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Examining the relationship of inflation, gross domestic product, oil price, foreign direct investment, and trade openness on unemployment in Saudi Arabia

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The study examines the correlation between oil price, foreign direct investment (FDI), trade openness and real gross domestic product (GDP) with the unemployment rate in Saudi Arabia for the period 2016–2023. The study used EViews and excel for the data analysis; and employed Autoregressive Distributed Lag (ARDL) model for the extraction of results. The findings show that oil price FDI, trade openness, inflation and real GDP have significant negative correlation with unemployment rate, and any changes in these factors affect unemployment rate in the long term, with the coefficient -0.063 , -1.630 , -2.061 , -3.170 , and -0.353 , standard error 0.097 , 0.333 , 0.716 , 0.426 , and 0.080 and t-statistics -6.507 , -4.900 , -2.877 , -7.449 , and -4.387 respectively. The results indicate that beside oil prices, there are other macroeconomic factors that also influence the unemployment rate, and show the importance of diversification of economy and reducing the reliance on oil. The findings have valuable insights for the economists and policymakers of Saudi Arabia and for other countries which mostly rely on oil exports.

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Introduction

Unemployment is one of the top issues of today's world (International Labor Organization, 2024), and almost all nations whether oil-producing or not, are facing this challenge (Report, 2024). The issue is higher in developing countries than the developed ones (Raifu et al., 2024). Middle Eastern and African countries despite of oil production still experience high unemployment rate (Report, 2024). It is evident that the inability of these nations to utilize labor has resulted in unemployment growth. This has led to a decrease in household incomes, an increase in poverty rates, and unemployment (Mahmud and Tohop, 2023). The findings of many other studies show that the increase in the unemployment rate is closely linked with the government policies (Chletsos and Sintos, 2023; Akinyele et al., 2023). Many countries fail to consider the necessary factors during policy making, leads to higher unemployment rate despite having various resources etc. (Janoski, 2024). Unemployment not only have financial consequences (Shesha, 2023) but have also political (Uddin and Rahman, 2023), social, psychological repercussions (Ani et al., 2024).

This study is focused on unemployment challenge in Saudi Arabia, which is one of the major oil exporters of world. It is one of the developing countries having the largest economy in Gulf Cooperation Council (GCC) (OPEC, 2023). The multifaceted issue of unemployment in Saudi Arabia has attracted many researchers to investigate the factors contributing to it. In 2020, the unemployment rate in Saudi Arabia reached 9% in the second quarter of 2020 (Economics, 2020). Reduction of unemployment rate is also one of the goals of Saudi Vision 2033 (ARABIA, 2016). In its Vision 2023, Saudi Arabia seeks to reduce unemployment, obtain foreign investment, etc., and reduce its dependence on oil and find out other opportunities for its economy. Although there are many macroeconomic factors that have relationships with unemployment rates (Hegelund and Taalbi, 2023), this study considers oil prices, FDI, inflation, GDP, and trade openness as the main macroeconomic factors for unemployment, and investigates their relationship with employment rate in the context of Saudi Arabia. The study is also aligned with Saudi Vision 2030 and with the advancement of United Nation's sustainable development goals (SDGs), having its stress on lowering unemployment, and diversification of economy.

Trade openness has also an important role in employment rate. Researchers are divided in the positive and negative influence of trade openness on employment rate (Alkhateeb et al., 2017). It also brings challenges for local industries to compete with products from foreign firms and sometimes leads to job loss (Fankem and Feyom, 2024). In the case of Saudi Arabia, the economy is majorly dependent on the export of oil and global trade dynamics play a significant role in its economy. Low trade openness in non-oil sectors limit employment to oil sector (Alkhateeb et al., 2017). To tackle this issue, Saudi Vision 2030 aims to develop non-oil sectors to enhance trade with foreign countries and increase employment.

Similarly, Various studies have highlighted the influence of oil prices on unemployment rate (Shesha, 2023). For decades, Saudi Arabia oil has been the most prominent source of revenue, it has made its labor market vulnerable to the variations of oil prices. For example, it obtains higher revenues when the prices are high, leading to more projects in infrastructure and creation of jobs in public sector which is the primary source of employment for Saudi Arabians (Alfalih, 2024). It is also evident from the oil prices in 2020, which has witnessed the highest employment rate of 9% (Economics, 2020). Further it also influences the country GDP, as it gets a significant amount of wealth from oil export which also influence unemployment rate (Rumzi Tausif et al., 2023).

Furthermore, it is evident from many researches that inflation also leads to unemployment (Uddin and Rahman, 2023). This is also the case in Saudi Arabia. Recent fiscal reforms have put inflationary pressure due to value-added tax and cuts in subsidies. Although critical for fiscal sustainability, these reforms increase living cost and diminishes purchasing power, that reduce the domestic consumption and sale. Subsequently, influence the labor demand and unemployment rate (Sfakianakis, 2024).

In addition, many studies have also explored the relationship between FDI and unemployment rate (Stepanok, 2023). Findings of researches show that FDI influences the economy positively, reduces employment rate, and create new business opportunities (Alabi, 2019). Although, it has some critic also, believing that it increases the reliance and dependency of the host country on the donor ones and does not reduce unemployment (Wimberley, 1990). Saudi Arabia has witnessed an increase in FDI since 2020 after the COVID-19 crisis and is working to increase it further through new industries, businesses and infrastructure development (Albassam, 2015). Researches show that macroeconomic factors like oil prices (Adeosun et al., 2023), FDI (Alkofahi, 2020), GDP (Shiferaw, 2023), and trade openness (Bhat and Beg, 2023) have correlation with unemployment rate. But as there are many other factors involved, it may be different for other countries. Therefore, it is difficult to generalized these factors for a specific country. The policies, data types and time, and models may get different results. Therefore, there is a need to continuously examine the relationships of these factors with unemployment rate at different time. Like in any other country, the unemployment rate in Saudi Arabia is also a complicated challenge shaped by many factors like oil prices, oil dependency for GDP growth, low non-oil trade, inflation, and FDI. Addressing these issues is also the core of Saudi Vision 2030, which seeks not only to promote the non-oil sector but also to diversify the economy, to enhance the private sector, and to increase the employment of Saudi Nationals. The aim of the study is:

1. To investigate the relationships of oil price, FDI, GDP, inflation, and trade openness with unemployment rate during 2016–2023.
The study has the following research questions.
2. How oil price, FDI, GDP, inflation, and trade openness impact the unemployment during 2016–2023?

The study provides theoretical understanding and statistical insights regarding the factors which influence the unemployment rate. It also advances the existing theories regarding unemployment and economic activities, filling the gap to consider other factors as well according to dynamics of a specific country. Further, it also provides empirical insights for the government of Saudi Arabia, and policymakers to enhance the necessary factors such as the development of non-oil sectors for enhancing employment. Part 1 includes the introduction/background, Part 2 includes the development of theoretical framework, Part 3 includes the literature review for each variable, Part 4 includes the analysis and Part 5 presents the conclusion of the study.

Development of theoretical framework

Researches have investigated factors that have a relationship with unemployment rate. This literature review includes the review of macroeconomic factors like oil price, inflation, trade openness, GDP, and FDI and their influence on unemployment rate in the context of Saudi Arabia. In addition, it also includes the theories used for the development of theoretical framework. Figure 1 shows the summery of statistics from 2016 to 2024 for all variables.

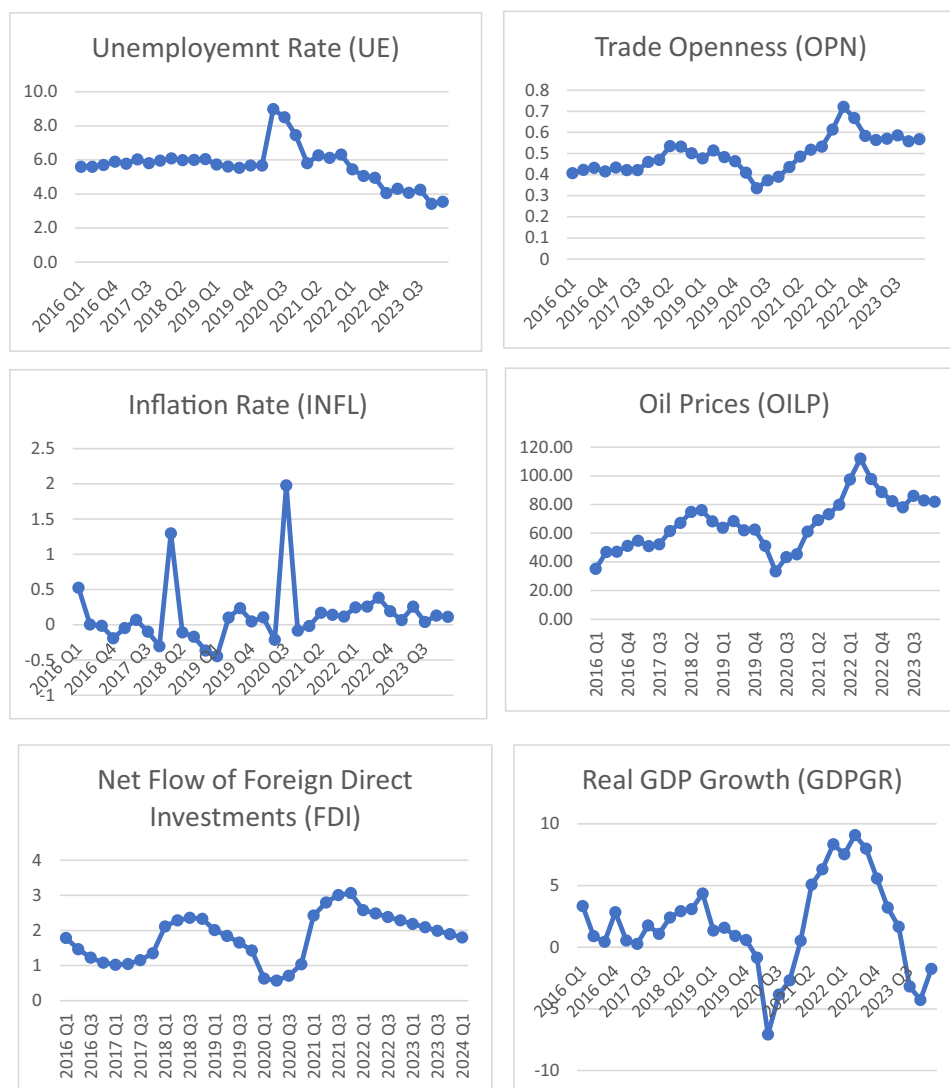


Fig. 1 Summary of oil price, inflation, trade openness, GDP, and FDI and unemployment rate in Saudi Arabia from 2016 to 2024.

Oil prices and unemployment rate. In Saudi Arabia, oil is one of the major sources of revenue, and the country is highly dependent on the production and export of oil. Being a significant factor for the country's economy, it has an important role in increasing or decreasing employment. Oil is also contributing substantially to the country's GDP (Almutairi, 2023). Generally, the relationship between oil price and unemployment rate is different for different countries. For example, the oil-producing and exporting countries will benefit more from the increase in oil price, whereas oil importing nations will consume less oil if the prices are high (Doğrul and Soytaş, 2010). In other words, increase in oil price will positively influence the employment in oil-producing countries and negatively in oil importing countries (Thuy Tien, 2022). This shows that oil price is directly linked with economic growth, unemployment rate etc. Research shows that increase in oil price increase government revenue, economic growth, and employment opportunities. This enables the country to invest more in projects and reduces joblessness (Al Naimi, 2022). Conversely, when oil price decline, the country's revenue also declines, leading to low investment and expenditures and high unemployment rate. Due to different geography, oil production capacity and other factors, researches indicate that the association of oil price with unemployment rate is not universal but differs from country to country (Ahmed et al., 2023). Through Saudi Vision 2030,

Saudi Arabia aims to minimize its dependence on oil and extend the economic activities to other sectors, that will influence the traditional relationship between oil price and unemployment rate (Moshashai et al., 2020; Derendinger et al., 2023). However, this shift is not simple, and it might not decrease the impact of oil price on employment instantly. Furthermore, studies have also found out that fluctuations in oil price also have negative impact on employment (Kisswani, 2019). This is also evident from the recent COVID-19 era, that due to a significant fall in oil price the unemployment rate was increased which not only highlight the vulnerability of Saudi Arabia labor market but also its higher dependency on oil price (Samargandi, 2023). In the context of this study, oil price and unemployment rate are closely correlated. If the oil price increase, the unemployment rate decreases. This is due to the country's high reliance on oil export, and oil sector being the biggest sector of employment for Saudi nationals. Based on this review, the following hypothesis is proposed.

H₁: Oil prices has negative relationship with unemployment rate.

Foreign direct investment and unemployment rate. FDI is defined as "is a category of cross-border investment in which an investor resident in one economy establishes a lasting interest in and a significant degree of influence over an enterprise resident in

another economy” (OECD, 2009). Many studies believe that it is one of significant source of development, economic growth and employment opportunities (Strat and Davidescu, 2025). The correlation between FDI and unemployment rate, especially in developing nations has been a hot topic for many economists and academic researchers. The relationship was investigated by many studies and concluded mixed results (Irpan et al., 2016; Johnny and Timipere, 2018). Generally, FDI is one of the main macro-economic factors for employment. It brings technology and capital that not only increase the existing productivity (Yin et al., 2023) but also establishes new business and industries. Similarly, it also brings expertise and advanced business practices that boost economy and creates jobs. It is evident from the findings of many researches that FDI significantly increase employment by improving economic growth in various countries (Khan et al., 2023). For example, in Ghana and African countries, FDI has reduced unemployment (Saani et al., 2023; Liu et al., 2024). Similar results have also provided by researches in other countries. Conversely, many researches show that FDI has negative consequences for the host nations, and it overtake the resources and businesses of the host country. It also makes the market competitive for the local job seekers and further increase unemployment rate by eliminating the local less advanced industries (Forte and Abreu, 2022). Furthermore, it makes the host country more dependent on FDI firms, and reduces its efforts and abilities for developing its own economic and development plans. Although there are contradictory findings regarding the influence of FDI of employment, it is still a major source of economic growth for developing countries. Its role should not be ignored due to its negative influence on local economy due to specific geographical etc., factors on some countries (Dao et al., 2023) (Obeng-Amponsah and Owusu, 2023).

Researches on Saudi Arabia show both positive and negative impact on the creation of employment (Albassam, 2015). For example, one study shows that FDI increase job opportunities and positively influenced GDP growth. In the context of Saudi Arabia, FDI is not only necessary for the creation of employment opportunities but also for the diversification of its economy, and reduction of its dependency (Derendinger et al., 2023). It has the potential to establish non-oil industries and might be a significant driver of employment rate and economic growth. It can be said that the FDI is necessary for the creation of employment opportunities, especially in developing countries. However, in some cases it further increases the issue. These contradictory results clarify the importance of other factors, like the policy, geography, political environment, stability etc., for the role of FDI and employment ratio. As in case of western countries, FDI has positively influenced the employment and contributed to economic growth. The study proposes the following hypothesis to be true.

H₂: Foreign Direct Investment has a negative relationship with unemployment ratio.

Trade openness and unemployment rate. Trade has been perceived as a major macroeconomic factor necessary for boosting the economy of a country. Due to this significance, nations especially the developing, make trade friendly policies to reduce barriers and enhance trade with other countries (Hasan and Mitra, 2012). Studies shows that trade influences economic growth and create opportunities for employment. Researches conducted in developed nations on the relationship of trade openness and unemployment rate show that unemployment was reduced due to increase in trade openness, due to its positive role in economic growth coming from trade liberalization (Alauddin and Khan, 2021). On the other hand, in developing nations,

studies also indicate the negative impact of trade openness in employment (Ademola and Abdulsalam, 2016). In such countries, it becomes very difficult for the vulnerable groups or businesses to compete and adequately adjust to globalization (Kim, 2011). This shows that the relationship between trade openness and unemployment rate significantly varies with the conditions of labor market and the nature of labor and trade policies (Nwaka and Uma, 2015). Research shows that trade openness is negatively related to UR in Saudi Arabia and has the potential to produce job opportunities in future as well (Alkhateeb et al., 2017). Currently, its economy is mainly relying on the oil export and it is making policies to liberalize trade and diversify economic sources and opportunities. Its participation in GCC and the Greater Arab Free Trade Area has boosted trade and minimized unemployment (El Amine, 2023).

In summary, trade openness has both positive and negative influence on employment. It increases the competition in local markets and hence attract more investments for the development of local industries to compete with imported goods and products. Thus, providing employment opportunities and significantly boost economy. In some countries and markets, it becomes difficult and challenges for the local products to compete with high quality and sometimes at fair prices and hence reduces the consumption of local products. This reduces the local production and leads to an increase in employment. The study considers the positive role of trade openness and proposes the following hypothesis.

H₃: Trade Openness has a negative relationship with unemployment rate.

GDP and unemployment rate. GDP growth is one of the important macroeconomic factors, and has been studied extensively by researchers. The relationship between GDP and unemployment rate was primarily based on the findings of Okun’s law, which suggests that 1% increase in GDP will reduce the unemployment by about 0.5% (Porrás-Arena and Martín-Román, 2023). Many studies show that GDP and employment are positively correlated, and an increase in GDP increases employment (Khalid, 2021). Similar results were also shown by researchers in the context of Middle Eastern and North African countries (Lopez-Acevedo, 2023). Similarly, studies also verify the negative correlation amongst GDP and unemployment rate in Jordan, 0.32% decrease occurred due to 1% increase in GDP (Khazaleh, 2024). Researches on Eastern European and Nigeria also validate the relationship between GDP and unemployment as suggested by Okun’s law (Uddin and Rahman, 2023). Interestingly, some researches have different findings (Khan et al., 2023). Their findings indicate that the relationship between GDP and unemployment rate also varies significantly across different countries over time, their economic conditions, geography and labor market. In Saudi Arabia, GDP and unemployment rate are correlated according to the fundamental macroeconomic concept of negative correlation; but national factors including its dependence on oil, the structure of the labor market, and economic reforms have an influence on it (Alfalih, 2024). It’s Vision 2030 seeks to minimize its reliance on oil by diversification of the economy to non-oil sectors and by increasing job opportunities for Saudi citizens (Alemahu, 2023). Recognizing these complications is critical in formulating strategies that efficiently boost the economy and lessen unemployment. This review shows that GDP and unemployment rate are negatively related, although there are some exceptions. This study proposes the following hypothesis to be true.

H₄: GDP has a negative relationship with UR

Inflation and unemployment rate. Inflation is the rate of increase in prices over a given period of time. Inflation is typically a broad measure, such as the overall increase in prices or the increase in the cost of living in a country (Oner, 2010). The connection of inflation and unemployment rate has been a core topic for economic researchers since long. In 1958, Phillip suggested that the inflation and unemployment rate are inversely proportional to each other, indicating that increase in inflation will decrease unemployment rate (Phelps, 1967). This was perhaps due to the high employment need from job seekers due to inflation. However, in 1970s, there was a high inflation and high unemployment rate which could not explain by Phillips Curve. This give the emergence of another theory by Milton Friedman and Edmund Phelps. They introduced the natural rate concept of unemployment rate, and suggested that there is no relationship between the inflation and unemployment rate, and any attempts for the reduction of unemployment rate below the natural rate will increase inflation and will bring no decrease in unemployment rate (Dimand, 2008). Studies show different findings for both the theories regarding inflation and unemployment rate, indicating that in some context Phillips Curve is correct while in other the Milton Friedman and Edmund Phelps theory is correct due to the different economic conditions (Lipsey, 2016) (Hall, Sargent, 2018). Other factors like labor market, globalization technological advancements etc., all have influence on the relationship of inflation and employment (Bliznina, 2024) (Zaman et al., 2024). Researches shows that inflation and unemployment rate are related according to Phillips curve in Saudi Arabia (Bonatti et al., 2022). Other studies also show that other factors like exchange rate, import/export, oil prices etc. have also impact on the relationship. Therefore, in 2020 crisis, the economic growth of Saudi Arabia was not much affected (Cutler and Summers, 2020). This study is going to investigate the relationship between inflation and unemployment rate in Saudi Arabia by assuming the following hypothesis.

H₄: Inflation has a positive relationship with unemployment rate

Theoretical mechanism. This research is based on Wealth Effect Theory (WET), Dependency Theory (DT), Pro-Foreign Direct Investment School, and Heckscher-Ohlin Theory (HOT). It is very difficult for a single theory to provide understandings for the relationships among these variables, and each theory focuses on a specific variable and mechanism that have an influence on unemployment. These theories provide the foundation for studying the complex relationships among FDI, oil prices, trade openness, GDP, inflation, and unemployment rate.

Wealth effect theory. According to the WET, rising household wealth increases consumption, which increases the demand for services and goods leading to more employment opportunities (Darby, 1987). In the context of this study, trade openness increases access to more affordable goods, and increasing consumption through increasing the purchasing power. It boosts the demand and produces more employment. But if the local industries offer expensive products in comparison to imported products, it will further increase unemployment rate. Similarly, FDI brings new technologies and businesses, thus creating more job opportunities (Sun et al., 2022). Conversely, inflation depletes actual wealth by lowering investment and consumption, which could result in increased unemployment. Oil prices have an influence on wealth since they raise the cost of energy. Lower oil prices increase production and increase employment, while higher prices discourage consumption and cause unemployment (El-Awady et al., 2020). But in case of Saudi Arabia, it is not so

simple as the country's main GDP is dependent on oil. Growth in GDP shows an increase in national income, and usually results in the creation of jobs (Javid et al., 2022).

Pro-foreign direct investment school. The Pro-FDI School believes that FDI as a core driver of employment. Trade openness is one of the main factors for attracting FDI, that creating employment through expansion of production, and increasing labor demand in host country through competition (Grieco, 1986). Similarly, stable inflation is necessary for FDI. High inflation causes unemployment due to low FDI and uncertainty. In addition, higher oil price may attract FDI, especially to the energy and oil sectors leading to job creation as in case of Saudi Arabia. Growth in GDP also attracts FDI which expands industries, increases production capacity, etc. (Singh and Jyoti, 2023), and leads to more job opportunities.

Dependency theory. The DT provides critical insights regarding trade openness and FDI. According to DT, in developing nations (Javid et al., 2022). Trade openness may leads to further unemployment especially in industries where there is high competition (Aman et al., 2022). It increases dependency on imported goods from advanced or developed nations and negatively impact the employment in domestic industries (Hamdi and Hakimi, 2022). Similarly, FDI often extracts the resources of the host countries, repatriates most of the profits and gives them a low share in profits, and leads to low employment (Yang et al., 2022). Moreover, inflation and dependency on imports destabilize the country's economy, while lowering purchasing power and raising reliance on FDI. In addition, FDI and trade openness destabilize the GDP growth of the host country and make it more dependent on foreign entities, leading to unemployment in the long run (Bradshaw et al., 2019).

Heckscher-Ohlin theory. The HOT focuses on factors like capital, labor and resources and believes that these determinants influence trade and employment (Blaug, 1992). According to this theory, trade openness lessens unemployment in areas where the country uses its abundant factor. For example, Saudi Arabia is an oil-abundant country and its oil trade will increase employment in the sector (Deryag and Khalifa, 2024). If FDI goes into sectors using abundant factors, it can help lower unemployment by channeling job seekers toward those industries. FDI in capital-intensive sectors, however, may result unemployment in economies with an abundance of labor. By driving up prices, inflation may skew the advantages of trade and FDI, which could lead to a rise in unemployment.

This dynamic is influenced by oil price; in oil-producing countries like Saudi Arabia, rising prices may increase employment in resource-related sectors, whereas in nations that import oil, rising oil price may increase unemployment (Almasria et al., 2024). This theoretical mechanism shows that WET, DT, Pro-FDI School, and HOT offer different understandings and perspectives on the relationship of trade openness, FDI, inflation, oil price, and GDP with unemployment. The integration of all these theories leads the research to the development of a theoretical framework as shown in Fig. 2 and hypotheses.

Research methodology

The study investigates the connection between oil prices, trade openness, inflation, FDI, GDP growth, and the unemployment rate. This study uses Auto Regressive Distributed Lagged Model (ARDL) to find out whether there is a long-run relationship between the variables. The model was introduced and popularized by Pearson (Pesaran, 1997). Relative to other techniques of

Table 1 Data source and description.

Variables	Description	Data Source
Unemployment rate (UE)	It is the percentage of the unemployed who are actively seeking employment and can work.	World Bank (Bank, 2024)
Oil price (OILP)	OPEC Basket price, composed of the averaged prices of various petroleum blends produced by OPEC countries, is used to set the price of OPEC crude oil.	(Macrotrends, 2024)
Trade openness (OPN)	The total of the products and services that are imported and exported is expressed as a percentage of GDP.	General Authority of Statistics (Statistics, 2024)
Inflation (INFL)	Captures the quarterly percentage change in the cost of acquiring particular goods and services, as assessed by the consumer price index. This set of products and services may undergo revisions or stay the same every year or more.	General Authority of Statistics (Statistics, 2024)
Net Foreign Direct Investment as a percentage of GDP (FDI)	Foreign direct investment (FDI) includes shareholder funds, internal company loans, and profits reinvested. This measure is a net flow of FDI as a percent of real GDP.	General Authority of Statistics (Statistics, 2024)
Gross domestic product (GDPGR) growth rate	A chain-linked Q-o-Q growth rate of real gross domestic product. The base year period was taken as 2018=100.	General Authority of Statistics (Statistics, 2024)

cointegration, ARDL has several advantages. First, in contrast to other cointegration techniques, ARDL does not necessitate all the variables to be integrated in a similar order. That is ARDL approach can be used whether the regressors are integrated of order one i.e., $I(1)$, order zero $I(0)$, or fractionally integrated. Second, ARDL is applicable even for small sample sizes, while other cointegration techniques are sensitive to the sample size. Third, even in the presence of endogenous regressors, ARDL gives unbiased estimates of the long-run model and valid t-statistics (Harris and Sollis, 2003). Fourth, after the appropriate selection of lag length, ARDL allows us to apply a simple Ordinary Least Square (OLS) method in order to obtain estimates. A quarterly frequency data for Saudi Arabia over the period 2016–2024 was taken from various sources. The data for unemployment rate was obtained from (Bank, 2024), for oil prices from (Macrotrends, 2024), trade openness, inflation, FDI, and GDP growth from (Statistics Saudi Arabia, 2024) as shown in Table 1 with the description of each variable. EVIEWS and Excel are used for data analysis.

Model specification. To explore the intricate relationship between oil prices, trade openness, inflation, foreign direct investments, GDP growth, and unemployment rate, this study employs the following generalized model.

$$UE_t = f(OILP_t, OPN_t, INFL_t, GDPGR_t, FDI_t) \quad (1)$$

Where: UE represents the unemployment rate, OILP represents oil prices per barrel, OPN is the sum of total export and import of goods and services as a percent of GDP, also known as trade openness, INFL measures the percentage change in consumer price index (CPI), GDPGR stands for Q-o-Q growth rate in real GDP and FDI is the net flow of foreign direct investment as a percent of GDP.

Specifically, the following model is used to obtain the long-run coefficients.

$$UE_t = \beta_0 + \beta_1 OILP_t + \beta_2 OPN_t + \beta_3 INFL_t + \beta_4 GDPGR_t + \beta_5 FDI_t + \varepsilon_t \quad (2)$$

Where: ε_t is the white noise error term.

Diagnostic tests. The study uses some necessary diagnostic tests for the variables to avoid certain unnecessary factors affecting the analysis. The tests include Cumulative Sum (CUSUM) and Cumulative Sum (CUSUM) of squares. CUSUM captures any

systematic change in the coefficients of regression, whereas, CUSUM of squares deals with a sudden change in them. Harvey and Breusch-Godfrey tests are used to trace Heteroscedasticity and Serial Correlation respectively. Furthermore, Jarque-Bera is used to test for normality.

Econometric methodology. To trace the presence of long-run relationships among the variables outlined earlier in Eqs. 1 and 2, this study employs the ARDL model. This model takes the lagged values of the dependent variable among the explanatory variables (the Auto Regressive part) and also the lagged values of the independent variables (the Distributed Lagged part). To perform this methodology, the first step is to determine the order of integration of the variables. ARDL is used when all the variables are integrated of either order two or one. This model has this advantage over the Johansen Cointegration technique in that the Johansen Cointegration technique is valid only when all the variables are integrated into order one. The Augmented Dickey-Fuller (ADF) unit root test was employed to determine the order of integration. ADF breakpoint unit root test was also brought into use because it can adjust for any structural breaks in the data. The next step is to perform the bound test to confirm cointegration and get the long-run coefficients. Finally, the Error Correction Mechanism (ECM) was used to get the short-run coefficients and determine the speed of adjustment to the long-run equilibrium.

The ARDL model for the variables under study can be represented as follows.

$$\begin{aligned} \Delta UE_t = & \alpha_0 + \sum_{i=1}^p \phi_1 \Delta UE_{t-i} + \sum_{i=0}^p \phi_1 \Delta OILP_{t-i} \\ & + \sum_{i=0}^p \phi_2 \Delta OPN_{t-i} + \sum_{i=0}^p \phi_3 \Delta INFL_{t-i} \\ & + \sum_{i=0}^p \phi_4 \Delta GDPGR_{t-i} + \sum_{i=0}^p \phi_5 \Delta FDI_{t-i} \\ & + \lambda_1 UE_{t-1} + \lambda_2 OILP_{t-1} + \lambda_3 OPN_{t-1} \\ & + \lambda_4 INFL_{t-1} + \lambda_5 GDPGR_{t-1} \\ & + \lambda_6 FDI_{t-1} + \varepsilon_t \quad t = 1, 2, \dots, T \end{aligned} \quad (3)$$

The bound testing will signify the long relationship among the variables based on the Wald (F-test). If the value of the F-stat is greater than the upper bound value, it will suggest the existence of a long-run relationship between the variables. The value of the F-stat to lie between the lower bound value or below the lower bound value will be the evidence of inconsistent or no long-run relationship, respectively. The null hypothesis for no

cointegration that the F-test tests is:

$$H_0 : \lambda_1 = \lambda_2 = \lambda_3 = \lambda_4 = \lambda_5 = \lambda_6 = 0 \quad (4)$$

$$H_1 : \lambda_1 \neq 0; \lambda_2 \neq 0; \lambda_3 \neq 0; \lambda_4 \neq 0; \lambda_5 \neq 0; \lambda_6 \neq 0 \quad (5)$$

In Eq. 3, the coefficients of the variables with the Greek letter Δ (the difference operator) capture the short-run impact whereas, from λ_2 through λ_6 capture the long-run impact on the unemployment rate.

The Error Correction form that captures the immediate impact of explanatory variables along with the speed of adjustment is represented as follows.

$$\begin{aligned} \Delta UE_t = & \alpha_0 + \sum_{i=1}^p \phi_1 \Delta UE_{t-i} + \sum_{i=0}^p \phi_1 \Delta OILP_{t-i} \\ & + \sum_{i=0}^p \phi_2 \Delta OPN_{t-i} + \sum_{i=0}^p \phi_3 \Delta INFL_{t-i} \\ & + \sum_{i=0}^p \phi_4 \Delta GDPGR_{t-i} + \sum_{i=0}^p \phi_5 \Delta FDI_{t-i} \\ & + \delta ECM_{t-1} + \varepsilon_t \end{aligned} \quad (6)$$

Where the coefficients ϕ_1 through ϕ_5 show the immediate impact of the variable under study on the unemployment rate and the coefficient δ represents the speed of adjustment towards long-run equilibrium.

Descriptive statistics. Table 2 presents the descriptive statistics of all the variables under study. The average quarterly unemployment rate remains 5.67% over the period 2016Q1-2024Q1. According to the results, openness has the lowest coefficient of variation. Inflation has the highest coefficient of variation 3.32 after real GDP growth that is 2.07. This means inflation is the most variable-dependent among all the variables.

Unit root test. The first step in performing a cointegration test is to determine the order of integration. This can be performed using a unit root test (Kočenda and Alexandr, 2014). This is to ensure that the data used in the time series analysis is stationary (Khamis et al., 2018). Variables with constant mean, variance, and covariance should be included in the regression model.

Table 2 Descriptive statistics.

Description	UE	OPN	OILP	INFL	GDPGR	FDI
Mean	5.67	0.49	66.88	0.13	1.82	1.82
Median	5.70	0.48	67.16	0.07	1.57	1.90
Maximum	9.00	0.72	111.99	1.98	9.10	3.06
Minimum	3.40	0.34	33.38	-0.44	-7.07	0.57
Std. Dev.	1.17	0.09	18.65	0.45	3.76	0.68
Skewness	0.59	0.55	0.29	2.61	-0.07	-0.14
Kurtosis	4.58	3.01	2.63	11.00	2.89	2.10
Coefficient of Variation	0.21	0.18	0.28	3.32	2.07	0.37

Augmented Dicky Fuller (ADF) test was used to determine the order of integration. Moreover, we also use the ADF breakpoint test to account for any structural breaks in the data. The later test is performed because sometimes the ordinary unit root tests show the data nonstationary, but due to structural breaks in the data, it is actually stationary. Results of both the unit root tests are presented in Tables 3 and 4, respectively.

The ADF test results in Table 3 indicate a mixed order of integration. UE, OPN, and OILP are stationary at 1st difference i.e., they are integrated of order one [I(1)], whereas, INFL, GDPGR, and FDI are stationary at level i.e., they are I(0) (Soummame et al., 2022). Based on these results the study step forward to perform the ARDL analysis. However, we perform the ADF breakpoint unit root test that shows a different picture.

Table 4 presents the results of breakpoint augmented dicky Fuller unit root test results. The test is performed using only the intercept and both the intercept and the trend. The variables show different structural breaks, e.g., UE, GDPGR, and INFL are showing 2020Q1 and 2020Q2. This was the period of the COVID-19 pandemic when the unemployment rate and inflation rates rose to record-high levels and real GDP growth was negative. The results illustrate that all the variables except for UE with only intercept is I(1), however, it is I(0) with both intercept and trend. The cointegration analysis was done using Johansen and Juselius cointegration technique. Based on the results of both Table 3 and Table 4, both ARDL and Johansen and Juselius cointegration techniques were used to confirm the existence of the long-run relationship (Halim et al., 2023).

Cointegration tests. ARDL bound testing is used to indicate the existence of a long-run relationship. Schwarz information criterion was used to select an appropriate lag length. The test generates an F-statistic to be compared with its upper and lower-bound critical values. As discussed earlier, if the F-stat value exceeds its upper bound critical value, a long-run relationship exists. Existing between lower and upper bounds indicates inconsistent results, whereas, if it lies below the lower bound critical value then there is no cointegration. Results in Table 5 indicate that the F-stat value of 12.79 exceeds the upper bound critical value of 3.38, hence we fail to accept the null hypothesis of no-cointegration. Therefore, the table shows that there exists a long-run relationship between the unemployment rate and the explanatory variable.

Johansen and Juselius tests were performed to further confirm the existence of cointegration. Johansen and Juselius technique tests two statistics, namely, Trace Statistic and Maximum-Eigen Statistic. If the Trace statistic and Maximum-Eigen Statistic exceed their respective critical value at a 5% level of significance, then cointegration exists (Johansen, 1991). Table 6 and Table 7 present the results of Johansen and Juselius technique both with trace and

Table 3 Augmented Dicky Fuller (ADF) unit root test results.

Variable	Level				First Difference			
	With Intercept		With Intercept and Trend		With Intercept		With Intercept and Trend	
	t-Stat	P-Value	t-Stat	P-Value	t-Stat	P-Value	t-Stat	P-Value
UE	-1.39	0.5756	-1.90	0.6302	-5.56	0.0001	-5.63	0.0004
OPN	-1.93	0.3107	-2.60	0.2825	-3.98	0.0045	-3.91	0.0237
INFL	-6.53	0.0000	-6.64	0.0000	-	-	-	-
GDPGR	-2.74	0.0797	-3.90	0.0248	-	-	-	-
OILP	-1.81	0.3699	-2.41	0.3694	-4.20	0.0026	-4.24	0.0138
FDI	-2.80	0.0692	-3.67	0.0404	-	-	-	-

Table 4 Breakpoint Augmented Dicky Fuller (ADF) unit root test results.

Variable	Level						First Difference		
	With Intercept			With Intercept and Trend			With Intercept		
	t-Stat	Break-Date	P-Value	t-Stat	Break-Date	P-Value	t-Stat	Break-Date	P-Value
UE	-3.28	2020Q1	0.8109	-15.82	2020Q1	<0.01	-11.67	2020Q2	<0.01
OPN	-4.79	2023Q2	0.0600	-5.27	2023Q2	0.0390	-	-	-
INFL	-8.31	2020Q2	<0.01	-7.98	2020Q2	<0.01	-	-	-
GDPGR	-4.75	2020Q1	0.0682	-6.02	2020Q1	<0.01	-	-	-
OILP	-4.87	2023Q3	0.0491	-6.18	2022Q4	<0.01	-	-	-
FDI	-4.32	2019Q4	0.201	-4.99	2019Q4	0.0785	-	-	-

Table 5 ARDL bound testing outcome.

Linear Model	F-stat	Lower bound (5%)	Upper bound (5%)	Conclusion
	12.79 ^a	2.39	3.38	Co-integration

^aRepresents significance at a 5% level of significance.**Table 6 Johansen and Juselius Cointegration (Trace).**

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob. ^a
None ^a	0.900	170.604	103.847	0.0000
At most 1 ^a	0.714	101.359	76.973	0.0002
At most 2 ^a	0.627	63.624	54.079	0.0056
At most 3	0.483	33.328	35.193	0.0784

^aRepresents significance at a 5% level of significance.**Table 7 Short-run coefficients, ARDL estimates.**

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	38.312	2.238	17.120	0.003
D(UE(-1))	-0.394	0.060	-6.535	0.023
D(OPN)	3.535	0.363	9.738	0.010
D(OPN(-1))	9.077	0.635	14.294	0.005
D(OILP)	-0.257	0.020	-12.594	0.006
D(OILP(-1))	-0.313	0.023	-13.816	0.005
D(INFL)	2.001	0.136	14.754	0.005
D(INFL(-1))	-2.162	0.182	-11.894	0.007
D(GDPGR)	-0.230	0.019	-12.259	0.007
D(GDPGR(-1))	-0.514	0.037	-13.946	0.005
D(FDI)	0.600	0.115	5.196	0.035
D(FDI(-1))	-1.924	0.146	-13.187	0.006
ECT(-1)*	-0.663	0.097	-6.835	0.021

Table 8 Long-run coefficients, ARDL estimates.

Variable	Coefficient	Std. Error	t-Statistic
OPN	-2.061*	0.716	-2.877
OILP	-0.063***	0.097	-6.507
INFL	-3.170***	0.426	-7.449
GDPGR	-0.353**	0.080	-4.387
FDI	-1.630**	0.333	-4.900

*, **, and *** represent significance at 10%, 5% and 1% levels, respectively.

Table 9 Stability and diagnostic test results.

R-squared	0.85
F-statistic	9.81
Breuch-Godfrey (test of serial correlation)	$\chi^2 = 3.17$
Harvey (heteroskedasticity test)	$\chi^2 = 9.94$
Jarque-Bera (normality test)	1.68
Ramsey RESET Test	3.522746

maximum-eigen statistics. The results in both tables suggest the existence of three cointegrating equations.

Short-run Impact. Table 7 illustrates the short-run coefficients estimated after taking the error correction form of ARDL model. In the error correction form, the term ECT (-1) must be negative and statistically significant to prove the existence of convergence towards long-run equilibrium significantly. Here, in the case of Saudi Arabia, the value of ECT (-1) is -0.663 and statistically significant at a 5% level of significance. This value indicates the quarterly rate of convergence toward the long-run equilibrium. This scenario suggests that 66.3% of the error in the model is eliminated each quarter to reach the equilibrium state.

These results clearly indicate the existence of a significant short-run association between UE and its lagged value. On the other hand, most of the explanatory variables under study have a negative and significant impact on the unemployment rate in the short run. Surprisingly, trade openness considerably increases the unemployment rate in the short run in the case of Saudi Arabia.

Long-term effects. Table 8 presents the explanatory variable's long-run impact on Saudi Arabia's unemployment rate. Results show that all the explanatory variables that are, trade openness, oil prices, inflation rate, GDP growth rate, and foreign direct investments tend to reduce unemployment in the long run (Wang et al., 2022). The reason for FDI to cut down the unemployment rate would be the direct result of multinational firms providing job opportunities to the locals. Oil prices may have several reasons to cause a drop in the unemployment rate. Saudi Arabia is one of the largest oil-producing and exporting economies and it heavily depends on oil exports. Higher oil prices mean more revenue for the government and oil companies, boosting the overall economy (Wang and Vladyslav, 2020). This economic growth leads to the creation of more jobs in companies directly and indirectly in other sectors. Trade openness, on the other hand, has the advantage of boosting foreign exchange reserves, knowledge and skill transfer, and enhancing entrepreneurship and innovation. Saudi workers can benefit from training and exposure to international standards and practices, making them more employable and competitive both locally and internationally.

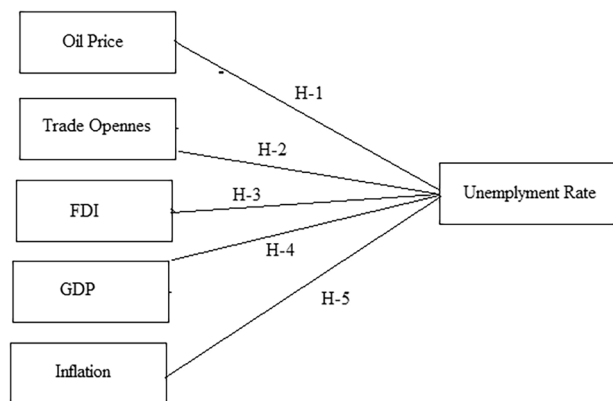


Fig. 2 Proposed Model for examining the impact of oil price, inflation, trade openness, GDP, and FDI on unemployment rate in Saudi Arabia from 2016 to 2024.

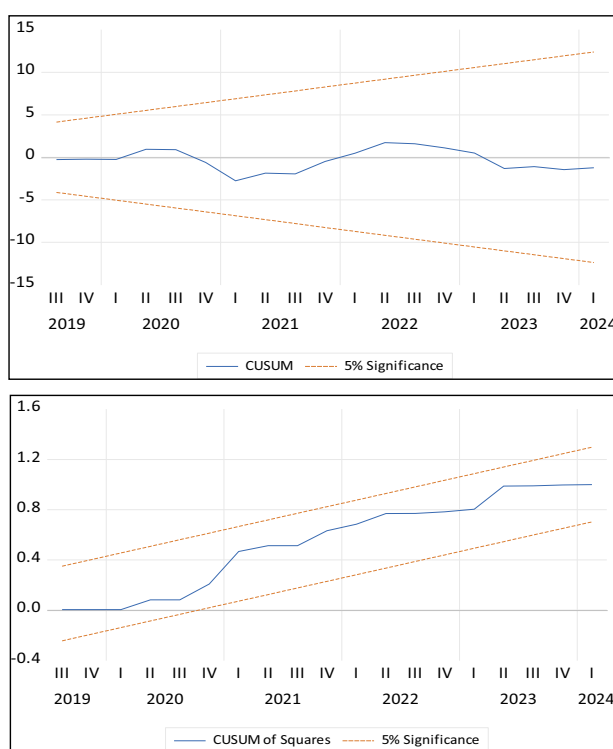


Fig. 3 CUSUM and CUSUM of squares results.

Stability and diagnostics. Table 9 and Fig. 3 display the stability and other outcomes with the center stage taken by diagnostic tests. The R -squared value of 0.85, the coefficient of correlation, states that around 85% of the unemployment rate variations are explained by explanatory variables. The value of F -stat shows that at a 1% level of significance, the distribution of the model fits the data quite well. The model was tested for serial correlation, heteroskedasticity, normality, and missing variable problems. These diagnostics were done using the Breuch-Godfrey test, Harvey heteroskedasticity test, Jarque-Bera normality test, and Ramsey Reset test, respectively, CUSUM and CUSUM of square as shown in Fig. 3.

The autocorrelation Breuch-Godfrey test confirms no serial correlation. According to the Harvey heteroskedasticity test, the variance of the error term is homoscedastic, i.e., there are no symptoms of heteroskedasticity. The residuals are normally distributed as confirmed by the Jarque-Bera normality test at a

5% level of significance. Furthermore, the Ramsey reset test shows that there is no evidence of a missing variable problem. According to the CUSUM and CUSUM of squares results presented in Fig. 1, there is a stable and consistent set of model parameters. A stable and consistent set of model parameters is there when the line stays inside the crucial 5% limit throughout (Gülaliyev et al., 2022). In the case of Saudi Arabia, the model is stable and consistent and can be trusted as the line lies within the percentage ranges.

Discussion

The study investigated the impact of oil price, inflation, trade openness, GDP and FDI on unemployment rate in Saudi Arabia. The findings show that all these macroeconomic variables have a significant impact on employment. The statistics shows that FDI has a negative and significant relationship with unemployment rate, having a t -statistics value -4.900 , and the coefficient value -1.630 , indicating that 1% increase in FDI will decrease the unemployment rate by 1.630% approximately, considering other all other variables as constant. For this relationship, the relatively small value of the standard error, 0.333, suggest a precise estimate. The findings are aligned with other studies (Saani et al., 2023; Liu et al., 2024; Strat and Davidescu, 2025), indicating the importance for Saudi Arabia to get more FDI and diverse its sources of employments. Similarly, the statistics show that GDP has also a negative and significant relationship with unemployment rate, having a t -statistics value -4.387 , and the coefficient value -0.353 , indicating that 1% increase in GDP will decrease the unemployment rate by $\sim 0.35\%$, considering other all other variables as constant. For this relationship, the relatively small value of the standard error, 0.080, indicates a precise estimate. Other studies have also similar findings (Porras-Arena and Martín-Román, 2023) (Lopez-Acevedo, 2023). It is critical for Saudi Arabia to find out and explore new opportunities and industries for increasing its GDP for decreasing unemployment rate. Similarly, the statistics show that inflation has also a negative and significant relationship with unemployment rate, having a t -statistics value -7.449 , and the coefficient value -3.170 , indicating that 1% increase in inflation will decrease the unemployment rate by $\sim 3.17\%$, considering other all other variables as constant in the long term. For this relationship, the relatively small value of the standard error, 0.426, indicates a precise estimate. The results reject the hypothesis of the study, claiming that inflation increases unemployment rate. This is quite interesting that the relationship of inflation and unemployment rate is negative in the context of Saudi Arabia. The findings are different from other studies (Zaman et al., 2024; Bonatti et al., 2022).

Furthermore, the statistics show that oil price has also a negative and significant relationship with unemployment rate, having a t -statistics value -6.507 , and the coefficient value -0.063 , indicating that one unit increase in oil price will decrease the unemployment rate by 0.63 units approximately, considering other all other variables as constant. For this relationship, the relatively small value of the standard error, 0.097, indicating a precise estimate. The findings are similar with the studies conducted in oil-producing countries (Al Naimi, 2022), where oil is the price source of economic growth. Studies conducted in oil-importing countries have different results (Thuy Tien, 2022). Lastly, the statistics shows that trade openness has also a negative and significant relationship with unemployment rate, having a t -statistics value -2.877 , and the coefficient value -2.061 , indicating that 1% increase in oil price will decrease the unemployment rate by $\sim 2\%$, considering other all other variables as constant. For this relationship, the relatively small value of the standard error, 0.716, indicates a precise estimate. The findings

are aligned with other studies (Alauddin and Khan, 2021; El Amine, 2023). In the context of Saudi Arabia, it is important to make such policies which can boost trade and explore new windows for economic growth, which can only be done with trade openness.

The findings of the study are very important for Saudi Arabia, as it is making policies for the attainment of vision 2030. Even its high reliance on oil export, other factors like GDP, FDI, trade openness, and inflation also influence the employment and play a significant role in its economy. The findings stress on the diversification of macroeconomic factors, like obtaining FDI, making trade-friendly policies to enhance its GDP and reduce the unemployment rate. It should be done very carefully, by considering other factors which may not impact the Saudi Arabia economy and employment opportunities negatively.

Conclusion

The study examined the impact of FDI, GDP, inflation, trade openness, and oil prices on the unemployment rate in Saudi Arabia. Eviews was used for the analysis and ARDL was employed for finding the relationship of FDI, GDP, inflation, trade openness, and oil prices on the unemployment rate in the long run. The results show that there is a negative and significant relationship between macroeconomic factors like FDI, GDP, inflation, trade openness, and oil prices and the unemployment rate. In other words, FDI, GDP, inflation, trade openness, and high oil prices are needed to reduce the unemployment rate in Saudi Arabia. The study provides valuable insights for Saudi Arabia for reducing unemployment by introducing FDI, GDP growth, trade-friendly policies as the country is highly dependent on oil export. This is necessary for opening new windows for employment opportunities, economic growth aligned with its Vision 2030.

Implications. The findings have the following implications for Saudi Arabia.

1. The findings imply that FDI significantly influences employment in Saudi Arabia. Therefore, FDI-friendly policies are necessary for attracting more FDI in multiple sectors. At the same time, the country must also take necessary steps to protect its existing industries from the negative impact of FDI. Such policies are necessary that channel the FDI to non-developed industries.
2. The results also imply that trade openness influences the employment in Saudi Arabia. Again, trade-friendly policies are necessary for attracting more businesses and industries to the country to increase employment opportunities. At the same time, the country must also take necessary steps to protect its existing industries from the negative impact of trade openness. The country should develop its own industries to obtain more benefits from trade openness.
3. The findings also imply that inflation has a negative correlation with unemployment rate. The finding is very interesting, as inflation becomes high when the buying power decreases. But in the case of Saudi Arabia, when it is high, more people start jobs leading to the reduction of unemployment rate.
4. The study also imply that GDP growth and unemployment are negatively correlated. This provide insights for making policies and establishing industries that ensure GDP growth especially in non-oil sector, due to its high reliance on oil export. The development of other sectors will boost the GDP and will reduce its dependence on oil.
5. Lastly, the findings also imply that oil price has a significant negative correlation with unemployment. Being the major contributor to Saudi Arabia's economy, when the oil price is

high, the employment opportunities are high as the chances of investment in other sector increases.

In general, the findings are considerably important for Saudi Arabia and provide evidence regarding the importance of FDI, trade openness, and GDP growth for employment in an oil-rich country. The results also stress on the necessity of diversification of economy and exploring new windows for employment opportunities.

Recommendations. The study has the following recommendations for Saudi Arabia. These recommendations provide Saudi Arabia guidance to make strategies and bring economic reform aligned with its Vision 2030, and ensure that GDP, FDI, and trade are also necessary for employment in addition to oil sector. Saudi Arabia should develop policies to attract non-oil sector FDI and should promote other sectors like manufacturing, tourism, technology and infrastructure. It should focus on the FDI, which must not impact the current economic activities negatively, but carefully welcome the FDI that ensures technology advancement, transfer of knowledge, and sustainability according to its Vision 2030. Similarly, the findings also suggest that Saudi Arabia should incentivize the development of the non-oil sector to reduce its dependency on oil in the future and open new doors for employment and economic growth. It should make trade-friendly policies necessary for global trade in non-oil sectors. Further research exploration is needed on finding the relationships of other macroeconomic variables with unemployment.

Limitations and future research directions. The study has also some limitations and direction for future researches. For example, the study is conducted in the context of Saudi Arabia, majorly dependent on oil exports. Due its special economic and policy structures, the findings may not be suitable for other countries with different economic and policy structures. The model of this study can be tested for other countries. There are other factors which may have impact on the study were not considered in this research, that may also have influence on employment rate. This can be done in future studies. The findings indicate that inflation has a negative relationship with unemployment rate in the long run. This can be further explored for getting much clarity and understanding. The study used data from 2016 to 2023. There might be different results for other data samples.

Data availability

The data set generated during and/or analyzed during the study is attached as a supplementary file.

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Author contributions

The authors confirm contribution to the paper as follows: Introduction: SFA and LC; Materials: YW, SJS, and MI; Methods: MI, LC and SFA; Data collection: SFA, FMA, AA, and MI; Data analysis and interpretation LC, YW, SFA, FMA, MIA, and SJS; Draft preparation: SFA, SJS, and MI Writing and review: LC, YW, SFA, SJS, MI, FMA, MIA, and AA. All authors read, edited and finalized the manuscript.

Competing interests

The authors have declared that they have no competing interests. All authors have approved the manuscript and agree with its submission. This manuscript has not been published and is not under consideration for publication elsewhere.

Ethical approval

Ethical approval was not required as the study did not involve human participants. Informed consent was not required as the study did not involve human participants.

Informed Consent

Informed consent was not required as the study did not involve human participants.

AI declaration

Grammarly was used for language improvement.

Additional information

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