EXPLORING THE OIL PRICES AND UNEMPLOYMENT NEXUS IN SELECTED SUB-SAHARAN AFRICAN COUNTRIES

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Abstract

This study aims to provide an empirical answer to the question of whether increase in oil price affects unemployment rate in some of the Sub-Saharan African countries namely Botswana. Burkina Faso, Burundi, Ethiopia, Ghana, Uganda, Zimbabwe, Ivory Coast, Kenya, Mauritania, Rwanda, Togo, Senegal, Sierra Leone, South Africa and Tanzania. The data for this study was secondary and was collected from African Development Indicators (ADI), International Energy Agency (IEA), International Monetary Fund (IMF), World Development Indicators (WDI), Energy Information Administration (EIA) of United State and United Nations Statistical Division (UNSD). This study covers the period of 1992 to 2021 of the 16 sub–Saharan African selected major oil importing countries. The model was estimated using panel ARDL PMG method. The results reveal that increase in oil price has a significant positive impact on the unemployment rate in the sixteen selected sub-Saharan African oil importing countries. The policy implication is that policy makers/ government need to consider investment and provision of alternative energy sources with the objective to reduce the cost of production of firms is recommended.

Keyword: Oil price, unemployment rate, ARDL, PMG, Sub Saharan Africa

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1. Introduction

Oil has been the most significant energy source to developing countries, because it is becoming more and more relevant for the developing countries, which already account for more than a half of world total oil consumption Pershin et al. (2015). As such, oil consumption has been growing for the past one decade and it is expected that it will remain at similar levels in the next two decades in sub–Saharan African region (EIA 2020). Therefore, oil energy consumption has for long remained the source of a primary energy input to industries in sub–Saharan African countries. Oil prices for over a decade have had a profound effect on macro-economic variables, prospect of oil-importing countries considering the ever-growing need for it in the near future to satisfy production needs. Oil-importing countries became and are still highly dependent in sourcing their energy input from countries with available oil resources (Exporting Countries) and are more sensitive to economic performance and increase as a result of value attached to variation in international trade and its consequences.

However, the sub-Saharan African oil-importing countries may possibly experience negative effect whenever a change occur in the world oil market due to an increase in supply or demand channels and relevance of oil politics in price determination. Most of these problems are

directly linked to the performance of economic indicators such as unemployment. Oil consumption in sub–Saharan African countries cannot determine the price of oil in the global market alone but any changes in the prices affect the countries because of the dependency nature of their economy on oil energy sources like emerging countries of Asia. One of these problems is that sub–Saharan African countries suffer various drawbacks from many external forces and crisis in energy price increase.

The effect is felt largely in sub–Saharan African countries than other regions of the World due to vulnerability and fragile nature of sub-Saharan African economies in absorbing such shocks. Previously, energy market responds mainly to the beat of rising Western and Asian economies alone but today the vibrations of a new driving force are beginning to be experienced throughout sub–Saharan African oil importing countries, this is because populations are increasing, cities are growing and economies are further advancing and as wealth accumulation and quality of life rise so will be the energy demand. In sub–Saharan African region some economic activities required oil as a production inputs.

Thus, the justification for selecting 16 sub–Saharan African countries oil importing countries for the study is that there are some factors that were taking into account, when selecting the 16 countries. First and foremost, which is the most important factor is the data availability. The second factor was they are the major oil importing countries in the region, this is because the study confirms that by comparability of the selected countries in terms of oil consumption and production, because all the 16 selected countries are importers and consumers of oil. The selected countries heavily relied on importation of oil from other countries, for instance in the year 2020, while oil production average is very low almost close to zero in the selected countries, the data for oil consumption for these countries namely, Botswana, South Africa, Burkina Faso, Burundi, Ghana, Mauritania, Rwanda, Ethiopia, Cote d Ivory, Senegal, Sere Leone, Tanzania, Togo, Uganda, Zimbabwe and Kenya shows a steady increase (Energy Information Administration, 2021), with a cumulative sum of 82.2% of all the crude oil import to sub Saharan Africa. In summary, all the 16 countries are net importers, because the sub-Saharan African region consists of 48 countries out of which 16 countries are deemed to be net oil importing. The selection of the countries was also carried out by comparing the import and export quantity of oil of all the sub-Saharan African countries for 30 years (1992-2021). Finally, 16 countries emerged to be net oil importing as their imports exceed their level of export throughout. Interestingly, these countries maintained a consistent positive major oil importing for a quite long period of time.

One of the macroeconomic problems facing sub–Saharan African countries today is the problem of unemployment. As a result of the psychological, socio-economic and political costs of unemployment, a great effort has been devoted to examine empirically the several factors that could be possibly accounting for the persistent rise in unemployment Folawewo and Adeboje (2017). However, little attention has been paid to how the price of crude oil affects unemployment in the region. As theoretically, argued that the price of crude oil affects unemployment rate, because the cost of purchasing the crude oil will directly be added to the cost of other inputs used by the firms. As such, an increase in the price of the crude oil would increase the cost of production of those firms. The increase in the production cost will, also in turn, lower their profits, output and future investment. Since the number of workers employed is related directly to the quantity of output, therefore the ability of the firms to employ more workers will decline as a result of falls in the firm's output. In fact, some of the existing workers will have to be retrenched, thereby, leading to more unemployment in these countries.

In this paper, we focus on some sub-Saharan African countries, because according to the World Bank Africa Overview (2020), it is crucially important the improvement of policy making in

the region in order to ensure economic stability of the region. Therefore, the main motivation of this paper is to explore the nexus between oil price and unemployment rate in the region, where so little has been done on policy improvement. The region needs better analysis of factors that may affect their economic stability such as oil price. The novelty of this paper is precisely, to study the effects of oil price in sixteen selected sub-Saharan African countries with a standard methodology widely, applied for the study in developed and developing countries. However, this paper investigates the relationship between oil prices and unemployment rates in sixteen sub–Saharan African oil importing countries using panel ARDL PMG technique from 1992 to 2021.

Moreover, there are a lot of studies on the relationship between oil price and unemployment in advanced countries while little attention has been paid to how the price of crude oil affects unemployment rate in these countries using panel ARDL PMG as method of estimation and adding FDI, education, real GDP and conflict as additional variables in these countries under study. To the best of our knowledge even the few studies conducted in sub Saharan African countries mostly focussed on single country and were time series (see; Terfa & Akiri (2019); Akinlo (2020); Raifu et al.(2020) and Senzangakhona & Choga (2015)), while the panel studies were in other countries and other regions (see; Cuestas (2017); Cuestas & Gil-Alana (2018); Nusair (2020); Raifu (2021); Katircioglu et al. (2015) and Cheratian, Farzanegan, & Goltabar (2019). The research gaps that this study intends to fill is that while this study only selects oil importing countries, theirs is oil exporting countries and this provides the gap that this study intents to fill. This study is structured as follows: The Section 1 contains the introduction, problem statement, motivation, purpose, contribution, gap and structure of the study. The Section 2 includes a review of related literature, which offers some related empirical literature. The Section 3 contains methodology, the Section 4 contains the estimation strategy where the results of the study are discussed, and the Section 5 concludes the study as well as provides policy recommendations based on the findings of the study.

2. Literature Review

Since the first oil price change took place in 1973, the issue of whether there is a link between oil price and economic activity has been an important subject for researchers. Since then, several issues related to the oil price–economy nexus have been investigated and documented. One of such issues is the provision of theoretical channels through which changes in oil price affect the economy. Specifically, six channels have been documented and they include supply-side channel, wealth transfer channel, real balance channel, monetary channel, sectoral adjustment channel and uncertainty about future increases in the price of crude oil channel.

However, the theoretical keystones of the transmission channels are that oil price can affect the economy via two main channels: supply and demand channels. According to the supply channel, which is analogous to an adverse supply side, most studies support the theoretical prediction of supply-side models that rising oil prices lead to higher cost of production and lower output. This happens because oil is one of the main factors of production along with labour and capital. Thus, an increase in the price of oil will increase the cost of production, which may decrease aggregate supply, leading to higher prices, falling production, and higher unemployment. As for the demand channel, which is analogous to an adverse aggregate demand side, rising oil prices lead to income transfers from oil-importing to oil-exporting countries, which may affect oil-importing and exporting countries differently. For oil-exporting countries, the transfer of income will lead to higher national income through higher export earnings, leading to higher purchasing power and consumer demand. As for oil-importing

countries, as part of their income is transferred to oil-exporting countries, national income and purchasing power will decrease, causing aggregate demand to decrease.

Therefore, a few studies questioned the relationship between real oil price and unemployment including other macroeconomic variables. Some of the studies focus on single countries study and employed a time series analysis; others focus on group of countries study and thus employed a panel method of analysis. Despite these, there is still no consensus among the various studies resulting from peculiarities of the country under study; nature of data employed; variable measurement and combination; sample size and the methodology employed.

Starting with the pioneering study of Hamilton (1983) and Mork (1989), their finding reveals a negative relationship between oil price shocks and GDP, they also maintained that oil price shocks are responsible for economic recessions, since then, the debate has not laid to rest regarding the relationship between oil price and macro-economic variables. For instance, Carruth et al. (1998) argued that the relationship between real oil price and unemployment is positive. Nasseh and Elyasiani (1984) find that the 1973 energy price shock generated a major inflationary impulse in the U.S, Canada, the UK, Germany and France. However, several studies have emerged recently, that investigated the oil price - unemployment nexus among which are: Ordonez, Monfort, and Cuestas (2019), Cuestas and Ordonez (2018) Cuestas and Gil-Alana (2018), Cuestas(2016), Rafiq, Salim, and Bloch (2008), Kisswani and Kisswani (2019), Cuestas (2017), Kocaaslan (2019),Nusair (2020), Raifu et al (2020), Bocklet and Baek (2017), Cheratian et al. (2019), Karaki (2018), Uri (1996), Senzangakhona and Choga (2015), Wang et al. (2022), Andreopoulos (2006), Aminifard and Bahadorkhah. (2014), Altay et al. (2013) and Ahmad (2013).

Ordonez et al. (2019), using structural vector autoregressive model (SVAR) in examining the effects of oil price changes on unemployment in Spain. By allowing asymmetric relationship, the findings revealed that increase in oil price has a negative impact on unemployment while decrease in oil price positively affects unemployment, even though the effect of increase in the price is stronger than the decrease in the oil prices. Similarly, the effect of oil price shocks on unemployment was examined in the UK, asymmetric and symmetric were allowed by utilising SVAR model, by differentiating between positive and negative oil price changes the study finds that a positive oil price shocks had a stronger negative effect on unemployment 2007/2008 financial crisis while negative shocks after the financial crises contributed to the keeping the rate of unemployment at low levels Cuestas and Ordonez (2018).

In similar vein, effects of oil price changes on unemployment in Central and Eastern Europe was investigated by Cuestas and Gil-Alana (2018), the findings revealed a mixed results for the short-run effect, where they find that rising oil price led to an increase in the equilibrium unemployment rate while falling oil price leads to a decrease in equilibrium unemployment rate. Cuestas (2016), investigated the oil price changes on unemployment rate using the NARDL model, the results show that the effect although oil prices have no effect on the unemployment rate, in such a way that rising oil price has a stronger and more harm and even damaging effect on the equilibrium unemployment rate than the falling oil price does. In another study conducted by Katircioglu et al. (2015), find a negative impact of oil price on the GDP, unemployment and consumer prices of the OECD countries. Rafiq, Salim, and Bloch (2008) revealed that volatility in oil price has a significant positive impact on unemployment and investment in Thailand. Similarly, changes in the oil prices do affect the countries' economic activities for several reasons because oil is considered as one of the inputs of

production process alongside capital and labour (Nusair, 2020). The effect of changes in oil price on unemployment might take place via the supply channel (Kilian, 2014).

Similarly, for a country specific study, nexus between oil price and employment was examined in Saudi Arabia using ARDL and NARDL and found that there was an asymmetric relationship between price of oil and employment and that an increase in oil price had a positive effect on employment. The positive effect of oil price increase on employment is even more than the positive effect of oil price decline Alkhateeb et al (2017). In another study oil price changes were examined by Bocklet and Baek (2017), in the State of Alaska in the USA, and it was found that an increase in oil prices only had a short run asymmetric effect on unemployment. The result also indicated that unemployment responded much more to a positive change in oil prices than to a negative change in oil prices. In a similar vein, Karaki (2018), investigated the oil price-unemployment nexus in the USA and its States. The study used nonlinear structural equation and structural vector autoregressive (SVAR) estimation technique and found no evidence against the null hypothesis of asymmetric effect. It was also revealed that oil demand shocks reduced unemployment rate across most of the States in the USA, while oil supply shocks worsened unemployment situation. However, oil-specific shocks had a little effect on unemployment in the States.

On the other hand, Kisswani and Kisswani (2019), investigated the asymmetric effects of oil prices on gender and total employment in the US market using NARDL and revealed that asymmetric effects of oil price changes can be observed on total and male employment in the long run only. However, asymmetric effects of oil price changes existed for all the categories of employment in the short run. Kocaarslan et al. [2019], studied the symmetric impact of oil prices, interest rate and oil price uncertainty on unemployment in the USA and found that asymmetric effects existed between the changes in oil prices and unemployment. It was also discovered that an increase in oil prices led to a significant increase in unemployment, while a decrease in the prices of oil had no significant effect on unemployment. Similarly, a reduction in oil price uncertainty was found to be resulting a decrease in unemployment, whereas, an increase in the oil prices uncertainty, had no significant impact.

However, for cross country studies a lot of studies have been conducted, for instance Cheratian et al. [2019], investigated the oil price shocks-employment rate nexus in Middle East North Africa (MENA) region using NARDL. Their results reveal that the positive changes in oil prices exerted a positive impact on the unemployment rate for oil exporting countries of MENA in the short run. Whereas, in the long run, an increase in oil prices had a significant increasing effect on unemployment rate for both oil importing and oil exporting countries in the region. However, the findings also reveal that negative changes in oil prices did not have any significant effect on the unemployment rate. In a similar study, Nusair [2020], examined the asymmetric effects of oil price changes on employment in Canada and the USA using ARDL and NARDL estimation techniques. The findings based on ARDL reveal that changes in oil prices had a significant effect on employment in the long run. While, there was no or little effect in the short run. The result from the NARDL reveal that positive changes in oil prices had a long run positive and significant effect on the unemployment rate in all cases. The negative effect of oil price changes was significant on the unemployment rate in the short run only.

The effect of the oil price change via the supply channel is leading to rise in the price level and fall in the level output. Firms might encounter the dilemma of either to delay the production or

cutting the level of production every time the oil price raised, at times they are even encountering the jeopardy of delaying production and cutting the level of output especially at a time when the increasing oil price is too much. Likewise, when the oil price drops, the costs of production drops too, the price of outputs is anticipated to drop if only there is absence of an upward wage rigidity. But in a case where the nominal wage rigidity exists, this may not even happen. The wage might not be increased and even if it is going to be increased it will be increased by a scanty amount if compared to the increase in the price of oil and that is asymmetric effect. The demand side channel is similar to the adverse shock of aggregate demand, as the increasing oil price is leading to the income transfer from the advanced oil importing economies to the developing oil exporting countries. The effect is different to the two categories of the countries, to the oil exporting countries, the increase of oil price is leading to the increase revenue, increase in the aggregate consumption which can boost the aggregate demand thereby triggering the decrease in the unemployment rate. While the effect for the oil importing countries like Japan and USA is decreasing of consumer demands as part of their wealth is being transferred to the oil exporting countries through the increased oil prices (Blanchard and Gali, 2007).

Herrera and Karaki (2015) investigate the effect of oil price shocks on job flows in US industrial sectors using a simultaneous equation model that nests symmetric and asymmetric responses. They were unable, however, to detect any significant evidence of asymmetry in the reaction of job flows to positive and negative oil price shocks. Furthermore, the effect of oil price innovations on job reallocation is found to be statistically insignificant at both the aggregate and sectoral levels, implying that oil price shocks affect employment primarily through aggregate channels (such as income transfers or output decreases) rather than allocative channels. The link between oil price and unemployment has long been established, as shown in the literature review above. However, the results have demonstrated clear evidence on the absence of consensus and also pave way for the study because the literature reviewed shows that the impact of oil price on unemployment has received relatively less attention especially in Sub Saharan African region. This provides the gaps that this study intends to fill in order to contribute to scientific knowledge and in order to contribute to ongoing scientific debate.

3. Methodology

This Section focuses on the theoretical framework as well as the methodological approach of the study, the data used for this study was secondary and was collected from African Development Indicators (ADI), International Energy Agency (IEA), International Monetary Fund (IMF), World Development Indicators (WDI), Energy Information Administration (EIA) of United State and United Nations Statistical Division (UNSD). This study covers the period of 1992 to 2021 of the 16 sub–Saharan African selected major oil importing countries. The model was estimated using panel ARDL PMG method. Therefore, the study rests on the basic model of efficiency-wage version by Shapiro and Joseph (1984).

Thus:

$$\text{Log } w = \log b + e + \frac{e.d}{\{1-a(U)\}(1-d)} \quad (1)$$

where w is the wage, b is the level of unemployment benefits, e is the level of the job effort (fixed due to technology), d is the probability of shirking successfully without been caught, U is the unemployment rate and a(u) is the probability of an unemployed worker.

Then this study followed Curuth et al. (1998); Bocklet and Baek (2017) & Raifu et al. (2020) with some modifications.

Thus;

$$w=f(B, UR) \quad (2)$$

where w remains as explained earlier, UR is the unemployment rate, B donates the level of unemployment benefits. However, in the equation (2), implies that wage is a function of the unemployment benefits and unemployment rate. In a production function labour and capital are the inputs used to produce a given unit of output. As such, as the economy becomes modernized, then energy will be another significant input used for production Polat (2018). Given these factors of production that is labour, capital and energy, the minimum cost of producing a unit of output sold at price (p) is given as:

$$c = \frac{1}{\delta}(W, IR, OP) \quad (3)$$

where IR is the interest rate, OP is the oil price and δ is used to measure neutral technical progress. If the market is perfectly competitive, then there must be no any form of profit in equilibrium. This implies that P-C =0. If P is set to unity as a result of the assumption of homogenous of degree one, then the equation can be specified as:

$$\delta=g(W, IR, OP) \quad (4)$$

Equation (2) is substituted in to equation (4) in order to eliminate wage from equation (2), then re-arranged and obtain equation;

$$UR = g(B(\delta), IR, OP) \quad (5)$$

Following the Bocklet and Baek (2017) and Raifu et al. (2020), unemployment benefit B (δ) is replaced with real GDP per capita and FDI as the determinants of the rate of unemployment Thus;

$$UR_t = \alpha + bOP_t + cIR_t + dY_t + \varepsilon_t \quad (6)$$

where URt is the logarithm of unemployment rate, OP_t is the logarithm of crude oil price, IR_t is the interest rate, Y_t is the log of real GDP and ε_t is the error term. The specification is modified to accommodate education and conflict, they are added as other factors that might affect unemployment while interest rate is replaced with foreign direct investment FDI then obtain equation as;

$$UR_{it} = f(Y_{it}, FDI_{it}, EDU_{it}, CONF_{it}, ROP_{it}) \quad (7)$$

where UR is the unemployment rate, Y is the real GDP per capita, FDI is the foreign direct investment, CONF is conflict and ROP is real oil price. The next section discusses the econometric model specification.

Given the nature of the sample observed in this study, which spans 16 countries and 30 years, panel data analysis is the right approach. The study covers the period of 1992 to 2021 of the 16 sub Saharan African selected major oil importing countries. The model was estimated using panel ARDL PMG method. Although there are many estimation techniques available in the panel data framework, this study used the panel autoregressive distributed lag (ARDL) method, which is based on three estimators: mean group (MG), Pooled mean group (PMG) by Peasaran and Smith (1995), and dynamic fixed effects (DFE) by Peasaran et al. (1999). Loayza and

Ranciere (2006) and Samargandi et al. (2015), suggest that the dynamic heterogeneous panel can be incorporated in to an error correction model based on ARDL (p, q) approach, which means p as the dependent variable's lag and q as independent variable's lag. For an unrestricted ARDL specification equation for period t = 1, 2…….T, with the number of countries I = 1, 2…..N, then the PMG parameters of interest are the long run association and the speed of adjustment, with the parameters consistent and asymptotically normal for both stationary (1(0)) and non- stationary (1(1)) explanatory variables (Pesaran et al. 1999). Thus, the model for this study is specified as;

$$\Delta UR_{i,t} = \sum_{j=1}^{p-1} \beta^{i}_{j} \Delta UR_{i,t-j} + \sum_{j=0}^{q-1} \rho^{i}_{j} \Delta X_{i,t-j} + \delta^{i}[UR_{i,t-1} - \{\theta^{i}_{0} + \theta^{i}_{1} X_{i,t-1}\}] + \mu_{i} \quad (8)$$

where UR is the unemployment rate, X is the vector set of all the independent variables included in the model, β and ρ are the respective short run dynamic coefficients of lagged dependent and independent variables. While θ represents the coefficients of the long run, δ is the coefficient of the speed of adjustment to the equilibrium in the long run, *i* represents the countries, *t* is the years and μ is the error term. The whole term in the square bracket represents the long run regression derived from;

$$UR_{i,t} = \theta^{i}_{0} + \theta^{i}_{1} X_{i,t} + \varepsilon_{it} \quad (9)$$

where $\varepsilon_{it} \sim 1(0)$

Table 1: Variables and sources of data

Variables	Proxy	Unit of Measurement	Source of Data	Expected Sign
UR	Unemployment Rate	Share of total labor force that are not working	WDI, World Bank	Dependent variable
ROP	Real oil price	US$ per barrel	EIA, U.S Energy Information Administration	Positive
Y	Real GDP per capita	Constant 2015 US Dollar	WDI, World Bank	Negative
FDI	Foreign direct investment, net inflows	Percentage of GDP	WGI, World Governance Indicators	Negative
EDU	Gross enrolment ratio, secondary	Percentage of GDP	WDI, World Bank	Negative
CONF	Event level data	total number of conflict-related deaths in each year	WDI, World Bank	Positive

(Source: Author's compilation, 2024)

4. Results and Discussion

Before the estimation of the panel ARDL model, PMG estimation some preliminary tests were conducted and this include descriptive statistics and followed by correlation matrix in order to ensure the normality and suitability of the series for the analysis. The result of the descriptive statistics is presented in Table 2, the results of descriptive statistics and other variables employed as control variables reveal that the series are well spread and normally distributed.

Table 2: Descriptive statistics

Variables	Mean	Standard Dev.	Minimum	Maximum	Observation
UR_{it}	6.957	23.387	0.871	28.77	464
ROP_{it}	134.339	15.741	31.57	138.86	464
Y_{it}	1476.89	24.801	215.636	6418.578	464
EDU_{it}	38.104	23.145	5.283	109.444	464
FDI_{it}	2.339	10.856	0.001	19.066	464
$CONF_{it}$	451.419	109.607	90	571	464

Notes: UR_{it} unemployment rate, ROP_{it} is the real oil price, Y_{it} is the real gross domestic product per capita, EDU_{it} is the education level, FDI_{it} is foreign direct investment and $CONF_{it}$ is the conflict and i and t are country and period, respectively.

The correlation testt for explanatory variables are reported in the form of correlation matrix in Table 3, for all the variables used in the study in order to explain the strength of relationship between the variables. The results indicates that the real oil price and conflict variables are positively correlated with unemployment. More importantly, the correlation test reveals that there is no high correlation between the variables, this is because all the variables are below the benchmark of 0.80 for the rule of thumb (Prodan, 2013).

Table 3 Correlation Matrix

Variables	UR_{it}	ROP_{it}	Y_{it}	EDU_{it}	FDI_{it}	$CONF_{it}$
UR_{it}	1.000					
ROP_{it}	0.625	1.000				
Y_{it}	-0.753	0.039	1.000			
EDU_{it}	-0.636	0.078	0.102	1.000		
FDI_{it}	0.219	0.032	0.089	0.232	1.000	
$CONF_{it}$	0.072	0.030	0.039	0.626	0.295	1.000

Notes: UR_{it} is the unemployment rate, ROP_{it} is the real oil price, Y_{it} is real gross domestic product per capita, FDI_{it} is the foreign direct investment EDU_{it} is the educational level and $CONF_{it}$ is the conflict and i and t are country and period, respectively.

It is imperative to conduct the unit root tests and cointegration tests considering the longer period the study covered, in order to assess the order of integration of the variables and that of the existence of a long run relationship between the variables, respectively. Table 4 presents the results of the unit root tests, based on the estimates under the unit root with common process Levin, Lin $ Chu t., Breitung t-stat. and *Harris*-Tzavalis rho tests suggests that FDI, conflict and real oil price are stationary at level. While, unemployment rate and education are found to be not stationary at level. Therefore, after taking the first difference, they became stationary. However, under the unit root with individual process, Im, Pesaran & Shin W stat., ADF Fisher Chi-square, ADF PPerron Chi-Square tests suggest that real oil price, foreign direct investment

(FDI) and conflict are stationary at level. Whereas, unemployment rate, real GDP per capita and education level are not found to be stationary at level, but after taking the first difference, they become stationary. However, under the no unit root with common unit root process, Hadri Z-stat. test suggests that all the variables are stationary at level. In general, the variables are considered to be a mixture of I (0) and I (1), which fit the application of ARDL panel estimators suitably.

Table 4. Results of unit root tests

Method Variable	UR	ROP	Y	FDI	EDU	CONF
Null Hypothesis: unit root with common process						
*Levin, Lin &Chu t**	-15.694***b	-46.007***a	-19.985***a	-11.682***a	-11.864***b	-12.854***a
Breitung t-stat.	-2.8899***b	0.0929*a	-4.2779***a	-2.7934***a	-5.9183***b	-0.4122***a
Harris-Tzavalis rho	-0.2948***b	-0.5111***a	'-0.1426***a	-0.4033***a	-0.3429***b	0.5798***a
Null Hypothesis: unit root with individual unit root process						
Im, Pesaran & Shin W stat	-9.1886***b	-47.383***a	-13.828***b	'-5.8757**a	-5.8637***b	13.185***a
ADF Fisher Chi-square	'-6.7568***b	-5.3626***a	-9.6842***b	'-4.5651***a	'-3.9197***b	-4.8149***a
ADF PPerron Chi-Square	'-9.7191***b	-15.207***a	-13.600***b	-6.9342***a	'-7.7681***b	-9.3251***a
Null hypothesis: no unit root with common unit root process						
Hadri Z-stat.	4.4629***a	7.0348***a	13.785***a	4.6436***a	14.0190***a	10.165***a
No. of Cross-sections	16	16	16	16	16	16
No. of Periods	30	30	30	30	30	30
Total observations	464	464	464	464	464	464

Note: **a** represents stationarity at level, whereas **b** represents first difference stationarity; ***, **, * show statistical significance at 1%, 5%, and 10%, respectively.

Table 5 reports the results of the long run relationship among the variables, where the study employs Pedroni cointegration test. However, as suggested by Pedroni (1999), two types of residual tests are reported in the Table. The first panel in the Table 5 contains the first type, which comprises of four sub-tests, that is, panel-v, panel-rho, panel PP and panel ADF statistics. These tests are based on pooling the residuals regression along the within the dimension of the panel. Whereas, the second type is contained in the table's second panel, which consists of three sub sets namely, group rho, group PP and group ADF statistics. On the other hand, these tests are based on pooling the residuals along the between the dimension of the panel. However, all the seven sub tests have the same null hypothesis of no cointegration from both the two types.

The results from these tests indicate that five out of the seven statistics are significant, meaning five out of the seven statistics including panel ADF and group ADF are significant. Lee and Chang (2008) and Smyth and Prasad (2007), assert that if at least four statistics are significant, then the null hypothesis of no cointegration should be rejected and hence cointegration exists. Moreover, Pedroni (1999) suggests that panel ADF and group ADF need to be considered before the study concludes about the existence of cointegration, because they have better small sample properties, as such their statistics provides reliable estimates. Therefore, following these authors, this study concludes that the long run relationship exists among the variables as five out of the seven statistics including panel ADF and group ADF are significant.

Table 5 Results for Pedroni panel cointegration test

	Test with trend	Test without Trend
Within Dimension		
Panel v-statistics	-0.026*	-5.034
Panel rho-statistics	1.803	0.736**
Panel PP-statistics	-0.238	-0.652***
Panel ADF-statistics	0.809**	-2.698***
Between Dimension		
Group rho statistics	3.359***	1.322
Group PP-statistics	1.738	-1.565**
Group ADF-statistics	1.171**	-3.602***

Note: ***, **, * show statistical significance at 1%, 5%, and 10%, respectively.

Table 6 shows the results of a panel data analysis of the PMG, MG, and DFE estimation techniques, which were used to investigate the relationship between the oil price and unemployment in both the long and short run, as well as the Hausman test, which measures the efficiency and consistency of the three estimates. According to both the MG and PMG estimators, the results show that real oil prices have a positive and significant long-run impact on unemployment rates in oil-importing countries in the Sub-Saharan African region. According to the DFE estimator, the results show that the real oil price has a negative and insignificant impact on unemployment. Hausman tests are performed and presented in Table 6

in order to ascertain the validity, consistency, and efficiency of long run homogeneity of restriction across cross sections, which is the advantage of PMG estimator over MG and DFE estimators.

However, since the p-value of 7.642(0.689) is insignificant, the Hausman test fails to reject the significant result of long run homogeneity of coefficients and accepts the null hypothesis of long run homogeneity of restriction on the long run coefficients. This means that PMG is a more efficient estimator than MG and DFE. Since the study discovered that the PMG estimator is the most efficient estimator among the three estimators, the study's analysis focuses on PMG estimates. Notably, the real oil price (ROP) has a very statistically significant positive impact on unemployment, with a significant coefficient of 3.224 in the long run, in line with the study of Nusair (2020). This suggests that if oil price rises over the long run, unemployment grows dramatically in the sub-Saharan oil-importing countries. This means that an increase in the real price of oil will lead to an increase in the cost of production for businesses that utilize oil as an input alongside labour and capital. The increase in production costs will lower output, resulting to an increase in the unemployment rate. Real GDP per capita (Y), on the other hand, emerges as a critical predictor with a very significant negative connection with unemployment. Its PMG coefficient of -5.152 indicates that higher real GDP per capita is linked to a reduction in unemployment in the mean countries, which is in line with the study of Bocklet and Baek (2017), which states that improving the economic conditions in Sub Saharan African oil importing countries has an effect on reducing unemployment in the mean countries.

Foreign direct investment (FDI) shows a significant negative impact on unemployment over the long run, which is in line with the study of Raifu et al. (2020), suggesting that foreign direct investment (FDI) is an excellent instrument in reducing unemployment in Sub-Saharan African oil-importing countries. As a result, attracting FDI in the form of multinational business portfolio or investment might provide job opportunities and lower the countries' unemployment rate. However, as evidenced by the PMG coefficient of -0.0132, the relationship between education (EDU) and unemployment remains negative but insignificant in the long run. This suggests that education has insignificant effect on the unemployment rate in the Sub-Saharan African oil-importing countries. In contrast, the level of conflict (CONF) has the desired result, with a PMG coefficient of 1.235 suggesting a significant positive impact on unemployment in the long run. This means that the higher the levels of conflict are connected with increased unemployment, which is consistent with the study of Hameed et al. (2023).

Moving to the short run relationship, the co-efficient of oil price on unemployment is found to be positive but insignificant from PMG estimator, however the result produced by MG shows that the co-efficient of oil price on unemployment has a positive and significant impact on the unemployment rate. Real GDP per capita (Y) retains its relevance with a statistically significant negative impact of oil price coefficient of -2.228 on unemployment, however the short run oil price (ROP) shows a positive impact on unemployment in DFE. This suggests that increased real GDP per capita is related with a reduction in unemployment in the short run. Other variables, such as foreign direct investment (FDI), education (EDU), and conflict level (CONF), reveal an insignificant effect on unemployment in the short run.

The results also include the "ECT" term, representing the error correction term, which is crucial in panel data analysis. The highly significant negative coefficient for "ECT" in the PMG model (-0.289) suggests that deviations from the long-run equilibrium in unemployment are being corrected over time, bringing the unemployment rate back to its stable state. Also, indicating the speed of the long run convergence among the variables is 28.9%, and affirms the long run relationship among the variables. Moreover, the PMG estimation results offer valuable insights into the complex relationships between the real oil price, real GDP per capita, foreign direct

investment, education, the level of conflict, and the outcome variable of unemployment. These findings can provide valuable guidance to policymakers and researchers aiming to address unemployment challenges and design effective policies to promote sustainable economic growth and employment opportunities in oil importing countries in Sub-Saharan Africa. Endogeneity problem is perceived to be associated with long run estimates of the PMG. However, to clear the doubt, the study has estimated the same model using panel DOLS with one lag and lead as a robustness check. Panel dynamic ordinary least square (DOLS) is famous for its power and ability to deal with serial correlation and endogeneity problems in a model. As such, the results of panel DOLS serves for two things, first, it serves as a diagnostic check for the long run PMG model against endogeneity bias and serial correlation as well as robustness check. The result is presented in Table 6, the result reveals that all the included variables in the model are significant and rightly signed as expected except the variable education which is not significant in PMG and shows a significant coefficient in DOLS. Therefore, the findings substantiate and validates the obtained result from long run estimates of PMG and conclude that, the result from PMG model are reliable and valid.

Table 6. Panel models estimation result

Long run coefficients				
Variables	MG	PMG	DFE	DOLS
Constant	6.976	-1.520***	-2.781*	
	(0.012)	(0.535)	(0.494)	
lnROP	0.038**	3.224***	-0.383	0.003**
	(0.533)	(0.776)	(0.991)	(0.001)
lnY	2.049	-5.152**	-2.024	-0.003***
	(0.016)	(0.343)	(0.054)	(0.001)
FDI	0.218	-0.045***	0.034***	-0.040*
	(0.217)	(0.060)	(0.115)	(0.057)
EDU	-0.017	-0.013	3.872***	-0.029**
	(0.046)	(0.019)	(0.056)	(0.016)
lnCONF	-0.563	0.235***	-1.296	0.007***
	(0.588)	(0.436)	-0.127	(0.001)
Short run coefficients				
lnROP	0.036**	0.051	-0.0936	
	(0.122)	(0.176)	(0.089)	
lnY	-2.208*	-2.228*	-0.967*	
	(0.168)	(0.245)	(0.558)	
FDI	-0.020	0.032	0.015	
	(0.021)	(0.022)	(0.011)	

EDU	0.0292	0.031	0.001	
	(0.048)	(0.029)	(0.017)	
lnCONF	-1.834	1.503	-0.022	
	(0.922)	(0.505)	(0.135)	
ECT	-0.255***	-0.289**	-0.105***	
	(0.051)	(0.035)	-0.0257	
Hausman		7.642(0.689)		
Observations	464	464	464	464

5.1 Conclusion

The results were estimated in three ways; first is the unit root tests and cointegration tests as a result of the longer period the study covered, in order to assess the order of integration of the variables and that of the existence of a long run relationship. Second the results were estimated using PMG, MG and DFE estimators. Third, the dynamic ordinary least square (DOLS) is used for diagnostic checks as well as robustness checks. However, the result discussion and analysis for unemployment and oil price reveals an insight into the relationship between these two important economic variables. The correlation analysis indicates a strong positive correlation between unemployment rate and the real oil price, suggesting that fluctuations in the oil market has a direct impact on unemployment rate in the countries under study. However, it is crucial to note that other factors that may be influencing unemployment rate in the studied region. In the long run, the Pooled Mean Group (PMG) estimation demonstrates a significant positive relationship between the real oil price and unemployment, with a substantial coefficient. This finding indicates that in the long run, an increase in the real oil price is linked to higher unemployment rates, potentially due to the implications of energy costs on production and labour demand.

5.2 Policy Recommendations

The implication is that increase in oil price results in a slowdown of economic activities, which leads to higher unemployment rates. This is because, oil is one of the important factors of production along with labour and capital, as such, whenever its price increases, the cost of production will also increase, which causes the output to decrease and unemployment to increase. The study also reveals a strong positive correlation between real GDP per capita and unemployment, highlighting that higher economic prosperity is associated with reducing unemployment rates. Overall, these findings suggest a complex interplay of various economic factors impacting unemployment, with the real oil price playing a significant role in the long run. The policy implication is that policy makers/ government need to consider investment and provision of alternative energy sources with the objective to reduce the cost of production of firms is recommended. Policy makers should also consider these results while formulating strategies to promote employment opportunities and sustainable economic growth in the region.

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