

Institutional Quality, Tax Incentives, and Youth Employment: A Mixed-Methods Assessment of Ghana's Green Economy Transition

Jones Adjei Ntiamoah¹, Mohammed Muntaka Abdul-Rahman^{1,✉}, Peter Arhenful¹

¹. Department of Accounting and Finance, Accra Technical University, Accra, GHA

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Abstract

This study examines how tax incentives, institutional quality, and renewable energy development influence youth employment in Ghana. Employing a mixed-methods design, the study combines a systematic qualitative policy analysis of legislative texts and budget reports with quantitative econometric modelling. Specifically, the Autoregressive Distributed Lag bounds testing framework and its associated Error Correction Model are applied to annual time-series data spanning 2000 to 2023 to evaluate both the short-run dynamics and the long-run equilibrium relationship among the study variables. The research evaluates whether Ghana's tax policies are aligned with national youth employment and skills development objectives.

The key findings are threefold. First, tax incentives, though associated with attracting foreign and local investment, show no statistically significant impact on youth employment in either the short or long run, a null result that must be interpreted with caution given the limited observations available for this variable. This null finding is robust across all estimators employed, though it must be interpreted with caution given the limited observations available for the tax incentive variable. Second, institutional quality, measured by government effectiveness, is identified as the strongest determinant of youth employment outcomes. Third, renewable energy production and foreign direct investment consistently yield positive employment effects.

The qualitative analysis highlights a structural misalignment between Ghana's existing tax incentive framework and national youth employment objectives: incentives primarily promote capital investment without conditioning eligibility on local hiring, technical training, or partnerships with technical and vocational education and training institutions. The study concludes that fiscal incentives should be redesigned with mandatory employment and skills-development conditionalities, supported by improved institutional coordination and strategic investment in renewable energy value chains, to maximize long-term inclusive job creation.

Categories: Auditing and taxation, Labor Economics, Sustainable Economic Development

Keywords: tax incentives, institutional quality, youth employment, green economy, renewable energy

JEL Classifications: J21, H25, H20, Q43, Q48, Q56, O55

Introduction

Over the past two decades, Ghana has made commendable progress in integrating renewable energy and green growth into its national development strategy. The passage of the Renewable Energy Act (Act 834) by the Parliament of Ghana ([Parliament of Ghana, 2011](#)) and the launch of the Renewable Energy Master Plan by the Energy Commission ([Ministry of Energy, 2019](#)) and the Energy Transition and Investment Plan by the Government of Ghana, Sustainable Energy for All, ([Sustainable Energy for All, 2023](#)) all signal strong political will to reduce emissions, attract green investment, and create

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jobs. Despite these advances, structural and financial challenges persist, and the contribution of non-hydro renewables remains minimal. It is important to note that while the econometric analysis in this study spans 2000 to 2023, thereby capturing the pre-policy baseline against which these legislative milestones can be assessed, the qualitative policy analysis is necessarily bounded by the post-2011 policy environment in which the Renewable Energy Act and subsequent instruments came into force. This dual temporal scope is intentional and serves the study's mixed-methods design. Existing tax incentives have yet to be fully aligned with goals such as youth employment and skills development. Bridging this gap by reconfiguring fiscal incentives to include clear employment and training conditions could enhance the social impact of Ghana's energy transition and deliver more inclusive growth.

Youth unemployment remains a critical challenge in Ghana, with 19.7% of individuals aged 15-35 unemployed and 34% underemployed in low-skill, informal work ([Ghana Statistical Service, 2023](#)). Although government programs like the National Builders Corps (NaBCo) and the National Youth Employment Program have provided short-term relief, they have lacked sustainability and skills advancement pathways ([World Bank, 2022a](#)) ([Baah-Boateng, 2016](#)). Meanwhile, a persistent skill mismatch limits young people's access to emerging green and digital job markets ([Ministry of Employment and Labour Relations and International Labour Organization, 2021](#)) ([World Bank, 2022b](#)). Technical and Vocational Education and Training (TVET) reforms have yet to fully modernize training or strengthen industry linkages ([UNESCO-UNEVOC, 2022](#)). With over 500,000 youth entering the labor force annually, the International Labor Organization (ILO) and the World Bank call for integrated reforms combining tax incentives, education, and private sector collaboration. The recent creation of the Ministry of Youth Development and Empowerment signals Ghana's intent to take a more coordinated, long-term approach.

From an institutional economics perspective ([North, 1990](#)) ([Acemoglu and Robinson, 2012](#)), the effectiveness of any policy instrument is conditioned by the quality of the institutional environment in which it operates. Tax incentives are no exception: without robust enforcement mechanisms, clear conditionalities, and coherent inter-agency coordination, fiscal instruments designed to attract investment are unlikely to generate the social returns in terms of youth employment and skills development that policymakers intend. This theoretical premise underpins the study's expectation that institutional quality will mediate the employment outcomes of tax incentives in Ghana's renewable energy sector ([Breen, 2005](#)), ([Pastore, 2018](#)), and ([Dietrich and Möller, 2016](#)).

This study contends that tax incentives in Ghana's renewable energy sector can be more impactful if tied directly to youth employment and skills development. Currently, incentives such as import duty waivers and tax relief mainly promote capital investment, with limited focus on human capital outcomes ([Parliament of Ghana, 2011](#)), ([Ministry of Energy, 2019](#)), and ([Afful-Dadzie et al., 2022](#)). Studies show that job creation, skills development, and local capacity building are stronger when tax benefits are linked to obligations like local hiring and technical training ([Hagemann, 2018](#)) ([IMF, 2022](#)). Ghana's renewable energy sector holds strong potential to create jobs for young people, but this can only be achieved if investments are supported by the right policies. Seidu ([Seidu, 2020](#)) stresses the need for better alignment between green economy plans and labor market strategies, particularly by linking renewable energy initiatives with TVET to build the skills needed for a greener future. In Ghana, such integration remains weak ([UNESCO-UNEVOC, 2022](#)) ([World Bank, 2022a](#)). This study advocates for realigning tax incentives with labor priorities to promote inclusive green growth.

Hagemann ([Hagemann, 2018](#)) emphasizes that tax incentives are most effective when they are explicitly linked to socio-economic goals such as job creation, skills development, and local capacity building. These incentives should be transparently monitored, time-bound through sunset clauses, and coordinated across sectors, particularly with education and labor policies, to enhance human capital development and safeguard public interest.

Table 1 presents a diagnostic mapping of Ghana's current tax incentive framework against the benchmarks of skills development and youth employment alignment. As is evident, while sector-targeted incentives are present, the critical dimensions of youth-skills conditionality and youth-led sustainable action remain absent from formal fiscal provisions.

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Area	Status
Sector-targeted incentives	✓ Present (imports, tax holidays)
Youth-skills conditionality	✗ Absent (no direct linkage)
TVET–private sector synergy	✓ Emerging through policy proposals
Youth-led sustainable action	✗ Occurring outside fiscal incentive realm

TABLE 1: Ghana's Current Tax Incentive Framework and their Alignments with Skills Development and Youth Employment

Sources: (Ministry of Finance, 2023a); (Ministry of Finance, 2023b); (Ministry of Employment and Labour Relations and International Labour Organization, 2021); (UNESCO, 2022); (CTVET and World Bank, 2022).

Ghana's current incentive architecture for the renewable energy sector is primarily orientated toward capital cost reduction through import duty exemptions and corporate tax holidays. While such instruments successfully lower investment barriers, they do not mandate local manufacturing linkages, resulting in a high dependence on imported equipment and weak domestic supply chain development. Employment creation, similarly, is treated as an incidental rather than a targeted outcome: capital-intensive project designs and the absence of hiring conditionalities mean that incentivized investments generate limited direct employment, particularly for young workers. The tax incentive framework's silence on TVET partnerships deepens this disconnect, as fiscal instruments and skills infrastructure operate in separate policy silos. Accountability mechanisms are equally underdeveloped. The absence of monitoring and evaluation requirements tied to tax relief means that the government cannot systematically assess whether public revenue forgone through exemptions is matched by commensurate social returns. This has created a policy gap between tax incentive policy and youth employment.

Table 2 maps the specific gaps between the stated objectives of Ghana's tax incentive instruments and their observed outcomes in practice, illustrating the structural and administrative constraints that limit their developmental impact on youth employment and skills development.

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Incentive Objective	Observed Outcome	Gap
Promote local manufacturing	High dependence on imports	Weak local supply chain and competition constraints
Stimulate employment	Limited direct job creation	Capital-intensive nature of projects
Advance youth skills development	No incentive link to TVET or training	Policy silos; lack of conditions
Support local EV assembly	Inconsistent VAT relief structure	Narrow applicability; limited uptake
Ensure accountability and effectiveness	No M&E mechanisms tied to tax incentives	Administrative weaknesses and lack of transparency

TABLE 2: Current Policy Gaps Between Tax Incentives and Skills Development and Youth Employment in Ghana

Source: (African Centre for Energy Policy, 2020); (Ministry of Energy and Green Transition, 2021). TVET, Technical and Vocational Education and Training; VAT, Value Added Tax; EV, Electric Vehicle

Youth unemployment remains a significant development challenge in Ghana, with 19.7% of individuals aged 15-35 unemployed and over 30% underemployed (Ghana Statistical Service, 2023). Simultaneously, the emerging renewable energy (RE) sector is constrained by insufficient human capital and limited technological expertise (Kipkoech et al., 2024). Despite this skills mismatch, the RE sector presents a substantial opportunity, capable of generating up to 30,000 direct green jobs by 2030, with strategic alignment of fiscal incentives potentially boosting Ghana's GDP by 1.5% (Seidu, 2020).

However, the developmental impact of existing tax incentives is limited. The current framework primarily supports capital investment by lowering costs, without mandating local youth hiring or technical training (Seidu, 2020, p. 35), (UNESCO-UNEVOC, 2022), and (Hagemann, 2018). This policy gap persists even as Ghana advances its energy transition through the Renewable Energy Master Plan and the Energy Transition and Investment Plan (Ministry of Energy, 2019) (Sustainable Energy for All, 2023). While previous interventions offered temporary relief, their long-term impact was constrained by coordination failure and misalignment with labor market needs (World Bank, 2022a) (Baah-Boateng, 2016). Considering the global emphasis on skill-based employment for sustainable development (Ministry of Employment and Labour Relations and International Labour Organization, 2021) (World Bank, 2022a), this study addresses the urgent need to redesign policy. This study seeks to find answers to the following question: What forms of tax incentives are currently available within Ghana's renewable energy sector? To what extent do these fiscal incentives align with national objectives for promoting youth employment and skills development? What policy and institutional constraints limit the integration of employment creation and skills development into Ghana's tax incentive schemes? And how can Ghana's tax incentive framework be strategically redesigned to strengthen its contribution to inclusive green industrialization?

Research Method

Research design and data collection

This study employs a mixed-methods approach. The qualitative component uses policy analysis to assess the alignment of Ghana's renewable energy tax incentives with national youth employment and skills development objectives, detailing policy content and institutional coherence. The quantitative component utilizes econometric estimation to determine

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the long- and short-run impacts of tax incentives, renewable energy production, and institutional quality on youth employment. The econometric model is controlled for key variables, including economic growth and foreign direct investment inflows.

The qualitative and quantitative strands are deliberately integrated: qualitative findings on policy design gaps, specifically the absence of employment conditionalities and weak TVET linkages, provide the institutional insights needed to interpret the econometric null result for tax incentives. Conversely, the econometric finding that government effectiveness is the strongest driver of youth employment reinforces the qualitative diagnosis that institutional fragmentation, not incentive magnitude, is the binding constraint. This triangulation of methods strengthens the internal validity and policy relevance of the overall findings.

Qualitative data sources and analytical procedure

The qualitative approach critically assesses the tax incentive regime using documentary evidence from legal, institutional, and international sources. Key reviewed documents include the Parliament of Ghana's (2011) Renewable Energy Act and GIPC Act, complemented by national budget statements, Ghana Revenue Authority (GRA) tax expenditure reports, and reports from development partners (ILO, World Bank).

Document selection followed a purposive criterion-based procedure guided by three principles: (i) primary legislative and regulatory relevance. Thus, documents were included only if they directly govern tax incentive design or youth employment policy in Ghana's energy or green economy sectors; (ii) temporal coverage: sources spanning the post-2011 policy period were prioritized, reflecting the operational window of the Renewable Energy Act; and (iii) institutional authority: preference was given to official government publications, intergovernmental organization reports, and peer-reviewed analyses over secondary commentary sources. This approach yielded a corpus of 18 key documents spanning legislation, tax expenditure reviews, policy strategies, and international benchmarking reports.

Content analysis was conducted in three stages. First, an inductive open-coding phase was applied to all documents to identify recurring themes related to tax incentive design, employment conditionalities, and skills development linkages. Second, codes were consolidated into a thematic framework comprising five analytical dimensions: (i) incentive instrument type, (ii) employment conditionalities, (iii) TVET linkages, (iv) institutional coordination, and (v) monitoring and accountability mechanisms. Third, findings were benchmarked against international practices drawn from the ILO, the Organization for Economic Co-operation and Development (OECD), and the United Nations Development Programme (UNDP), selected because these bodies provide globally recognized standards for linking fiscal incentives to social outcomes. Contextual differences between Ghana and comparator economies are acknowledged throughout, and international benchmarks are treated as aspirational reference points rather than prescriptive templates.

To enhance the reliability of the qualitative analysis, findings from legislative texts were triangulated against institutional reports and academic literature. Where documents presented conflicting signals, for example, legislative mandates for local participation that were not reflected in actual GRA reporting practices, both signals are reported, and the divergence is discussed. The study acknowledges the limitation of single-analyst coding and does not claim inter-coder reliability in the formal sense; instead, reliability is strengthened through systematic documentation of coding decisions and transparent citation of evidentiary sources.

Quantitative data sources

The quantitative approach utilizes time-series data spanning 2000–2023. Data on youth employment, GDP, Foreign direct investment (FDI), and government effectiveness are sourced from the World Bank's WDI. Renewable energy production data is from Our World in Data. Tax incentive data (2008–2023) is collected from the Global Tax Expenditure Database and the Ministry of Finance. Due to the limitation of the tax incentive data, backward extrapolation was applied using the Compound Annual Growth Rate (CAGR) method to construct a full 2000–2023 series. However, owing to the unbalanced structure of the resulting dataset, the ARDL/ECM estimation was restricted to the 16 years for which TAX_INC is directly observed (2008–2023), as reported in Table 14. The CAGR-extrapolated values for 2000–2007 therefore do not enter the main estimation. Table 3 provides the empirical data description.

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The tax incentive variable (TAX_INC) requires particular methodological transparency. Systematic records of total tax exemption amounts were available from the Global Tax Expenditure Database (Redonda et al., 2025) and the Ministry of Finance beginning in 2008. To construct a consistent series back to 2000, which is necessary for the Autoregressive Distributed Lag (ARDL) estimation, backward extrapolation was applied using CAGR method. Specifically, the CAGR was computed from the earliest available paired observations (2008-2010) and applied iteratively to generate values for 2000-2007. While this approach is commonly employed in fiscal time-series construction where administrative records are incomplete, it introduces a degree of approximation into the pre-2008 observations. All findings involving the tax incentive variable should therefore be interpreted with this limitation in mind. As a direct consequence, the tax incentive variable is based on only 16 observed (non-extrapolated) data points (2008-2023), which critically constrains the degrees of freedom available for estimation and reduces the statistical power of tests involving this variable.

Variable	ID	Description	Sources
Youth Employment	YEMP	Employment to population ratio, ages 15-24, total (%) (modeled ILO estimate).	(World Bank, 2025)
Real GDP per Capita	RGDPC	GDP per capita (constant LCU).	(World Bank, 2025)
Foreign Direct Investment	FDI	Foreign direct investment, net inflows (% of GDP).	(World Bank, 2025)
Government Effectiveness	GEF	An index that captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	(World Bank, 2025)
Renewable Energy Production	RENW	Share of renewable energy production in electricity mix.	(Ember, 2025)
Tax Incentives and Exemption	TAX_INC	All tax exemption amounts announced by the finance ministry and approved by the parliament of Ghana or reported by the Global Tax Expenditure database.	(Redonda et al., 2025), (Ministry of Finance, 2023a), (The Parliament of Ghana, 2025)

TABLE 3: Data Description

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Econometric methodology

Unit root testing was conducted prior to model estimation to determine the order of integration of each variable, using the Augmented Dickey-Fuller (ADF) test. The results in Table 11 show all variables are non-stationary at levels but stationary at first differences, confirming that they are integrated of order I(1). No variable was found to be I(2), satisfying a critical precondition for the application of the ARDL bounds testing approach.

The ARDL bounds testing framework of Pesaran et al. (Pesaran et al., 2001) was selected as the primary estimation approach for two principal reasons. First, the ARDL model is appropriate when all regressors are I(1), and it does not require variables to be integrated of the same order. This makes it more flexible than traditional cointegration frameworks such as Engle-Granger or Johansen. Second, the ARDL framework performs well in small-sample situations. This sample size limitation is a known constraint of the analysis and is reflected in the lag structure (ARDL[1,0,0,0,0]) selected by the Akaike Information Criterion.

Where cointegration is established via the bounds test, the associated Error Correction Model (ECM) is estimated to capture short-run adjustment dynamics and the speed of convergence to the long-run equilibrium. The general long-run ARDL specification is:

$$YEMP_t = \alpha_0 + \sum_{i=0}^p \alpha_i YEMP_{t-i} + \sum_{i=0}^{q_1} \beta_{1i} TAX_INC_{t-i} + \sum_{i=0}^p \beta_{2i} RGDP_{t-i} + \sum_{i=0}^p \beta_{3i} RENW_{t-i} + \sum_{i=0}^p \beta_{4i} GEF_{t-i} + \sum_{i=0}^p \beta_{5i} FDI_{t-i} + \varepsilon_t \quad (1)$$

The short-run ECM model is expressed as:

$$\Delta YEMP_t = \phi ECM_{t-1} + \sum_{i=0}^p \alpha_i \Delta YEMP_{t-i} + \sum_{i=0}^{q_1} \beta_{1i} \Delta TAX_INC_{t-i} + \sum_{i=0}^p \beta_{2i} \Delta RGDP_{t-i} + \sum_{i=0}^p \beta_{3i} \Delta RENW_{t-i} + \sum_{i=0}^p \beta_{4i} \Delta GEF_{t-i} + \sum_{i=0}^p \beta_{5i} \Delta FDI_{t-i} + \varepsilon_t \quad (2)$$

Where $YEMP_t$, TAX_INC_t , $RGDP_t$, $RENW_t$, GEF_t , and FDI_t represent youth employment, tax incentives, real GDP per capita, renewable energy production, government effectiveness, and foreign direct investment, respectively. ECM_{t-1} is the error correction term. ϕ measures the speed of adjustment. When ϕ is less than 0 and is statistically significant, it indicates a valid long-run equilibrium. ε_t is the error term. β_1 , β_2 , β_3 , β_4 , and β_5 are the coefficients of the regressors. α_0 is the intercept of the model. $YEMP_{t-1}$ is the lag of the dependent variable.

All variables except Government Effectiveness are expressed in natural logarithms prior to estimation to stabilize variance and facilitate elasticity interpretation. Government Effectiveness is retained in levels because it is a bounded institutional quality index that includes negative values and therefore cannot be logarithmically transformed. Consequently, the estimated coefficients on TAX_INC , $RGDP$, $RENW$, and FDI represent elasticities, thus, the percentage change in youth employment is associated with a one-percent change in the respective regressor, while the coefficient on GEF represents a semi-elasticity, indicating the percentage change in youth employment is associated with a one-unit change in the government effectiveness index.

The associated ECM derived from the ARDL estimates enables decomposition of the dynamics into short-run adjustments and long-run equilibrium effects. This dual structure aligns with the study's objective of examining both the immediate and persistent effects of tax incentives, institutional quality, renewable energy production, and FDI on youth

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employment. For robustness checks, long-run estimators such as fully modified ordinary least squares (FMOLS), dynamic ordinary least squares (DOLS), and canonical cointegration regression (CCR) were also used as triangulation checks to validate the ARDL long-run coefficients and ensure the stability and reliability of the findings.

For robustness validation, three alternative long-run estimators - FMOLS, DOLS, and CCR - were employed alongside Ordinary Least Squares with Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors. These estimators adjust for potential endogeneity in time-series data and provide triangulation checks on the ARDL long-run coefficients. The consistency of findings across these four estimators constitutes the primary basis for confidence in the long-run results.

Results And Discussion

Qualitative results

Overview of Ghana's Renewable Energy Tax Incentive Regime

The qualitative results indicate that Ghana has operationalized a diverse array of fiscal incentives designed to attract investment and accelerate the development of renewable energy and green technologies. This regime is underpinned by legislative frameworks including the Renewable Energy Act ([Parliament of Ghana, 2011](#)), the GIPC Act ([GIPC, 2013](#)), the Free Zones Act ([Parliament of Ghana, 1995](#)), and various Value Added Tax (VAT) Amendment Acts. The primary objective of these measures is to target cost reduction and operational viability.

Central to this regime are import duty and VAT exemptions for renewable energy equipment. Solar modules enjoy full exemptions, while the eligibility of other components such as inverters and battery storage systems is often determined on a case-by-case basis following recommendations from the Energy Commission ([Ministry of Energy, 2019](#)) ([GIZ, 2023](#)). These exemptions have been operative since the enactment of the Renewable Energy Act in 2011, though their scope and consistency have evolved through subsequent VAT Amendment Acts and annual budget provisions, creating some uncertainty about investor eligibility over time.

The fiscal structure also offers substantial Corporate Income Tax concessions, including a reduced rate of 15% for firms engaged in local manufacturing or assembly and tax holidays of up to 10 years for entities operating under the GIPC or Free Zones regimes ([GIPC, 2023](#)) ([Deloitte, 2020](#)).

The Renewable Energy Fund (REF), established as a tax-exempt mechanism under Act 832, is mandated to support research, capacity building, and project development through grants and concessional loans. However, the functional efficacy of the REF has been compromised by underfunding and limited disbursement capacity (Partnership for Action on Green Economy [PAGE]) ([PAGE, 2024](#)). Furthermore, although the feed-in tariff mechanism has shifted toward competitive procurement, net metering remains active, allowing small-scale producers to export surplus power to the national grid ([Parliament of Ghana, 2011](#)) ([Energy Commission, 2020](#)).

The 2024 national budget introduced targeted incentives for the Electric Vehicle (EV) sector, including import duty waivers and zero-rated VAT for EV parts, aiming to position Ghana as a regional assembly hub ([Ministry of Finance, 2024](#)). Investors also benefit from accelerated capital allowances under the Income Tax Act, which facilitate the rapid depreciation of qualifying assets to reduce taxable income ([GRA, 2016](#)). It is critically noted, however, that while these allowances indirectly support green sector expansion, they systematically lack explicit conditionality regarding local hiring or skills training.

Employment and Training Linkages

The qualitative analysis indicates that while Ghana's tax incentives have been effective in promoting investment and technology adoption, few are designed with explicit conditions to advance youth employment or skills development. Explicit linkages exist within the Renewable Energy Act, which mandates the Energy Commission to promote local participation and capacity building. Furthermore, the REF is legally permitted to fund training and skills development initiatives, though such activities remain limited in practice ([Parliament of Ghana, 2011](#)) ([Ministry of Energy, 2019](#)).

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Implicit linkages are observed in incentives promoting local manufacturing and assembly - for example, CIT reductions and import duty waivers - which may indirectly generate employment, particularly in installation and maintenance. However, the current regime lacks mandatory provisions that tie tax relief to specific outcomes such as hiring quotas, apprenticeship programs, or partnerships with TVET institutions (World Bank, 2022b).

Table 4 details the youth labor market indicators from Ghana Statistical Service (Ghana Statistical Service, 2023), providing quarterly labor force estimates covering unemployment, underemployment, and those not in employment, education, or training (NEET) across regions and age cohorts.

Indicator	Value/Trend	Source
Youth unemployment rate (ages 15–35)	19.7%	(Ghana Statistical Service, 2023)
Youth underemployment rate	Approximately 34%	(Ghana Statistical Service, 2023)
Youth not in employment, education, or training (NEET)	1.9 million (21–27% of youth)	(Ghana Statistical Service, 2023)
Share of youth in total unemployed population	Approximately 77%	(Ghana Statistical Service, 2023)
Average monthly unemployment rate (Q1-Q3, 2023)	14.7%; higher female youth unemployment	(Ghana Statistical Service, 2023)

TABLE 4: Youth Labor Market Indicators

Source: (Ghana Statistical Service, 2023)

Youth Participation in Green Sectors

Although Ghana's transition to a green economy has introduced novel employment avenues within the renewable energy and environmental sustainability sectors, our analysis show that the extent to which these opportunities currently benefit the youth population (through either direct employment or technical skills development) remains limited and underreported. Nevertheless, the long-term outlook indicates significant labor-absorptive potential, which the International Labour Organization (PAGE, 2024) acknowledged and posited that the adoption of green energy policies, such as investments in solar PV, clean cooking, and energy-efficient systems, is projected to generate approximately 100,000 net new jobs by 2030. Of these anticipated roles, an estimated 60% are expected to benefit women and youth, particularly within semi-skilled and entry-level capacities, thereby highlighting the critical role of renewable energy and green technologies in addressing the nation's persistent youth unemployment. Table 5 presents projections from the International Labour Organization, which estimates that Ghana's green economy transition could create approximately 100,000 net new jobs by 2030, with 60% intended to benefit youth and women.

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Indicator	Value/Trend
Net green jobs by 2030 (solar PV, off-grid, and others)	Approximately 100,000 additional jobs
Share of green jobs expected to benefit youth	60% of projected jobs targeted at youth and women

TABLE 5: Projected Green Jobs

Source: (PAGE, 2024)

Data Limitations on Youth Employment and Tax Exemption Beneficiaries

A critical examination of fiscal policy documents and corporate filings reveals a significant data transparency gap. Tax-incentivized green economy projects (solar farms, EV assembly, biomass installations) report only aggregate employment figures which lacks granular disaggregation by age, gender, or training status (GRA, 2016) (Ministry of Finance, 2023a). Crucially, the fiscal relief granted under key legislative instruments, including the Renewable Energy Act, GIPC Act, and Free Zones Act, imposes no explicit conditionalities mandating youth recruitment or technical and vocational training. This regulatory disconnection persists despite the objectives of Ghana's National Green Jobs Strategy (2021-2025), which advocates for integrated frameworks to align fiscal incentives with skills development (Ministry of Employment and Labour Relation and International Labour Organization, 2021). However, actual implementation remains fragmented. Notably, national initiatives such as the Youth Employment Agency (YEA) and the NABCo have not been formally integrated into green-sector job creation streams or supported by targeted fiscal incentives for employment outcomes (Lambon-Quayefio et al., 2025). Table 6 summarizes key employment and policy indicators affecting youth engagement.

Indicator	Observation
Projected green jobs by 2030	Approx. 100,000 net new jobs; 60% targeted at women and youth (PAGE, 2024)
Youth unemployment	19.7% (Ghana Statistical Service, 2023); with high rates of underemployment
Youth data in green sectors	Lacking; sectoral and demographic disaggregation unavailable
Tax-beneficiary job creation	No formal conditions or age-based reporting requirements (GRA, 2016) (Ministry of Finance, 2023a)
Policy alignment	National Green Jobs Strategy exists; weak alignment with tax policy tools

TABLE 6: Summary of Youth Employment Outcomes

Source: (PAGE, 2024); (Ghana Statistical Service, 2023); (GRA, 2016); (Ministry of Finance, 2023a); (Ministry of Employment and Labour Relation and International Labour Organization, 2021).

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Skills Development Linkages in the Green Economy

This section evaluates the integration between firms benefiting from fiscal incentives in Ghana's renewable energy sector and national skills development infrastructure, particularly TVET institutions. Although legislative instruments (Renewable Energy Act and the Free Zones Act) encourage local participation, analysis reveals a notable lack of formal collaboration between incentivized firms and TVET institutions. Case studies of major projects, such as solar installations and electric vehicle assembly initiatives, show few public commitments to structured trainee placements or curriculum co-development with vocational colleges (Aryeetey et al., 2011) (World Bank, 2022b). Furthermore, grants from the Skills Development Fund are often awarded without mandatory industry-TVET partnerships which results in ad hoc, staff-oriented training programs not systematically designed for youth inclusion.

The limited skills development efforts initiated by firms are typically small-scale and unsystematic. While some facilities offer short-term internships or informal apprenticeships for immediate operational needs, these initiatives generally lack institutional oversight, certification frameworks, and alignment with national TVET standards (UNESCO, 2022). Consequently, these firm-led efforts remain disconnected from formal education systems and fails to establish scalable capacity pathways critical for structured youth workforce development. Table 7 summarizes the current state of coordination.

Theme	Status in Practice
Firm partnership with TVET	Largely absent
Formal Training Programs	Small scale and informal
Oversight by CTVET	Regulatory but not linked to tax incentives
YEA alignment	No formal tax incentive linkage
Policy alignment	National Green Jobs Strategy exists; weak alignment with tax policy tools
Inter-agency coordination	Ad hoc but institutionalized

TABLE 7: Summary of Skills Development Linkages

Sources: (CTVET and World Bank, 2022); (Ministry of Finance, 2023a); (Ministry of Employment and Labour Relations and International Labour Organization, 2021); (UNESCO, 2022). TVET, Technical and Vocational Education and Training; CTVET, Commission for Technical and Vocational Education and Training; YEA, Youth Employment Agency

Institutional Frameworks that Support or Hinder Alignment

The effectiveness of Ghana's fiscal incentives in supporting skills development is significantly undermined by institutional fragmentation and regulatory gaps. Although the Commission for Technical and Vocational Education and Training (CTVET) set national TVET standards, it lacks formal mechanisms to track or enforce training obligations among employers receiving tax exemptions. This prevents meaningful integration between skills policy and fiscal instruments. Concurrently, the GRA, which publishes annual tax expenditure reviews, omits critical performance indicators such as employment generation or training outcomes associated with tax-exempt firms. This systemic lack of transparency

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weakens the developmental accountability of the incentives (GRA, 2016) (Ghana Statistical Service, 2023). Furthermore, the YEA, responsible for job placements, operates in isolation, with no formal referral systems or direct incentive linkages with YEA placements as eligibility for tax benefits.

This regulatory isolation is compounded by a persistent lack of consistent, structured coordination among key ministries (Energy, Finance, Employment and Labour Relations, and CTNET). While these entities engage through occasional policy platforms, their interactions fail to establish the necessary coherence needed to align tax exemptions with measurable skills outputs or TVET participation (Ministry of Employment and Labour Relation and International Labour Organization, 2021) (World Bank, 2022a). Consequently, the institutional framework hinders policy coherence, which ensures that the gaps in skills tracking and the disconnection between fiscal policy and youth training remain a central challenge (PAGE, 2024). The information summarized in Table 8 highlights these critical gaps.

Document/Institution	Key Data/Insights
Labour Statistics Bulletin Q3 (Ghana Statistical Service, 2023)	Provides youth employment, NEET, and underemployment figures
Green Jobs Assessment Model (PAGE, 2024)	Models employment projections in green sectors by demographic segments
Ghana Green Jobs Strategy (Ministry of Employment and International Labour Organization, 2021)	Recommendations targeted at green employment and skills integration strategies
Skills Development Fund Evaluation (CTNET and World Bank, 2022)	Reports grant allocation; limited formal linkage to green-sector firms
Tax Expenditure Review (Ministry of Finance, 2023a)	Lists tax incentives granted; no employment disaggregation or conditionalities

TABLE 8: Institutional Data and Policy Reports

Sources: Author's compilation. NEET, Youth not in employment, education, or training

Empirical results

Descriptive Statistics

Table 9 presents the descriptive statistics of variables used in this study. In terms of magnitude, real GDP per capita (RGDPC) and tax incentives and exemptions (TAX_INC) record the highest means (8.278 and 7.509, respectively). However, TAX_INC is the most volatile variable, with a standard deviation of 1.308. This high volatility partly reflects the CAGR-extrapolated values for 2000-2007, which may not accurately capture year-to-year fluctuations in pre-2008 exemption levels. Youth employment (YEMP) shows the least variation, with a standard deviation of 0.084. Government effectiveness (GEF) has a mean of -0.157 and a variation of 0.123, while FDI has a mean of 1.329. Renewable energy production has a mean of 4.051 and a standard deviation of 0.310.

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Variable	Obs	Mean	Std. Dev.	Min	Max
Youth Employment	24	3.714	0.084	3.582	3.805
Foreign Direct Investment	24	1.329	0.69	-0.045	2.248
Tax Incentives and Exemption	16	7.509	1.308	5.182	8.723
Real GDP per capita	24	8.278	0.254	7.902	8.618
Government Effectiveness	23	-0.157	0.123	-0.351	0.086
Renewable Energy Production	24	4.051	0.31	3.549	4.515

TABLE 9: Descriptive Statistics

Source: Authors' estimation with EViews 13 Software. GDP, Gross Domestic Product

Correlation Analysis

This correlation matrix in Table 10 reveals that yemp shows a strong positive correlation with renw (0.905*), rgdpc (0.931), fdi (0.151) and gef (0.034). This indicates that higher youth employment has a relationship with greater renewable energy production, economic growth, foreign direct investment and effective governance policy. Tax incentives (-0.7418) exhibit a negative correlation with yemp.

This strong negative bivariate correlation between tax incentives and youth employment appears, at first glance, to contradict the positive, though insignificant, coefficients that TAX_INC records in most multivariate estimations (FMOLS, DOLS, CCR). This apparent contradiction is examined in the sub-section below, "Unpacking the Correlation-Regression Contradiction for Tax Incentives."

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Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) yemp	1.000					
(2) fdi	0.151	1.000				
(3) tax_inc	-0.718	-0.666	1.000			
(4) rgdpc	0.931	0.299	0.848	1.000		
(5) gef	0.343	0.100	-0.563	-0.321	1.000	
(6) renw	0.905	-0.050	-0.741	-0.865	0.219	1.000

TABLE 10: Pairwise Correlations

Source: Authors' own estimation with EViews 13 software

Unit Root Tests

Table 11 presents the ADF unit root test results. All variables are non-stationary at levels but stationary at first differences, confirming that they are integrated of order one I(1). The confirmation that all variables are I(1) and none is I(2) satisfies the preconditions for the ARDL bounds testing approach and validates its application in this study (Pesaran et al., 2001).

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Variables	Level		1st Difference		Order of Integration
	Constant	Trends	Constant	Trends	
Youth Employment	-0.123	-2.771	-3.601***	-3.532**	I (1)
Foreign Direct Investment	-1.161	-0.888	-4.454***	-4.836***	I (1)
Tax Incentives and Exemption	-1.808	-1.996	-4.424***	-4.561***	I (1)
Real GDP per capita	-0.658	-1.102	-3.197**	-3.193*	I (1)
Government Effectiveness	-2.121	-1.977	-3.588***	-3.428**	I (1)
Renewable Energy Production	-1.248	-2.717	-4.413***	-4.299***	I (1)

TABLE 11: ADF Unit Root Test

Source: Authors' own estimation with EViews 13 software. ***p < 0.01, **p < 0.05, *p < 0.1. ADF, Augmented Dickey-Fuller; GDP, Gross Domestic Product

Bounds Test and ARDL/ECM Results

The Pesaran et al. (Pesaran et al., 2001) ARDL bounds test was applied to determine the existence of a long-run equilibrium relationship among the variables. As shown in Table 12, the F-statistic (3.607) exceeds the I(1) upper critical bound at the 10% significance level, while the T-statistic (−0.904) falls below all critical bands. The divergence between the F- and T-statistics is a recognized feature of small-sample ARDL applications (Pesaran et al., 2001) and is partly attributable to the limited effective sample size of 16 observations. In line with established practice, the F-statistic is treated as the primary criterion for the existence of a long-run level relationship, while the T-statistic is interpreted as an ancillary diagnostic. On this basis, we proceed with ECM estimation, while explicitly acknowledging that the evidence for cointegration is borderline and that the long-run equilibrium results should be interpreted with appropriate caution. This limitation is mentioned in the "Limitations" subsection.

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F-statistic	3.607347					
T-statistic	-0.904442					
	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
			F-Statistic			
Asymptotic	2.260	3.350	2.620	3.790	3.410	4.680
			T-Statistic			
Asymptotic	-2.570	-3.860	-2.860	-4.190	-3.430	-4.790

TABLE 12: Bounds Test Results

Source: Authors' own estimation with EViews 13 software

The results of ARDL model and conditional ECM are shown in Table 13. The ARDL results indicate that the past levels of youth employment (lag of youth employment) influence current levels by 70% ceteris paribus. Real GDP per capita ($\beta = 0.102$, $p < 0.10$), renewable energy production ($\beta = 0.095$, $p < 0.05$), government effectiveness ($\beta = 0.342$, $p < 0.01$), and FDI ($\beta = 0.075$, $p < 0.05$) are all positively significant determinants of youth employment, ceteris paribus. Tax incentives and exemptions ($\beta = -0.0099$, $p > 0.10$) are negative and insignificant, indicating a minimal and negligible long-run impact. Tax incentives and exemptions are negative and insignificant. This implies that there is a minimal and negligible long-run impact. Real GDP per capita, renewable energy production, government effectiveness, and FDI are positively significant and impact youth employment as follows: a one-percent increase in real GDP per capita is associated with a 10.2% increase in youth employment ($p < 0.10$); a 1% increase in renewable energy production is associated with a 9.5% increase in youth employment ($p < 0.05$); a one-unit improvement in government effectiveness is associated with a 34.2% increase in youth employment ($p < 0.01$); and a 1% increase in FDI inflows is associated with a 7.5% increase in youth employment ($p < 0.05$), ceteris paribus. That is, when the economy is growing, the renewable energy sector is expanding, governance and policy become effective, and targeted investment inflows increase, it provides opportunities for more youth to be employed.

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Variable (Dep Var Youth Employment)	ARDL Model	EC-Model (Conditional)
Youth Employment (-1)	0.703* (0.328)	
Tax Incentives and Exemptions	-0.0099 (0.0084)	-0.0099 (0.0084)
Real GDP per Capita	0.102* (0.086)	0.102* (0.086)
Renewable Energy production (% electricity)	0.095** (0.019)	0.095** (0.019)
Government Effectiveness	0.342*** (0.098)	0.342*** (0.098)
Foreign Direct Investment	0.075** (0.024)	0.075** (0.024)
Constant	0.211 (1.266)	0.211*** (0.039)
CointEq		-0.297*** (0.051)
R ²	0.952	0.706
Adjusted R ²	0.921	0.685
S.E. of regression	0.019	0.0153
Durbin-Watson stat	2.297	2.297
F-statistic	30.002***	33.667***

TABLE 13: ARDL and ECM Models

Source: Authors' own estimation with EViews 13 software. ***p < 0.01, **p < 0.05, *p < 0.1. ARDL, Autoregressive Distributed Lag; ECM, Error Correction Model; GDP, Gross Domestic Product

The ECM results indicate that immediate short-run effects match long-run magnitudes, possibly due to no additional lags on differences due to data constraints (unbalanced data and only 17 years of annual data). The Cointegration Equation (CointEq) term indicates a 29.7% adjustment speed toward equilibrium per period if the system deviates from equilibrium in the long run. Model fit is strong in the ARDL model (R² 0.952, adjusted 0.921) and in the ECM model (R² 0.706, adjusted 0.685). The Durbin-Watson statistics of 2.3 for both models indicate no serial correlation, and the significant F-statistics of 30.002 and 33.667, respectively, reject the null hypothesis of no overall effect.

Unpacking the Correlation-Regression Contradiction for Tax Incentives

The pairwise correlation between TAX_INC and YEMP is strongly negative (-0.718), yet TAX_INC enters the multivariate regressions with small positive (though insignificant) coefficients in FMOLS, DOLS, and CCR. This apparent contradiction is not a statistical anomaly; rather, it reflects a well-understood phenomenon in multivariate regression when correlated regressors are included simultaneously.

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In the bivariate setting, TAX_INC is positively correlated with RGDPC (0.848) and negatively correlated with RENW (-0.741) and GEF (-0.563). In the full model, once RGDPC, RENW, and GEF are controlled for, they absorb the shared variance between TAX_INC and YEMP, reversing the apparent sign of the tax incentive coefficient. This phenomenon, known as Simpson's paradox or sign reversal due to confounding, is particularly common in small samples with highly collinear regressors.

The practical interpretation is that the negative bivariate correlation does not imply that tax incentives cause lower youth employment. Instead, it likely reflects a spurious temporal pattern: Ghana's tax incentive spending expanded during a period when youth employment was declining due to macroeconomic shocks, particularly during the fiscal consolidation period post-2014, and this trend correlation confounds the bivariate relationship. In the multivariate models that control for these macroeconomic dynamics, the tax incentive coefficient becomes small and statistically indistinguishable from zero, which is the most credible interpretation: tax incentives, as currently designed, neither significantly help nor harm youth employment levels.

This null result is reinforced, not undermined, by the data limitations discussed in "Quantitative data sources" section. With only 16 effective observations for TAX_INC, the statistical power to detect modest employment effects is substantially reduced. The true effect of tax incentives on youth employment may be positive, negative, or zero; the current data architecture cannot discriminate reliably among these possibilities.

Diagnostic Tests and Robustness Check

We performed diagnostic tests for the model in Table 14. First, the model selection criteria for the ARDL model were checked. Due to the unbalanced nature of the data, the model included 16 observations, with the listing showing only the model specification of ARDL (1,0,0,0,0), which indicates 1 lag on the dependent variable and 0 lags on each of the five regressors. As a further sensitivity check addressing the potential bias introduced by the CAGR extrapolation procedure, the model was re-estimated on the full 2000-2023 sample incorporating the CAGR-constructed TAX_INC values for 2000-2007 ($n = 23$). The tax-incentive coefficient remained small and statistically insignificant in this specification ($\beta = 0.0003$, $p = 0.97$), confirming that the null finding for tax incentives is robust to the inclusion of the extrapolated period. However, it is noted that the coefficients on RGDPC, RENW, GEF, and FDI lose statistical significance in the full-sample specification, which is attributable to the dilution of signal by the CAGR-approximated pre-2008 observations and to the substantial reduction in degrees of freedom relative to the variation in the dependent variable over the longer window. This finding reinforces the importance of the data-constraint caveat noted in the "Limitations" subsection.

Model	LogL	AIC*	BIC	HQ	Specification
1	45.253437	-4.781680	-4.443672	-4.764371	ARDL(1,0,0,0,0)

TABLE 14: Model Selection Criteria Table

Source: Authors' own estimation with EVIEWS 13 software. AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; ARDL, Autoregressive Distributed Lag

Since only one model is shown, it implies that this lag structure was chosen as optimal. Minimizing AIC for forecasting or inference and the small sample size favor AIC over BIC to avoid underfitting. Second, the Breusch-Godfrey serial correlation test results in Table 15 suggest that we fail to reject the null hypothesis of no serial correlation. This means the model's assumptions regarding independent errors hold, supporting its validity for inference and Durbin-Watson statistic we earlier found.

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Null hypothesis: No serial correlation			
F-statistic	0.533878	Prob. F(2,7)	0.6084
Obs*R ²	2.117578	Prob. Chi-Square (2)	0.3469

TABLE 15: Breusch-Godfrey Serial Correlation LM Test

Source: Authors' own estimation with EViews 13 software. LM, Lagrange Multiplier

Third, we performed the Ramsey Regression Equation Specification Error Test (RESET) test, which assesses potential misspecification in the model's functional form (such as omitted non-linearity or variables) by adding the squared fitted values from the original regression as an additional regressor and testing their significance, with the null hypothesis that the model is correctly specified.

Statistic	Value	df	Probability
t-statistic	0.774054	8	0.4612
F-statistic	0.599159	(1, 8)	0.4612
Likelihood ratio	1.155566	1	0.2824
F-test summary	Sum of Sq.	df	Mean Squares
Test SSR	0.000228	1	0.000228
Restricted SSR	0.003273	9	0.000364
Unrestricted SSR	0.003045	8	0.000381
LR test summary	Value		
Restricted LogL	45.25344		
Unrestricted LogL	45.83122		

TABLE 16: Ramsey RESET Test

Source: Authors' own estimation with EViews 13 software. RESET, Ramsey Regression Equation Specification Error Test; SSR, Sum of Squared Residuals; LR, Likelihood Ratio

The results in Table 16 indicate that we fail to reject the null hypothesis. This means that there is no statistically significant evidence of functional form misspecification in the underlying ARDL model.

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Fourth the CUSUM and CUSUM squared graphs are presented in Figures 1 and 2. The CUSUM graph shows that the test fails to reject the null hypothesis of parameter constancy, indicating no statistically significant structural breaks or shifts in the model's coefficients over time. This supports the reliability of the ARDL estimates and other diagnostics like the absence of serial correlation and misspecification. Additionally, the CUSUM squared graph indicates that the test fails to reject the null hypothesis of constant residual variance (homoscedasticity) and no variance-related structural breaks. This confirms the model's stability over time, complementing the earlier CUSUM test for mean stability.

It should be noted that the CUSUM plots begin in 2015 rather than 2000. This is a direct consequence of the ARDL(1,0,0,0,0) specification estimated on 16 effective observations (2008–2023). In ARDL stability testing, the initial segment of the sample is consumed by the regression estimation and the recursive residuals cannot be computed until the model has sufficient observations, typically after the model's initial estimation period, which in this case corresponds approximately to the 2008–2014 interval. The CUSUM plots thus commence in 2015 and the visual stability evidence should be interpreted within this bounded window, not as applying to the full 2000–2023 period.

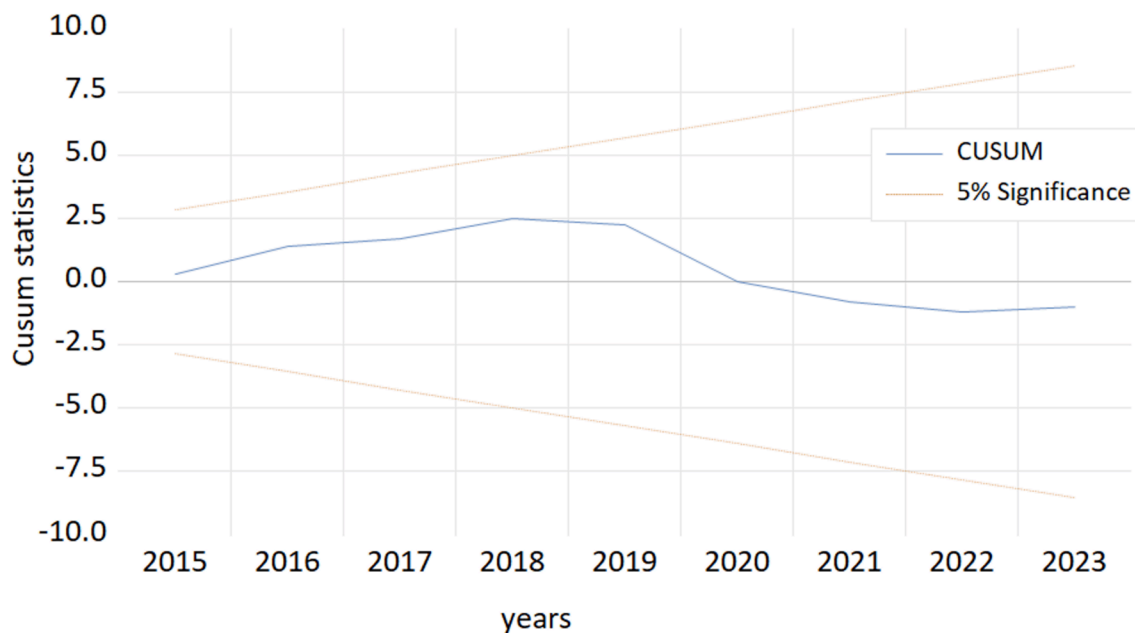


FIGURE 1: CUSUM Graph. The Solid Line Plots the Cumulative Sum of Recursive Residuals Derived From the ARDL Model Estimated Over 2008–2023. The X-Axis Denotes the Year; the Y-Axis Denotes the CUSUM Statistic. The Dashed Lines Represent the 5% Significance Bounds. The CUSUM Statistic Remains Within the Bounds Throughout the 2015–2023 Estimation Window, Indicating No Statistically Significant Parameter Instability Over This Period

Note: the plot commences in 2015 because the initial 2008–2014 observations are consumed by recursive estimation. Source: Authors' own estimation with EViews 13 software.

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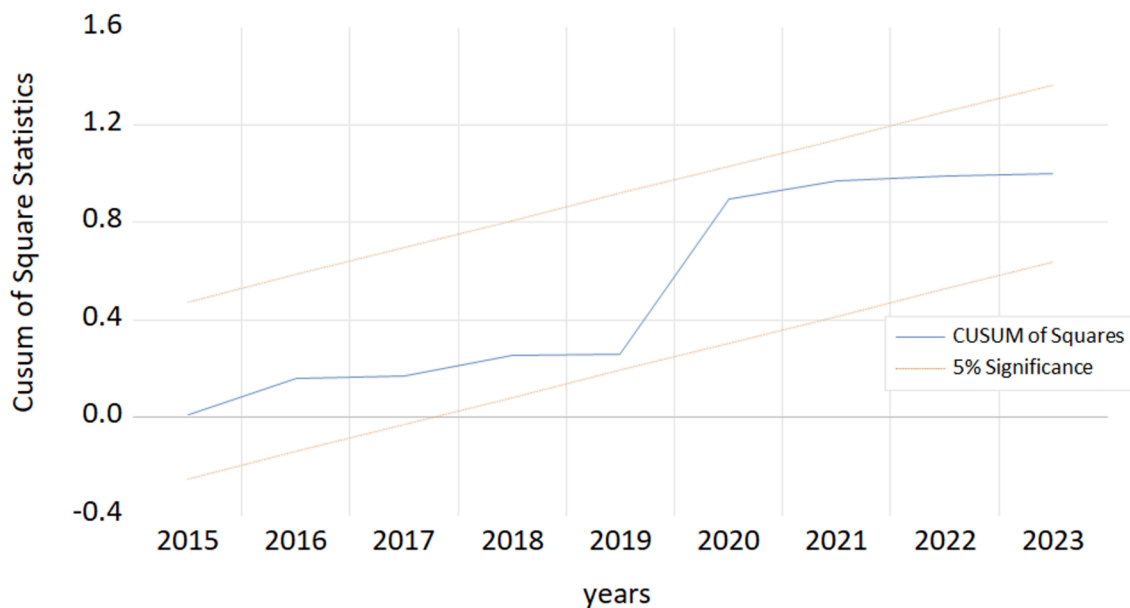


FIGURE 2: CUSUM of Squares Graph. The Solid Line Plots the Cumulative Sum of Squared Recursive Residuals Derived From the ARDL Model Estimated Over 2008–2023. The X-Axis Denotes the Year; the Y-Axis Denotes the CUSUM of Squares Statistic (Bounded Between 0 and 1). The Dashed Lines Represent the 5% Significance Bounds. The Statistic Remains Within the Bounds Throughout the 2015–2023 Window, Confirming the Absence of Significant Residual Variance Instability

Note: the plot commences in 2015 because the initial 2008–2014 observations are consumed by recursive estimation. Source: Authors' own estimation with EViews 13 software.

We further conducted robustness checks of our models by employing dynamic models such as the FMOLS, DOLS, and CCR. We also conducted OLS regression with HAC standard errors. While the OLS with HAC SE offers a baseline, FMOLS/DOLS/CCR adjust for potential endogeneity in time series. The results in Table 17 confirm the results obtained from the models in Table 13. Table 18 provides the sensitivity check of data which show results for the extrapolated data sample from 2000 to 2023. TAX_INC (Tax Incentives) is consistently insignificant across FMOLS, DOLS, CCR, OLS-HAC, and the full-sample sensitivity check. The null finding is robust and model-independent. RENW (Renewable Energy Production) is significant at 1% in FMOLS, CCR, and OLS-HAC ($\beta \approx 0.161$). Furthermore, GEF (Government Effectiveness) is significant at 5% across FMOLS, CCR, and OLS-HAC ($\beta \approx 0.248$). This is consistent with the primary ARDL finding of institutional quality as the dominant driver. FDI (foreign direct investment) is also significant at 1% across FMOLS, CCR, and OLS-HAC ($\beta \approx 0.071$) and supports the primary results. However, DOLS results require a caution in interpretation. DOLS yields $R^2 = 1.000$ on 13 observations after lead/lag augmentation. This is a known small-sample artefact. DOLS standard errors collapsed to near-zero, making all coefficients appear significant.

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Variable	FMOLS	DOLS	CCR	OLS (HAC SE)
	Coef. (SE)	Coef. (SE)	Coef. (SE)	Coef. (SE)
TAX_INC	0.0074	0.0048	0.0074	0.0074 (0.0073)
	-0.0073	-0.0086	-0.007	
RGDPC	0.1078** (0.0464)	0.3239***	0.1078** (0.0441)	0.1078** (0.0464)
		-0.069		
RENEW	0.1611*** (0.0179)	0.1822***	0.1611*** (0.0192)	0.1611*** (0.0179)
		-0.047		
GEF	0.2482** (0.1155)	0.2145***	0.2482** (0.1080)	0.2482** (0.1155)
		-0.091		
FDI	0.0711*** (0.0158)	0.1217*** (0.0240)	0.0711*** (0.0151)	0.0711*** (0.0158)
Constant	2.0025*** (0.4341)	2.0020*	2.0025*** (0.4248)	2.0025*** (0.4341)
		-0.988		
R ²	0.928	1	0.928	0.928
Adj R ²	0.892	0.998	0.892	0.892
N	16	13	16	16

TABLE 17: Robustness Check (16-Observation Sample, 2008–2023). All Variables Except Government Effectiveness (GEF) Are in Natural Logarithms. Standard Errors (HAC-Corrected for OLS; Long-Run Variance for FMOLS/CCR) Are in Parentheses. DOLS Augmented With One Lead and One Lag of First Differences of Regressors

Source: Authors' own estimation. ***p < 0.01, **p < 0.05, *p < 0.10. FMOLS, Fully Modified OLS; DOLS, Dynamic OLS; CCR, Canonical Cointegrating Regression; HAC SE, Heteroskedasticity and Autocorrelation Consistent Standard Errors.

DOLS R² = 1.000 due to near-perfect fit with augmented leads/lags on only 13 degrees of freedom. This is a known artefact of the DOLS augmentation in very small samples and does not reflect overfitting in the structural sense. DOLS uses 13 observations after consuming 3 for lead/lag augmentation.

TAX_INC row highlighted: consistent insignificance across all four estimators confirms the null finding is not model-specific.

RGDPC flips to negative (−0.231***) when the extrapolated 2000–2007 period is included. This sign reversal reflects data quality issues in the pre-2008 extrapolated values, not a genuine economic relationship. GEF and FDI lose significance. TAX_INC remains insignificant ($\beta = 0.007$, $p = 0.44$). This confirms the null finding on tax incentives is genuine and not a sample artefact.

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Variable	Coefficient	Std. Error (HAC)	Significance
TAX_INC	0.0065	-0.0083	Insignificant
RGDPC	-0.2308	-0.0753	p < 0.01 ***
RENEW	0.105	-0.0483	p < 0.05 **
GEF	0.0553	-0.0661	Insignificant
FDI	0.005	-0.0091	Insignificant
Constant	5.1584	-0.7428	p < 0.01 ***
R ²	0.914		
Adj R ²	0.89		
N	24		

TABLE 18: Sensitivity Check - Full Extrapolated Sample (2000–2023, n = 24). This Table Re-Estimates the Long-Run Specification Using the Full 2000–2023 Sample Including CAGR-Extrapolated TAX_INC Values for 2000–2007. Reported as OLS with HAC Standard Errors. Comparison with Table 17 Shows Whether the 16-Observation Results Are Driven by Sample Restriction

Source: Authors' own estimation. ***p < 0.01, **p < 0.05, *p < 0.10. HAC standard errors with 2 lags.

TAX_INC remains insignificant in the full sample, confirming the null finding is robust to the inclusion of the CAGR-extrapolated 2000–2007 period.

RGDPC sign reversal (negative) in the full sample reflects confounding by the CAGR-approximated pre-2008 observations and reduced degrees of freedom; this does not invalidate the 16-observation primary results, which use only directly-observed data.

Tax Incentives and Exemptions show small positive coefficients in FMOLS, DOLS, and CCR but a negative in OLS, although they are all insignificant. Real GDP per capita, renewable energy production, government effectiveness, and FDI all have a positive and significant impact on youth employment.

Discussion

Tax Incentives Show No Statistically Significant Effect on Youth Employment

Across the econometric models, tax incentives are consistently positive but statistically insignificant. This indicates that variations in fiscal exemptions do not translate into measurable improvements in youth employment. However, as discussed previously, the null result must be interpreted in light of two compounding constraints: (i) the small effective sample size for TAX_INC substantially reduces statistical power, and (ii) the CAGR-extrapolated pre-2008 values introduce approximation error. The finding is therefore best characterized as follows: there is no statistically detectable positive employment effect of tax incentives as currently designed and measured. Therefore, it is best to have a consistent conclusion that does not reflect a true zero effect.

A negative pairwise correlation between TAX_INC and YEMP (-0.718) is also observed; however, as discussed in the subsection "Unpacking the Correlation-Regression Contradiction for Tax Incentives" below, this raw correlation reflects confounding by GDP growth, renewable energy expansion, and institutional quality trends rather than a direct causal

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relationship, and should not be interpreted as evidence that tax incentives suppress youth employment. The multivariate evidence (a small, statistically insignificant coefficient across all estimators) is the most credible basis for inference. This result aligns with the study of Ranchhod and Finn ([Ranchhod and Finn, 2016](#)), who found that South Africa's Employment Tax Incentive had no statistically significant positive effect on short-run youth employment. Similarly, Albanese et al. ([Albanese et al., 2024](#)) found that a hiring subsidy (tax incentive) for low-educated youths in Belgium resulted in no net long-run increase in employment over six years. Despite Ghana's renewable energy sector benefiting from significant fiscal incentives, their broader developmental impact on youth employment and skills development remains ambiguous. Evidence from the qualitative analysis suggests that while these mechanisms successfully attract capital, they operate without requiring explicit commitments to local hiring or collaboration with TVET institutions. Key gaps accounting for this include the absence of mandated employment targets, skills transfer reporting, and formal TVET partnerships ([PAGE, 2024](#)) ([UNESCO, 2022](#)).

From a policy evaluation perspective, Ghana's tax incentives in the green economy are moderately effective in attracting capital but fall short of promoting youth employment outcomes. The absence of mandatory employment or training linkages limits their developmental impact, which results in forgone public revenue without quantifiable returns in job creation. To enhance the inclusive impact of these incentives, there is a clear need for improved coordination among the Ministry of Employment and Labour Relations, CTNET, and GRA to operationalize employment conditionalities, similar to practices in South Africa and Mauritius ([UNDP, 2018](#)) ([Ministry of Employment and Labour Relation and International Labour Organization, 2021](#)).

Institutional Quality as a Primary Driver of Youth Employment

Government effectiveness emerges as the strongest and most reliable determinant of youth employment. Quantitative results demonstrate that improvements in institutional performance directly raise youth employment levels. The finding is consistent across all long-run estimators (FMOLS, DOLS, CCR) and the baseline regression (OLS-HAC SE). The error-correction term further confirms meaningful long-run adjustment. Thus, institutional quality actively drives youth employment through better regulatory enforcement, policy coordination, and administrative efficiency ([Breen, 2005](#)), ([Contini, 2010](#)), ([Dietrich and Möller, 2016](#)), and ([Pastore, 2018](#)).

Effective governance and accountability are essential for ensuring that tax incentives contribute meaningfully to development goals like youth employment. In Ghana's renewable energy sector, incentive administration is weakened by fragmented legal frameworks, such as the Renewable Energy Act, GIPC Act, and Free Zones Act, that lack uniform criteria for measuring developmental impact. Oversight by key agencies like the GRA and GIPC remains limited, as they neither systematically track employment nor training outcomes. Tax Expenditure Reports highlight revenue losses but fail to assess public value. Addressing these gaps requires coordinated institutional reforms, performance-linked eligibility standards, and integration with national strategies like the National Green Jobs Strategy (2021-2025).

Importantly, the institutional quality finding also provides a mechanism for interpreting the tax incentive null result. The effectiveness of any fiscal instrument is a function of the institutional environment in which it is administered. In a situation of weak institutional coordination and absent monitoring, as documented in the qualitative analysis, it is expected that tax incentives would fail to generate employment effects regardless of their fiscal magnitude. The path from fiscal incentive to employment outcome runs through institutional channels: from incentive design, regulatory enforcement, firm compliance, hiring/training, to employment creation. In Ghana, the middle links in this chain are largely absent, which explains why tax incentive variation does not predict youth employment variation. Table 19 presents the authors' proposed framework for aligning targeted tax incentives with skill development and youth employment.

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Metric	Simulated Values (in USD)
Number of Renewable Energy Firms	500
Compliant firms	300
Non-compliant firms	200
Total youth employed	300
Total training hours per tax year	90,000
Rebate for youth employed	3,000,000
Rebate for skills training	180,000
Total rebate paid	3,180,000
Total fees collected	400,000
Net fiscal balance	2,780,000

TABLE 19: A Simulation of the Alignment of Tax Incentives with Skills Development and Youth Employment in the Renewable Energy Sector

Source: Authors' own compilation

Renewable Energy Holds Strong Long-Run Youth Employment Potential

Although renewable energy (RE) production is a relatively new phenomenon in Ghana, the long-run results reveal a compelling positive employment trajectory. This confirms the sector's potential for job creation. This finding is corroborated by studies that found that RE technologies create more jobs per unit of energy than fossil fuels (Aceleanu et al., 2015), (Wysocka, 2023), and (Hlongwane and Khobai, 2025). This implies strong long-term potential for job creation. As the RE sector in Ghana matures, it is becoming an increasingly important driver of employment and reflects favorable structural economic dynamics.

From a policy perspective, it is imperative for the government to leverage this potential by designing and implementing stronger local content rules and enhanced TVET industry linkages. Moreover, policymakers should introduce tax incentives that are tailored and conditioned to RE value chains for employment. Such interventions would ensure that green sector growth translates into tangible labor-market gains for Ghana's young workforce.

However, the fiscal sustainability of conditional rebate schemes is a binding constraint that cannot be overlooked. The simulation in Table 19 demonstrates a projected annual fiscal deficit of USD 2.78 million under the baseline assumptions. This fiscal gap implies that performance-based incentive redesign cannot be funded from existing exemption budgets alone. Three alternative financing scenarios merit consideration: (i) a graduated co-funding model in which the GRA reallocates a portion of revenue saved through narrowing existing unconditional exemptions to fund conditional employment rebates; (ii) a green economy employment bond issued via the REF to provide upfront financing for training outcomes; and (iii) a blended finance arrangement drawing on international climate finance instruments including the

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Green Climate Fund and bilateral development finance to offset the domestic fiscal cost. Each scenario carries different trade-offs between fiscal risk and program scale. Regardless of the scenario chosen, a detailed actuarial or fiscal impact assessment conducted by the Ministry of Finance, in consultation with the GRA and development partners, is recommended before any pilot implementation.

Table 20, which models the fiscal impact of linking tax incentives to youth employment, highlights a critical challenge. While 300 compliant firms can generate significant job and training outcomes, the total rebate cost of \$3.18 million far outweighs the \$400,000 collected from non-compliant firms. This results in a \$2.78 million fiscal deficit. This suggests that while the policy could boost youth inclusion and skills development, strong financial backing or co-funding mechanisms are necessary for sustainability.

Variable	Assumed Values
Number of Renewable Energy Firms	500
Average number of youths employed per firm	20
Average training hours provided per firm per tax year	300
Rebate per youth employed	\$500
Rebate per 100 training hours	\$200
Fees per non-compliant firm	\$2,000
Compliance rate	60%
Non-compliant	40%

TABLE 20: Assumptions Underlying the Simulation

Source: Authors' Own Compilation

Foreign Direct Investment Creates Youth Jobs, Unlike Domestic Tax Incentives

FDI consistently demonstrates a strong positive impact on youth employment across all models. The results posit that FDI becomes a powerful driver of youth employment once macroeconomic and institutional factors are controlled for. This finding is similar to the results of Setyanti and Wahyudi (Setyanti and Wahyudi, 2021), Anyanwu (Anyanwu, 2013), Aqeel et al. (Aqeel et al., 2025), and Mkombe et al. (Mkombe et al., 2020). The sharp contrast between the significant FDI effects and the statistically insignificant tax incentive effects suggests that external capital inflows outperform domestic fiscal incentives in generating jobs. FDI often facilitates technology transfer, managerial expansion, new project activities, and sectoral diversification, which are channels that create operational and technical employment accessible to young workers. These crucial spillover channels are largely absent from the current tax incentive framework.

To ensure Ghana's tax incentives deliver more than investment attraction, they must be redesigned to support youth employment and skills development in the renewable energy sector. The qualitative analysis and fiscal simulation suggest that offering a conditional rebate of USD 500 per young person hired and USD 200 per 100 hours of training delivered could boost youth inclusion in the renewable energy workforce. However, these policy recommendations must

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be qualified. The rebate amounts are illustrative, derived from simulation assumptions rather than empirical cost-benefit analysis, and the fiscal sustainability analysis reveals a net deficit that requires resolution before implementation. Policymakers should treat these figures as a starting framework for further feasibility assessment, not as a concluded policy design.

Table 21 presents a proposed tax incentive policy framework, mapping specific incentive types to relevant renewable energy activities and their estimated youth employment impact channels, which serves as a template for the conditional incentive redesign recommended in this study.

Tax Incentive Type	Target Renewable Energy Activity	Employment Impact (Youth-Focused)	Rationale/Commentary
VAT Exemption	Importation of solar panels and batteries	+50-80 jobs per 1 MW installed (installation, logistics, retail)	Reduces upfront system costs, boosts demand for solar home systems and installers
Import Duty Relief	Entry of inverters, charge controllers, mounting kits	+30-50 skilled trade jobs per 1 MW	Enables SMEs to scale installation and support services
Accelerated Depreciation	Investment in RE manufacturing or assembly units	+200-300 formal jobs annually per major plant	Attracts local investors and foreign direct investment into green manufacturing
Income Tax Holiday (5 yrs)	Youth-led solar startups and assembly firms	+100 jobs per cluster incubated annually	Encourages entrepreneurship among youth in solar services
Corporate Tax Rebate	Off-grid solar mini-grid operators in rural areas	+25 local youth jobs per community (O&M, fee collection, education)	Makes rural energy business models viable, leading to permanent jobs
Customs Waivers	Educational and R&D equipment for green tech	+Indirect academic/research employment, 20 youth-led innovations/year	Promotes university –industry collaboration and innovation hubs
Training Grant Deductions	Technical training for solar, wind technicians	+500 youth trained annually (CTVET + industry schemes)	Makes private training investment tax-deductible, expanding skills pipeline

TABLE 21: Proposed Tax Incentive Policy Framework for Youth Employment in Renewable Energy

Source: Authors' own compilation. VAT, Value Added Tax; SME, Small and Medium Enterprises; RE, renewable energy; CTVET, Commission for Technical and Vocational Education and Training

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Conclusions

This study has highlighted the disconnect between Ghana's existing tax incentive framework in the renewable energy and green sectors and the broader national goals of youth employment and skills development. Although fiscal incentives have attracted investment, they lack conditionalities that ensure inclusive, skills-driven outcomes. The analysis underscores the urgent need for greater policy coherence, where tax reliefs are tied to measurable employment and training benchmarks.

The empirical findings reveal four principal conclusions. First, tax incentives, as currently designed and administered, have no statistically significant effect on youth employment, a null result that is robust across multiple estimators but should be interpreted cautiously given the data constraints. Second, institutional quality is the strongest and most consistent determinant of youth employment, operating through better regulatory enforcement, policy coordination, and administrative efficiency. Third, renewable energy production holds strong long-run employment potential, and investment in this sector, if supported by appropriate conditionalities, can generate significant youth employment gains. Fourth, FDI consistently delivers stronger employment effects than domestic tax incentives. This highlights the importance of attracting high-quality investment rather than merely reducing investor costs.

Policy redesign must embed explicit employment conditionalities into tax relief agreements, requiring firms to demonstrate annual hiring targets for young workers, supported by clawback provisions for non-compliance. Skills development must be formalized: tax-beneficiary firms should be required to partner with TVET institutions and make certified apprenticeships a core eligibility requirement. Institutional effectiveness requires strengthening monitoring systems within the GRA and sector ministries and establishing a central oversight mechanism to track employment outcomes linked to tax expenditures. Finally, maximizing the impact of FDI requires prioritizing incentives for firms that create downstream jobs through spin-offs such as installation, maintenance, and operations and establishing a unified results framework to evaluate performance and reduce incentives that consistently fail to generate adequate social returns.

Study contributions

This study makes three principal contributions to the literature. First, it provides one of the first empirical assessments of the employment effects of tax incentives in Ghana's renewable energy sector, combining time-series econometrics with systematic qualitative policy analysis. The mixed-methods design allows for a richer interpretation of null econometric results by grounding them in documented institutional failures. Second, it extends the institutional economics perspective on youth employment, which was previously applied primarily in European economies, to a Sub-Saharan African economy. The study demonstrates that government effectiveness is the dominant driver of youth employment even after controlling for sectoral and macroeconomic variables. Third, it provides a replicable methodological template, thus combining ARDL bounds testing with FMOLS/DOLS/CCR triangulation and qualitative policy analysis for future research on the employment effects of green economy fiscal policies in developing countries.

Limitations

Several limitations should be noted. First, the tax incentive variable is based on only 16 directly observed data points (2008–2023), with pre-2008 values constructed via CAGR backward extrapolation. This substantially constrains statistical power and introduces measurement approximation. Future research should utilize more granular, sector-specific exemption data when such records become available. Second, the tax incentive variable aggregates all sector exemptions across the economy rather than isolating renewable energy-specific incentives, creating a disconnect between the qualitative focus and the quantitative proxy. Sector-disaggregated data would allow a more targeted test of the renewable energy incentive-employment relationship. Third, the study's cross-country benchmarking of international practices draws on aggregated ILO, OECD, and UNDP frameworks that may not fully account for Ghana's institutional and structural specificities. The recommendations derived from international comparisons should therefore be contextualized rather than directly transplanted. Fourth, the fiscal simulation underlying the policy proposals relies on illustrative assumptions rather than empirically derived cost parameters; a formal cost-benefit analysis is required before

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operationalizing any recommended incentive redesign. Fifth, the ARDL framework assumes parameter stability over time, which, while supported by the CUSUM stability tests within the available estimation window, cannot be confirmed for the full 2000-2023 period given the bounded CUSUM plot.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Acquisition, analysis, or interpretation of data: Mohammed Muntaka Abdul-Rahman

Drafting of the manuscript: Mohammed Muntaka Abdul-Rahman, Jones Adjei Ntiamoah, Peter Arhenful

Critical review of the manuscript for important intellectual content: Mohammed Muntaka Abdul-Rahman

Concept and design: Jones Adjei Ntiamoah, Peter Arhenful

Supervision: Jones Adjei Ntiamoah

Disclosures

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Data Availability Statements

The datasets (and/or code) supporting this study are available from the corresponding author upon reasonable request.

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