads, railway lines, airports, and sea ports, promoting the uninterrupted and smooth supply of renewable energy technologies, which are crucial for promoting clean energy justice. Further, the policymakers need to simplify the customs procedures and promote efficient trade channels, which are instrumental in disseminating clean energy components across the globe. Second, digital finance also promotes clean energy justice. Thus, to help marginalized people buy solar panels and other clean energy equipment, policymakers must focus on developing digital financial methods by promoting mobile banking and digital wallets. Policymakers should promote the development of digital lending platforms, which are crucial for offering small loans to poor and low-income households and small entrepreneurs for installation of microgrids. Policymakers should enable people and small enterprises to engage in renewable energy initiatives to clean energy justice by endorsing policies that improve financial literacy and internet accessibility. Third, political stability also proves vital in fostering clean energy justice. Therefore, the government should build a stable regulatory environment to attract local and foreign investors who are ready to invest in riskier clean energy ventures. Consistent energy policies are made possible by stable governments, which promotes innovation and lessens energy disparities. In addition, the government should also promote democratic norms and allow the participation of the common people in policy formulation, which is crucial for protecting their interests. Consequently, the government is forced to devise policies that encourage the equal distribution of energy resources.

This study has several limitations. First of all, the study relies on data from 2007 to 2022 due to the unavailability of earlier data, which restricts the scope of analysis. Future research should address this limitation by incorporating extended datasets to provide a more comprehensive analysis. Secondly, comparing the dynamics of clean energy justice between low, middle, and high-income economies could offer valuable insights. Thirdly, although this study employs advanced econometric approaches for long-run and short-run results. Future studies are encouraged to utilize nonlinear PMG-ARDL estimation methods to capture the nonlinear effects of these factors on clean energy justice.

6. ACKNOWLEDGEMENT

The authors are thankful to the Deanship of Graduate Studies and Scientific Research at University of Bisha for supporting this work through the Fast-Track Research Support Program. The authors also extend their appreciation to Northern Border University, Saudi Arabia, for supporting this work through project number (NBU-CRP-2025-2922).

REFERENCES

Acheampong, A.O., Nghiem, X.H., Dzator, J., Rajaguru, G. (2023b), Promoting energy inclusiveness: Is rural energy poverty a political Failure? Utilities Policy, 84, 101639.

Acheampong, A.O., Opoku, E.E.O., Dogah, K.E. (2023a), The political economy of energy transition: The role of globalization and governance in the adoption of clean cooking fuels and technologies. Technological Forecasting and Social Change, 186, 122156.

Alegre-Bravo, A., Anderson, C.L. (2023), Exploring the influence of multidimensional variables on access to electricity in rural areas of the Global South. Applied Energy, 333, 120509.

Arellano, M., Bover, O. (1995), Another look at the instrumental variable estimation of error-components models. Journal of Econometrics, 68(1), 29-51.

Blundell, R., Bond, S. (1998), Initial conditions and moment restrictions in dynamic panel data models. Journal of Econometrics, 87(1), 115-143.

Blundell, R., Bond, S. (2023), Initial conditions and blundell-bond estimators. Journal of Econometrics, 234, 101-110.

Browning, M., Collado, M.D. (2007), Habits and heterogeneity in demands: A panel data analysis. Journal of Applied Econometrics, 22(3), 625-640.

Chen, R., Majeed, M.T. (2024), How does green investment respond to ICT and financial development? Borsa Istanbul Review, 24(6), 1067-1076.

Chernozhukov, V., Hansen, C. (2008), Instrumental variable quantile regression: A robust inference approach. Journal of Econometrics, 142(1), 379-398.

Cumby, R.E., Huizinga, J., Obstfeld, M. (1983), Two-step two-stage least squares estimation in models with rational expectations. Journal of Econometrics, 21(3), 333-355.

Dong, B., Jiang, Q., Dou, Y., Dong, X. (2024), Can financial inclusion reduce energy inequality? Evidence from China. Applied Economics, 56(50), 6109-6125.

Gomber, P., Koch, J.A., Siering, M. (2017), Digital finance and FinTech: Current research and future research directions. Journal of Business Economics, 87, 537-580.

Górecka, A.K., Pavlić Skender, H., Zaninović, P.A. (2021), Assessing the effects of logistics performance on energy trade. Energies, 15(1), 191.

Hasan, M.M., Yajuan, L., Khan, S. (2022), Promoting China's inclusive finance through digital financial services. Global Business Review, 23(4), 984-1006.

Heffron, R.J., McCauley, D. (2017), The concept of energy justice across the disciplines. Energy Policy, 105, 658-667.

John, L., Piotrowicz, W.D., Ruggiero, A. (2024), Supply chain disruptions and their impact on energy sector during COVID-19. In: Sustainable and Resilient Supply Chain. Vol. 12. United Kingdom: Emerald Publishing Limited. p65-92.

Kaplan, D.M. (2022), Smoothed instrumental variables quantile regression. The Stata Journal, 22(2), 379-403.

Kaygusuz, K. (2012), Energy for sustainable development: A case of developing countries. Renewable and Sustainable Energy Reviews, 16(2), 1116-1126.

Krammer, S.M., Kafouros, M.I. (2022), Facing the heat: Political instability and firm new product innovation in sub-Saharan Africa. Journal of Product Innovation Management, 39(5), 604-642.

Le, D.N., Nguyen, H.T., Truong, P.H. (2020), Port logistics service quality and customer satisfaction: Empirical evidence from Vietnam. The Asian Journal of Shipping and Logistics, 36(2), 89-103.

Li, H. (2024), The effect of digital technology innovation on low carbon investment in renewable energy enterprises. Renewable Energy, 239, 121991.

Li, X., Sohail, S., Majeed, M.T., Ahmad, W. (2021), Green logistics, economic growth, and environmental quality: Evidence from one belt and road initiative economies. Environmental Science and Pollution Research, 28, 30664-30674.

Manju, S., Sagar, N. (2017), Progressing towards the development of sustainable energy: A critical review on the current status, applications, developmental barriers and prospects of solar photovoltaic systems in India. Renewable and Sustainable Energy Reviews, 70, 298-313.

Munro, P., Van Der Horst, G., Healy, S. (2017), Energy justice for all? Rethinking sustainable development goal 7 through struggles over traditional energy practices in Sierra Leone. Energy Policy, 105, 635-641.

Newell, P. (2021), Power Shift: The Global Political Economy of Energy Transitions. United Kingdom: Cambridge University Press.

Nguea, S.M., Kaguendo, U.V.E., Noumba, I. (2022), Are growth effects of foreign capital significant for increasing access to electricity in Africa? Energy Policy, 168, 113129.

Peng, J.H., Wang, K.L., Cheng, Y.H., Miao, Z. (2024), How does digital inclusive finance affect energy justice? Evidence from China. Finance Research Letters, 67, 105844.

Qamruzzaman, M., Karim, S. (2024), Green energy, green innovation, and political stability led to green growth in OECD nations. Energy Strategy Reviews, 55, 101519.

Rafique, R., Mun, K.G., Zhao, Y. (2017), Designing energy supply chains: Dynamic models for energy security and economic prosperity. Production and Operations Management, 26(6), 1120-1141.

Raghutla, C., Shahbaz, M., Chittedi, K.R., Jiao, Z. (2021), Financing clean energy projects: New empirical evidence from major investment countries. Renewable Energy, 169, 231-241.

Rehman, I.H., Kar, A., Banerjee, M., Kumar, P., Shardul, M., Mohanty, J., Hossain, I. (2012), Understanding the political economy and key drivers of energy access in addressing national energy access priorities and policies. Energy Policy, 47, 27-37.

Roodman, D. (2009), How to do xtabond2: An introduction to difference and system GMM in Stata. The Stata Journal, 9(1), 86-136.

Saidi, S., Mani, V., Mefteh, H., Shahbaz, M., Akhtar, P. (2020), Dynamic linkages between transport, logistics, foreign direct Investment, and economic growth: Empirical evidence from developing countries. Transportation Research Part A: Policy and Practice, 141, 277-293.

Sen, K.K., Hosan, S., Karmaker, S.C., Chapman, A.J., Saha, B.B. (2024), Clarifying the linkage between renewable energy deployment and energy justice: Toward equitable sustainability. Sustainable Futures, 8, 100236.

Shahbaz, M., Siddiqui, A., Sinha, A., Bigerna, S. (2024), Does financial development enhance access to electricity? A rural-urban perspective in India. Energy, 291, 130464.

Shittu, I., Saqib, A., Abdul Latiff, A.R., Baharudin, S.A. (2024), Energy subsidies and energy access in developing countries: Does institutional quality matter? Sage Open, 14(3), 21582440241271118.

Tercan, I., Özdemir, D.I. (2024), The role of logistics in SDG 7 "affordable and clean energy". In: Effective Logistics for Sustainable Development Goals. United States: IGI Global. p79-98.

Wang, J., Wang, K., Dong, K., Shahbaz, M. (2022), How does the digital economy accelerate global energy justice? Mechanism discussion and empirical test. Energy Economics, 114, 106315.

Wang, J.Z., Feng, G.F., Chang, C.P. (2024), How does political instability affect renewable energy innovation?. Renewable Energy, 230, 120800.

Wei, D., Ahmad, F., Abid, N., Khan, I. (2023), The impact of digital inclusive finance on the growth of the renewable energy industry: Theoretical and logical Chinese experience. Journal of Cleaner Production, 428, 139357.

Wooldridge, J.M. (2010), Econometric Analysis of Cross Section and Panel Data. United States: MIT Press.

Zhao, Y., Wang, S., Liu, X., Tang, X. (2023), Effect of the logistics industry on the promotion of China's position in the global value chain: An international trade perspective. International Review of Economics & Finance, 86, 834-847.