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Renewable Energy Consumption and Inflation in Low- and Middle-Income Countries

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Abstract

Inflationary pressures in low- and middle-income countries are shaped by energy import dependence, global price shocks, and structural constraints. This study examines the renewable energy-inflation nexus across low- and middle-income countries over 2000-2022. Unlike studies treating developing countries as homogeneous, it accounts for differences in energy dependence, institutional quality, and external vulnerability. Using FGLS, PCSE, and System GMM, the study addresses heteroskedasticity, cross-sectional dependence, autocorrelation, and endogeneity. Results indicate a positive and significant association between renewable energy consumption and inflation in low-income countries, while the relationship is statistically insignificant in middle-income countries. System GMM estimates further indicate a positive association and substantial inflation persistence. The findings highlight the importance of expanding domestic renewable energy capacity, upgrading energy infrastructure, improving access to targeted financing, and managing the energy transition gradually to mitigate potential inflationary pressures and support price stability.

Keywords: Renewable energy consumption, inflation, System GMM, Developing countries.

Section I. Introduction

According to the World Bank (2025), low- and Middle-Income countries are defined as countries with relatively lower income levels, limited industrial diversification, and are more vulnerable to external economic and financial shocks such as energy prices, exchange rate volatility, and capital flow instability, adding to weak infrastructure. In fact, these factors significantly impact macroeconomic variables, including interest rates, exchange rates, and real output, and particularly inflation. In addition to these, geopolitical landscapes and COVID-19 have contributed to worsening inflation levels in low- and middle-income countries (Grekou, 2022).

To the IMF (2022), goods and services inflation globally border up to 8.8% in 2022, however, in many low- and Middle-Income countries, the inflation rate exceed the global average; namely Bosnia and Herzegovina (14.02%), Ghana (31.25%), the Democratic Republic of the Congo (22.80%), Sri Lanka (49%), Pakistan (19.87%), Sierra Leone (27.20%), Mongolia (15.15%), and Sudan (138.81%). These high inflation rates are partly due to rising energy prices, as many middle-income countries depend on exporting raw commodities and importing finished products (IMF, 2022, 2025). Besides, it should be noted that high volatility of prices undermines not only a country's economic growth, but it also affects consumer purchasing power. Thus, those that highly rely on imported fossil fuels are vulnerable to international energy price changes and external shocks (IMF, 2025). In this context, adopting an energy transition and renewable energy appear as strategic alternatives not only to minimise fossil fuel dependency and limit price volatility, but also to promote economic and environmental sustainability (International Renewable Energy Agency, 2023; IRENA, 2021).

Renewable energy, defined as energy produced continuously from inexhaustible natural resources such as sunshine, wind, water, geothermal heat, and biomass, allows for sustainable energy production with low greenhouse gas emissions (IRENA, 2020).

In the economic literature, authors such as Friedman (1956), Lucas (2000), and Pavlík et al. (2025) emphasise that inflation is a monetary phenomenon primarily determined by monetary policy and fluctuations in the money supply. It consists of maintaining low and predictable prices over time, not to erode household income, weaken their purchasing power, and distort economic expectations and enhances planning capacity and preserves real incomes (Lucas, 2000). However, recent studies conducted by Arı and Lauridsen (2025) and Pavlík et al. (2025) demonstrate that energy costs can directly influence price dynamics and generate significant inflationary pressures.

Within this framework, renewable energy may contribute to lower inflation levels through its low marginal costs, reduced exposure to global price shocks, and contribution to energy diversification (Arı & Lauridsen, 2025; Millischer et al., 2024; Zhang et al., 2024). Similarly, hybrid energy systems that combine fossil fuels with renewable sources can reduce vulnerability to external shocks and moderate inflation (Owolabi et al., 2023; Pavlík et al., 2025; Zhang et al., 2024). However, in low- and middle-income countries, this stabilising potential is often weakened by high initial investment costs, institutional constraints, and socio-political resistance (Nwankwo & Lele, 2024; Nwosu et al., 2025). All of these constraints call for the need to investigate the relationship between renewable energy consumption and inflation in the contexts of low- and middle-income economies.

Despite the amount of literature on renewable energy and inflation, important gaps persist. First, existing studies are predominantly concentrated in advanced economies, offering limited evidence for low- and middle-income countries where energy import dependence, weak productive structures, and exposure to external shocks intensify inflationary pressures(Ahmed & Shimada, 2019; Wang et al., 2024). Second, the empirical literature on the renewable energy–inflation nexus remains fragmented and inconclusive. While some studies report that renewable energy contributes to lower inflation through energy diversification and reduced dependence on fossil fuels (Durani et al., 2025; Grekou et al., 2022), others find short-run inflationary effects associated with transition costs, infrastructure constraints, and adjustment pressures (Deka et al., 2022a; Zhang et al., 2024). Third, many previous studies rely on conventional econometric techniques that inadequately address heteroskedasticity, cross-sectional dependence, autocorrelation, and endogeneity, thereby weakening the robustness and credibility of their findings (Whba, 2025).

This study is original in examining the renewable energy–inflation nexus by distinguishing between low-income and middle-income countries over the period 2000–2022, a relationship that remains underexplored in developing economies. Unlike prior studies that treat developing countries as a homogeneous group, this study accounts for structural differences in energy dependence, institutional quality, and exposure to external shocks, yielding more context-specific evidence on inflation dynamics across levels of development. In addition, unlike studies that focus primarily on monetary determinants of inflation, this research integrates energy transition(Geels, 2002; Smil, 2019), macroeconomic conditions, and institutional quality within a unified analytical framework.

The study contributes to the literature in three major ways. First, it provides new empirical evidence on how renewable energy consumption affects inflation dynamics in developing economies. Second, it applies robust and complementary econometric techniques, including FGLS, PCSE, and System GMM, to address key methodological challenges and improve estimation reliability. Third, it offers policy-relevant insights on how renewable energy transition strategies can support price stability and strengthen macroeconomic resilience in low- and middle-income countries.

The main objective is to assess the effect of renewable energy consumption on inflation in low- and middle-income countries (see Appendix). The study is original in directly examining the renewable energy–inflation nexus in low- and middle-income countries, a relationship that remains insufficiently explored in the literature, particularly in relation to overall consumer price stability. Its novelty further lies in extending beyond conventional approaches that emphasise monetary determinants of inflation by incorporating energy structure, technological change, and institutional factors within a unified analytical framework. In addition, it provides evidence from a broad panel of low- and middle-income countries and applies robust econometric techniques to address key methodological challenges, thereby enhancing the validity of the findings. Overall, the study contributes both to theoretical advancement and to policy design by offering evidence on how energy transition strategies in low- and middle-income countries can support price stability and strengthen macroeconomic resilience.

The article is structured as follows: Section 1 introduces the study; Section 2 reviews the literature; Section 3 presents the methodology; Section 4 discusses the results; and Section 5 concludes with policy implications.

Section 2. Literature Review

This section is divided into two parts. The first presents the theoretical framework linking renewable energy consumption to inflation, while the second synthesises the empirical evidence on this relationship.

2.1 Theoretical Review

This study is grounded in energy diversification (Awerbuch, 2006) and energy transition (Geels, 2002; Smil, 2019) theories, which posit that inflation is shaped not only by monetary factors but also by structural and supply-side forces, particularly energy-related shocks (Blanchard & Galí, 2007; Smil, 1994). In economies highly dependent on imported fossil fuels, fluctuations in global energy prices are transmitted into domestic production and consumption costs, generating persistent cost-push inflationary pressures. These theories provide a structural explanation of inflation that goes beyond monetary factors by focusing on energy systems, which are central to this study. Specifically, they explain how renewable energy adoption can reduce exposure to fossil fuel price shocks and reshape cost structures, thereby directly linking energy consumption patterns to inflation dynamics in low- and middle-income countries.

Within this framework, renewable energy can mitigate inflation by diversifying the energy mix, reducing import dependence, and strengthening energy security (Sadorsky, 2009; Smil, 2019). Low marginal cost structure and reduced exposure to international price volatility enable it to function as a favourable supply-side shock, thereby contributing to macroeconomic stability.

Energy transition theory further explains that the shift from fossil fuels to renewable energy improves efficiency and reduces vulnerability to external shocks (Geels, 2002; Smil, 1994). However, this transition may also entail short-run adjustment costs, infrastructure constraints, and institutional limitations, which can generate temporary inflationary pressures, especially in developing contexts (Asante et al., 2020; Obuseh et al., 2025). Energy diversification theory complements this view by emphasising that hybrid energy systems reduce exposure to inflationary shocks and enhance macroeconomic stability (Awerbuch, 2006; Sadorsky, 2009). These stabilising effects are further strengthened by supportive policy frameworks, technological progress, and institutional quality, which facilitate smoother energy transitions (Akono & Kemezang, 2024).

2.2 Empirical Review

Empirical evidence broadly reveals that renewable energy is associated with lower inflationary pressures in the long run, although findings remain mixed and method-dependent (Ahmed & Shimada, 2019; Wang et al., 2024). A first strand of the literature reports short-run inflationary effects, attributed to high capital costs, adjustment frictions, and transitional inefficiencies in

energy systems (Deka et al., 2022a; Dinçer et al., 2023; Zhang et al., 2024). However, these results are often sensitive to model specification, time horizon, and measurement of renewable energy, raising concerns about their robustness and comparability across studies.

In contrast, a second strand identifies long-run disinflationary effects through reduced energy costs, improved efficiency, and enhanced energy security (Durani et al., 2025; Grekou et al., 2022). Yet, these findings are frequently based on long-run averages that may conceal short-term adjustment costs and structural breaks, thereby overstating the stability of the relationship. This divergence suggests that the renewable energy–inflation nexus is inherently dynamic and non-linear rather than uniform across time.

For instance, Apergis and Danuletiu (2014) emphasise the stabilising role of renewable energy in mitigating macroeconomic vulnerability to external shocks, whereas Omri et al. (2014) show that fossil fuel dependence remains a dominant inflationary channel, indicating that structural energy dependence conditions the effect of renewables. Similarly, Markowski & Kotliński (2023) report significant inflation reductions with higher renewable energy penetration, while Deka et al. (2022) find macroeconomic stabilisation through exchange rate channels; however, both sets of results are highly sensitive to country coverage and econometric strategy. Recent studies further confirm long-run inflation-reducing effects, although short-run volatility persists due to transition dynamics (Muğaloğlu et al., 2025). Overall, the evidence suggests that the sign and magnitude of effects are contingent on structural conditions, institutional quality, energy mix composition, and empirical methodology, limiting generalisability.

Overall, while the literature generally reveals that the potential stabilising role of renewable energy consumption on inflation, the evidence remains fragmented and inconclusive. The short-run effects are particularly contested, with divergent findings reflecting differences in methodology, data frequency, and country context. Two main gaps persist. First, the literature remains heavily concentrated in developed economies, limiting external validity for low- and middle-income contexts where energy dependence and macroeconomic vulnerabilities are more pronounced. Second, there is no clear consensus on the temporal dynamics of the relationship, particularly the trade-off between short-run inflationary pressures and long-run stabilisation effects. These limitations underscore the need for a more rigorous, methodologically robust, and context-specific investigation of the renewable energy–inflation nexus in low- and middle-income economies using advanced panel data techniques.

Section III. Methodology

This study investigates the relationship between renewable energy consumption and inflation stability in low- and middle-income countries using secondary data. The dataset covers 85 developing countries over 23 years, from 2000 to 2022. This period is selected to ensure adequate data availability and consistency across countries, while capturing major global economic, energy, and inflationary shocks that shape the relationship between renewable energy and price stability. The sample is constructed around emerging economies that share structural characteristics, such as energy import dependence, exposure to external shocks, and evolving institutional frameworks, which heighten their sensitivity to energy price volatility (Blanchard and Galí, 2007). In addition, sample selection is constrained by strict data availability and consistency requirements over the study period. Following established panel data methodology, only countries with complete and continuous observations for all core variables are included, thereby ensuring a strongly balanced and internally consistent dataset (Arellano and Bond, 1991). This stringent selection process mitigates biases arising from missing data and sample attrition, enhances cross-country comparability, and reinforces the robustness, internal validity, and statistical reliability of the econometric estimates (Hsiao, 2022; Wooldridge, 2002).

According to the World Bank (2025), low-income countries are economies with a Gross National Income (GNI) per capita of $1,135 or less, including countries such as Benin, Burkina Faso, Burundi, Central African Republic, Chad, Congo republic, Gambia, Guinea, Haiti, Liberia, Madagascar, Mali, Mozambique, Niger, Rwanda, Sierra Leone, Sudan, Tanzania, Togo, and Uganda. In addition, middle-income countries are economies with a Gross National Income (GNI) per capita between $1,136 and $13,845, including lower-middle-income and upper-middle-income countries: Algeria, Angola, Azerbaijan, Bahamas, The, Bangladesh, Belarus, Belize, Bolivia, Bosnia and Herzegovina, Brazil, Bulgaria, Cabo Verde, Cambodia, Cameroon, China, Côte d'Ivoire, Dominican Republic, Ecuador, Egypt, Arab Rep., El Salvador, Equatorial Guinea, Fiji, Gabon, Ghana, Guatemala, Honduras, India, Indonesia, Iran, Islamic Rep., Iraq, Jamaica, Kenya, Lao PDR, Lesotho, Libya, Mauritius, Mongolia, Morocco, Myanmar, Namibia, Nepal, Nicaragua, Nigeria, Pakistan, Panama, Papua New Guinea, Peru, Philippines, Senegal, South Africa, Sri Lanka, Thailand, Tunisia, Ukraine, Viet Nam, and Zambia. Countries are listed in Appendix 1.

Renewable energy consumption is expressed as a percentage of total energy use and is derived from the World Development Indicators (WDI) database. It is the share of renewable energy in total final energy consumption (World Bank, 2025). Inflation stability data are derived from pertinent macroeconomic measures, while governance metrics are sourced from the World Bank's Worldwide Governance Indicators (WGI) database. In this study, inflation (Infl) as the

dependent variable is proxied by the consumer prices (annual %) (World Bank, 2025). The main explanatory variable, renewable energy consumption (Renerg), is measured as the share of renewable energy in total final energy consumption (%), also expressed in logarithmic form (IRENA, 2021; World Bank, 2025). The control variables include GDP per capita (World Bank, 2015 US$), government final consumption expenditure (% of GDP), trade openness (World Bank), broad money (M2 as % of GDP), corruption control index (Kaufmann et al., 2011) and total population (World Bank). These variables capture key demand-side, supply-side, monetary, and institutional determinants of inflation, consistent with established macroeconomic theory (Blanchard & Galí, 2007; Lucas, 1972).

Building on Kouadio & Njong Mom's (2025b, 2025a) studies highlighting the presence of heteroskedasticity (Appendix 2) and autocorrelation (Appendix 4), slope homogeneity (Appendix 5) and cross-sectional dependence (Appendix 7), adding to the fact that N=20 with T=23, which used the feasible generalised least squares (FGLS). This study first analyses the renewable energy and price stability nexus in low-income countries. Accordingly, the model employed in this study is specified as follows:

$$Inflation_{it} = \alpha_0 + \alpha_2 EnergyConspt_{it} + \alpha_3 fos_Cons_{it} + \alpha_4 X_{it} + \varepsilon_{it} \quad (1)$$

Where $Inflation_{it}$ proxied of stability price, measured by the consumer price index (Fischer, 993), $EnergyConspt_{it}$ represents renewable energy consumption in country *i* at time *t*. Energy imports net (% of energy use) is the share of a country's total energy use that is met through net imports (World Bank, 2025). The $X_{i,t}$is the matrix of control variables including GDP per capita, trade openness, foreign direct investment and government effectiveness selected based on the literature on macroeconomic stability determinants. ε_{it} is the error term.

Secondly, building on Ikpesu et al. (2019) and Xu et al. (2023), which document heteroskedasticity, autocorrelation, and cross-sectional dependence (Appendix 7), and given the panel structure of the data (N = 65, T = 23), this study employs Panel-Corrected Standard Errors (PCSE) to obtain robust inference in the presence of non-spherical error structures. The PCSE estimator is appropriate in this context because the data exhibit heteroskedasticity across countries and contemporaneous correlation driven by common global shocks, while the time dimension (T = 23) is sufficiently large to ensure reliable estimation of the error variance–covariance matrix. Although PCSE corrects standard errors for these issues, it retains the OLS coefficient structure and therefore assumes correct model specification while not addressing potential endogeneity. Accordingly, the empirical model is specified as follows:

$Inflation_{it} = \alpha_0 + \alpha_2 EnergyConspt_{it} + \alpha_3 fos_Cons_{it} + \alpha_4 X_{it} + \varepsilon_{it}$ (2).

In the third part of the analysis, both groups of countries are merged into a balanced panel of 85 countries over 2000–2022 (T = 23). The Durbin–Wu–Hausman tests (Patrick, 2019) and the (Appendix 4) reject the null hypothesis of exogeneity (Durbin χ^2 = 50.94, p < 0.01; Wu–Hausman F = 52.08, p < 0.01), confirming the presence of endogeneity in the model. The Hausman test also confirms the presence of fixed effects (Appendix 3).

To address this issue, the study employs the system GMM estimator (Arellano & Bond, 1991; Blundell & Bond, 1998), which controls for endogeneity, reverse causality, and unobserved heterogeneity by using lagged variables as instruments in a system of equations estimated in levels and first differences. This estimator is particularly suitable for dynamic panels with a lagged dependent variable and persistent regressors. The validity of the estimation strategy is confirmed through Hansen/Sargan tests for instrument validity and Arellano–Bond AR(1) and AR(2) tests for serial correlation. In contrast, instrument proliferation is controlled by collapsing the instrument matrix and restricting lag depth. The analysis is based on a dynamic econometric model inspired by Wang et al. (2024). The model is specified as follows:

$$\text{Infl}_{it} = \alpha_0 + \alpha_1 ren_energy_{it} + \alpha_2 fos_Cons_{it} + \alpha_2 EnergImp_{it} + \beta' X_{i,t} + \pi_t + \mu_i + \epsilon_{it} \quad (3)$$

Where π_t captures time fixed effects, μ_i the country fixed effects and ϵ_{it} error term.

Section IV. Results and Discussions

In Table 1, the descriptive statistics reveal substantial variation across countries and variables. Inflation is highly volatile, with a mean of 7.96 (SD = 20.62) and values ranging from -16.86 to 79.907, indicating phases of severe price instability. Fossil fuel energy consumption remains dominant, averaging 82.13%, while renewable energy consumption averages 45.79% (SD = 30.62). GDP per capita exhibits marked disparities, ranging from 253.69 to 33,568.70, with a mean of 3,540.62. Trade openness is relatively high on average (74.26%) but varies across countries. Foreign direct investment is highly volatile, ranging from -37.17 to 103.34. Energy imports average 9.07%, reflecting moderate external dependence. Government effectiveness is slightly negative on average (-0.55), ranging from -1.67 to 1.62, highlighting heterogeneity in institutional quality across the sample.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Inflation	1978	7.956	20.620	-16.860	79.907

Renewable energy consumption (%)	1978	45.791	30.618	0.100	98.300
GDP per capita (US$)	1978	3540.617	4363.274	253.692	33568.700
Trade openness (% of GDP)	1978	74.261	33.419	2.699	186.676
Foreign direct investment (% of GDP)	1978	4.087	6.657	-37.173	103.337
Fossil fuel energy consumption	1978	82.128	29.479	0.112	131.119
Energy imports	1978	9.069	11.484	0.002	88.592
Government effectiveness	1978	-0.546	0.614	-1.673	1.618

Source: Author's calculation based on WDI and IRENA data (2000-2022).

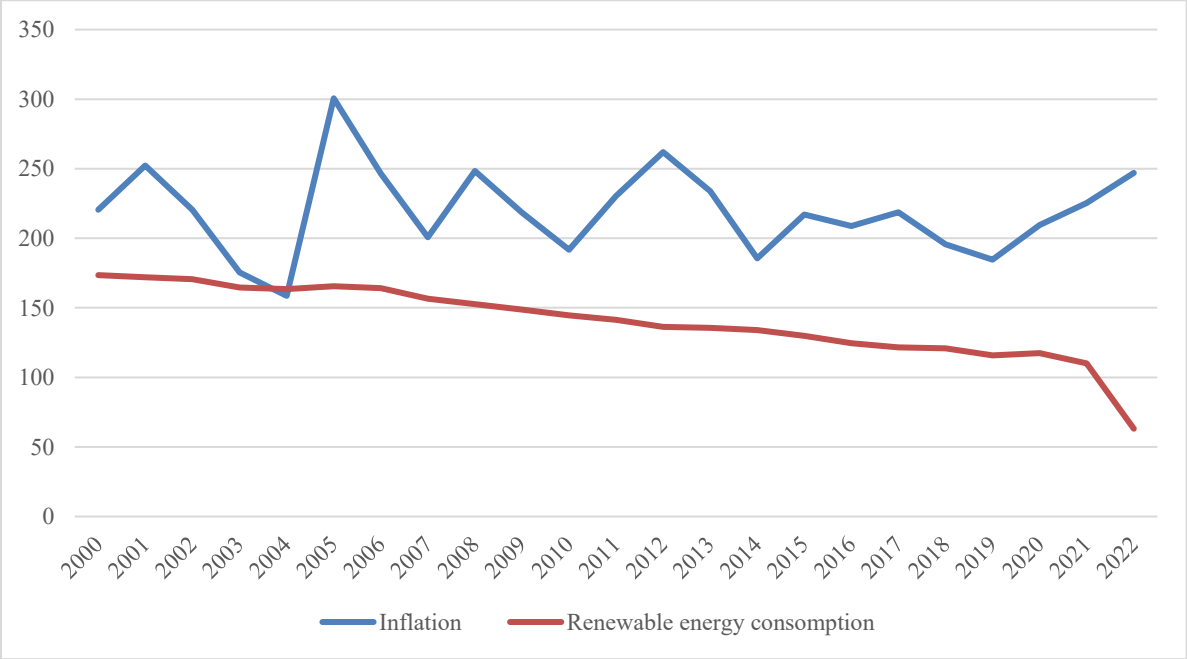


Figure 1. Relationship Between Renewable Energy Consumption and Inflation in Low-Income Countries

Author's calculation based on WDI and IRENA data (2000-2022).

Summary statistics in Table 1 are highlighted in Figure 1, which presents a graph showing a contrasting evolution between 2000 and 2022 in low-income countries. Inflation exhibits significant fluctuations, with peaks around 2005, 2008, and 2012, followed by periodic declines,

reflecting notable macroeconomic instability. In contrast, renewable energy consumption follows a generally steady downward trend throughout the period, with a sharp drop after 2020. This divergence suggests that increases in renewable energy consumption are not immediately associated with lower inflation in these low-income countries.

Figure 2 demonstrates the descriptive trends in middle-income nations from 2000 to 2022, revealing diverse macroeconomic and energy dynamics. Inflation is very volatile, reflecting persistent macroeconomic instability, recurring external shocks, and episodic policy adjustments that are characteristic of these economies. In contrast, renewable energy consumption is gradually dropping, demonstrating structural, institutional, and financial obstacles that impede energy transition development. Thus, the weak co-movement between inflation and renewable energy consumption indicates a limited interdependence between price stability and sustainable energy adoption, highlighting middle-income countries' ongoing developmental and structural challenges in aligning macroeconomic stability with long-term environmental sustainability objectives.

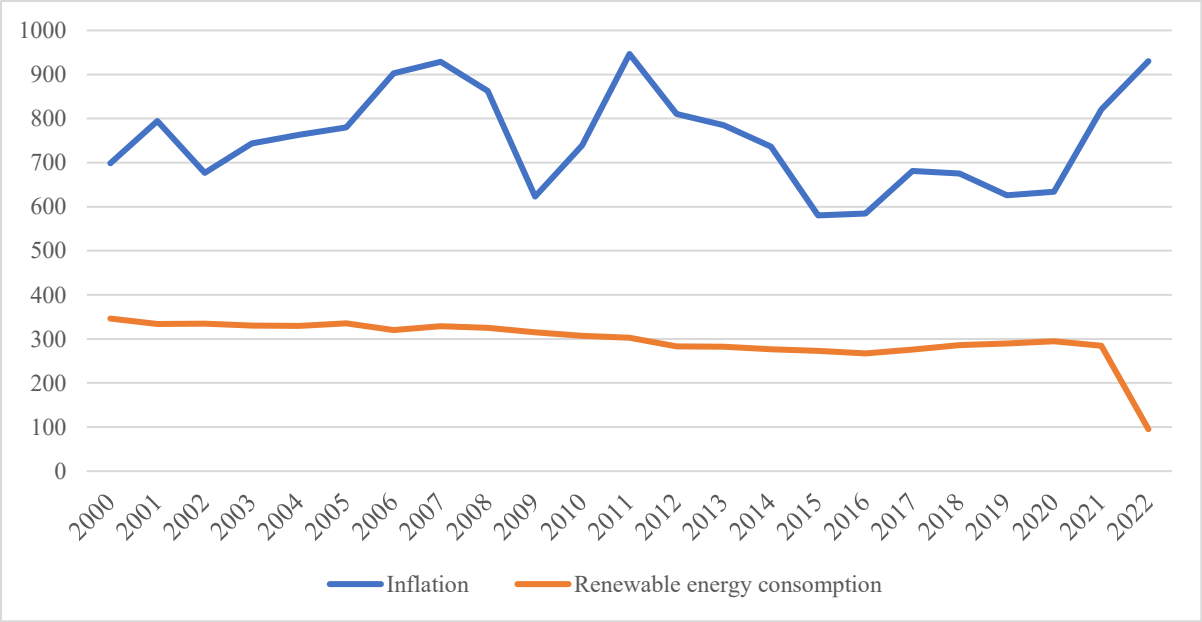


Figure 2. Renewable Energy and Inflation Nexus in Middle-Income Countries

Author's calculation based on WDI and IRENA data (2000-2022).

Figure 3 illustrates the relationship between inflation and renewable energy consumption in developing countries over the period 2000–2022. Inflation is characterised by pronounced volatility, with recurrent fluctuations and notable peaks, particularly during the late 2000s and early 2020s, reflecting episodes of macroeconomic instability.

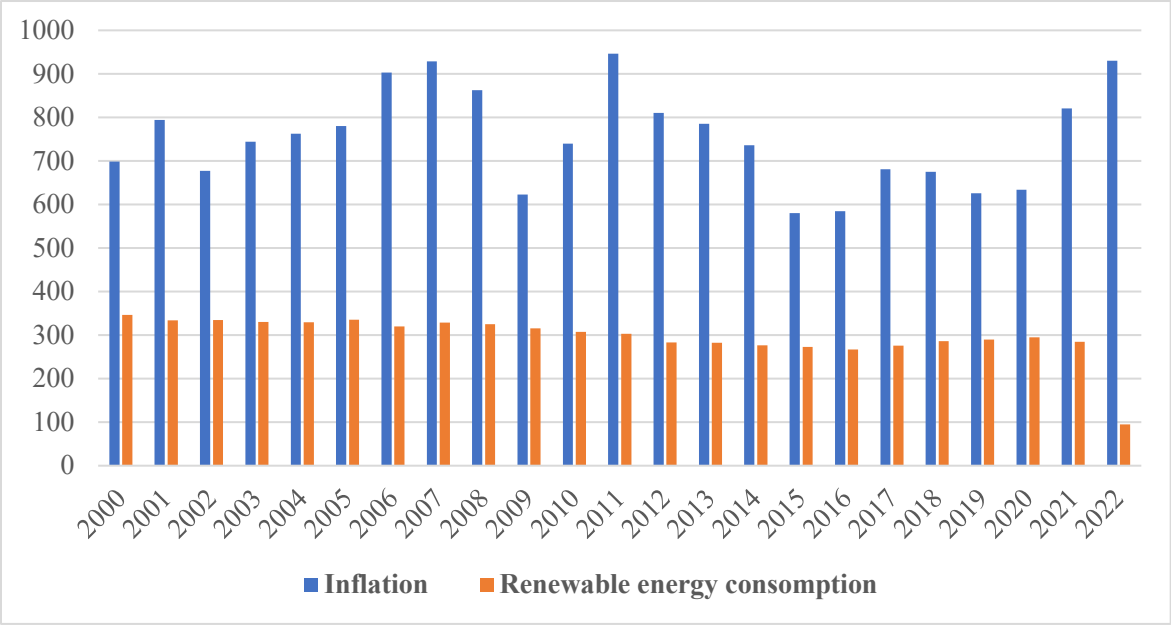


Figure 3. Relationship Between Renewable Energy and Inflation in Developing Countries

Author's calculation based on WDI and IRENA data (2000-2022).

In contrast, renewable energy consumption remains relatively low and exhibits a broadly stagnant to mildly declining trend over the same period. Statistics indicate a weak direct association between the two variables, as variations in inflation do not systematically correspond to contemporaneous changes in renewable energy consumption. Nonetheless, the observed pattern suggests a potential indirect relationship, whereby heightened inflation and macroeconomic instability may constrain renewable energy uptake through increased uncertainty, higher cost of capital, and reduced investment capacity.

Table 2. Relationship Between Renewable Energy Consumption and Inflation in Low-Income Countries (FGLS results)

Variables	Inflation		
	(1)	(2)	(3)
Renewable energy consumption	0.194**	0.173***	0.192**
	(0.0767)	(0.0451)	(0.0880)
Fossil fuel energy consumption	0.0567	0.0493**	0.0349
	(0.0498)	(0.0226)	(0.0561)
Energy imports	0.115*	0.112***	0.127*
	(0.0623)	(0.0294)	(0.0694)
GDP per capita	0.0874*	0.0558*	0.0960*
	(0.0449)	(0.0305)	(0.0521)
Trade openness	-0.0693*	-0.0210	-0.0593
	(0.0414)	(0.0247)	(0.0456)

Foreign direct investment	0.120***	0.0997***	0.105**
	(0.0435)	(0.0177)	(0.0462)
Government effectiveness	0.0350	0.0749***	0.0288
	(0.0430)	(0.0163)	(0.0473)
Constant	121.5***	121.2***	126.2***
	(28.50)	(15.33)	(31.94)
Observations	460	460	460
Number of countries	20	20	20

Source: Author's calculation based on WDI and IRENA data (2000-2022) p<0.01, ** p<0.05, * p<0.1

In Table 2, the FGLS estimation techniques accounting for heteroskedasticity (1), autocorrelation (2), and both jointly (3) consistently indicate that a 1% increase in renewable energy consumption leads to at least a 0.17% increase in inflation in low-income countries. This positive and statistically significant coefficient suggests that increases in renewable energy are associated with inflationary pressures in these countries. In contrast, when the same relationship is estimated using PCSE in Table 3 for middle-income countries, the coefficient on renewable energy consumption is not statistically significant, indicating no measurable inflationary effect in this group. Together, these findings are consistent with Deka and Dube (2021) and Deka et al. (2022), who similarly report that in the short run, there is a positive association between renewable energy consumption and inflation. This relationship can be justified by several structural mechanisms: the high capital intensity of renewable energy investments, dependence on imported technologies and exposure to exchange rate pass-through, as well as institutional and market inefficiencies. Collectively, these factors raise production costs and generate cost-push inflationary effects during the energy transition in low-income countries.

Table 3. Relationship Between Renewable Energy Consumption and Inflation in Middle-Income Countries (PCSEs results)

Inflation	Coefficient.	St.Err.	t-value	p-value	[95% Conf	Interval]	Sig
Renewable energy consumption	0.134	0.105	1.27	0.203	-0.072	0.340	
Fossil fuel energy consumption	-0.052	0.05	-1.04	0.298	-0.149	0.046	
Energy imports	-0.017	0.044	-0.39	0.697	-0.103	0.069	
GDP per capita	0.022	0.03	0.73	0.467	-0.037	0.081	
Trade openness	-0.097	0.031	-3.15	0.002	-0.158	-0.037	***
Foreign direct investment	0.025	0.029	0.88	0.380	-0.031	0.082	
Government effectiveness	-0.039	0.035	-1.13	0.257	-0.107	0.028	
Constant	842.775	90.166	9.35	0.000	666.053	1019.497	***

Mean dependent var	753.172	SD dependent var	435.587
R-squared	0.192	Number of obs	1518
Chi-square	16.825	Prob > chi2	0.019

Source: Author's calculation based on WDI and IRENA data (2000-2022); p<0.01, ** p<0.05, * p<0.1

The coefficients on energy imports are positive and statistically significant across all specifications (0.115, 0.112, and 0.127; Table 2), indicating that higher levels of energy imports are associated with an increase in inflation. These findings are consistent with Sahu and Mahalik's (2026) study, which found that reliance on overseas energy hampers macroeconomic resilience and energy import dependence constitutes a key channel of external price transmission. This relationship can be explained through exchange rate pass-through effects, whereby international energy price fluctuations and domestic currency depreciation are transmitted to domestic price levels. Moreover, exposure to global energy market volatility and external supply shocks further amplifies inflationary pressures in energy-importing economies.

The coefficients on GDP per capita in Table 2 also show that higher income levels are associated with higher inflation. This finding is in line with Yilmaz's (2016) study, which reveals that income growth can generate demand-side inflationary pressures in developing economies. The result is explained by demand-pull mechanisms, whereby increases in GDP per capita raise aggregate demand, which translates into higher price levels under conditions of limited supply responsiveness.

The coefficients on trade openness in Table 2 are negative across specifications (-0.0693), with statistical significance only in the first model, indicating a weak and non-robust disinflationary effect. This finding is consistent with the empirical literature suggesting that trade openness can reduce inflation, confirming Romer's (1993) hypothesis that trade openness creates competitiveness and hence reduces inflation. Secondly, trade openness leads to diversification, which may lower aggregate inflation by reducing price shocks. However, Munir et al. (2015) reveal that there is no relationship between inflation and trade openness.

An increase in foreign direct investment (0.120, 0.099, and 0.105) is positive and statistically significant across all specifications (Table 2. This finding is consistent with recent empirical evidence suggesting that foreign direct investment may lead to a moderate increase in inflation pressure through demand expansion, exchange rate dynamics, and sectoral price adjustments (Sekmen and Gökırmak, 2020). In particular, an increase in foreign capital inflows may stimulate aggregate demand and place upward pressure on prices, especially in economies characterised by structural rigidities and limited supply responsiveness.

Finally, enhancing government effectiveness in low-income countries increases the level of inflation. This finding contradicts Maiti & Ramesha (2026), who found that government effectiveness has a negative long-run relationship with inflation. However, in the developing economies context, the relationship can be explained through demand-side channels, whereby stronger institutional capacity enhances fiscal implementation and policy effectiveness, potentially stimulating aggregate demand. In addition, improved governance may coincide with increased public investment and structural transformation, generating temporary inflationary pressures.

Robustness Check

As a robustness check, a System GMM estimator is employed to address endogeneity, dynamic persistence, and unobserved heterogeneity. The results largely corroborate the baseline FGLS and PCSE findings while providing additional insight into long-run dynamics. Inflation exhibits strong persistence, as indicated by the highly significant lagged dependent variable (0.832***). Renewable energy consumption remains statistically significant and positive (0.256***), reinforcing a robust association with inflation once endogeneity is controlled for, in line with the baseline short-run results. GDP per capita is also positively associated with inflation (0.412), confirming persistent demand-side pressures. Conversely, government effectiveness exerts a strong negative effect (-0.999), while FDI also reduces inflation (-0.297), suggesting potential stabilising roles in the long run. Diagnostic tests validate the specification, with no evidence of second-order autocorrelation (AR (2) p = 0.339) and valid instruments (Hansen p = 0.215).

Table 4: Relationship between renewable energy consumption and price stability (GMM estimation results)

Variable	GMM Coefficient	Std. Error	Significance
Lagged Inflation	0.832	0.0759	***
Renewable Energy consumption	0.256	0.0738	***
GDP per Capita	0.412	0.0964	***
Trade Openness	-0.0950	0.0749	-
Fossil fuel energy consumption	0.141	0.124	-
FDI	-0.297	0.130	
Trade openness	0.0401	0.0115	***
Government effectiveness	-0.999	0.349	***
Constant	4.666	1.402	***
Observations	1978	-	-
Countries	85	-	-
Fisher (p-value)	-	-	0.000
AR(1) Test (p-value)			0.021
AR(2)	-	-	0.339
Sargan Test (p-value)	-	-	0.756
Hansen Robustness Test	-	-	0.215

Source: Authors' calculation based on WDI and IRENA data (2000-2022)

Section V. Conclusion and Recommendations

This research has been motivated by persistent inflationary pressures in low- and middle-income nations, which are caused by structural limitations such as reliance on energy imports, vulnerability to external shocks, and restricted productive capacity. In this context, shifting from global energy to renewable sources raises important concerns regarding its implications for price stability in low and middle-income economies. Using FGLS, PCSE, and System GMM estimators over the period 2000–2022, the results show that renewable energy consumption is associated with inflationary pressures in low-income countries in the short run, while no significant effect is found in middle-income countries. However, the System GMM estimates confirm a robust and persistent positive relationship, indicating that the inflationary effect remains significant once endogeneity and dynamic persistence are accounted for. Inflation is highly persistent, GDP per capita increases inflation through demand-side pressures, and government effectiveness significantly reduces inflation in the long run. Overall, the evidence

suggests that the renewable energy-inflation nexus is dynamic, context-dependent, and shaped by structural and institutional conditions.

From a policy standpoint, the findings indicate that mitigating the inflationary impact of renewable energy necessitates realistic, action-oriented approaches rather than broad policy declarations. First, governments should prioritise domestic manufacturing and assembly of renewable energy technologies (such as solar panels, batteries, and inverters) to reduce dependence on imports and exchange-rate risk. Second, improving grid infrastructure, transmission capacity, and energy storage technologies is critical for reducing inefficiencies and ensuring supply. Third, government officials should encourage public-private partnerships (PPPs) to increase financing for renewable energy projects while lowering initial investment costs. Fourth, implementing targeted subsidies or concessional financing for renewable energy equipment can help alleviate short-term cost constraints throughout the transition. Fifth, improving institutions in the energy sector through transparent procurement methods and increased regulatory control can minimise inefficiencies while increasing policy effectiveness. Finally, governments should implement progressive and well-timed energy transition policies that combine renewable and conventional energy sources to avoid price shocks and maintain macroeconomic stability during the transition period.

Declarations

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Data availability statement

We collected Data from the World Development Indicators (WDI) and World Governance Indicators (WGI) (https://databank.worldbank.org/source/world-development-indicators) and BCEAO for the eight West African Economic and Monetary Union (WAEMU) countries (https://edenpub.bceao.int/). Additionally, data will be available upon request. The study covers 2000 to 2022.

Ethics Approval

Not applicable.

Consent to Participate

Not applicable.

Consent to Publish

Not applicable.

References

Ahmed, M. M., & Shimada, K. (2019). The Effect of Renewable Energy Consumption on Sustainable Economic Development: Evidence from Emerging and Developing Economies. *Energies*, *12*(15), 2954. https://doi.org/10.3390/en12152954

Akono, E. B., & Kemezang, V. C. (2024). Balancing short-term costs and long-term benefits: An analysis of the impact of hydroelectric power generation on electricity prices volatility in Cameroon. *Sustainable Energy Research*, *11*(1), 7. https://doi.org/10.1186/s40807-024-00099-y

Apergis, N., & Danuletiu, D. (2014). Renewable Energy and Economic Growth: Evidence from the Sign of Panel Long-Run Causality. *International Journal of Energy Economics and Policy*, *4*, 578–587.

Arellano, M., & Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies*, *58*(2), 277–297. https://doi.org/10.2307/2297968

Arı, A., & Lauridsen, J. T. (2025). The Impact of Renewable Energy Diversity on Inflation: A Case Study Based on China. *Sustainability*, *17*(17), 7811. https://doi.org/10.3390/su17177811

Asante, D., He, Z., Adjei, N. O., & Asante, B. (2020). Exploring the barriers to renewable energy adoption utilising MULTIMOORA- EDAS method. *Energy Policy*, *142*, 111479. https://doi.org/10.1016/j.enpol.2020.111479

Awerbuch, S. (2006). Portfolio-Based Electricity Generation Planning: Policy Implications For Renewables And Energy Security. *Mitigation and Adaptation Strategies for Global Change*, *11*(3), 693–710. https://doi.org/10.1007/s11027-006-4754-4

Blanchard, O., & Galí, J. (2007). Real Wage Rigidities and the New Keynesian Model. *Journal of Money, Credit and Banking*, *39*(s1), 35–65. https://doi.org/10.1111/j.1538-4616.2007.00015.x

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics*, *87*(1), 115–143. https://doi.org/10.1016/S0304-4076(98)00009-8

Deka, A., Cavusoglu, B., & Dube, S. (2022a). Does renewable energy use enhance exchange rate appreciation and stable rate of inflation? *Environmental Science and Pollution Research*, *29*(10), 14185–14194. https://doi.org/10.1007/s11356-021-16758-2

Deka, A., Cavusoglu, B., & Dube, S. (2022b). Does renewable energy use enhance exchange

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

Dinçer, H., Yüksel, S., Çağlayan, Ç., Yavuz, D., & Kararoğlu, D. (2023). Can renewable energy investments be a solution to the energy-sourced high inflation problem? In *Managing inflation and supply chain disruptions in the global economy* (pp. 220–238). IGI Global Scientific Publishing. https://www.igi-global.com/chapter/can-renewable-energy-investments-be-a-solution-to-the-energy-sourced-high-inflation-problem/309570

Durani, F., Anwar, A., Sharif, A., Hamid, A., Ali, S., & Syed, Q. R. (2025). Exploring the link between inflation, tourism, trade, foreign direct investment, and renewable energy consumption: Evidence from novel wavelet quantile correlation approach. *Clean Technologies and Environmental Policy*, *27*(8), 3897–3911. https://doi.org/10.1007/s10098-024-03073-w

Fischer, S. (1993). The role of macroeconomic factors in growth. *Journal of Monetary Economics*, *32*(3), 485–512. https://doi.org/10.1016/0304-3932(93)90027-D

Friedman, M. (1956). TheQuantityTheoryofMoney: A Restatement. *Ch. 1inStudies in the Quantity Theory of Money, Ed. by Milton Friedman (Chicago University Press, 1956)*, 3–21.

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy*, *31*(8–9), 1257–1274.

Grekou, C., Hache, E., Lantz, F., Massol, O., Mignon, V., & Ragot, L. (2022). Guerre en Ukraine: Bouleversements et défis énergétiques en Europe. *CEPII, Policy Brief*, (37). https://www.ifp-school.com/sites/ifp-school.com/files/telechargements/documents/CEPII-PolicyBrief_mai22.pdf

Hsiao, C. (2022). *Analysis of Panel Data* (4th edn). Cambridge University Press. https://doi.org/10.1017/9781009057745

Ikpesu, F., Vincent, O., & Dakare, O. (2019). Growth effect of trade and investment in Sub-Saharan Africa countries: Empirical insight from panel corrected standard error (PCSE) technique. *Cogent Economics & Finance*, *7*(1), 1607127. https://doi.org/10.1080/23322039.2019.1607127

IMF. (2022). *Regional Economic Outlook for Sub-Saharan Africa, October 2022*. IMF. https://www.imf.org/en/publications/reo/ssa/issues/2022/10/14/regional-economic-outlook-for-sub-saharan-africa-october-2022

IMF. (2025). *Perspectives de l'économie mondiale, octobre 2025*. IMF. https://www.imf.org/fr/publications/weo/issues/2025/10/14/world-economic-outlook-october-2025

International Renewable Energy Agency. (2023). *Global Energy Transformation: The REmap transition pathway (Background report to 2019 Edition)*.

IRENA. (2020). *Renewable Power Generation Costs 2020*.

IRENA. (2021). *World Energy Transitions Outlook*. https://www.irena.org/publications/2021/Jun/World-Energy-Transitions-Outlook

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2011). The worldwide governance indicators: Methodology and analytical issues1. *Hague Journal on the Rule of Law*, *3*(2), 220–246.

Kouadio, M., & Njong Mom, A. (2025a). Education expenditure and income inequalities reduction in West African countries: Does governance matter? *Development and Sustainability in Economics and Finance*, *5*, 100051. https://doi.org/10.1016/j.dsef.2025.100051

Kouadio, M., & Njong Mom, A. (2025b). Health Expenditure, Governance Quality, and Health Outcomes in West African Countries. *The International Journal of Health Planning and Management*, *40*(2), 427–441. https://doi.org/10.1002/hpm.3887

Lucas, R. E. (2000). Inflation and Welfare. *Econometrica*, *68*(2), 247–274.

Maiti, S., & Ramesha, K. (2026). Good Governance and Inflation: Countries' Outlooks. In *Economic Growth, Price Stability and Good Governance Implications of Fiscal and Monetary Policies*. Routledge.

Markowski, Ł., & Kotliński, K. (2023). Renewables, energy mix and inflation in the European union countries. *Energies*, *16*(23), 7808.

Millischer, L., Fu, C., Volz, U., & Beirne, J. (2024). *Do Renewables Shield Inflation from Fossil Fuel-Price Fluctuations?* https://www.elibrary.imf.org/view/journals/001/2024/111/article-A001-en.xml

Muğaloğlu, E., Kılıç, E., Keskin, H., & Selçuklu, S. (2025). *Dynamics of Electricity Price Volatility and its Impacts on Energy Investments* (SSRN Scholarly Paper No. 5225487). Social Science Research Network. https://doi.org/10.2139/ssrn.5225487

Munir, S., Hasan, H., & Muhammad, M. (2015). The effect of trade openness on inflation: Panel data estimates from selected Asian economies (1976-2010). *Southeast Asian Journal of Economics*, 23–42.

Nwankwo, C., & Lele, D. (2024). Socioeconomic challenges and opportunities in renewable energy transition. *International Journal of Applied Research in Social Sciences*, *6*, 1503–1519. https://doi.org/10.51594/ijarss.v6i7.1337

Nwosu, C., Maduekwe, E., Obalum, D., & Udemba, J. (2025). *Governance and the energy transition in developing nations: Attaining sustainable development*. *15*, 21–29.

Obuseh, E., Eyenubo, J., Alele, J., Okpare, A., & Oghogho, I. (2025). A Systematic Review of Barriers to Renewable Energy Integration and Adoption. *Journal of Asian Energy Studies*, *9*, 26–45. https://doi.org/10.24112/jaes.090002

Omri, A., Nguyen, D. K., & Rault, C. (2014). Causal interactions between CO2 emissions, FDI, and economic growth: Evidence from dynamic simultaneous-equation models. *Economic Modelling*, *42*, 382–389.

Owolabi, O. O., Schafer, T. L. J., Smits, G. E., Sengupta, S., Ryan, S. E., Wang, L., Matteson, D. S., Getmansky Sherman, M., & Sunter, D. A. (2023). Role of Variable Renewable Energy Penetration on Electricity Price and its Volatility across Independent System Operators in the United States. *Data Science in Science*, *2*(1), 2158145. https://doi.org/10.1080/26941899.2022.2158145

Patrick, R. H. (2019). Durbin?Wu?Hausman Specification Tests. In *Handbook of Financial Econometrics, Mathematics, Statistics, and Machine Learning* (pp. 1075–1108). WORLD SCIENTIFIC. https://doi.org/10.1142/9789811202391_0028

Pavlík, M., Kurimský, F., & Ševc, K. (2025). Renewable Energy and Price Stability: An Analysis of Volatility and Market Shifts in the European Electricity Sector (2015–2025). *Applied Sciences*, *15*(12), 6397. https://doi.org/10.3390/app15126397

Romer, D. (1993). Openness and Inflation: Theory and Evidence*. *The Quarterly Journal of Economics*, *108*(4), 869–903. https://doi.org/10.2307/2118453

Sadorsky, P. (2009). Renewable energy consumption, CO2 emissions and oil prices in the G7 countries. *Energy Economics*, *31*(3), 456–462. https://doi.org/10.1016/j.eneco.2008.12.010

Sahu, A. K., & Mahalik, M. K. (2026). Unveiling the nexus between energy import dependency and macroeconomic instability: Panel evidence from emerging market economies. *The Journal of International Trade & Economic Development*, *35*(2), 435–454. https://doi.org/10.1080/09638199.2024.2443401

Sekmen, F., & Gökırmak, H. (2020). Inflation and foreign direct investment in Turkey. *Applied Econometrics*, *60*, 70–79. https://doi.org/10.22394/1993-7601-2020-60-70-79

Smil, V. (1994). *Energy In World History*. Westview Press.

Smil, V. (2019). *Energy in world history*. Routledge. https://www.taylorfrancis.com/books/mono/10.4324/9780429038785/energy-world-history-vaclav-smil

Wang, G., Sbai, E., Wen, L., & Sheng, M. S. (2024). The impact of renewable energy on extreme volatility in wholesale electricity prices: Evidence from organisation for economic co-operation and development countries. *Journal of Cleaner Production*, *484*, 144343.

Whba, R. (2025). Renewable Energy in Developing Countries: Insight into Challenges, Policy, and Financing. In M. S. Su'ait, H. Jarimi, & S. A. M. Noor (Eds), *ACS Symposium Series* (Vol. 1499, pp. 15–38). American Chemical Society. https://doi.org/10.1021/bk-2025-1499.ch002

Wooldridge, J. M. (2002). Econometric analysis of cross section and panel data MIT press. *Cambridge, Ma*, *108*(2), 245–254.

World Bank. (2025). *World Development Indicators | DataBank*. https://databank.worldbank.org/source/world-development-indicators

Xu, S., Zhang, Y., Chen, L., Leong, L. W., Muda, I., & Ali, A. (2023). How Fintech and effective governance derive the greener energy transition: Evidence from panel-corrected standard errors approach. *Energy Economics*, *125*, 106881. https://doi.org/10.1016/j.eneco.2023.106881

Zhang, L., Padhan, H., Singh, S. K., & Gupta, M. (2024). The impact of renewable energy on inflation in G7 economies: Evidence from artificial neural networks and machine learning methods. *Energy Economics*, *136*(C). https://ideas.repec.org//a/eee/eneeco/v136y2024ics0140988324004262.html

Appendices

1. List of countries

Afrique du Sud	Côte d'Ivoire	Liberia	Samoa
Algérie	Equateur	Libye	Sao Tome et Principe
Angola	Egypte	Madagascar	Sénégal
Azerbaijan	El Salvador	Mali	Serbie
Bahamas	Fiji	Maroc	Sierra Léone
Bangladesh	Gabon	Maurice	Slovénie

Belize	Gambie	Mongolie	Îles Salomon
Bénin	Géorgie	Mozambique	Sri Lanka
Biélorussie	Ghana	Myanmar	Saint-Vincent et les Grenadines
Bhoutan	Guatemala	Namibie	Soudan
Bolivie	Guinée	Népal	Tanzanie
Bosnie-Herzégovine	Guinée équatoriale	Nicaragua	Tchad
Brésil	Haïti	Niger	Thaïlande
Bulgarie	Honduras	Nigeria	Togo
Burkina Faso	Inde	Pakistan	Tonga
Burundi	Indonésie	Panama	Tunisie
Cambodge	Iran	Papouasie-Nouvelle Guinée	Ouganda
Cameroun	Irak	Pérou	Ukraine
Cap-Vert	Jamaïque	Philippines	Vietnam
Centrafrique	Kenya	République Domi-dominicaine	Zambie
Chine	Laos PDR	Rwanda, Congo	Lesotho

Source: World Bank (2025)

2. Heteroskedasticity test

Test Used: Modified Wald test for groupwise heteroskedasticity.

- for all groups i(homoskedasticity, i.e., constant error variance across groups).
- $H_1: \sigma_i^2 \neq \sigma^2$ for at least one group (heteroskedasticity, i.e., error variance differs across groups).

Results:

- Test statistic: $\chi^2(86) = 6414.96$
- p-value $= 0.0000$

Prob > chi2 = 0.0000

The chi-square p-value being less than 0.05 confirms the presence of heteroskedasticity, indicating that the OLS coefficients are potentially biased and inefficient. Therefore, it is necessary to use generalised least squares (GLS) to correct for this issue.

3. Hausman Test

Purpose: To determine whether to use fixed effects or random effects in panel data analysis.

Null Hypothesis (H_0): The difference in coefficients is not systematic (random effects are consistent and efficient).

Test statistic:

$$\chi^2(7) = (b - B)'[(V_b - V_B)^{-1}](b - B) = 47.79$$

p-value: 0.0000
(Note: $V_b - V_B$is not positive definite, but the test statistic can still be interpreted.)

Interpretation:
Since the p-value < 0.05, we reject the null hypothesis. This implies that the fixed effects model is more appropriate than the random effects model for this analysis.

4. Endogeneity Test Results (Durbin–Wu–Hausman Test)

Test	Statistic	Degrees of Freedom	p-value	Decision
Durbin (score) χ^2 test	50.9412	1	0.0000	Reject H_0
Wu–Hausman F test	52.0776	(1, 1968)	0.0000	Reject H_0

Source: Authors' calculation based on WDI and IRENA data (2000-2022).

H_0: All explanatory variables are exogenous.
H_1: At least one explanatory variable is endogenous.
The results indicate rejection of the null hypothesis at the 1% significance level, confirming endogeneity in the model.

5. Autocorrelation Test

Test Used: Wooldridge test for first-order autocorrelation in panel data.

Null Hypothesis: is (H_0): No first-order autocorrelation.

Results: $F(1,85) = 49.140$, p-value $= 0.0000$

6. Slope homogeneity test

Testing for slope heterogeneity (Pesaran, Yamagata. 2008. Journal of Econometrics) H0: slope coefficients are homogeneous		
	Delta	p-value
	8.744	0.000
adj.	11.379	0.000

Source: Authors' calculation based on WDI and IRENA data (2000-2022).

7. Granger Causality Test

Dumitrescu & Hurlin (2012) Granger non-causality test results:		
Lag order: 2		
W-bar =	2.3040	
Z-bar =	1.4094	(p-value = 0.1587)
Z-bar tilde =	-0.0129	(p-value = 0.9897)
H0: d_lnrenerg does not Granger-cause d_lninfl.		

H1: d_lnrenerg does Granger-cause d_lninfl for at least one panel (ID).

Source: Authors' calculation based on WDI and IRENA data (2000-2022).

8. Cross-Sectional Dependence Test (Pesaran CD Test)

Source: Authors' calculation based on WDI and IRENA data (2000-2022).

The Pesaran (2004) CD test results indicate significant cross-sectional dependence across all variables, as all p-values are below 0.05. This suggests that countries in the sample are interdependent and affected by common shocks. Therefore, second-generation panel estimators that are robust to cross-sectional dependence, such as Driscoll–Kraay and GMM, are appropriate for the analysis.

9. Panel Unit Root Test Results (Im–Pesaran–Shin, IPS)

Variable	CD-test	p-value	Corr	Abs(Corr)	Decision
Inflation (lnipc)	53.50	0.000	0.193	0.294	CD present
Broad Money (lnbroadmon)	142.35	0.000	0.514	0.587	CD present
Foreign Direct Investment (lnfdi)	24.87	0.000	0.089	0.267	CD present
Trade Openness (lntrade)	24.32	0.000	0.084	0.365	CD present
Control of Corruption (lnconcorr)	-1.99	0.047	-0.007	0.363	CD present
Renewable Energy Consumption (lnrencons)	68.63	0.000	0.248	0.524	CD present
GDP per Capita (lngdpcap21)	148.20	0.000	0.535	0.692	CD present

Variable	IPS Level (t-bar / p-value)	IPS First Difference (t-bar / p-value)	Order of Integration
Inflation (lninfl)	-3.1974 (0.0000) ***	-	I(0)
Renewable Energy Consumption (lnrencons)	-1.6846 (0.0818) *	-	I(0)*
GDP per Capita (lngdpcap21)	-2.030 (0.713)	-2.572* (0.013)	I(1)

Trade Openness (lntrade)	-1.644 (0.568)	-3.509*** (0.000)	I(1)
Broad Money Supply (lnbroadmon)	-1.750 (0.290)	-3.600*** (0.000)	I(1)
Foreign Direct Investment (lnfdi)	-2.100* (0.032)	-	I(0)
Natural Resource Rents (lntotrents)	-1.900 (0.210)	-4.200*** (0.000)	I(1)
Control of Corruption (lnconcorr)	-2.050* (0.041)	-	I(0)

Source: Authors' calculation based on WDI and IRENA data (2000-2022).

Table 4. Relationship between renewable energy consumption and inflation (Driscoll-Kraay estimation results).

Variables	Coefficient	Std. Error	z-stat	p-value	95% Confidence Interval
Renewable energy consumption (lnrenerg)	0.3420***	0.0485	7.05	0.000	[0.2470 ; 0.4371]
GDP per capita (lngdppc)	0.4502***	0.0527	8.55	0.000	[0.3470 ; 0.5534]
Trade openness (lntrade)	-0.0643***	0.0185	-3.48	0.001	[-0.1005 ; -0.0280]
Foreign direct investment (lnfdi)	-0.0893***	0.0253	-3.53	0.000	[-0.1389 ; -0.0397]
Broad money supply (lnbroadmon)	0.0898***	0.0183	4.90	0.000	[0.0539 ; 0.1257]
Control of corruption (lnconcorr)	-0.3553***	0.0638	-5.57	0.000	[-0.4803 ; -0.2302]
Constant	-1.7321***	0.6301	-2.75	0.006	[-2.9670 ; 0.4972]

Source: Authors' calculation based on WDI and IRENA data (2000-2022).

10. Instrumental Variable (2SLS) Regression Results

Variables	Coefficient	Std. Error	z-stat	p-value	95% Confidence Interval
Renewable energy consumption (lnrenerg)	0.3420***	0.0485	7.05	0.000	[0.2470 ; 0.4371]
GDP per capita (lngdppc)	0.4502***	0.0527	8.55	0.000	[0.3470 ; 0.5534]
Trade openness (lntrade)	-0.0643***	0.0185	-3.48	0.001	[-0.1005 ; -0.0280]
Foreign direct investment (lnfdi)	-0.0893***	0.0253	-3.53	0.000	[-0.1389 ; -0.0397]
Broad money supply (lnbroadmon)	0.0898***	0.0183	4.90	0.000	[0.0539 ; 0.1257]
Control of corruption (lnconcorr)	-0.3553***	0.0638	-5.57	0.000	[-0.4803 ; -0.2302]
Constant	-1.7321***	0.6301	-2.75	0.006	[-2.9670 ; 0.4972]

Source: Authors' calculation based on WDI and IRENA data (2000-2022).