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Energy Investment and Its Impact on Unemployment: A Comparative Study between Iraq and Sudan

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ABSTRACT: Investment in the energy sector constitutes a key pillar for achieving sustainable economic growth and addressing unemployment, particularly in developing and rentier economies such as Iraq and Sudan. Economic literature indicates that energy investment contributes to stimulating the Gross Domestic Product (GDP), enhancing exports (Eg), increasing foreign direct investment inflows (FDI), and raising per capita income (Pc), in addition to its capacity to absorb labor (Wo) and reduce unemployment rates (Up). Empirical studies further show that the impact of energy investment is not confined to a single sector but extends across various economic activities through both direct and indirect effects on the labor market. In light of challenges faced by Iraq and Sudan, such as oil price volatility and weak infrastructure, diversifying energy sources and relying on renewable energies emerge as strategic options to combat unemployment and strengthen economic stability. International experiences (Iran, Pakistan, Uzbekistan, Azerbaijan) indicate that integrating fiscal and monetary policies with energy strategies enhances growth and reduces economic and social disparities. Thus, investment in energy represents a dual-purpose tool for achieving energy security and mitigating unemployment.

KEYWORDS: foreign investment, labor force, per capita income.

1. INTRODUCTION

Iraq and Sudan represent prominent examples of rentier economies, where revenues from natural resources—particularly the energy sector—constitute the primary foundation of financial resources and aggregate economic activity. Although energy investments are often considered drivers of growth and structural transformation, their capacity to reduce unemployment and enhance labor market stability remains insufficiently examined in empirical literature. Both countries face structural imbalances, including high unemployment rates, weak economic diversification, and heavy reliance on extractive industries, making them vulnerable to global energy market fluctuations and weaknesses in the domestic institutional environment.

The central problem addressed in this study is that unemployment in Iraq and Sudan remains high despite substantial investments in the energy sector, raising questions about the actual impact of these investments on job creation and other economic indicators. Accordingly, the main research question is: What is the nature and magnitude of the relationship between energy investment and unemployment in Iraq and Sudan?

The significance of this study stems from its ability to fill two key gaps. First, it provides a sector-specific analysis of the role of energy investment as a channel for labor absorption. Second, it offers a comparative quantitative analysis between two rentier economies facing similar structural challenges, allowing for more generalizable findings. This study contributes to equipping policymakers with quantitative evidence regarding the capacity of energy investment to reduce unemployment, thereby supporting the formulation of more sustainable and stable economic strategies.

Based on this issue, the study aims to: (1) measure the short- and long-term relationship between energy sector investment and unemployment in Iraq and Sudan using the ARDL methodology; (2) determine the speed of adjustment toward equilibrium through an ECM model; (3) analyze the dynamic interrelationships among variables using VAR; and (4) provide a quantitative comparison between the two countries to highlight similarities and differences in the effectiveness of energy investments on employment.

Consequently, the study is guided by two main hypotheses. The first assumes the existence of a significant inverse relationship between energy investment and unemployment in the long run, such that higher energy investments lead to lower unemployment rates. The second posits that this relationship is relatively weak in the short run due to institutional and structural constraints that limit the labor market's capacity to absorb new investments rapidly

2. LITERATURE REVIEW

Economic literature has increasingly focused on examining the relationship between investment, unemployment, and economic growth, although the approaches vary, with some studies emphasizing public investment, foreign direct investment (FDI), or trade and economic openness. In the Iraqi context, the impact of public investment expenditure during 2006–2017 was investigated, showing that such expenditure contributed to reducing unemployment when directed toward labor-intensive sectors (Ibrahim & Ismail, 2022). They emphasized that the effectiveness of government investment is realized only through the prudent allocation of resources to productive sectors, thereby enhancing the economy's capacity to absorb more labor. This perspective aligns with Keynesian thought, which highlights the role of government spending in stimulating economic activity and mitigating unemployment (Keynes, 1936; Blanchard & Johnson, 2017).

Recent empirical studies in developing and rentier economies further confirm that the employment effect of public investment depends largely on its sectoral orientation. Calderón and Servén (2014) found that infrastructure-related investments, particularly in energy and transport, have a stronger employment multiplier compared to other forms of public spending, especially in low- and middle-income countries. Similarly, ILO (2021) reports emphasize that energy-related investments generate both direct and indirect employment through backward and forward linkages with other productive sectors.

In Sudan, trade openness and economic growth during 1970–2017 significantly enhanced employment levels, particularly among youth (Al-Waseela Mohamed, 2023). However, the study also highlighted the limited short-term impact, revealing the labor market's vulnerability to external shocks and weak absorption mechanisms. These findings are consistent with Rodrik (2018), who argues that openness alone does not guarantee employment creation unless supported by structural transformation and targeted sectoral investments. In this context, energy investment plays a crucial enabling role by reducing production costs and enhancing competitiveness across agriculture and manufacturing sectors (World Bank, 2020).

Other studies have focused on foreign direct investment as a primary channel for job creation. FDI inflows in Iraq during 2004–2022 had no significant effect on unemployment rates, attributed to the limited scale of investments and weak institutional environment (Hassan, 2025). Similarly, foreign investments after 2003 contributed only marginally to job creation due to challenges related to weak infrastructure and an unstable legislative environment (Al-Lami et al., 2024). These findings align with the broader literature suggesting that the employment impact of FDI is conditional on absorptive capacity, institutional quality, and sectoral composition (Alfaro et al., 2010; UNCTAD, 2022). The effectiveness of FDI in reducing unemployment largely depends on political and security stability, in addition to comprehensive institutional reforms that enhance the investment climate (Mohamed, 2025).

Recent studies further support these trends. The impact of public and private investment in Iraq showed that efficient resource allocation is the decisive factor between the success and failure of investment in generating employment (Alkhazraji & Salman, 2023). Comparable evidence from energy-exporting economies indicates that investment in the energy sector has a stronger long-run employment effect when it is integrated with domestic value chains rather than operating as an enclave sector (Arezki et al., 2017). In Sudan, energy-supported agricultural investment can create extensive employment opportunities, particularly when combined with integrated infrastructure and adequate institutional facilitation (Ahmed & Musa, 2024). This finding is also supported by FAO (2021), which highlights the role of energy access in improving rural employment and productivity.

Despite the importance of these contributions, most studies focused on total investment or FDI without paying special attention to energy sector investment, which is closely linked to other productive sectors and possesses a strong capacity to stimulate growth and absorb labor. Empirical evidence from cross-country analyses suggests that energy investment has a dual effect: it directly generates employment and indirectly reduces unemployment through higher economic growth and increased private sector activity (Stern & Kander, 2012; Apergis & Payne, 2014). However, such mechanisms remain underexplored in country-specific studies of rentier economies.

Moreover, most studies were limited to a single-country analysis, restricting the generalizability of their findings in similar rentier environments. Additionally, some relied on descriptive analyses or conventional econometric techniques and did not systematically integrate macroeconomic and sectoral variables within a single model capable of capturing the complex interactions between investment and unemployment. Recent methodological advances, such as ARDL and VAR frameworks, have demonstrated superior ability to capture both short- and long-run dynamics in labor market studies (Pesaran et al., 2001; Nkoro & Uko, 2016), yet remain underutilized in the context of energy investment.

Accordingly, the research gap lies in the absence of studies directly examining energy sector investment and its effect on unemployment in rentier economies, as well as the clear lack of comparative studies between Iraq and Sudan, despite the similarity in their economic structures and heavy reliance on energy as a primary resource. The significance of this study lies in its differentiation from previous research by: (1) focusing on the energy sector as the main analytical axis; (2) adopting a comparative approach between two countries facing similar challenges; (3) employing modern econometric tools such as ARDL, ECM, and VAR to measure short- and long-term relationships; and (4) integrating macroeconomic and sectoral variables into a more comprehensive model. This study thus provides both scientific and practical added value, contributing to filling a knowledge gap and equipping policymakers with quantitative evidence to guide investments toward reducing unemployment and enhancing economic stability.

3. DATA AND METHODOLOGY

This study adopts a quantitative econometric methodology to examine the impact of energy investment on unemployment in Iraq and Sudan. In addition, a descriptive analytical approach is employed to clarify the theoretical foundations linking energy-led growth to labor market dynamics. This combined approach allows for a comprehensive assessment of both the theoretical and empirical dimensions of the relationship under investigation.

The study relies on annual time-series data covering the period 2000–2022. This period was deliberately selected to capture the major economic transformations experienced by both countries, particularly those related to structural reforms, energy sector development, and labor market changes. Data were collected from official and reliable sources, including the Central Statistical Organization of Iraq, the Central Bureau of Statistics of Sudan, reports of the Central Bank of Iraq, the World Development Indicators (WDI) database of the World Bank, and publications of the International Monetary Fund (IMF). Cross-checking across these sources was conducted to ensure data consistency and reliability.

The variables included in the analysis consist of energy investment (Ew) as the main independent variable, representing domestic and foreign investments in the energy sector. The dependent variable is the unemployment rate (Up), which reflects labor market performance. In addition, several control variables are incorporated to capture broader macroeconomic and structural effects, namely merchandise exports (Eg) as a proxy for trade openness, foreign direct investment (Fi), gross domestic product (GDP) as an indicator of overall economic activity, per capita income (Pc) as a measure of living standards, and the labor force (Wo) to account for labor market absorption capacity.

To empirically assess the relationship between energy investment and unemployment, the study employs the Autoregressive Distributed Lag (ARDL) modeling approach. The ARDL technique is particularly suitable for this analysis due to its flexibility in handling variables integrated at different orders, I(0) and I(1), without requiring them to be integrated at the same level. Prior to model estimation, unit root tests, including the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, were applied to determine the stationarity properties of the time-series variables.

The optimal lag structure was selected based on the Akaike Information Criterion (AIC). Subsequently, the Bounds Testing approach was employed to examine the existence of a long-run cointegration relationship among the variables. Upon confirmation of cointegration, long-run coefficients were estimated, and an Error Correction Model (ECM) was derived to capture short-run dynamics and measure the speed at which unemployment adjusts toward its long-run equilibrium following short-term shocks.

To further investigate the direction of relationships among variables, Granger causality tests were conducted, alongside Vector Autoregression (VAR) analysis to illustrate dynamic interdependencies. Diagnostic tests, including tests for serial correlation, heteroskedasticity, and normality, were performed to ensure the robustness of the estimated models. Model stability was also examined using the CUSUM test.

Finally, the estimated results are interpreted from an economic perspective to assess whether energy investment contributes to reducing unemployment, to identify differences in the magnitude and direction of effects between Iraq and Sudan, and to evaluate the role of supporting variables such as GDP, per capita income, foreign direct investment, and labor force size in strengthening or weakening this relationship.

First: Conceptual Framework of Study Variables

1. Energy Investment (EW)

Energy investment is defined as the allocation of financial and human resources to projects related to the production, transmission, and distribution of both conventional and renewable energy. This investment represents a key pillar for economic growth, as it contributes to creating direct and indirect employment opportunities. For instance, an ARDL-based study in Uzbekistan found that renewable energy consumption had a significant negative impact on unemployment in the long run, indicating that investment in renewable energy reduces unemployment (Business Perspectives, 2023, pp. 100–105).

2. Merchandise Exports (EG)

Exports are fundamental to enhancing economic and monetary stability, providing a primary source of foreign currency and supporting national investments. Exports also reflect the degree of economic openness to global markets, enhancing competitiveness. In rentier economies such as Iraq and Sudan, oil exports constitute the largest share of total exports, directly influencing energy project financing. A study in Iran indicated that oil production, as part of exports, was closely linked to changes in unemployment rates through its effect on industrial energy consumption (Shah et al., 2021, pp. 1150–1158).

3. Foreign Investment (FI)

Foreign direct investment (FDI) is considered a strategic tool to stimulate economic growth and develop productive sectors, facilitating the transfer of modern technologies, providing long-term financing, and creating new jobs. Its significance is particularly evident in the energy sector, as it allows for the introduction of advanced production methods that enhance resource utilization efficiency. A study in Azerbaijan confirmed a significant negative relationship between FDI inflows and long-term unemployment, highlighting FDI's capacity to support employment and stimulate economic activity (Karimov et al., 2024, pp. 161–165).

4. Gross Domestic Product (GDP)

GDP is the most comprehensive indicator for measuring economic performance, reflecting the total value of goods and services produced within the economy. Energy investment is a key driver of GDP due to its close association with increased productivity and expanded economic activities. An applied study in Pakistan found that FDI inflows into the energy sector were positively associated with GDP growth, illustrating the critical role of energy in promoting sustainable economic growth (Khan et al., 2019, pp. 198–202).

5. Per Capita Income (PC)

Per capita income is used as an indicator of individual welfare and the extent to which people benefit from economic growth. This measure depends on both the size of GDP and its equitable distribution among the population. Recent studies in Uzbekistan indicate that increased reliance on renewable energy not only reduced unemployment but also improved individual income levels, thereby enhancing economic welfare and reducing social disparities (Business Perspectives, 2023, pp. 100–105).

6. Unemployment (UP)

Unemployment is a major economic and social challenge in both developing and developed countries, representing the gap between labor supply and demand. It encompasses not only the rate of joblessness but also hidden and structural unemployment, reflecting the economy's limited absorption capacity. Literature indicates that energy investment helps reduce unemployment by creating direct jobs in the energy sector and indirect jobs in related sectors. For example, Omarova et al. (2025, p. 48) found that increased consumption of renewable energy contributed to reducing unemployment in developed countries.

7. Labor Force (WO)

The labor force represents the human resource that economic activities rely on to convert investments into actual production. Its role extends beyond the total number of available workers to include qualifications, skills, and sectoral distribution. A skilled labor force is essential for the success of energy investments, as modern energy projects require advanced technical knowledge. Studies such as Khan et al. (2019, p. 202) in Pakistan and Shah et al. (2021, pp. 1155–1158) in Iran indicate that energy investments achieve developmental objectives only when a specialized industrial workforce capable of absorbing modern technologies is available.

Second: Theoretical Relationship between Variables in Light of Economic Theories

1. Energy Investment and GDP (EW → GDP)

According to Keynesian theory, investment is a component of aggregate demand; thus, any increase in energy investment leads to higher GDP. Investments in power plants or renewable energy generate demand for goods and services, expanding economic activity (Mankiw, 2020, p. 313). In contrast, the neoclassical perspective argues that investment raises long-term productive efficiency through technology adoption and lower production costs (Krugman & Obstfeld, 2018, p. 318).

2. Energy Investment and Unemployment (EW → UP)

The Keynesian multiplier effect suggests that increased investment expands aggregate demand, employing more labor and thereby reducing unemployment (Rahman, 2024, p. 52). Conversely, classical theory posits that unemployment may be temporary, and labor market equilibrium is achieved through wage and price flexibility, implying that the effect of investment on unemployment depends on market flexibility (Krugman & Obstfeld, 2018, p. 320).

3. Energy Investment and Exports (EW → EG)

Classical trade theory (Adam Smith and Ricardo) asserts that investment expansion enhances comparative advantage and increases exports. In rentier economies such as Iraq and Sudan, investment in oil and energy directly strengthens export capacity and boosts foreign currency inflows (Rodrik, 2008, p. 370).

4. Energy Investment and Foreign Direct Investment (EW → FI)

Economic development theory highlights that domestic investment in infrastructure, including energy, encourages FDI by reducing market risks and providing a stable production environment (Almula-Dhanoon, 2021, p. 9). Additionally, FDI itself contributes to technology transfer and increased job opportunities.

5. Energy Investment and Per Capita Income (EW → PC)

The Keynesian model links increased output to higher individual incomes, thus raising per capita income (Falcone, 2023, p. 6687). Structural development theory emphasizes that per capita income rises only if investments are directed toward productive sectors and public services; otherwise, growth remains limited to aggregate indicators without improving individual welfare (Rahman, 2024, p. 49).

6. Energy Investment and Labor Force (EW → WO)

The new classical labor market theory asserts that labor demand rises with investment expansion, but the effectiveness depends on skill levels. The higher the skill level of the workforce, the more effective the impact of investment (Krugman & Obstfeld, 2018, p. 320).

7. Overall Interaction among Variables

From the perspective of Balanced Growth Theory, energy investment is the key variable driving exports, GDP, FDI, and per capita income. Through these intermediate channels, the final effect on unemployment is realized. Unemployment does not decrease directly with increased investment; rather, it follows an integrated path starting with output expansion, improved exports, enhanced FDI, and finally increased labor market absorption capacity (Elnourani, 2024, p. 108).

4. RESULTS AND DISCUSSION

Econometric Framework: Variable Definition and Estimation of the Economic Relationship

The stage of specifying or formulating the econometric model represents one of the most critical and complex phases of model construction, as it requires the accurate identification of explanatory and dependent variables that should be included in the model, as well as those that must be excluded. At this stage, economic theory serves as the primary foundation for defining the nature and direction of relationships among economic variables within the model, ensuring consistency between the analytical framework and economic logic, and enhancing the credibility of the econometric results.

Accordingly, annual data for all study variables were collected from official and reliable sources, including the Central Bank of Iraq, the Central Bank of Sudan, the Central Statistical Organization of both Iraq and Sudan, in addition to the World Bank database. Investment in energy (Ew) is considered the main explanatory variable in the model and is measured by the annual value of domestic and foreign investments directed toward the energy sector, encompassing oil, gas, electricity, and renewable energy projects. These values are expressed in real terms after adjusting for inflation, thereby reflecting the scale of capital formation in the energy sector and its potential capacity to generate employment.

The dependent variables include the unemployment rate (Up), which is measured as the percentage of the labor force that is unemployed and represents a key indicator of labor market performance. Merchandise exports (Eg) are measured by the real value of total commodity exports and serve as a proxy for trade openness and external demand. Foreign direct investment (Fi) is measured by net FDI inflows as a percentage of gross domestic product, reflecting the role of foreign capital in supporting economic activity and employment creation.

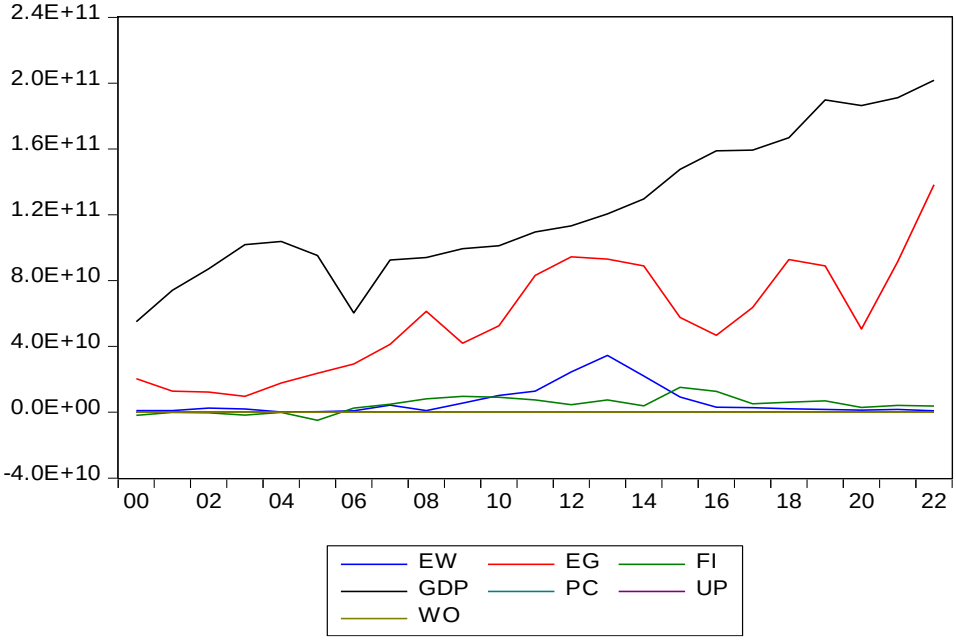
Gross domestic product (GDP) is measured in real terms to capture the overall level of economic activity and growth, while per capita income (Pc) is calculated by dividing real GDP by total population, representing average living standards. The labor force variable (Wo) is measured by the total number of economically active individuals, including both employed and unemployed persons, and is incorporated into the model to control for labor market size and its capacity to absorb new investments.

To enhance the econometric robustness of the model and reduce potential heteroskedasticity problems, several variables were transformed into their natural logarithmic form. This transformation allows the estimated coefficients to be interpreted as economic elasticities and improves the statistical properties of the time-series data. This econometric framework constitutes the analytical foundation upon which the ARDL, ECM, and VAR models are employed to examine the relationship between energy investment and unemployment in both Iraq and Sudan.

1. Iraq: Econometric Analysis and Statistical Description of Variables

1. Statistical Description of Variables in Iraq

The descriptive statistical analysis indicates that all variable series follow a normal distribution, as evidenced by the Jarque-Bera (J-B) test values, all of which exceed 0.05. Additionally, the energy investment series exhibits a kurtosis value of 5.73, indicating a leptokurtic distribution. Most variables show a right-skewed distribution, except for per capita income, which is left-skewed.



Source: Eviews

Figure 1: Description of Variables

2. **Unit Root (Stability) Test**

From the table above, it can be observed that all variables are stationary at the 5% significance level after taking the first difference, except for **Energy Investment (EW)** and **Labor Force (WO)**, which became stationary only after taking the second difference at the 5% significance level. This supports conducting econometric analysis using models appropriate for differenced data.

Table (1): Results of the estimated model – Iraq

Variable	Critical value at 5% significance level	ADF test value	Stability level
Ew	**- 3.029970**	**- 4.597143**	Second Difference
Eg	**-3.020686**	**- 4.948312**	First Difference
Fi	**-3.012363**	**- 5.856515**	First Difference
GDp	**-3.012363**	**- 5.127239**	First Difference
Pc	**-3.012363**	**- 3.323962**	First Difference
Up	**-3.012363**	**- 3.473817**	First Difference
Wo	**-3.029970**	**- 4.475971**	Second Difference

Source: Eviews

3. **Estimated Model after Excluding Insignificant Variables**

Table (2): Estimated Model Results – Iraq

Variable	Coefficient	Std – Error	T- statistics	Pro b
C	**2.2410**	**5.4609**	**4.106705**	**0.0006**
Fi	**- 0.617199**	**0.281839**	**- 2.189899**	**0.042**
Pc	**5075073**	**7790313**	**6.514595**	**0.000**
Up	**- 3.5609**	**6.3508**	**- 5.60227**	**0.000**

Source: Eviews

The Durbin-Watson (D–W) statistic is 1.74, and the model explains 75% of the variation in the dependent variable (R^2 = 75%). All variables in the model are statistically significant (P < 0.05). The relationship between energy investment and the unemployment rate is negative, indicating that increased investment leads to a reduction in unemployment. Additionally, the relationship with per capita income is positive, reflecting a beneficial economic impact. Overall, the model provides a good fit (R^2 = 75%) and shows no evidence of autocorrelation.

This outcome can be attributed to several factors, including the reliance of many Arab countries on local labor and domestic firms, which helps reduce unemployment, alongside security challenges that limit foreign investment and exchange rate instability. The model's overall significance is confirmed by the F-statistic value (0.0000), while the absence of autocorrelation is supported by the D–W value of 1.74.

4 -Bounds Test for Cointegration

The results of the Bounds Test indicate that the variables are not cointegrated in the long run. This is evident from the F-statistic value of 0.75, which is lower than the critical value of 3.67 at the 5% significance level. Accordingly, the null hypothesis of no cointegration is accepted.

5-Error Correction Model (ECM)

Table (3): Error Correction Model – Iraq

Variable	Coeffigent	Std – Error	T- statistics	Pro b
D(Fi)	**- 0.56467**	**0.26209**	**-2.15443**	**0.045**
D(Pc)	**3249604**	**1091952**	**0.00000**	**0.000**
D(Up)	**2079873**	**10569094**	**0.00000**	**0.000**
Cointeg – 1	**- 0.7887**	**0.210254**	**-3.751189**	**0.000**

Source: Eviews

The estimation results of the error correction model (ECM) reveal that, in the short run, energy investment contributes to an increase in per capita income, though at a lower rate compared to recent years. At the same time, it leads to a decline in foreign investment, which in turn keeps the unemployment rate relatively high in the short term. Moreover, the error correction term indicates that deviations from the long-run equilibrium are corrected at a speed of 75% per period, moving toward long-run cointegration.

6- ARCH Test for Heteroskedasticity

Table (4): ARCH Test – Iraq

F- statistics	**Pro b**	**0.231**
Obs R- squared	**Pro b**	**0.2115**

Source: Eviews

The results of the ARCH test show that the value of the F-statistic reached **0.231**, which is greater than the 0.05 threshold at the 5% significance level. This indicates that the model does not suffer from the problem of heteroscedasticity.

7- Correlation Matrix

Table (5): Pearson Correlation Matrix among Variables – Iraq

	EW	PC	FI	UP
EW	**1**	**0.58**	**0.30**	**-0.32**
PC	**0.58**	**1**	**0.60**	**0.39**
FI	**0.30**	**0.60**	**1**	**0.01**
UP	**-0.32**	**0.39**	**0.01**	**1**

Source: Eviews

The results of the above correlation matrix indicate that there is no linear correlation among the variables.

8- Granger Causality Test

The results of the Granger causality test indicate that there is no bidirectional causal relationship between the independent variable and the dependent variables during the studied period.

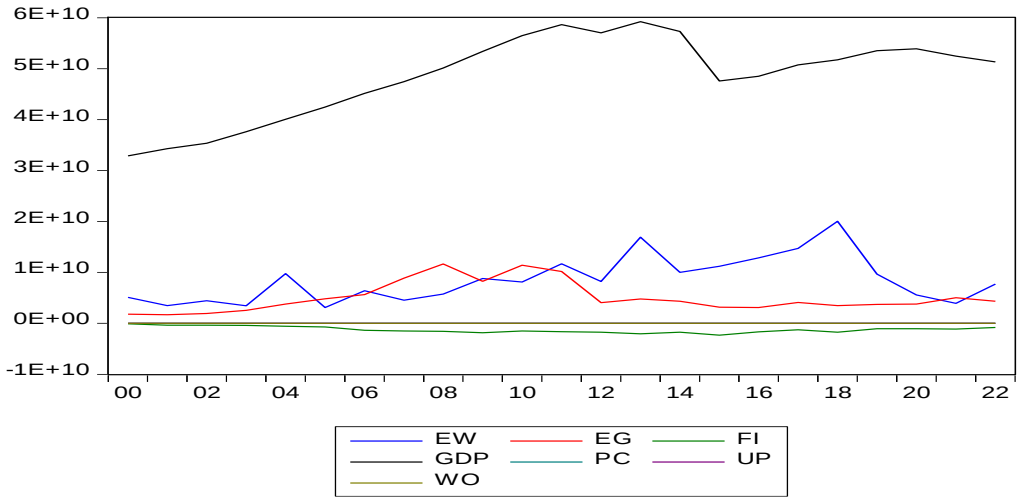
9- Vector Autoregression (VAR) Model

The VAR test results, which measure lagged effects, indicate that lagged energy investment **EW(-1)** affects the current unemployment rate **UP** by 3%. Similarly, lagged energy investment **EW(-2)** impacts current per capita income **PC** by 3%. Furthermore, past values of the unemployment rate have a very weak effect on both energy investment and foreign investment, but they exert a substantial effect on current per capita income **PC**, accounting for 45%.

II. Sudan

1. **Statistical Description of Variables in Sudan**

The Jarque-Bera test results indicate that most variables follow a normal distribution (P > 0.05), except for **EG**, which is close to the rejection threshold. Skewness and kurtosis show a slight rightward tendency, supporting the assumptions for subsequent econometric analysis.



Source: Eviews

Figure(2): Description of Variables

2. **Unit Root (Stability) Test-** Sudan

The results of the Augmented Dickey-Fuller (ADF) test indicate that all variables became stationary at the 5% significance level after taking the first difference, except for the **Labor Force (WO)** variable, which became stationary only after taking the second difference at the 5% significance level.

Table (6) :Results of the estimated model

Variable	Critical value at 5% significance level	ADF test value	Stability level
Ew	**- 3.012363**	**-6.938147**	First Difference
Eg	**- 3.012363**	**-4.76889**	First Difference
Fi	**- 3.012363**	**-6.025089**	First Difference
GDp	**- 3.012363**	**-3.152439**	First Difference
Pc	**-3.012363**	**-3.265067**	First Difference
Up	**-3.012363**	**-3.500683**	First Difference
Wo	**-3.020686**	**-4.901576**	Second Difference

Source: Eviews

3. **Estimated Model after Excluding Insignificant Variables**

Table (7): Estimated Model – Sudan

Variable	Coefficient	Std – Error	T- statistics	Pro b
C	**6.030**	**2.170**	**2.774**	**0.0117**
Fi	**-7.773**	**1.885**	**- 4.122**	**0.0005**
Pc	**- 7192**	**3251**	**- 2.212**	**0.0387**

Source: Eviews

Durbin-Watson = 1.70/ R^2 = 0.49

The estimated model results show that the **Prob** values for all variables are less than 0.05 at the 5% significance level, indicating that all variables are statistically significant. The coefficients of foreign investment and per capita income are negative, consistent with economic theory. This can be explained by the fact that recent energy investments in Sudan have relied primarily on local labor and domestic firms. Consequently, the low level of foreign investment led to a reduction in per capita income, contributing to higher unemployment rates in recent years.

Additionally, the model explains 49% of the variation in the dependent variable, as indicated by the R^2 value. The Durbin-Watson statistic of 1.70 suggests no autocorrelation problem, and the overall significance of the model is confirmed by the F-statistic, which equals 0.011.

4- Bounds Test for Cointegration

The results of the Bounds Test indicate that the F-statistic value is **2.54**, which is lower than the critical value of 3.87 at the 5% significance level. This suggests that the variables are not cointegrated in the long run, and thus the null hypothesis of no cointegration is accepted.

5- Error Correction Model (ECM)

Table (8): Error Correction Model – Sudan

Variable	Coeffigent	Std – Error	T- statistics	Pro b
D(Fi)	- 6.099820	2.039798	-2.987952	0.007
D(Pc)	5489425	73.4022	0.00000	0.000
Cointeg – 1	- 0.84426	0.236484	-3.570087	0.000

Source: Eviews

The negative coefficient of the error correction term (-0.844) indicates a relatively rapid adjustment of deviations toward equilibrium. The relationship is also negative between energy investment and both foreign investment and per capita income, reflecting an economic reality characterized by weak external investment flows.

6- ARCH Test for Heteroskedasticity

Table (9): ARCH Test – Sudan

F- statistics	**Pro b**	**0.4899**
Obs R- squared	**Pro b**	**0.464**

Source: Eviews

The results of the ARCH test show that the F-statistic (Prob) equals **0.48**, which is greater than 0.05 at the 5% significance level, indicating that the model does not suffer from heteroskedasticity.

7- Correlation Matrix

Table (10): Pearson Correlation Matrix – Sudan

	EW	PC	FI
EW	1	0.247	-0.607
PC	0.247	1	-0.775
FI	-0.607	-0.775	1

Source: Eviews

The results of the above correlation matrix indicate that there is no linear correlation among the variables.

8- Granger Causality Test

Table (11): Granger Causality Test – Sudan

Null Hypothesis:	Obs	F-Statistic	Prob.
PC does not Granger Cause FI		11.7769	0.0028

Source: Eviews

The only significant causal relationship identified was from **PC** to **FI**, reflecting the economic impact of per capita income on attracting or deterring foreign investment.

9- Vector Auto regression (VAR) Model

The results of the VAR test indicate that lagged energy investment has a very weak effect on current per capita income, amounting to only 1%. Likewise, lagged foreign investment has a very weak impact on both current per capita income and energy investment. However, past values of per capita income exert a very strong effect on both energy investment and foreign investment in the current period.

5. CONCLUSION

This study investigated the impact of energy investment on unemployment in Iraq and Sudan using annual data for the period 2000–2022 and applying advanced econometric techniques, namely the ARDL, ECM, and VAR models. The main objective was to assess whether investment in the energy sector can serve as an effective mechanism for reducing unemployment in rentier economies and to compare the magnitude and dynamics of this effect between the two countries.

The empirical results of the Bounds Test confirm the existence of a long-run cointegration relationship between energy investment and unemployment in both Iraq and Sudan, indicating that the effects of energy investment are not transitory but persist over time. The long-run ARDL estimates reveal a statistically significant and negative relationship between energy investment and unemployment, implying that increased investment in the energy sector contributes to reducing unemployment rates in the long term. This finding is consistent with Keynesian economic theory, which emphasizes the role of investment in stimulating aggregate demand and job creation (Keynes, 1936; Mankiw, 2020), and aligns with empirical evidence highlighting the long-term employment effects of energy-related investment (Apergis & Payne, 2014; Khan et al., 2019).

However, the short-run dynamics captured by the Error Correction Model (ECM) indicate that the immediate impact of energy investment on unemployment is limited in both countries. This result reflects the existence of adjustment lags between the initiation of energy projects and their translation into actual employment opportunities, particularly given the capital-intensive nature of many energy investments. Similar short-run limitations have been documented in previous studies on investment and employment in Iraq and other developing economies, where job creation materializes gradually rather than instantaneously (Alkhazraji & Salman, 2023; Ibrahim & Esmaeel, 2022).

The comparative analysis reveals that the long-run employment effect of energy investment is stronger and more persistent in Iraq than in Sudan. This difference can be attributed to Iraq's larger scale of energy projects, especially in the oil and gas sector, as well as its relatively higher capacity to integrate energy investment with other productive activities. These results are consistent with earlier findings showing that large-scale energy and infrastructure investments in resource-rich economies tend to have stronger spillover effects on employment when supported by sufficient institutional and financial capacity (Arezki et al., 2017; Calderón & Servén, 2014). In contrast, the weaker employment response observed in Sudan reflects structural and institutional constraints, including inadequate infrastructure, limited financial depth, and weaker coordination between the energy sector and the broader economy. This outcome is in line with previous studies emphasizing that the effectiveness of energy and foreign investment in Sudan is constrained by institutional fragility and infrastructure gaps (Ahmed & Musa, 2024; World Bank, 2020).

The VAR analysis further supports these conclusions by showing that shocks to energy investment gradually influence unemployment rates over time, with stronger and more sustained effects in Iraq than in Sudan. This dynamic behavior confirms that energy investment operates as a long-term adjustment mechanism rather than a short-term labor market instrument. These findings

also complement earlier empirical work that highlights the delayed but cumulative impact of energy investment and production on employment in energy-dependent economies (Shah et al., 2021; Stern & Kander, 2012).

Based on these results, several policy implications can be derived. First, energy investment strategies in both Iraq and Sudan should not focus exclusively on capital-intensive projects but should increasingly prioritize labor-absorbing investments, particularly in renewable energy, energy services, and energy-linked downstream industries. This recommendation is supported by empirical evidence indicating that renewable and diversified energy investments tend to generate broader employment effects than conventional energy projects alone (Falcone, 2023; Rahman, 2024). Second, improving the investment environment through institutional reforms, regulatory stability, and transparency is essential, especially in Sudan, to enhance the employment impact of energy investment. This aligns with prior studies demonstrating that institutional quality is a key determinant of investment effectiveness in reducing unemployment (Alfaro et al., 2010; UNCTAD, 2022).

Third, the development of human capital through vocational and technical training programs is crucial to ensure that the local workforce can meet the skill requirements of modern energy projects. Without such complementary policies, the employment benefits of energy investment may remain limited or unevenly distributed, as highlighted by the ILO (2021) and FAO (2021). Fourth, strengthening energy-related infrastructure—such as electricity networks, transmission systems, and export facilities—would enhance the spillover effects of energy investment on economic growth and employment, particularly in Sudan. Finally, aligning energy investment policies with broader sustainable development objectives, including social inclusion and environmental sustainability, is necessary to ensure that energy-led growth translates into long-term employment stability and improved living standards.

In conclusion, this study provides robust empirical evidence that energy investment can serve as an effective tool for reducing unemployment in rentier economies when supported by appropriate institutional frameworks and complementary economic policies. By offering a comparative analysis of Iraq and Sudan, the study extends the existing literature beyond single-country analyses and highlights how differences in institutional capacity and economic structure shape the labor market outcomes of energy investment. These findings contribute to filling an important gap in the literature and provide policymakers with evidence-based insights for designing energy investment strategies that promote inclusive growth and sustainable employment.

Conflict of Interest

The authors declare no conflict of interest .

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