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# An ARDL estimation is conducted to examine the dynamical connection among energy use and joblessness in Saudi Arabia

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***Abstract***

*The rate of joblessness in Saudi Arabia has been a major worry in the past few years, exhibiting swings because of several economic causes. The nation has the formidable task of accommodating a substantial influx of fresh graduates into the labor market annually, posing an obstacle for government officials to offer sufficient employment prospects. Nevertheless, there has been a lack of comprehensive research on the influence of macroeconomic variables, such as energy consumption, on joblessness. The objective of this study is to examine the influence of several macroeconomic factors, such as foreign and domestic investment, trade liberalization, inflation, urbanization, economic growth, and energy consumption, on the levels of unemployment in Saudi Arabia. The ARDL estimate method was used to assess the yearly data spanning from 1971 to 2022. The findings indicate a varied anticipated influence of the independent and dependent variables over an extended period of time. While there is a short-term negative correlation between energy consumption and rate of joblessness, this relationship does not hold true in the long term. The study culminates with a compilation of policy suggestions.*

***Keywords:*** *ARDL, Joblessness, Energy Use, Saudi Arabia.*

## INTRODUCTION

The problem with joblessness is a substantial macroeconomic obstacle encountered by several emerging nations. According to the most recent statistics published by the Department of Statistics of Saudi Arabia, the rate of joblessness has increased from 5% in April 2020 to 5.3% in May 2020. This means that out of the total population of 826,100 inhabitants, there has been a growth of 47,300 individuals who are now jobless (DoSM, 2021). The countrywide execution of the Movement Control Order is responsible for this tendency. The issue of youth unemployment in Saudi Arabia is a pressing concern, as emphasized by Abd Rahman et al. (2020a), who have seen challenges in securing work opportunities that align with their credentials (Abd Rahman et al., 2020b). The issue of joblessness has significant consequences, including both economic and social instability within a given community, less money to spend, and a deceleration in economic progress. Furthermore, the quality of life of people is negatively influenced by this phenomenon, since it has a direct effect on their monthly income (Michael & Geetha, 2020).

In conclusion, the increase in joblessness in Saudi Arabia as a result of the Movement Control Order (MCO) is a concerning pattern, particularly among the youth. The situation at hand has substantial economic and social ramifications, necessitating urgent attention in order to mitigate the potential exacerbation of the nation's economy and society. Based on the data shown in Figure 1, it can be seen that Saudi Arabia has maintained a continuously low rate of joblessness of below 8% from 1984 to 2020, suggesting a state of steady management. Significantly, Saudi Arabia saw its lowest rate of joblessness in 2014, standing at 2.85%. This may be attributed to the country's sustained economic development and the presence of a wide range of job possibilities, which have become Saudi Arabia a popular choice for neighboring nations in the region. Nevertheless, the energy use in Saudi Arabia has seen a steady rise over time, mostly driven by the combustion of fossil fuels and coal, owing to their comparatively lower expenses. Regrettably, the aforementioned phenomenon has led to an increase in carbon emissions, hence exacerbating the phenomenon of global warming. This assertion is

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supported by empirical investigations undertaken by Voumik et al. (2023), Pujiati et al. (2023), Shaari et al. (2022), Ridzuan et al. (2022), and Ridzuan et al. (2020).

As Saudi Arabia undergoes a shift from an agrarian economy to an industrialization one, industries need a greater amount of energy to support increased economic activity. This is seen from the consistent annual increase in gross domestic product (GDP) from 1984 to 2020. The observed increase in energy consumption has occurred concurrently with the rise in the rate of joblessness, prompting an inquiry into the potential correlation between these two measures. In Saudi Arabia, 30% of all labor is in the industrial sector, while the service sector makes up 50% of the country's GDP. Despite the optimistic GDP development trend in Saudi Arabia, it is imperative to implement lasting strategies in order to address joblessness concerns across every sector of the economy.

To maintain sustainable economic development in Saudi Arabia, it is imperative to determine the primary reasons that contribute to jobless. Failure to do so might result in economic emergencies, such to those saw in 1997 and 2008.

The objective of this research is to analyze the correlation, both in both the short and long term, between several macroeconomic indicators and the rate of joblessness in Saudi Arabia. Through the identification of the fundamental factors contributing to joblessness, governments may develop enduring strategies to tackle the problem and maintain consistent economic expansion. The following part is dedicated to the examination of existing literature. The third part elucidates the technique used in this research, while the fourth part provides an analysis and thorough examination. The last portion of the document focuses on the final remarks and policy suggestions.

## LITERATURE REVIEW

A number of investigations are being undertaken to examine the factors that determine the rate of joblessness. The second part provides a concise overview of relevant previous research conducted on this subject. In this part, we may identify many macroeconomic parameters that are often employed as possible factors in the joblessness concept. Johnny et al. (2018) examined the influence of Foreign Direct Investment (FDI) on the joblessness rate in Nigeria throughout the period from 1980 to 2015. The analysis reveals a strong and inverse correlation between foreign direct investment (FDI) and unemployment, as well as a strong and direct correlation among the creation of capital and joblessness. Based on the results, it is recommended that the government enact laws to enhance the economic environment in Nigeria and prioritize the use of every asset for productive uses without considering any savings.

Irpan et al. (2018) examined the influence of foreign direct investment (FDI) on the job creation level in Malaysia. The research also took into account other parameters, including the quantity of foreign laborers, gross domestic product (GDP), and the foreign exchange rate (EXCR). The research used yearly data from 1980 to 2012. The autoregressive distributed lag (ARDL) model was employed to establish the long-term relationship among the parameters. The research found that Foreign Direct Investment (FDI) and Gross Domestic Product (GDP) have a major impact on additional analysts, such as Grahovac and Softi (2017), who adopt an increasingly active stance towards the relationship between FDI and the joblessness rate of the host nation. The researchers examined the correlation between worldwide joblessness and foreign direct investment (FDI) flows in West Balkans nations. They conducted a comparative study, including chosen countries, from 2000 to 2014. The analysis showed a substantial decrease in net investments since 2009, particularly in the case of foreign direct investment (FDI) due to reduced domestic and external demand caused by the global economic crisis. This drop has led to a decline in jobs and an increase in joblessness. The results also indicated that there was no beneficial effect of foreign direct investment (FDI) on employment, despite the presence of such an effect in most Central and Eastern European (CEE) nations throughout the transitional era, as shown by multiple investigations.

Bulavskaya and Reynès (2017) analyzed the influence of green energy on employment generation in the Netherlands employing a neo-Keynesian CGEM Three-ME model. The conclusion drawn by the researchers is that the shift towards green energy might potentially provide around 50,000 employment opportunities by

the year 2030, therefore making a 1% contribution to the Gross Domestic Product (GDP). Khodeir (2016) found a negative relationship among the production of green energy and joblessness in Egypt from 1989 to 2013, employing the ARDL technique. The research sought to identify the impacts over the short as well as the long run, nevertheless it was determined that the hypothesis was only confirmed in the long run. In their study, Bekmez and Ağpak (2016) examined the correlation among non-hydro green energy consumption and a job across 80 nations. They found that in low to middle-income nations, there is a one-way causal relationship from employment to non-hydro renewable energy consumption. However, they did not observe a causal connection in countries with high incomes. The data therefore provide no evidence to support the idea that renewable energy has a beneficial effect on jobless. Apergis and Salim (2015) conducted a study on 80 nations from 1990 to 2013. They used sophisticated techniques such as unit root analysis, cointegration analysis, and nonlinear Granger causality analysis in panel data. Their findings yielded varied outcomes on the correlation between the use of renewable energy and the rate of unemployment. Nevertheless, comprehensive research has shown that the use of renewable energy has a beneficial effect on the rate of joblessness, particularly when examining data that is broken down by specific geographic areas, such as Asia and Latin America.

Thayaparan (2014) examined the influence of inflation and economic growth on unemployment in Sri Lanka. The research used yearly time series data extracted from the annual reports of the Central Bank of Sri Lanka (CBSL) spanning the years 1990 to 2012. In this work, the Augmented Dickey-Fuller (ADF) Test was used to ascertain the stationarity of the series. The Granger Causality Test was used to ascertain the causal connection between the variables. Based on the outcomes of the unit root test, it is shown that only GDP exhibits stationarity at its original level, although unemployment and inflation show stationarity when their initial differences are considered. The study's overall results indicate that price increases has a substantial detrimental effect on unemployment in Sri Lanka, whereas GDP has a favorable but inconsequential effect on joblessness.

Abdul-Khaliq et al. (2014) undertook an empirical investigation to examine the correlation between joblessness and GDP growth in nine Arab nations from 1994 to 2010. This research used pooled panel unit root tests to examine the stationarity of the variables. The Pooled EGLS (Crosssection SUR) estimate techniques were used to examine the correlation between the variables. Based on the analysis, there is a strong negative correlation between economic growth and joblessness. The current body of research provides quantitative explanations for the correlation between trade openness and the unemployment rate. Mohler et al. (2018) examined the correlation between foreign trade and joblessness in Switzerland. The research spanned from 1991 to 2008 and included almost 33,000 persons employed in the industrial sector. The research used the panel regression approach and discovered a statistically negligible correlation between foreign commerce and unemployment. Martes (2018) examined the correlation between trade openness and unemployment rates in 28 OECD (Organization for Economic Cooperation and Development) nations. The research used the panel regression estimation approach, covering the period from 2000 to 2016. The study's results indicated that trade openness had a substantial and adverse influence on the rate of joblessness, both in the short term and the long term. Awad-Warrad (2018) examined the influence of trade liberalization and economic expansion on the reduction of joblessness in the Arab area. The study included a total of seven Arab nations, namely Algeria, Bahrain, Egypt, Jordan, Oman, Saudi Arabia, and Tunisia, spanning the period from 1990 to 2015. The research discovered that the Arab area had a notable decrease in unemployment as a result of trade liberalization and economic development, as determined by the panel-weighted least square estimate approach.

Hala et al. (2021) found that there is a positive and substantial relationship between urban residents and the rate of joblessness. Specifically, for every 1% rise in the urban population, there is a 4.06% increase in the unemployment rate. Urban dwellers are constrained to employment opportunities in sectors such as manufacturing, service provision, and public administration, among others. Conversely, those residing in rural areas have the chance to engage in farming activities at different levels, all the while benefiting from a cheaper cost of living. Bouzid (2016) conducted an empirical study using young unemployment as a measure to examine the correlation between corruption and unemployment. Based on his findings, the involvement of government officials in corrupt practices throughout the hiring process leads to an increase in unemployment rates among workers and the younger population. The act of seeking employment sometimes leads to an increase in corruption as individuals often resort to offering bribes to authorities in order to acquire job opportunities. In

their study, Chella and Phiri (2017) examined the correlation between foreign direct investment (FDI), local investment, and unemployment in South Africa. The Autoregressive Distributed Lag (ARDL) model was used to analyze quarterly data from 1970 to 2014. The results suggest that local investments have a detrimental effect on unemployment rates, whereas foreign direct investment seems to have little influence on unemployment levels.

## RESEARCH METHODOLOGY AND RESULTS

*Data*

The study covers the time span from 1971 to 2022 in the Saudi economy, using supplementary information sourced from the World Bank's database. The parameters we have been displaying in Table 1.

**Table 1. Variables' definition and description.**

| Variable | Notation | Description | Sources |
|---|---|---|---|
| Unemployment | LUE | Rate of joblessness % | WDI |
| GDP per capita | LGDP | GDP per capita equal to Real GDP/Population | WDI |
| ENY | LENY | Using the energy before transformation to other end-use fuels | WDI |
| DI | LDI | Gross fixed capital formation % GDP | WDI |
| FDI | LFDI | Foreign direct investment net inflows are the value of inward direct investment made by non-resident investors | WDI |
| IN | LINF | Inflation, consumer prices (annual %) | WDI |
| TO | LTO | Trade (% of GDP) | WDI |
| UR | LURB | Urban population growth (annual %) | WDI |

Table 2 displays a statistical analysis of the parameters. The logarithmic method was applied to the parameters, LUE, LGDP, LENY, LDI, LFDI, LINF, LTO and LURB to assess the uniformity of the results. The remainder of the parameters were computed either as percentages or per capita (Gujarati, 2009). The use of logs resulted in improved behavior of the distribution.

**Table 2. Statistical description of variables.**

| | LUE | LGDP | LENY | LDI | LFDI | LINF | LTO | LURB |
|---|---|---|---|---|---|---|---|---|
| Mean | 11.382 | 12.239 | 25.047 | 74.725 | 1.1082 | 4.603 | 0.138 | 3.673 |
| Median | 11.1401 | 8.371 | 20.320 | 66.343 | 0.4961 | 7.151 | 0.062 | 5.706 |
| Maximum | 14.878 | 8.970 | 21.346 | 102.67 | 7.2321 | 7.524 | 0.906 | 6.004 |
| Minimum | 8.3449 | 8.1922 | 19.292 | 47.742 | −6.995 | 5.863 | 4.521 | 4.678 |
| Std. Dev. | 1.6714 | 0.2426 | 0.5792 | 11.012 | 2.6321 | 0.475 | 0.330 | 0.379 |
| Skewness | 0.4155 | 0.8563 | −0.0608 | 0.5558 | 0.0524 | 1.041 | 0.0065 | 0.830 |
| Kurtosis | 2.0868 | 2.1114 | 1.7571 | 3.2636 | 3.5848 | 2.783 | 0.449 | 2.220 |
| Jarque-Bera | 1.9571 | 6.738 | 1.3981 | 3.7478 | 2.3140 | 9.463 | 0.290 | 7.551 |
| Probability | 0.2696 | 0.0162 | 0.3744 | 0.0943 | 0.2186 | 0.0032 | 0.027 | 0.002 |
| Sum | 500.30 | 373.12 | 894.62 | 2925.2 | 44.322 | 307.3 | 45.557 | 245.225 |
| Sum Sq. Dev. | 141.126 | 2.9737 | 16.947 | 6128.2 | 349.98 | 11.43 | 43.887 | 9.121 |
| Observations | 51 | 51 | 51 | 51 | 51 | 51 | 51 | 51 |

*Model of Study*

This research employed the ARDL framework, which is a contemporary flexible look at that incorporates time, for evaluating the theories. The objective was to determine both short- and long-term connections between the factors in question and offer proof supporting the model hypothesis in Saudi Arabia during the research period.

The first equation demonstrates how the relationship between rate of joblessness and energy consumption (use), economic development, gross fixed capital, trade, inflation, urban population growth and FDI can be described, as follows:

$$LUE = f(LGDP, LENY, LDI, LFDI, LINF, LTO, LURB) \quad (1)$$

*Unit-Root Test*

We utilized the unit root test of Phillips and Perron (1988) (PP test) and the Augmented Dickey and Fuller (Dickey and Fuller 1979) (ADF test) to assess the stationarity of the research variables (Pesaran 2015). With respect to the findings shown in Table 3, our variables exhibit a combination of integrating orders, namely

order zero (I(0)) and order one (I(1)). This indicates that we used the Autoregressive Distributed Lag (ARDL) model to ascertain the short- and long-term associations among the parameters under investigation (Nkoro and Uko, 2016).

**Table 3. PP test and ADF test results.**

| Series | PP Test | | | | ADF Test | | | |
|---|---|---|---|---|---|---|---|---|
| | Level | | First Difference | | Level | | First Difference | |
| | *t*-Statis. | Prob. | *t*-Statis. | Prob. | *t*-Statis. | Prob. | *t*-Statis. | Prob. |
| LUN | −2.1300 | 0.2344 | −6.3804 | 0.0000 *** | −2.1300 | 0.2344 | −6.3804 | 0.0000 *** |
| LGDP | −1.6965 | 0.4258 | −5.0449 | 0.0002 *** | −1.6965 | 0.4258 | −5.0449 | 0.0002 *** |
| LENY | −3.5190 | 0.0121 ** | −9.9726 | 0.0000 *** | −3.5190 | 0.0121 ** | −9.9726 | 0.0000 *** |
| LDI | −1.4204 | 0.5635 | −5.0627 | 0.0001 *** | −1.4204 | 0.5635 | −5.0627 | 0.0001 *** |
| LFDI | −0.2607 | 0.0924 | −3.1733 | 0.0021 *** | −0.3548 | 0.7589 | −3.2659 | 0.0011 *** |
| LINF | −0.4083 | 0.8986 | −7.1287 | 0.0000 *** | −0.4083 | 0.8986 | −7.1287 | 0.0000 *** |
| LTO | −3.0570 | 0.0376 ** | −10.5649 | 0.0000 *** | −3.0570 | 0.0376 ** | −10.5649 | 0.0000 *** |
| LURB | −3.0570 | 0.0376 ** | −10.5649 | 0.0000 *** | −3.0570 | 0.0376 ** | −10.5649 | 0.0000 *** |

**Notes:** *** and ** denote significance at the 10%, and 5% levels, respectively.

*Econometric Model*

The equation (1) may be reformulated in a more clear manner as below.:

$$LUE_t = \beta_0 + \beta_1 LGDP_t + \beta_2 LENY_t + \beta_3 LDI_t + \beta_4 LFDI_t + \beta_5 LINF_t + \beta_6 LTO_t + \beta_7 LURB_t + \varepsilon \quad (2)$$

A significant challenge encountered in traditional models and regression evaluation is to the presence of linear correlation, also known as multi-collinearity, among the variables that are uncorrelated. This implies the inability to satisfy one of the conditions of the Ordinary Least Squares (OLS) approach. According to Zahari et al. (2014), the model used for regression exhibits strong connections between both dependent and independent variables, hence posing challenges in disentangling their individual impacts. Several indications may be used to identify this issue (Wooldridge 2015). The correlation matrix among the variables that are independent and the variance-inflating factor (VIF) may be used as one of the indications. Multi-collinearity is indicated by a Variance Inflation Factor (VIF) over 10 and an in pairs or a zero-order correlation value for both declines beyond 0.8 (Gujarati, 2009).

The Relationship Graph demonstrates the absence of multiple linearity among the independent variables, provided that the Pearson correlation coefficient is below 0.8. The findings shown in Table 4 suggest that LGDP2 was excluded from the relationship between LNG and LGDP.

**Table 4. The findings of the association matrices indicate the individually relationships.**

| | LUN | LGDP | LENY | LDI | LFDI | LINF | LTO | LURB |
|---|---|---|---|---|---|---|---|---|
| LUN | 1.00000 | | | | | | | |
| LGDP | -0.1656 | 1.00000 | | | | | | |
| LENY | 0.2988 | 0.6676 | 1.00000 | | | | | |
| LDI | 0.49265 | 0.6231 | −0.1960 | 1.0000 | | | | |
| LFDI | 0.3913 | 0.2462 | 0.4239 | 0.2516 | 1.0000 | | | |
| LINF | 0.2653 | 0.2999 | −0.6699 | 0.6209 | −0.2505 | 1.0000 | 1.0000 | |
| LTO | 0.2739 | −0.3324 | 0.8966 | −0.2918 | 0.4669 | −0.7344 | 0.5570 | 0.3504 |
| LURB | 0.3056 | −0.2441 | 0.0255 | −0.8633 | 0.7271 | −0.3559 | -0.5502 | 1.0000 |

In order to determine the most suitable lag longitude for each parameter in the model, we used several metrics such as AIC, HIC, and SIC. Table 5 displays the lag values that range from 1 to 3, where the majority of these lag length requirements are represented by asterisks, indicating the minimum values. According to Schwarz's criteria, the minimum value is observed after one time, however Akaike's criterion indicates that the minimum value is seen after three different instances.

**Table 5. Criterion for model selection.**

| Lag | AIC | SC | HQ |
|---|---|---|---|
| 0 | 16.55991 | 16.76889 | 16.63601 |
| **1** | 7.890607 | 9.144441 * | 8.347184 * |
| 2 | 7.853450 | 10.15214 | 8.690507 |
| **3** | 7.848290 * | 11.19185 | 9.065829 |

**Note:** * indicates lag order choices by the standard. Akaike information criterion (AIC). Schwarz Criterion (SC). Hannan-Quinn (HQ).

The autoregressive distributed lag (ARDL) model is well recognized as a prominent contemporary dynamic methodology that incorporates the temporal dimension. In order to determine the connection among variables in both the short and long term, in addition to the rate at which the system reaches balance, we examined the long-term relationship between variables using data collected over time. This framework comprises two parts: (1) Autoregressive (AR), which is a model that relies on its past values, treating the dependent variable as a lagged independent variable; and (2) Distributed Lagged (DL), which suggests that the dependent variable is also affected by modifications to the independent variables and their past values.

The equation (3) illustrates the ARDL model used in the research we conducted:

$$\mathrm{LUE}_t = \beta_0 + \beta_1 \mathrm{LGDP}_t + \beta_2 \mathrm{LENY}_t + \beta_3 \mathrm{LDI}_t + \beta_4 \mathrm{LFDI}_t + \beta_5 \mathrm{LINF}_t + \beta_6 \mathrm{LTO}_t + \beta_7 \mathrm{LURB}_t + \varepsilon$$

$$\begin{aligned} &+ \alpha_1 \mathrm{LGDP}_{t-1} + \alpha_2 \mathrm{LENY}_{t-1} + \alpha_3 \mathrm{LDI}_{t-1} + \alpha_4 \mathrm{LFDI}_{t-1} + \alpha_5 \mathrm{LINF}_{t-1} + \alpha_6 \mathrm{LTO}_{t-1} + \alpha_7 \mathrm{LURB}_{t-1} \\ &+ \sum_{j=1}^{p} \beta_{1j} \Delta \mathrm{LGDP}_{2_{t-j}} + \sum_{j=0}^{q} \beta_{2j} \Delta \mathrm{LENY}_{t-j} + \sum_{j=0}^{n} \beta_{3j} \Delta \mathrm{LDI}_{t-j} + \sum_{j=0}^{r} \beta_{4j} \Delta \boldsymbol{LINF}_{t-j} \\ &+ \sum_{j=0}^{m} \beta_{5j} \Delta \mathrm{LFDI}_{t-j} + \sum_{j=0}^{k} \beta_{6j} \Delta \mathrm{L}TO_{t-j} + \sum_{j=0}^{s} \beta_{7j} \Delta \mathrm{L}URB_{t-j} + \mu_{it} \end{aligned} \quad (3)$$

The first-difference operators are denoted by (d), while lags are indicated by p, q, r, m, n, k, and s. Long-run variables are represented by (α1–α7), short-run parameters are represented by (β1–β7), the intercept is represented by (α0), and the error term is represented by ($\mu_t$).

The immediate impacts were calculated based on the following:

$$\begin{aligned} \mathrm{dLUE}_t = \alpha_0 &+ \sum_{j=1}^{p} \beta_{1j} \Delta \mathrm{LGDP}_{2_{t-j}} + \sum_{j=0}^{q} \beta_{2j} \Delta \mathrm{LENY}_{t-j} + \sum_{j=0}^{n} \beta_{3j} \Delta \mathrm{LDI}_{t-j} + \sum_{j=0}^{r} \beta_{4j} \Delta \boldsymbol{LINF}_{t-j} \\ &+ \sum_{j=0}^{m} \beta_{5j} \Delta \mathrm{LFDI}_{t-j} + \sum_{j=0}^{k} \beta_{6j} \Delta \mathrm{L}TO_{t-j} + \sum_{j=0}^{s} \beta_{7j} \Delta \mathrm{L}URB_{t-j} + \mu_{it} \end{aligned} \quad (4)$$

The variable $\varphi \mathrm{ECT}_{t-1}$ denotes the rate at which the system progresses towards long-run equilibrium. This implies that if the system deviates from equilibrium in one direction, it will subsequently return to equilibrium (Ali et al., 2021). A coefficient with a positive value signifies a divergence, while a coefficient with a negative value implies convergence. When the estimate of ECt is equal to 1, the adjustment occurs entirely inside the period, meaning it is immediate and complete. Conversely, if the estimate of ECt is equal to 0.5, the adjustment occurs 50% each period or year. The value of ECt = 0 indicates the absence of any adjustment, rendering the assertion of a long-term association illogical (Nkoro and Uko 2016).

**Table 6. ARDL model estimation in the short-run and long-run.**

| **Short run estimates** | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Std. error** | ***t*-Statistic** | **Prob.** |
| LUN | 0.772469 | 0.101941 | 7.577609 | 0.0000 |
| LGDP | 5.835308 | 1.880034 | 3.103831 | 0.0038 |
| LENY | −4.034057 | 1.979621 | -2.037793 | 0.0492 |
| LDI | 0.595700 | 0.383425 | 1.553628 | 0.1293 |
| LFDI | 0.013262 | 0.016283 | 0.814469 | 0.4209 |
| LINF | −0.141843 | 0.061535 | -2.305078 | 0.0272 |
| LTO | 0.185506 | 0.053963 | 3.437652 | 0.0015 |
| LURB | 0.371754 | 0.054449 | 6.827563 | 0.00302 |
| C | −0.264716 | 0.057598 | -4.595923 | 0.0001 |
| **Long-run estimates** | | | | |
| LUN | 7.916522 | 4.317275 | 1.833685 | 0.0752 |
| LGDP | 2.618109 | 1.399359 | 1.870934 | 0.0697 |
| LENY | 0.058286 | 0.071057 | 0.820271 | 0.0076 |
| LDI | 0.191902 | 0.328451 | 0.584264 | 0.0028 |
| LFDI | 0.216511 | 0.617325 | 0.350724 | 0.0153 |
| LINF | 0.116805 | 0.071697 | 1.629148 | 0.00561 |
| LTO | 0.384572 | 0.331407 | 1.160422 | 0.0063 |
| LURB | 0.433888 | 0.622881 | 0.696582 | 0.0695 |
| C | −132.0875 | 65.80327 | -2.007309 | 0.0525 |

The use of the SIC criteria to define the lags in the ARDL model did not provide with statistically significant coefficient estimation outcomes for the (LMV) variable in the short run. Furthermore, the coefficient estimation results for all independent variables in the long run did not show statistical significance.

*Outcomes of Short-term Correlation Estimation*

The estimates shown in Table 6 demonstrate that in the near term, there is a considerable impact of (LGDP) on carbon dioxide emissions in Saudi Arabia. The parameter (LGDP) exhibits a positive correlation, indicating a direct relationship between GDP and emissions. An increase of one unit in gross domestic product is associated with a corresponding rise of around 6% in carbon dioxide emissions. This phenomenon may be traced to various economic activities that contribute to the generation of these emissions. The variable (LFDI) exhibits a statistically significant estimate of emissions, characterized by a parameter with a negative sign. When the level of foreign direct investment (LFDI) reduces by one unit, the level of carbon dioxide (LCO2) rises by roughly 0.19%. This phenomenon may be attributed to certain regulations and environmental rules aimed at limiting emissions and maintaining the environment. The estimations indicate that the two variables (LMV) and (LTR) have little impact on carbon dioxide emissions in the near term.

In relation to the outcomes of the error correction model (ECM), it is observed that the error correction term ($ECT_{t-1}$) exhibits a high level of significance, specifically at the specified significance level of 5%. This finding suggests the presence of a cointegration relationship among the variables in the model, indicating a short-term equilibrium relationship. The coefficient associated with the variable (ECT) is about equivalent to 0.26. This implies that any aberrations in the short-term are rectified by around 26% during a span of one year, bringing the relationship back to its short-term equilibrium.

*Outcomes of Long-term Correlation Estimation*

The long-term findings shown in Table 6 indicate a statistically significant and non-negative economic association between the variables (LGDP), (LGDP2), LTR, and (LFDI) with (LCO2). This suggests a favorable connection in the long run. For every one unit rise in LGDP2, there is an estimated 2.6% increase in LCO2. Therefore, the convex function is (7.917 + 2.618LGDP2). Similarly, for every one unit increase in LTR, there is an approximate 0.2% increase in LCO2. Similarly, for every one unit increase in LFDI, there is an approximate 0.22 increase in LCO2. The findings contradict the research assumptions, indicating that industrialization does not have a long-term impact on environmental pollution. Additionally, the theory of the environmental Kuznets curve aligns with the situation in Saudi Arabia.

*Bounds Test*

The identification of correlation connections in the autoregressive distributed lag (ARDL) model is accomplished by the use of the limits test. The significance of this test is determined by the F-Statistic value, as noted by Nkoro and Uko (2016).

Based on the findings shown in Table 7, it can be concluded that there is no evidence of a cointegration connection. This conclusion is supported by the calculated F-statistic value, which falls below the lower limit, I(0), of the critical values at a significance level of 5%.

**Table 7. Bounds test result.**

| **F-bounds test** | | **Null hypothesis: No co-integration relationship** | | |
|---|---|---|---|---|
| Test Statistic | Value | Signif. | I(0) | I(1) |
| F-statistic | 0.04128 | 10% | 2.2 | 3.09 |
| K | 4 | 5% | 2.56 | 3.49 |
| | | 2.5% | 2.88 | 3.87 |
| | | 1% | 3.29 | 4.37 |

Therefore, we may conclude that the null hypothesis H0 is accepted, indicating the absence of co-integration and the lack of a long-term equilibrium connection.

3.8. ARDL *Diagnostic Tests*

Based on the findings presented in Table 8, the diagnostic procedures conducted to assess remaining distribution, self-correlation and recognition issues reveal that the null hypothesis (H0) has been accepted based on the Jarque-Bera statistic. Consequently, the residuals of the model exhibit a distribution that is normal, as depicted in Figure 2 (Gujarati, 2009; Rufus Carter Hill, 2011). According to Greene (2018) and Gujarati (2009), the acceptance of the null hypothesis (H0) in the Breusch-Godfrey (BG) test for LM serial correlation (autocorrelations) indicates the absence of serial correlation. The Ramsey RESET test (regression specification error test) was used to identify any misunderstanding of the generic functional form (Wooldridge 2015). In relation to the issue of heteroscedasticity (Gujarati, 2009), the Breusch-Pagan-Godfrey (BPG) test did not provide sufficient evidence for rejecting the null hypothesis (H0). Figure 4 displays the plots of the critical lines at a significance level of 5% for the variables CUSUM and CUSUMSQ, which were used to assess the reliability of the calculated parameters of the model.

**Table 8. ARDL diagnostic tests result.**

| | **Test** | **Value** | **Probability** |
|---|---|---|---|
| Residuals Distributed | Normality Test<br>Jarque–Bera | 3.270557 | 0.173835 |
| Serial Correlation | LM Test/Breusch–Godfrey (BG) | 1.128449 | 0.309635 |
| Heteroskedasticity | Breusch–Pagan–Godfrey Test (BPG) | 18.19303 | 0.023662 |
| Stability | Ramsey RESET Test | 0.631393 | 0.407761 |
| | CUSUM TEST | --- | --- |
| | CUSUMSQ TEST | --- | --- |

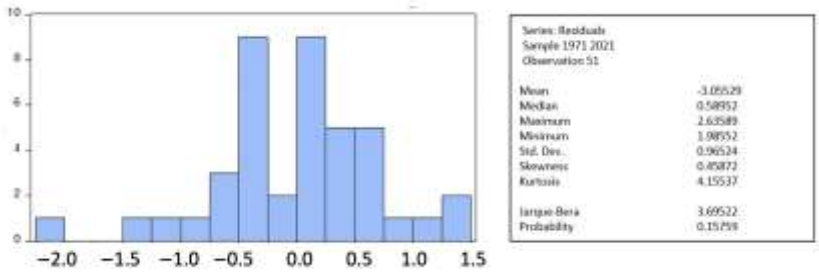


**Figure 2. Histogram of residuals—normal distribution.**

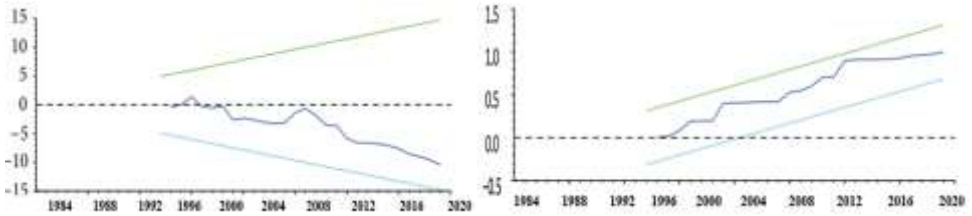

**Figure 3.**

Figure 3 illustrates the plots of the cumulative sum of recursive residuals and the cumulative sum of squares of recursive residuals. The linear boundaries shown in the graph indicate the critical point at a threshold of significance of 5%.

## SUMMARY AND POLICY SUGGESTIONS

This research aims to examine the correlation between energy usage and joblessness in Saudi Arabia. The research used both the Augmented Dickey-Fuller (ADF) and Philip Perron Test (PP) techniques to examine stationarity. The findings reveal that both approaches provide consistent outcomes, indicating the presence of a stationary unit root at the 1% and 10% significance levels. The research further examines long-term correlations among the factors using a co-integration test, which verifies the presence of these connections. The cumulative sum chart is used for monitoring the trend during the whole operation.

The study's findings indicate that all factors have a considerable impact on short-term rate of joblessnesss, with varying lag values and predicted indications. More precisely, research indicates that foreign direct investment (FDI) and inflation (INF) contribute positively to joblessness, but domestic investment (DI), and trade openness (TO), are associated negatively with joblessness in the long term. The paper provides many policy suggestions. Initially, it is essential for the government to guarantee that foreign investors who establish their operations in the nation engage local talent to be employed in their enterprises. This will bolster the government's initiatives on employment creation via foreign direct investments. Additionally, it is important for the government to closely monitor the nation's inflation rate in order to mitigate the risk of excessive escalation, which has the potential to detrimentally impact the welfare of its citizens. It is advisable to pursue contractionary fiscal and monetary policies, with particular focus on the level of joblessness.

Furthermore, governments should prioritize the growth of economic sectors in rural regions, even when increased urbanization has resulted in reduced joblessness. Individuals are relocating from rural to urban regions in search of improved employment prospects and higher remuneration. However, it is important to ensure that work possibilities are still accessible to those who remain in the countryside.

Ultimately, increased domestic investment and trade openness promote economic activity and result in a greater number of employment possibilities. The government may bolster the economy via increased investment in infrastructure and the provision of subsidies to local entrepreneurs engaged in foreign commerce, resulting in a multiplier effect on job growth and a decrease in joblessness. The use of influence, such as familial relations or connections, is strictly prohibited, since it conveys an inappropriate message to community.

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## REFERENCES

Abdul Rahman, N.H., Ismail, S., Abd Samad, K., Ridzuan, A.R. (2020b), Graduates' mindset in designing their initial career. International Journal of Academic Research in Business and Social Sciences, 10(10), 917-924.

Abdul-Khaliq, S., Soufan, T., Shihab, R.A. (2014), The relationship between unemployment and economic growth rate in Arab Country. *Journal of Economics and Sustainable Development*, 5(9), 56-59.

Apergis, N., & Salim, R. (2015). Renewable energy consumption and unemployment: evidence from a sample of 80 countries and nonlinear estimates. *Applied Economics*, *47*(52), 5614–5633. https://doi.org/10.1080/00036846.2015.1054071

Awad-Warrad, T., (2018), Trade Openness, economic growth and unemployment reduction in Arab region. *International Journal of Economics and Financial Issues*, 8(1), 179-183.

Bekmez, S., Ağpak, F. (2016), Non-Hydro renewable energy and employment: A bootstrap panel causality analysis for countries with different income levels. *Journal of Business and Economic Policy*, 3(1), 32-45.

Borhan, H., Ridzuan, A. R., Razak, M. I. M., & Mohamed, R. N. (2023). The Dynamic Relationship between Energy Consumption and Level of Unemployment Rates in Malaysia: A Time Series Analysis Based on ARDL Estimation. *International Journal of Energy Economics and Policy*, *13*(2), 207–214. https://doi.org/10.32479/ijeep.13893

Bouzid, B.N. (2016), Dynamic Relationship between Corruption and Youth Unemployment: Empirical Evidences from a System GMM Approach. *Policy Research Working Paper; No. 7842*. Washington, DC: World Bank.

Chella, N., Phiri, A. (2017), *Long-Run Cointegration between Foreign Direct Investment, Direct Investment and Unemployment in South Africa*. Available from: https://www.mpra.ub.unimuenchen. de/82371/1/MPRA_paper_82371.pdf

Grahovac, D., & Softić, S. (2017). Impact of the FDI on unemployment rate in countries of west balkan. *Review of Innovation and Competitiveness*, *3*(2), 65–82. https://doi.org/10.32728/ric.2017.32/4

Gujarati, D.A. (2009), *Basic Econometrics*. United States: McGraw-Hill/ Irwin.

Hala, H., Mehdi, S., Huseyin, O. (2021), The nexus between the economic growth and unemployment in Jordan. *Future Business Journal*, 7(42), 1-10.

International Country Risk Guide. (2017), Available from: https://www. prsgroup.com/explore-our-products/international-countryrisk-guide.

Irpan, M.H., Saad, R.M., Md Nor, A.H.S., Md Noor, A.H., Ibrahim, N. (2016), Impact of foreign direct investment on the unemployment rate in Malaysia. Journal of Physics: Conference Series, 710, 012028.

Johnny, N., Timipere, E. T., & Okoyan, K. (2018). Impact of Foreign Direct Investment on Unemployment rate in Nigeria (1980-2015). *International Journal of Academic Research in Business & Social Sciences*, *8*(3). https://doi.org/10.6007/ijarbss/v8-i3/3905

Khodeir, A. N. (2016). The Relationship between the Generation of Electricity from Renewable Resources and Unemployment: An Empirical Study on the Egyptian Economy. *the Arab Economics and Business Journal*, *11*(1), 16–30. https://doi.org/10.1016/j.aebj.2015.10.003

Martes, E. (2018), The Effect of Trade Openness on Unemployment: Long Run Versus Short Run. B.Sc. Thesis, Erasmus School of Economics, Erasmus Universiteit Rotterdam. Available from: https://www.thesis. eur.nl/pub/43403

Mohler, L., Weder, R., & Wyss, S. (2018). International trade and unemployment: towards an investigation of the Swiss case. *Zeitschrift Für Schweizerische Statistik Und Volkswirtschaft/Schweizerische Zeitschrift Für Volkswirtschaft Und Statistik/Swiss Journal of Economics and Statistics*, *154*(1). https://doi.org/10.1186/s41937-017-0006-7

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326. https://doi.org/10.1002/jae.616

Pujiati, A., Yanto, H., Handayani, B. D., Ridzuan, A. R., Borhan, H., & Shaari, M. S. (2023). The detrimental effects of dirty energy, foreign investment, and corruption on environmental quality: New evidence from Indonesia. *Frontiers in Environmental Science*, *10*. https://doi.org/10.3389/fenvs.2022.1074172

Rahman, N. H. A., Ismail, S., Ridzuan, A. R., & Samad, K. A. (2020). The issue of graduate unemployment in Malaysia: post COVId-19. *International Journal of Academic Research in Business & Social Sciences*, *10*(10). https://doi.org/10.6007/ijarbss/v10-i10/7843

Ridzuan, A. R., Kumaran, V. V., Fianto, B. A., Shaari, M. S., Esquivias, M. A., & Albani, A. (2022). Reinvestigating the presence of environmental Kuznets curve in Malaysia: The role of Foreign Direct Investment. *International Journal of Energy Economics and Policy*, *12*(5), 217–225. https://doi.org/10.32479/ijeep.13461

Ridzuan, A. R., Albani, A., Latiff, A. R. A., Razak, M. I. M., & Murshidi, M. H. (2020). The impact of energy consumption based on fossil fuel and hydroelectricity generation towards pollution in malaysia, indonesia and thailand. *International Journal of Energy Economics and Policy*, *10*(1), 215–227. https://doi.org/10.32479/ijeep.8140

Shaari, M. S., Lee, W. C., Ridzuan, A. R., Lau, E., & Masnan, F. (2022). The impacts of energy consumption by sector and foreign direct investment on CO2 emissions in Malaysia. *Sustainability*, *14*(23), 16028. https://doi.org/10.3390/su142316028

Thayaparan, A. (2014), Impact of inflation and economic growth on unemployment in Sri Lanka: A study of time series analysis. *Global Journal of Management and Business Research*, 13(5), 45-53.

Voumik, L. C., Islam, M. A., Ray, S., Yusoff, N. Y. M., & Ridzuan, A. R. (2023). CO2 Emissions from Renewable and Non-Renewable Electricity Generation Sources in the G7 Countries: Static and Dynamic Panel Assessment. *Energies*, *16*(3), 1044. https://doi.org/10.3390/en16031044

World Development Indicators. (2022), Data Series by the World Bank Group. Washington, DC, USA: The World Bank. Available from: https://www.databank.worldbank.org/source/world-development- indicators