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Crude Oil Price Variability and Employment Dynamics in Pakistan: A Sectoral Analysis

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ABSTRACT

This research analyzed the link between crude oil prices and employment in Pakistan's agricultural, industrial, and services sectors. Pakistan, being an oil-importing country, is heavily dependent on imported oil for its macroeconomic performance. In 2022, the country imported crude oil worth $5.23 billion and was the 29th largest importer of crude oil in the world. The entire economy, as well as each sector, is heavily dependent on imported oil, and consequently its fluctuating prices. Changes in oil prices pose a challenge for Pakistan's sectoral employment through different transmission channels. This research fills the gap in the literature by analyzing the impact of crude oil price on sectoral employment in Pakistan. In this research, time series data for the period 1981–2019 has been used. For employment dynamics in the agricultural, industrial, and service sectors, models based on efficiency wage theory have been developed and estimated using the ARDL co-integration technique. Estimated models indicate that a 1% increase in real crude oil prices resulted in a 0.13%, 0.1%, and 0.02% decline in employment in the agricultural, industrial, and services sectors, respectively. Among sector-specific variables, exports from each sector have a positive impact, while imports have a negative impact on employment in the respective sector. The results of the study recommend the stabilization of oil prices by readjustment of taxes and profit margins of oil companies by the Government of Pakistan. This shall promote tangible sectoral employment leading to the welfare of the impoverished masses.

1 | Introduction

Changes in oil prices are a significant source of macroeconomic fluctuations. A rise in oil prices has a negative impact on the macroeconomic performance of oil-importing countries (Khan and Ahmed 2011). Moreover, fluctuating oil prices impact macroeconomic variables in both developing and developed economies. The impact of high oil and energy prices is not limited to the macroeconomy; it also affects social development, environmental sustainability, and employment (Ahmad 2013; Liaqat et al. 2022). Additionally, it influences the stock market in developing countries like Pakistan (Shabbir et al. 2020) and in upper-middle-income countries like Turkey (Pata et al. 2024). Similarly, prices for natural gas and oil can affect carbon efficiency, but this link is multi-faceted and dependent on economic changes, incentives for investing in renewable energy, and laws and regulations pertaining to energy infrastructure. Nevertheless, energy consumption plays a significant role in environmental degradation (Sun et al. 2024), with oil consumption being a major contributor to worsening CO_2 emissions (Erdogan et al. 2023). The production process of oil, gas, and their substitutes results in greenhouse gas (GHG) emissions and indicates that price fluctuations in these resources indirectly

contribute to emissions (Liu et al. 2023). These greenhouse gas emissions are also caused by oil usage in the transportation sector (Nasir et al. 2024).

Being an oil-importing economy, Pakistan has to fulfill her energy requirements by relying on imports more than domestic production (shown in Figure 1). The total consumption of petroleum products was 19.68 million tons in 2019. Pakistan fulfilled her oil needs by generating 11.59 million tons through domestic production while importing 8.9 million tons (Government of Pakistan 2020). Oil consumption in Pakistan is about 22% of the total energy mix (Government of Pakistan 2022) and is essential for economic growth, sustainability, and stock market returns (Cevik et al. 2020).

In Pakistan, total oil consumption depends on the utilization of oil in three main economic sectors. The growth of each economic sector is sensitive to crude oil prices; however, the transport sector is the most sensitive to oil price changes. According to Taghizadeh-Hesary et al. (2015), oil is an important commodity and changes in oil prices affect each economic sector and their sectoral employment (Saleem and Ahmad 2015).

An increase in the price of oil increases input and production costs, while decreasing the employment rate (Ahmad 2013). Therefore, due to the high dependence on oil, oil consumption remains high in oil-importing countries (as shown in Figure 2).

Employment is a key indicator that generates income for the citizenry and ensures their welfare. Pakistan has the ninth-largest labor force in the world (Government of Pakistan 2020). The employed labor force significantly affects consumption and production in all economic sectors.

The agriculture sector is the mainstay of Pakistan's economy in terms of growth, output, trade, and labor. The growth of the agriculture sector depends upon the production of its subsectors, that is, fisheries, crops, livestock, and forestry. Similarly, the industrial sector, which consists of the manufacturing, mining, and construction sectors, also plays a key role in the development of Pakistan's macroeconomy and development (Government of Pakistan 2019). The services sector in Pakistan is expanding with a growth rate higher than other economic sectors. This sector consists of sub-sectors like wholesale and retail trade; transport, storage and communication; finance and insurance; housing services; general government services, and other private services (Government of Pakistan 2020).

The employment and growth of the economic sectors are intertwined with each other. Job creation in Pakistan can be

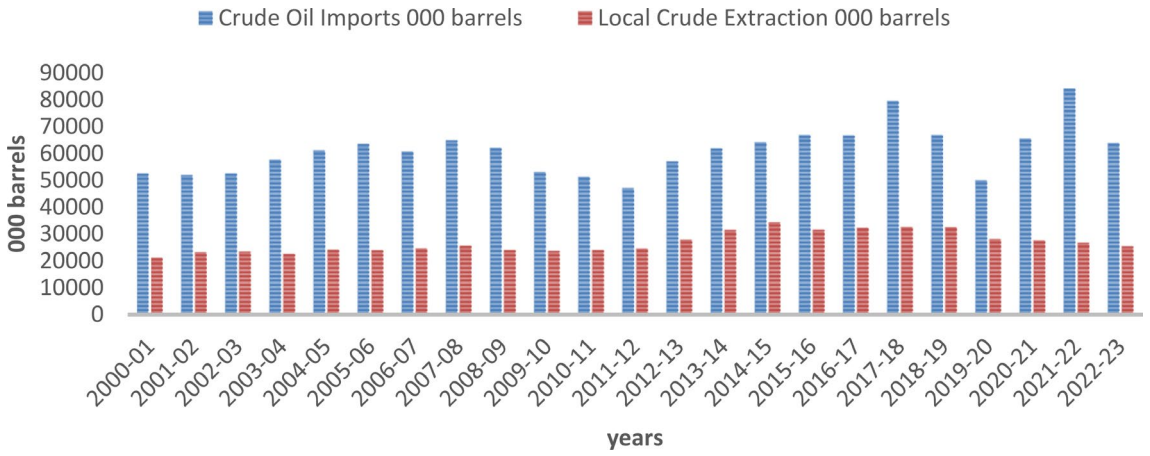

FIGURE 1 | Crude oil imports and local crude extraction in Pakistan. *Source:* Government of Pakistan (2024).

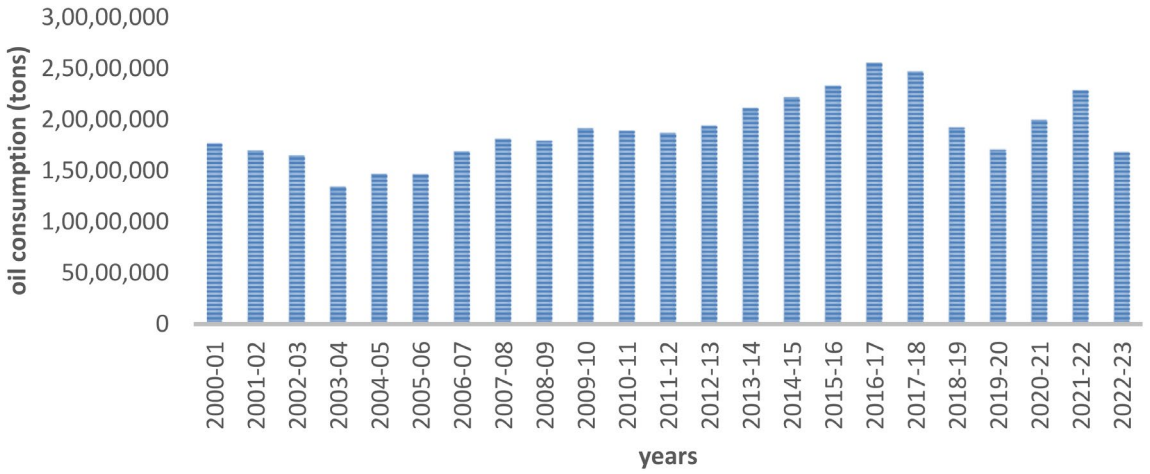

FIGURE 2 | Commercial Energy Consumption in Pakistan (oil/petroleum). *Source:* Government of Pakistan (2024).

achieved by targeting each economic sector, as they act as an engine of growth (Samad and Ahmed 2019). Labor force employment fluctuates in different sectors of the economy due to changes in input prices (Ahmad 2013). Crude oil, being an important input in the production of goods and services in Pakistan, has the potential to affect aggregate employment in the economy and its growth (Ahmad 2013). Thus, a rapid rise in crude oil prices can adversely affect employment across economic sectors. However, the relationship between oil prices and employment across economic sectors is complex and depends on the overall health of the economy. No substantive academic research has been conducted to assess the association between crude oil prices and sectoral employment in the agricultural, industrial, and services sectors of Pakistan. There is a dire need to analyze the impact of crude oil prices on sectoral employment in Pakistan's agriculture, industry, and services sectors. Thus, this study fills this research gap in the literature by using annual data at the sectoral level for Pakistan from 1981 to 2019.

2 | Review of the Literature

The relationship between crude oil price and employment has been studied by many researchers. The seminal work of Hamilton (1983) explored the association between crude oil prices and the U.S. recession after World War II by using Granger causality. The results of the study pointed towards a causality between crude oil prices and the U.S. recession before 1973. Similarly, the study of Gisser and Goodwin (1986) and Hooker (1996) showed a significant relationship between crude oil prices and macroeconomic variables, including unemployment. Fluctuations in oil prices can harm developing countries. For example, the study of Ahmad (2013) investigated the effect of oil prices on unemployment in Pakistan and found that oil prices significantly cause unemployment in Pakistan. Similarly, Dogrul and Soytas (2010) tested the association between oil prices, interest rates, and unemployment in Turkey. The analysis showed that oil prices caused unemployment in the long run.

Changes in oil prices affect the employment rate varyingly in different periods. The study of Yahia and Saleh (2008) explored the relationship between economic sanctions (UN resolution of 1992), oil price changes, and employment in Libya. Results revealed that oil prices positively impacted the country's employment from 1972 to 1982 and negatively from 1983 to 1998. Specifically, oil prices had a significant effect on the employment of domestic Libyan workers, but no long-term relationship between oil price changes and the employment of non-Libyan or foreign workers could be established.

On the other hand, in developed countries, the oil price had a negative impact on employment in Greece, Turkey, and the USA (Altay et al. 2013; Kang et al. 2015; Decker and Wohar 2005; Papapetrou 2001). However, Alkhateeb et al. (2017) found that oil prices and GDP growth had a significant positive impact on employment in Saudi Arabia. Similarly, Karlsson et al. (2018) found unidirectional causality from oil prices to unemployment in Norway. According to them, there was a significant relationship between oil price and aggregate employment present in Norway. In addition, the price of oil significantly affected sectoral employment. Uri (1996) examined the relationship between employment in the agricultural sector and crude oil prices in the United States. Results revealed that changes in crude oil prices had a significant impact on agricultural sector employment and decreased by 0.2% with a 1% increase in crude oil price. This negative impact of oil prices on agricultural output has also been noticed by Abdlaziz et al. (2018), who revealed that an increase in oil prices significantly decreases the agricultural output in oil-exporting countries. It has also been recognized that international sanctions significantly affect employment in the manufacturing sector with disproportionate effects on male and female employment in Iran (Demir and Tabrizy 2022).

Ewing and Yang (2009) examined the impact of oil prices and exchange rates on the employment of manufacturing and non-manufacturing sectors of the U.S. at the state level. They indicated the existence of cointegration of oil prices with manufacturing and non-manufacturing sector employment at the state level. Similarly, Oskooee et al. (2007) investigated the relationship among wage rate, sectoral employment, energy prices, government expenditure, and exchange rate in the United States. According to their study, a rise in energy prices led to a rise in the wage rate of finance, manufacturing, retail, wholesale, transportation, services, and mining sectors while reducing construction sector wages and employment. According to Davis and Haltiwanger (2001), energy-intensive sectors were more sensitive to oil price shocks. They found that the increased price of oil resulted in job reduction and a decline in employment opportunities. However, oil price changes can have different effects on employment across sectors. For example, Keane and Prasad (1996) indicated that an increase in oil price reduced employment at the aggregate level in the short run but positively affected employment in the industry in the long run. Oil prices also affect employment in the coal mining sector. According to Hoag and Wheeler (1996), oil price shocks explained a larger portion of the change in total employment, surface employment, and underground employment. Herrera and Karaki (2015) estimated the relationship between job reallocation (sectoral job flows) and oil price shocks in the U.S. manufacturing and transportation sector. Further, Bocklet (2016) revealed that oil prices had a negative relationship with employment in the oil industry sector but had a positive relationship with employment in the non-oil industry in Alaska. Oil prices also affect different sectors in a developing country like Pakistan.

Besides oil prices, several macroeconomic and sector-based indicators also affect employment in an economy. Rodríguez-Benavides et al. (2022) investigated the international oil price uncertainty on the economic growth of the primary, secondary, and tertiary economic sectors in Mexico using the VAR model. Their study indicated that oil price uncertainty has different effects on each sector. Results revealed that oil prices do not affect the primary sector while having a negative effect on the secondary and have mixed effects on the tertiary sector. Dias (2013) investigated the link between gross domestic product, employment, inflation, and oil prices for Portugal's economy. In response to oil price shocks, he found its negative impact on GDP and employment. Macroeconomic variables like education and trade had a significant impact on employment and overall economic activity. Like other countries, oil price inflation also negatively affects the economic growth

of Pakistan. Liaqat et al. (2022) investigated the impact of oil price inflation on the economic growth of Pakistan using the co-integration technique ARDL from the time period between 1972 and 2020. The results revealed that economic growth in Pakistan is anti-growth with a rise in oil prices. It showed that a rise in oil prices negatively affects the GDP in the long run and short run. On the contrary, Hayat and Nadir (2023) indicated the positive impact of oil prices on the economic growth of Pakistan, suggesting purchasing crude oil at any price. Khan et al. (2022) found the mixed impact of oil price changes in Pakistan on stock returns (bullish/bearish) across different sectors. Similarly, Ali et al. (2022) concluded in their study that oil price shocks significantly affect the sectoral stock returns of Pakistan's commercial banking, power generation, and chemical and fertilizer production. In addition, Samiullah (2014) estimated the relationship between employment, health, and education in Pakistan. A rise in public spending on education increased the employment of the labor force in the economy. Similarly, Qazi et al. (2017) indicate that education was one of the main indicators in the determination of employment in the labor market of Pakistan. Results revealed a negative and significant relationship between higher education and unemployment. Further, health indicators also played a significant positive role in determining employment. Sibanda et al. (2015) explored the link between oil prices and sectoral employment (public and private) in South Africa. Results showed that a rise in oil prices affected employment in the private sector, especially in the construction, finance, and trade sectors, but changes in oil prices did not affect the employment of the public sector. In the public sector, oil prices had an insignificant impact on employment. Further, exports also seem to be a positive and significant determinant of employment. Balassa (1989) revealed that developing countries experience an increase in employment by high exports and economic growth. The study of Pashtoon et al. (2018) also showed the existence of a long-term association between exports and employment in Afghanistan.

In existing literature, the impact of oil prices on the macroeconomy and a particular sector of the economy was examined by researchers in different parts of the world. Evidence shows that there is a mixed relationship between oil prices and employment/unemployment. Higher oil prices lead to a decrease in employment and an increase in unemployment in developing/oil-importing countries. On the other hand, in oil-exporting countries, there was a positive association between oil prices and employment. This research adds to the body of literature by analyzing the link between crude oil prices and sectoral employment in Pakistan from 1981 to 2019.

3 | Modeling

3.1 | Theoretical Model

The relationship between employment and the crude oil price has been initially assessed under the efficiency wage theory proposed by Shapiro and Stiglitz (1984). It was modified by Carruth et al. (1998), and their model has been employed as a starting point in this study to examine the employment in three major sectors of Pakistan. There are three reasons for doing so. Firstly, the model is reliable because the relation between unemployment and factors of production (interest rate and oil prices) can be justified under this framework. Secondly, an assumption that all unemployment is not voluntary and can be involuntary. Thirdly, a slight change in wages does not have an impact on the employment level.

According to Carruth et al. (1998)

$$U = \epsilon(r, p) \tag{1}$$

In this equation, U denotes unemployment, r is the real interest rate, and p is the oil prices. However, to determine the relationship between crude oil price and sectoral (i.e., across agriculture, industry, and services) employment in Pakistan, we have replaced unemployment with sectoral employment in Equation 1. According to Carruth et al. (1998), oil prices have a positive impact on the unemployment rate. However, in this study, as the dependent variable is employment in all three sectors, the expected association between oil price and sectoral employment is negative.

TABLE 1 | Variables description.

Variables	Description
EMPA	Number of people employed in the agriculture sector.
EMPI	Number of people employed in the industrial sector
EMPS	Number of people employed in the services sector
COP	Crude oil price in rupee (using exchange rate)
I.R.	Real interest rate
POPU	Urban Population: Population living in urban areas
POPR	Rural Population: Population living in rural areas
CA	Cropped area (million hectors)
HCP	Human capital in the agriculture sector (proxied by the school-age population of primary education)
HCS	Human capital in the industrial sector (proxied by the school-age population of secondary education)
HCT	Human capital in the services sector (proxied by the school-age population of the tertiary sector)
EXPF	Food exports (constant 2010 US$)
IMPF	Food imports (constant 2010 US$)
EXPM	Manufactured exports (constant 2010 US$)
IMPM	Manufactured imports (constant 2010 US$)
EXPS	Service exports (constant 2010 US$)
IMPS	Service imports (constant 2010 US$)

3.2 | Empirical Model

The autoregressive distributed lag (ARDL) model developed by Pesaran et al. (2001) has been used to estimate the relationship between crude oil price and sectoral employment in Pakistan. It is an effective technique in time series analysis if variables of the model are stationary at level I (0), or at the first difference I (1), or combinations of both. Moreover, it is an appropriate method when lags of both dependent and independent variables influence dependent variables to estimate the short-run and long-run association between variables.

In the estimated models of this study, the employed labor force is a dependent variable, while interest rate, oil prices, and a set of macroeconomic variables as a control act as independent variables. As this is a sectoral analysis of employment in Pakistan, the control variables of the model consist of a combination of macroeconomic variables at aggregate and sector-specific levels.

TABLE 2 | Results of augmented Dickey-Fuller (ADF) unit root test.

	Level		First difference		
Variables	**With intercept**	**With trend and intercept**	**With intercept**	**With trend and intercept**	**Decision**
EMPA	−0.8019 (0.992)	−1.740 (0.713)	−7.579* (0.000)	−8.0185* (0.000)	I (1)
EMPI	−2.692 (1.000)	−0.677 (0.967)	−5.499* (0.0001)	−7.18* (0.000)	I (1)
EMPS	−1.329 (0.99)	−2.634 (0.268)	−7.38* (0.0000)	−7.936* (0.000)	I (1)
COP	−2.943 (0.052)	−2.66 (0.256)	−1.44 (0.547)	−5.247* (0.0008)	I (1)
IR	−3.674* (0.008)	−3.62* (0.0412)	−7.93 (0.0000)	−7.822 (0.000)	I (0)
POPR	−2.14 (0.9999)	−4.751* (0.002)	−2.68 (0.087)	−3.289 (0.08)	I (0)
POPU	−5.256 (1.000)	−0.345 (0.9860)	−6.044* (0.00000)	−9.7488* (0.0000)	I (1)
EXPF	−3.13* (0.03)	−3.46 (0.05)	−7.45* (0.0000)	−7.939* (0.000)	I (1)
IMPF	−1.55 (0.49)	−3.19 (0.101)	−7.50* (0.0000)	−7.436* (0.0000)	I (1)
EXPM	−0.74 (0.82)	−1.90 (0.62)	−5.728* (0.0000)	−5.924* (0.0001)	I (1)
IMPM	−2.22 (0.20)	−2.09 (0.53)	−4.76* (0.0004)	−4.72* (0.0028)	I (1)
EXPS	−1.399 (0.572)	−2.8668 (0.1841)	−8.451* (0.0000)	−8.338* (0.000)	I (1)
IMPS	−1.906 (0.3259)	−2.814 (0.2014)	−4.322* (0.0015)	−4.267* (0.0090)	I (1)
HCP	−1.88 (0.3355)	−2.31 (0.4142)	−2.54 (0.1142)	−4.7* (0.0034)	I (1)
HCS	−0.8726 (0.7854)	−10.09* (0.0000)	−2.209 (0.2065)	−2.27 (0.4372)	I (0)
HCT	−0.95 (0.759)	−4.416* (0.0078)	−1.698 (0.423)	−1.604 (0.77)	I (0)
CA	−2.34 (0.164)	−2.499 (0.326)	−8.218* (0.0000)	−8.44* (0.0000)	I (1)

Note: Values in parentheses show the *p*-values of the computed statistic. According to the ADF unit root test, all variables were either stationary at level or first difference and fulfilled the requirement of the ARDL cointegration technique. The sign * shows the significance at 5% level of significance.
Source: Author's Calculation.

These sector-specific variables considered in this analysis were rural and urban population, food exports and imports, cropped area, manufacturing exports and imports, service exports and imports, and human capital proxied by primary, secondary, and tertiary school-age population.

Data from 1981 to 2019 is used in this study due to the presence of volatile, stable, increasing, and decreasing price periods for oil. This was the time when oil prices fluctuated due to major economic and geopolitical factors, that is, 1980s oil glut, Iran-Iraq war (1980–1988), Gulf war (1990–1991), 9/11 attacks, 2000s demand boom, and price spike due to IMF's phasing out subsidies and reforms in Pakistan's power sector, shale oil revolution driven by increased US oil production, and the 2008 financial crisis. These fluctuations in international oil prices have always posed economic challenges for oil-importing countries like Pakistan. Furthermore, during this period, while the share of the agricultural sector in GDP presented a decreasing trend, the industrial sector did not depict any trend, and the services sector showed an increasing trend. This enabled us to analyze the impact of fluctuations in oil prices on employment in the agricultural, industrial, and services sectors under different patterns.

3.3 | Data Sources

The variables used in the estimated models are described in Table 1, and data from 1981 to 2019 have been obtained from the International Labor Organization (ILOSTAT 2020), International Financial Statistics (IMF 2020), World Development Indicators, World Bank Education Statistics, World Bank Pink Sheet—Commodity Prices (World Bank 2020), and Pakistan Economic Surveys (Various issues).

In this study, the data of the employed labor force in agricultural, industrial, and services sectors has been calculated by using the data of the total labor force and the percentage of the employed labor force in respective sectors, while the data of all other variables have been collected from the enlisted sources as it.

Based on the theoretical model, the following functional forms for sectoral employment in Pakistan are used:

$$EMPA_t = f\left(COP_t, IR_t, POPR_t, HCP_t, EXPF_t, IMPF_t, CA_t\right) + \mu_t \quad (2)$$

$$EMPIt_t = f\left(COP_t, IR_t, POPU_t, HCS_t, EXPM_t, IMPM_t\right) + \vartheta_t \quad (3)$$

$$EMPS_t = f\left(COP_t, IR_t, HCT_t, EXPS_t, IMPS_t\right) + \epsilon_t \quad (4)$$

Other than the main independent variables COP and IR, the choice of the sector-specific variables is based on their significance for employment in the respective economic sector. A growing rural and urban population in the case of Pakistan significantly influences macroeconomic indicators like employment. A growing population with scarcity of resources can create hazardous issues for any country, and this is amplified in the case of developing countries like Pakistan. It has been observed that an increasing population can create unemployment with fewer resources and highlights that the population must be in line with the resource requirements available in the country (Sweezy and Owens 1974). Therefore, POPR and POPU variables are used in agricultural and industrial models. Similarly, educated people can contribute more to the labor force. Increased enrollment can increase the literacy rate, which can increase the employment opportunities for qualified labor (Samiullah 2014). To evaluate the impact of education in the current study, HCP, HCS, and HCT variables are used in agricultural, industrial, and services models, respectively. In the agricultural sector, cropped areas play an important role in this sector's employment and production. In fact, cropped area shows the ability of a country to produce crops within the cropping season (Qureshi et al. 1990). Similarly, imports and exports in the respective sectors have been added in models to capture their influence on sectoral employment.

For the above functional forms, short-run relationships are also estimated. The following double-log models have been selected based on Akaike information criterion (AIC) and Schwarz information criterion (SIC) and estimated to find out the short-run relationship among variables:

TABLE 3 | Bound test results of agricultural, industrial, and services sector model.

Null hypothesis: No long-run relationship exists						
	Agriculture		**Industrial**		**Services**	
	F stats =128.29 (K = 7)		F stats = 7.074735 (K = 7)		F stats = 11.20802 (K = 5)	
Significance	I (0) bound	I (1) bound	I (0) bound	I (1) bound	I (0) bound	I (1) bound
10%	2.38	3.45	1.7	2.83	2.75	3.79
5%	2.69	3.83	1.97	3.18	3.12	4.25
2.5%	2.98	4.16	2.22	3.49	3.49	4.67
1%	3.31	4.63	2.54	3.91	3.93	5.23

Source: Author's calculation.

TABLE 4 | Results of autoregressive distributed lag models—agricultural sector.

Short-run coefficient results			
Variables	**Coefficients**	***t*-statistics**	***P*-values**
DLOG (EMPA [−1])	0.232758	2.162189	0.0967
DLOG (EMPA [−2])	0.437586	7.572395	0.0016
DLOG (COP)	0.007602	0.297197	0.7811
DLOG (COP [−1])	0.253469	6.616293	0.0027
DLOG (COP [−2])	−0.192635	−6.956545	0.0022
D(IR)	0.007671	3.316550	0.0295
D (IR [−1])	−0.006359	−4.453146	0.0112
D (IR [−2])	−0.013508	−7.238694	0.0019
DLOG (POPR)	22.730441	0.844667	0.4459
DLOG (POPR [−1])	−456.8153	−7.727383	0.0015
DLOG (POPR [−2])	221.6776	10.428517	0.0005
DLOG (HCP)	18.035712	5.037794	0.0073
DLOG (HCP [−1])	−30.084722	−13.59164	0.0002
DLOG (EXPF)	0.363699	8.636677	0.0010
DLOG (EXPF (−1))	−0.473942	−19.02416	0.0000
DLOG (EXPF [−2])	−0.485503	−12.06839	0.0003
DLOG(IMPF)	−0.134346	−5.135809	0.0068
DLOG (IMPF [−1])	−0.001059	−0.051553	0.9614
DLOG (IMPF [−2])	0.257659	5.576617	0.0051
DLOG (CA)	1.466438	6.664755	0.0026
DLOG (CA [−1])	1.257070	9.915358	0.0006
DLOG (CA [−2])	−1.078248	−3.676366	0.0213
Trend	0.243127	6.298440	0.0032
CointEq (−1)	−1.871435	−15.94066	0.0001
Long-run results			
LOG (COP)	−0.130171	−7.483622	0.0017
IR	0.015083	4.834315	0.0084
LOG (POPR)	−6.534687	−4.433168	0.0114
LOG (HCP)	2.596946	4.699806	0.0093
LOG (EXPF)	0.804937	10.976683	0.0004
LOG (IMPF)	−0.163520	−3.342412	0.0288
LOG (CA)	1.241307	3.250004	0.0314
C	73.54194	4.174636	0.0140
Trend	0.129915	5.520173	0.0053

Source: Author's calculation.

$$\begin{aligned}\triangle logEMPA_t = {} & \alpha_1 \triangle logEMPA_{t-1} + \alpha_2 \triangle logEMPA_{t-2} \\ & + \alpha_3 \triangle logCOP_t + \alpha_4 \triangle logCOP_{t-1} - \\ & \alpha_5 \triangle logCOP_{t-2} + \alpha_6 \triangle IR_t - \alpha_7 \triangle IR_{t-1} - \\ & \alpha_8 \triangle IR_{t-2} + \alpha_9 \triangle logPOPR_t - \alpha_{10} \triangle logPOPR_{t-1} \\ & + \alpha_{11} \triangle logPOPR_{t-2} + \alpha_{12} \triangle logHCP_t - \alpha_{13} \triangle logHCP_{t-1} \\ & + \alpha_{14} \triangle logEXPF_t - \alpha_{15} \triangle logEXPF_{t-1} \\ & - \alpha_{16} \triangle logEXPF_{t-2} \\ & - \alpha_{17} \triangle logIMPF_t - \alpha_{18} \triangle logIMPF_{t-1} \\ & + \alpha_{19} \triangle logIMPF_{t-1} + \alpha_{20} \triangle logCA_t \\ & + \alpha_{21} \triangle logCA_{t-1} + \alpha_{22} \triangle logCA_{t-2} + \alpha_{23} trend + e_{1t}\end{aligned} \tag{5}$$

$$\begin{aligned}\triangle logEMPI_t = {} & \beta_1 \triangle logCOP_t + \beta_2 \triangle IR_t \\ & + \beta_3 \triangle logPOPU_t - \beta_4 \triangle logHCS_t \\ & + \beta_5 \triangle logHCP_t - \beta_5 \triangle logHCP_{t-1} \\ & + \beta_6 \triangle logEXPM_t + \beta_7 \triangle logIMPM_t \\ & + \beta_8 \triangle logIMPM_{t-1} + e_{2t}\end{aligned} \tag{6}$$

$$\begin{aligned}\triangle logEMPS_t = {} & £ + \gamma_1 \triangle logEMPS_{t-1} + \gamma_2 \triangle logEMPS_{t-2} \\ & - \gamma_3 \triangle logCOP_t - \gamma_4 \triangle IR_t + \gamma_5 \triangle logHCT_t \\ & - \gamma_6 \triangle logHCT_{t-1} + \gamma_7 \triangle logHCT_{t-2} \\ & + \gamma_8 \triangle logEXPS_t - \gamma_9 \triangle logEXPS_{t-1} \\ & - \gamma_{10} \triangle logEXPS_{t-2} - \gamma_{11} \triangle logIMPS_t \\ & + \gamma_{12} \triangle logIMPS_{t-1} + \gamma_{13} trend + e_{3t}\end{aligned} \tag{7}$$

In the above equations, α, β, and γ are coefficients and depict short-run associations among variables.

4 | Results and Discussion

Table 2 reports the unit root results of the Augmented Dickey-Fuller (ADF) test.

After testing unit root, the Bound Test of cointegration has been applied on estimated models. The value of F-statistics was greater than the upper Bound value (Table 3), which indicated

the existence of a long-run relationship among the variables for all three sectoral models, and results in rejection of the null hypothesis of no long-run association between crude oil price and sectoral employment.

Tables 4, 5, and 6 reports the short-run and long-run results of ARDL models for agricultural, industrial, and services sector employment, respectively. The estimation of three models was conducted using EViews 9. In the long run, the crude oil price had a negative and significant relationship with the employment of the agricultural, industrial, and services sectors. Results indicated that a 1% increase in real crude oil prices brought 0.13%, 0.1%, and 0.02% decline in employment in the agricultural, industrial, and services sectors, respectively. A rise in oil prices usually leads to an increase in the cost of production, which decreases the aggregate supply. This decrease in aggregate supply declines the aggregate output for rural commodities, which decreases the demand for agricultural workers (Uri 1996). In addition, an increase in oil prices would shift the primary source of input from oil to other sources, thus increasing the production costs due to the requirements of new skills of labor, which cannot be developed immediately. Therefore, this will cause a decline in employment (Ahmad 2013) in the long run, however, the oil price has an insignificant impact on sectoral employment in the short run. The findings for oil price and employment were in line with the efficiency wage theory of Carruth et al. (1998). These results are also similar to the studies carried out by Dogrul and Soytas (2010), and Ahmad (2013).

The real interest rate has a positive relationship with agricultural employment. The positive sign of the coefficient showed that a 1% increase in interest rate increases the agricultural sector's employment by 1.5% in the long run and 0.7 in the short run. In fact, an increase in the real interest rate leads to an increase in the supply of credit to farmers from formal credit sources. This increase in credit availability results in an increase in the finance provided to farmers, which leads to high productivity. Thus, high productivity results in high employment in the agriculture sector. This relationship is in line with ZTBL (2019) study, which showed the positive relationship between the monetary policy rate and agricultural growth or productivity. On the other hand, the interest rate has an insignificant impact on the industrial and services sector employment.

Sector-specific variables, human capital plays an important role in determining employment and economic growth. In the present study, the school-age population (primary education) was used as a proxy for human capital. Results revealed that primary enrollment increased agricultural employment in both the short and long run. It showed that a 1% rise in the enrollment of the primary school-age population leads to a 2.59% rise in the long run and an 18% increase in short-run agricultural employment. The results are similar to the study of Shaihani et al. (2011) who found the negative relationship between primary education and economic variables in the long run. Similarly, a 1% rise in secondary education increases industrial employment by 3.97% in the long run and by 2.9% in the short run. On the other hand, human capital represented by primary education leads to a significant decline in industrial employment by 5.13% in the long run. For the services sector model, a 1% rise in human capital represented by tertiary education leads to a 5.01% increase in services sector employment in the short run and a 0.40% increase in the long run. A cross-country analysis by Bhattacharya and Mitra (1997) also showed the positive relationship between the human development index and employment in the tertiary sector. Results of this study also showed that primary, secondary, and tertiary levels of education have a significant positive impact on the employment of agricultural, industrial, and services sectors, respectively, in both the short and long run. However, primary education did not positively contribute to industrial employment. Hence, it might be possible that primary education is only a significant contributor to agricultural employment and not to industrial employment or overall economic growth. This relationship between sectoral employment and human capital indicators is in line with Shaihani et al. (2011), who found that secondary and tertiary education significantly contribute to economic growth and the negative impact of primary schooling on economic growth. Similarly, the study of Abbas and Nasir (2001) conducted a comparative analysis of Pakistan and Sri Lanka, which showed that primary enrollment had a negative impact on growth.

Food exports played a significant role in employment. Results revealed that a 1% rise in food exports significantly increased

TABLE 5 | Results of autoregressive distributed lag models—industrial sector.

Short-run results			
Variable	**Coefficient**	***t*-statistics**	***P*-values**
DLOG (COP)	−0.007537	−0.258845	0.7980
D (IR)	0.001468	0.613398	0.5454
DLOG (POPU)	1.203811	3.043756	0.0056
DLOG (HCS)	−2.902983	3.754690	0.0010
DLOG (HCP)	2.574747	0.584660	0.5642
DLOG (HCP [−1])	−8.800789	−2.107225	0.0457
DLOG (EXPM)	0.008249	0.167763	0.8682
DLOG (IMPM)	0.011495	0.196785	0.8457
DLOG (IMPM [−1])	0.123371	2.618392	0.0151
CointEq (−1)	−0.730955	−4.598651	0.0001
Long-run results			
LOG (COP)	−0.102285	−1.894984	0.0702
IR	0.002008	0.595041	0.5574
LOG (POPU)	1.646903	5.449402	0.0000
LOG (HCP)	−5.133487	−5.851353	0.0000
LOG (HCS)	3.971496	4.928781	0.0000
LOG (EXPM)	0.011286	0.167625	0.8683
LOG (IMPM)	−0.099205	−1.649682	0.1120

Source: Author's calculation.

agricultural employment by 0.80% in the long run and 0.36% in the short term. Trade in the agriculture sector seems to be a significant indicator of rural employment. ZTBL (2019) found the positive and significant impact of food exports on agricultural productivity in Pakistan. Similarly, food imports had a negative association with agricultural employment. Results revealed that a 1% rise in food imports leads to a 0.16% decline in the long run and a 0.13% decline in the short run in agricultural sector employment. Similarly, a 1% increase in services exports leads to a 0.07% increase in the short run and 0.16% in the long run in services employment, while a 1% rise in service imports leads to a 0.16% and 0.09% reduction in services

TABLE 6 | Results of autoregressive distributed lag models—services sector.

Short-run coefficient results of ARDL model 3: Services Sector			
Variables	**Coefficients**	**T-statistics**	**Probabilities**
DLOG (EMPS [−1])	0.852021	2.770771	0.0136
DLOG (EMPS [−2])	0.489170	2.543882	0.0217
DLOG (COP)	−0.002944	−0.147509	0.8846
D (IR)	−0.001337	−0.707740	0.4893
DLOG (HCT)	5.019847	2.211341	0.0419
DLOG (HCT [−1])	−2.590746	−0.393199	0.6994
DLOG (HCT [−2])	3.277586	1.154999	0.2650
DLOG (EXPS)	0.072387	2.113579	0.0506
DLOG (EXPS [−1])	−0.135986	−3.588757	0.0025
DLOG (EXPS [−2])	−0.092915	−2.835678	0.0119
DLOG (IMPS)	−0.161852	−4.513153	0.0004
DLOG (IMPS [−1])	0.073365	2.402404	0.0288
D (TREND)	0.073365	6.923299	0.0000
CointEq (−1)	−2.255515	−6.026568	0.0000
Long-run coefficients			
LOG (COP)	−0.024637	−3.241028	0.0051
IR	−0.000593	−0.696472	0.4961
LOG (HCS)	0.402232	3.947077	0.0012
LOG (EXPS)	0.163998	3.574835	0.0025
LOG (IMPS)	−0.098859	−3.436786	0.0034
C	7.791973	5.285546	0.0001
Trend	0.032527	8.592952	0.0000

Source: Author's calculation.

TABLE 7 | Diagnostic test—Serial correlation and heteroskedasticity.

	Breusch-Godfrey Serial Correlation L.M. test	**Heteroskedasticity Test: Breusch-Pagan-Godfrey**
Models	***F*-statistics (Prob)**	***F*-statistics (Prob)**
Agriculture sector	1.729084 F (1,3) = 0.2800	0.621650 F (28,7) = 0.8259
Industrial sector	0.0.027300 F (1,23) = 0.8702	0.691648 F (13,23) = 0.7520
Services sector	0.317387 F (1,15) = 0.5815	4.602010 F (18,16) = 0.4024

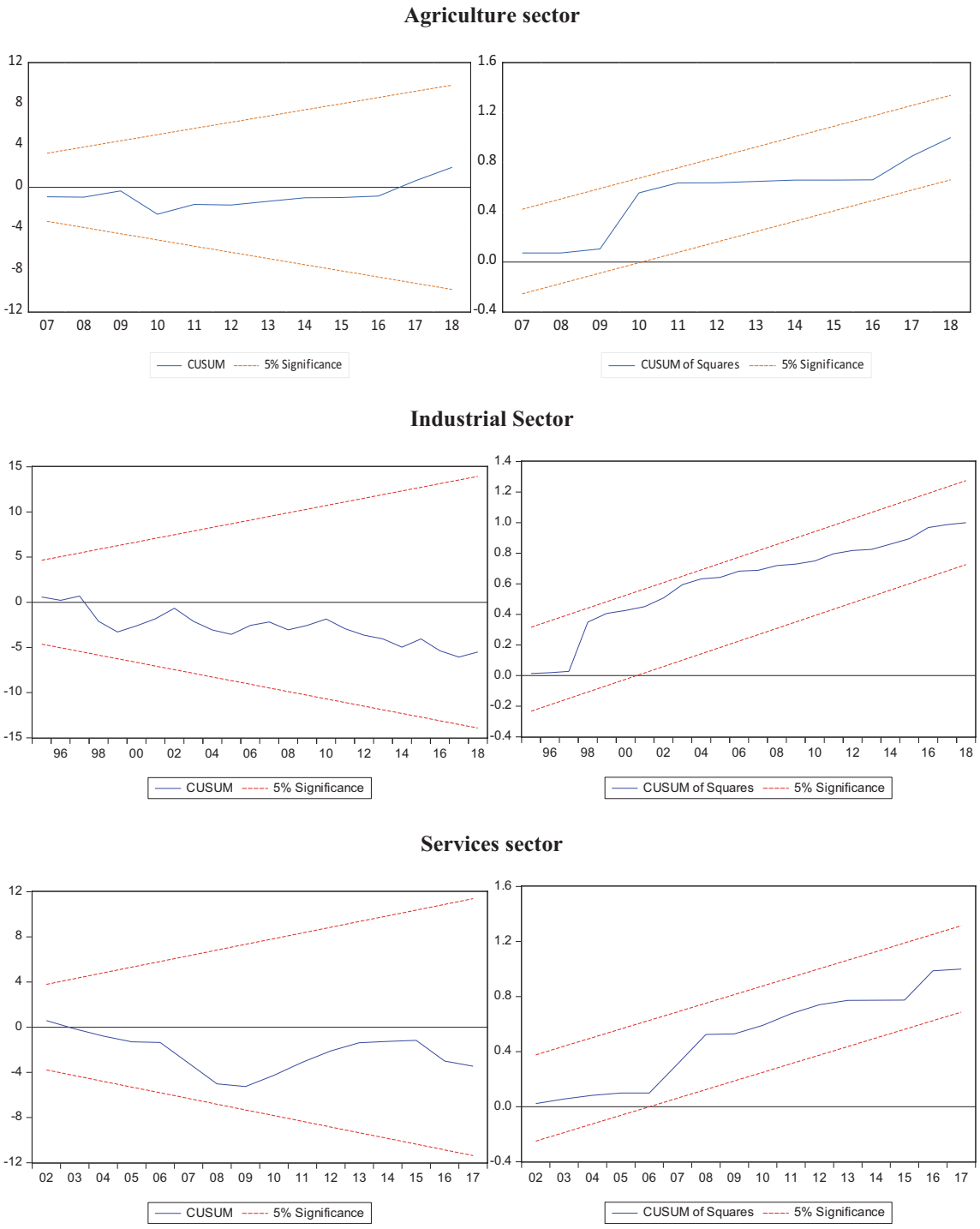

FIGURE 3 | Stability Test Results—CUSUM and CUSUMSQ Plots.

employment in the short run and long run, respectively. Bhattacharya and Mitra (1997) showed that trade openness has a positive association with service sector employment but not in all sub-sectors of this sector. Trade openness enhances commercialization and specialization, which increases employment in the services sector. In fact, trade openness tends to shift labor from other sectors to the services sector. A study by Alam and Azhar (1987) showed that the average annual growth rate of exports had a significant positive association with services sector employment in developing countries, while manufactured exports and imports had an insignificant impact on industrial sector employment.

The cropped area tends to have a positive relationship with agricultural sector employment. Results indicated that an increase in cropped area in Pakistan led to a 1.24% rise in employment in the agricultural sector in the long run and 1.4% in the short run. The cropped area seems to be an important indicator of the labor employed in rural areas. Qureshi et al. (1990) found that agricultural growth for employment generation depends upon multiple

factors, and the cropped area is one of them. They found that the increase in the cropped area is a significant factor for Pakistan's rural growth and employment during the pre- and post-green revolution. The area under crop has been identified as a significant factor in creating jobs in the agriculture sector. Results showed that the rural population has a negative impact on agricultural employment. This relationship is significant in the long run but insignificant in the short run. One percent increase in the rural population tends to decrease agricultural employment by 6.53% in the long run. Therefore, the increase in the rural population of Pakistan is negatively contributing to employment in the agriculture sector. Kalim (2003) also explored that increasing population usually erodes employment opportunities in economies. Results of the study indicated that a 1% rise in urban population leads to a 1.64% rise in industrial employment in the long run and by 1.2% in the short run. It shows that with an increase in the urban population, employment in the industrial sector has increased significantly.

In the estimated models, the lagged error correction term's (CointEq) coefficient was negative and significant. The CointEq value of −1.87 and −2.25 indicated the presence of disequilibrium in the agricultural and services sector model, respectively. The short-run disequilibrium in these sectors moves to the long-run equilibrium in 5–6 months. Similarly, for the industrial sector, the coefficient of CointEq (−1) also showed the existence of long-run co-integration among variables and convergence of the system toward the long-run equilibrium.

After testing for cointegration, diagnostic tests for serial correlation (Breusch Godfrey Langrage multiplier) and heteroscedasticity (Breusch-Pagan-Godfrey) had been applied. Table 7 reports the results for the diagnostic tests of serial correlation and heteroscedasticity. Results showed that all three models did not have serial correlation and heteroscedasticity problems. Therefore, the null hypothesis of no autocorrelation between residuals and homoscedastic variance of the error term at a 5% significance level has not been rejected.

Figure 3 shows the plots for CUSUM and CUSUMSQ for all estimated models. CUSUM and CUSUMSQ plots indicated the stability of parameters and insignificant change in variance over sample period for agricultural, industrial and services sector models, respectively.

5 | Conclusion and Policy Implications

The results revealed a negative association between crude oil prices and sectoral employment in Pakistan. Therefore, policymakers should be aware of the adverse impact of increasing crude oil prices on employment. The Government of Pakistan should stabilize the effect of the rise in crude oil prices on sectoral employment by reducing taxes on petroleum products. Predominantly an oil-importing country, Pakistan cannot control or influence international oil prices, but it can control taxation on oil in the domestic market. This can be achieved through short-term policies and long-term structural reforms; however, the prevailing culture of ad-hocism and piecemeal reform efforts hinders this process. Thus, targeted subsidies for farmers and low-income households need to be operationalized instead of blanket subsidies, aligning with international best practices. Sectoral interventions and sustainable and pro-poor labor market policies can boost both employment, leading to growth in these sectors. In the long term, through structural reforms, the government can promote and strengthen the renewable energy sector to expand domestic production.

Secondly, the food and services exports have a significant positive association with the agricultural and services sector employment. Thus, the government should formulate suitable policies to promote exports of these sectors. The Government of Pakistan can provide subsidies to farmers for producing more food items. As Pakistan is an agricultural economy, it can minimize its trade deficit by promoting food exports. Moreover, the government should promote services exports by providing progressive tax exemptions to the services sector to create more job opportunities in Pakistan. The negative impact of imports on sectoral employment shows that Pakistan should discourage imports to improve labor employment.

This research inquiry proves that the rural population has a negative relation with employment in the agricultural sector, while the urban population has a positive impact on employment in the industrial sector. Thus, policymakers should formulate policies to control the rural population. This is possible by launching/monitoring awareness campaigns on family planning in rural areas to educate families. Since the urban population has a positive effect on employment in the industrial sector of Pakistan, the government should provide enough facilities in urban areas of the country to promote urbanization. These include health and education facilities with necessities of life in urban areas. It will increase the movement of labor from rural to urban areas. Our analysis also revealed that primary, secondary, and tertiary school-age populations have a positive and significant impact on the employment of agriculture, industrial, and services sectors, respectively. Therefore, the Government of Pakistan should formulate regulations to enhance enrollment of students across all levels of education. This can be done by providing scholarships/stipends to students at primary, secondary, and higher education levels, and free transport and meals.

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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