Oil price volatility and industrial productivity: a comparative analysis of Nigeria and Egypt

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Abstract

This study examines the relationship between oil price volatility and industrial productivity in Nigeria and Egypt from 1980 - 2020. The study employs cointegration analysis and the Error Correction model to analyze data. The result shows that oil price volatility hinders industrial productivity in both Countries. But the magnitude of the effect was more in Nigeria than in Egypt. It can be traced to the fact that Nigeria is an importing Country while Egypt is a net exporting country. Also, Nigeria has neglected important sectors like the Industrial sector at the advent of oil, which made Nigeria a mono-product country for decades. Based on these findings, the study recommended diversification of the export revenue base for Nigeria to minimize reliance on oil. Also, alternative energy sources such as biofuel and solar power plants should be developed for the two countries to reduce dependency on oil consumption.

Keywords: *Industrial productivity, Industrial value-added*, *Oil price volatility*

JEL Classification: O44, Q41, Q43

INTRODUCTION

Oil plays a dominant role in the economy of any nation because it is one of the most important natural resources with the world's largest commodity market. It has a huge contribution to the revenue of a country. For instance, oil receipts accounted for 82.1%, 83%, and about 90% of Nigerian's foreign exchange earnings in 1974, 2008, and 2010 respectively (CBN Statistical bulletin, 2011). The effect of oil price volatility on the industrial productivity of an oil-exporting country is different from its effect on a net importing country. The immediate effect of the Oil Price increase is to increase the cost of production for oil-importing countries, as this will surely reduce the output. Higher oil price lowers disposable income and decreases consumption. Where the increase is perceived as persistent, oil is less utilized in production, capital, labor productivity decreases, and potential industrial output falls. For oil-exporting countries, oil production usually accounts for a large share of their GDP, and an increase in Oil price directly increases the country's currency value. However, the total effect of oil price increase on each sector of the economy depends on what the oil-producing nation does with the additional revenue (Hakan & Nukhet, 2010). The effect is also different across sectors depending on the nature of the sector's activity and its capacity to absorb and transmit the oil risk to its consumers and other economic sectors (Martins & Filian, 2004; Shawkat & Salim, 2006).

Industrial productivity refers to the output of industrial establishments, and it covers sectors such as construction, mining, manufacturing, and public utilities (electricity, water, and gas). The industrial sector is energy-intensive, using electricity and oil as the main energy source in its production processes, transport, distribution, and service rendering activities (Onuonga et al. 2011).

In this study, Nigeria and Egypt were chosen to compare the effects of oil price volatility on their industrial productivity because of the difference in economic characteristics. In the Nigerian economy, the history of industrial productivity is a classical illustration of how a nation could neglect a vital sector through policy inconsistency and distraction attributable to crude oil discovery.

Oil was discovered in commercial quantity at Oloibiri in Nigeria's Niger Delta region in 1956, but production did not start until 1958. In 1960, there was a significant increase in the industrial sector from 4.8% to 8.2% in 1990. However, in 2000 and 2002, this economic sector took a big hit and reduced its contribution from 64.1% to 3.4%. Since 2000, the oil sector has dominated all other sectors by increasing its contribution to 47.5%. However, due to the rapid growth and dominance of the oil sector, the industrial sector could not experience much growth (Ayadi, 2000).

In 1971, Nigeria became a member of the Organization of Petroleum Exporting Countries (OPEC). She was the fifth-largest supplier of crude oil to the United States and the seventh-largest producer of oil in the world. Nigeria's economy depends heavily on oil. 1t accounts for over 90% of the nation's export revenues and over 90% of foreign exchange earnings. The oil boom made the economy depend heavily on it, causing the agricultural sector to neglect. Many manufacturers and industries have been denied their source of raw materials. Import substitution and promotion of export earnings are affected by the absence of locally sourced input, which is the main industrialization strategy, resulting in low industrialization. The crux of the problem lies in the fact that Nigeria relied on this commodity over the years, making it's economy a mono-product economy, which has triggered severe economic structural difficulties.

The Egyptian economy is similar to that of Nigeria, as agriculture was the mainstay of its economy. In the 1970s, agriculture employed more than 90% of the Egyptian working population. Today, it only employs 32% of the labor force, and its share in Gross Domestic Product has been reduced to 13.1% as of 2010. This was due to oil discovery and rapid industrialization. In 1886, oil was first discovered in Ras Gemsar with 10 barrels per day production. In 1969, oil production reached 500,000 barrels per day. In January 2013, Egypt's oil reserve was estimated at 4.4 billion barrels per day. This increase was due to several new oil discoveries by United States Apache since 2008 (OAPEC Statistical bulletin). Egypt is an important none OPEC energy producer. It has the sixth-largest proved oil reserve in Africa. However, Egypt is not a member of OPEC but the Organization of Arab Petroleum Exporting Countries (OAPEC).

Egyptian oil production began to decline from its peak in 1996. Then, the production was 922000 barrels per day; in 2002, it was 631,000 barrels per day; in 2011, it declined to 555,000 barrels per day. In contrast, industrial demand for oil increased from 501,000 barrels per day in 1996 to 585,000 barrels per day in 1999. This increase in demand was attributable to rapid industrial growth and government subsidies, as the government-subsidized most oil products to prevent rising prices. The price of fuel has not changed in the past decades, which has encouraged overconsumption (Amcham, 2003). As of April 20, 2016, Egypt was the largest none OPEC oil producer in Africa.

The Industrial sector is the second largest sector in Egypt and accounted for 32% of Gross Domestic Product In 1999. It employs approximately 17% of the labor force and contributes 37% to Gross Domestic Product. The sector's contribution depends heavily on the performance of the world market and fluctuates accordingly. In the early 1970s, Egypt was faced with a drop in industrial growth due to its defeat in the 1967 war resulting in the loss of revenues from oil fields.

According to the World Bank, in the year 2013. The oil price fell from $105.9 per barrel to $28 per barrel in February 2016. Within this period, the value-added of the industrial sector to Gross Domestic Product was 16%. In the first quarter of 2015, the value-added was reduced by 7% (World Bank, 2013).

Similar studies in the past have discussed oil price volatility and its effect on economic growth. Olomola & Adejumo (2006), Chuku et al. (2010), and Ikla et al. (2012) have all provided evidence that there is indeed a relationship between the two.

Empirical studies focusing on developed economics (Hamilton, 1983; Hooker, 1996; Jimenez-Rodrigues & Sanchez, 2005; Fills & Chatziantoniou, 2013) have revealed that crude oil price increase tends to have an adverse effect on industrial productivity and economic growth. Nevertheless, they all concluded that this relationship had not been stable for these countries over time. The unsteady relationship that had been perceived in the literature was confirmed in a study by Blanchard & Gali (2007), who compared the present response of inflation and output to oil price shocks in the group of developed economies to those in the 1970s Blanchard & Gali. (2007) concluded that the main cause behind the weak responses of economies in recent years was smaller energy intensity, a more flexible labor market, and improvement in monetary policy.

Jiranyakul (2006) examines the effect of changes in all prices on industrial productivity in Thailand using the Johansen cointegration test. He found that oil price change positively affected industrial productivity in the long run, while the change in oil prices negatively affected industrial production in the short run. Empirical studies on the oil price and industrial productivity growth relationship for developing economies have reported different results.

Chang & Wong (2003) used a structural VAR model to examine the effects of oil price fluctuations on the Singaporean economy. They found an insignificant negative relationship between oil price shocks and Singapore's gross domestic output, inflation, and unemployment rate. On the contrary, studies by Olomola (2006); Akpan. (2009) and Oriakhi & Osaze (2013) found a positive relationship between oil price increases and the growth of industrial productivity in Nigeria. Studies by Wakeford (2006), and Bouzid. (2012) found a negative relationship between oil price and industrial productivity growth for South Africa and Tunisia, respectively. Some exporting countries like Iran, Saudi Arabia, Indonesia, Mehrara, and Sarem (2009) said there was a unidirectional causality from oil price shocks to industrial productivity.

Tang et al. (2010) in China used structural VAR and found out that increases in oil prices affect industrial productivity negatively. Akpan (2009) used the VAR model and found a strong positive relationship between oil price changes and real government expenditures. Unexpectedly, the result identifies a marginal Impact of oil price fluctuations on Industrial productivity growth. Furthermore, the "Dutch Disease" syndrome is observed through significant real effective exchange rate appreciation.

Oriakhi & Osazee (2013) used quarterly data and employed the VAR methodology in carrying out their findings using data from 1970 to 2010. They found out that oil price volatility directly impacted real government expenditure, real exchange rate, and real import, which in tum had an impact on the real gross domestic product, real money supply, and inflation through other variables, notably government expenditure. This implies that an oil price change determines government expenditure level, which determines industrial productivity growth.

Riman et al. (2013) employed annual time series data spanning the years (1970-2010), and the methodology of VAR examined the asymmetric effect of oil price shocks on exchange rate volatility and industrial productivity in Nigeria. The study reveals that government expenditure responded immediately to the oil price shock. Still, public investment, private investment, and industrial productivity negatively responded to the oil price shock, further confirming the evidence of a "Dutch disease" in Nigeria.

Olomola (2006) investigated the impact of oil price shocks on aggregate economic activities such as industrial productivity and real exchange rate in Nigeria. The Vector Autoregressive method was used on quarterly data from 1970 to 2003. The findings revealed that, contrary to the previous empirical findings, oil price shocks do not significantly affect industrial productivity in Nigeria. However, oil price shocks significantly influenced the real exchange rate. The author argues that oil price shocks may give rise to a wealth effect that appreciates the exchange rate and may squeeze the tradable sector, giving rise to "Dutch disease".

But in Egypt, Hakan et al. (2010) examined the impact of oil price shocks on the economic growth of selected Middle East and North Africa Countries using the data from 1952-2005 and the Vector Autoregressive approach. He found out that oil price volatility does not have a statistically significant effect on the output of Egypt, and he said the output increase in Egypt is not a result of the oil shock.

Hang & Guo (2007) studied the impact of oil prices on the industrial growth of Egypt using a structural vector autoregressive framework. They found no significant impact of oil price shock on industrial performance. Amr Saber Algarhi (2010) assessed Egypt's oil and natural gas sector using SWOT analysis. It also considered the effect of oil prices on the real economic activity in Egypt using annual data set from 1991-2010. The Autoregressive Distributed lag model (ARDL) was utilized and found that fluctuation in oil prices had an advert effect on the industrial growth of Egypt. He attributed this adverse impact to huge government subsidies on petroleum products.

Al-Risheq, (2012) investigated the impact of oil prices and other key variables on Industrial productivity by utilizing data from fifty-two countries, using a fixed-effect model on variables like real exchange rate and oil prices. He found that oil price volatility growth in developing countries negatively and significantly impacts industrial productivity.

Some of these past researches above provided evidence of a positive relationship, while some said there is a negative relationship between oil price volatility and industrial productivity. Moreover, some lots captured the relationship between oil price volatility and industrial productivity, there are even some that compared a country with another country on the effect of industrial productivity on oil price volatility, but none of these studies had been able to compare oil-producing countries from different cartels that is, members of Organization of Petroleum Exporting Countries (OPEC) with non - OPEC members when it comes to the relationship between oil price volatility and industrial productivity. They all focused on OPEC with little or no attention to other cartels. Therefore, this study aims to determine if the effect of oil price volatility on each economy's industrial sector is the function of the cartel to which such economy belongs.

And this research will fill the gap in previous literature by comparing countries from different cartels, OPEC and OAPEC members, in looking at the relationship between oil price volatility and industrial productivity.

In view of this, the study seeks to address the research question, "How does oil price volatility affect industrial productivity in Nigeria and Egypt". And the objective of the study is to determine the effect of oil price volatility on industrial productivity in Nigeria and Egypt from 1980 – 2020. The study will use Oil rent, exchange rate, and oil price volatility, while industrial value-added would be the dependent variable. The data is sourced from the World Bank data bank, Organization of Petroleum Exporting Countries' Annual Statistical Bulletin.

METHODS

Theoretical framework

The theoretical framework for Industrial productivity revolves around the growth accounting model, otherwise known as the source of growth analysis. The origin of the growth accounting framework can be traced back to the work of Solow (1957), Kendrick (1961), Denison (1962), and Jorgenson & Griliches (1967). More recently, the subject has been revisited and expanded by Rasche & Tatom (1977), Hamilton (1983), Barro (1998), and Al Risheq (2012). The growth accounting framework decomposes observed growth in industrial productivity into its main component. The first component was known as Solow's residual. It was originally viewed as growth in industrial productivity attributable to technical progress. The name is quite functional because it encompasses all sources of industrial output growth apart from those attributable to capital and labor. After all, the intermediate inputs are usually assumed to net out.

At the industrial level, the growth accounting exercise relates factors growth to relative factor share. One sterling contribution of the growth accounting framework is in determining whether the growth in industrial productivity has been generated by the growth in factor input derived by productivity. The relevance of this distribution is that observed growth in industrial productivity propelled by a rapid increase in capital-labor or material inputs is not sustainable in the long run. Sustainable long-run growth in output can only be guaranteed through productivity. Following the theoretical proposition of the Solow growth model employed in the study of economic growth through a neoclassical production function of Cobb Douglass type, it attempts to explain long-run output growth by means of accumulation of capital, labor, and increase in productivity, with regards to the linkage between energy and productivity growth from the neoclassical production function, the industrial value-added which is the proxy for industrial productivity is expressed as a function of the exchange rate, oil rent and oil price volatility. (Al-Risheq, 2012).

Model specification

This study adopts the model with some modifications. The modification, as regards the Changes in techniques of oil price volatility trend in Nigeria, with the determinant (oil rent, exchange rate, and oil price volatility) will enable this study to capture the effect of oil price volatility on industrial productivity.

The functional form of the model:

IVA = f (OR, EXR, OPV, U).

Where:

IVA = Industrial Value Added
OR = Oil Rent
EXR = Exchange Rate
OPV = Oil Price Volatility

The econometric form is written as

$IVAt = \beta_0 + \beta_1 OR_t + \beta_2 EXR_t + \beta_3 OPV_t + U_t$----(1)

U = error term and other variables has defined earlier. The apriori economic expectations. $\beta_1 < 0$, $\beta_2 < 0$, $\beta_3 < 0$

RESULTS AND DISCUSSION

Descriptive statistics of data

Table 1 shows the descriptive statistics for all the variables in both Nigeria and Egypt. During the period covered, the mean value of Industrial Value Added in Egypt is less than that of Nigeria; the exchange rate in Nigeria is higher while it is low in Egypt. The large margins between the minimum and maximum values of all the series indicate significant variations in the series' trend.

Table 1. Summary of statistical data

	Nigeria				Egypt			
	IVA	OP	OR	EXR	IVA	OP	OR	EXR
Mean	51.15	40.18	24.51	73.01	32.17	40.18	10.07	3.82
Maximum	104.64	109.45	54.09	158.55	39.89	109.45	27.42	7.08
Minimum	20.16	12.28	3.03	0.55	25.33	12.28	2.61	0.70
Std.Dev	22.01	30.20	10.60	61.62	4.05	30.20	5.62	1.79
Skewness	0.74	1.21	0.54	0.00	0.20	1.21	1.25	0.16
Kurtosis	2.66	3.11	3.45	1.34	2.04	3.11	4.21	1.83
Jacqu.Bera	3.37	8.82	1.88	4.02	1.62	8.82	11.63	2.17
Probability	0.19	0.01	0.40	0.13	0.44	0.01	0.00	0.33

Regarding the statistical distribution of the series, the exchange rate in both countries and the industrial value-added in Egypt show normal skewness around its mean because the values are approximately "0”. In contrast, oil rent and oil price are positively skewed in both countries. Kurtosis measured the peakedness or flatness of the series distribution. The exchange rate and industrial value-added in both countries are platykurtic because its kurtosis value is less than “3” which means the series will have lower values below its sample mean. It is flat curved. While the oil price is mesokurtic, i.e., normally distributed because it is approximately 3". Oil rent and industrial value-added are leptokurtic, meaning these series' distribution is peaked curves.

This is buttressed by the Jacque Bera test, which shows that industrial value-added in Nigeria, oil price, and oil rent in Egypt are generally not distributed because the probability values are less than 5% critical value, while others are normally distributed.

Test for the volatility of the oil price

In order to test for volatility, ARCH and GARCH models would be used. And before this test can be done, there must be an ARCH effect.

Table 2. Heteroskedasticity test: ARCH

Variable	Coefficient	Standard Error	t-statistics	Probability
C	260.0491	192.2567	1.352614	0.1854
RESID^2(-1)	0.716189	0.121255	5.906472	0.0000

Table 2 shows the result of the ARCH test. The result indicates that the null hypothesis of no arch effect is rejected at a 5% critical value with a probability value of 0.000, which means there is a problem with the ARCH effect in the residual.

Table 3. ARCH, GARCH, TARCH, EGARCH

	AIC	SIC	Log Likelihood
ARCH (5, 0)	7.69	8.08	-129.44
GARCH (1, 1)	7.24	7.51	-124.41
TARCH	7.38	7.68	-125.85
EGARCH	7.35	7.62	-126.45

After comparing ARCH (5.0), GARCH (I.1), TARCH, and EGARCH, the result in table 3.3 above shows that GARCH (I,1) is the most suitable model because it is the one with the lowest Akaike Information Criteria (AIC) and Schwarz Information Criteria(SIC).

Table 4. Summary of GARCH (1,1) result

Variable	Coefficient	Standard Error	Z – statistics	Prob
C	12754.44	22433.18	0.568552	0.5697
$Resid(-1)^2$	- 723.1057	1397.850	- 0.517298	0.6049
Garch Resid1 (-1)	1.218406	0.077186	15.78536	0.0000
C	35.72317865	7.225749	4.868513	0.0000
AR(1)	0.940498	0.045937	20.47353	0.0000

The result of the GARCH model is presented in Table 4. For industrial productivity with the effect of oil price volatility represented in table 3.4, the model reveals that the existence of ARCH and GARCH is significant. The probability value is statistically significant at a 5% critical value, which shows that oil price volatility is a significant determinant of industrial productivity. The GARCH (1,1) results in Table 4 generated data for oil price volatility from the fitted values.

Unit root test results

The analysis starts with exploring the time series property of the variables specific test for stationarity is conducted. The unit root test was applied to know the order of integration of the variables. Part of the conditions for applying Johnson Cointegration techniques below shows the result of the unit root.

Table 5. Summary of unit root test result (Augmented Dickey-Fuller)

Variables	Level		First difference		
	ADF statistics	Probability	ADF Statistics	Probability	Order of Integration
IVA – Nig	-2.3636	0.1592	-6.5839	0.0000	I (1)
OR- Nig	-0. 7182	0.8280	-7.8252	0.0000	I (1)
OPV – Nig	-0. 1636	0.9341	-6.2155	0.0000	I (1)
EXR – Nig	-0.0778	0.9440	-4.3756	0.0015	I (1)
IVA – Eg	-1.1525	0.6836	-4.9767	0.0003	I (1)
OR – Eg	-1.2801	0.6277	-4.3335	0.0016	I (1)
OPV – Eg	-0.1636	0.9341	-6.2155	0.0000	I (1)
EXR – Eg	0.0060	0.9525	-4.3813	0.0015	I (1)

The test result indicates that the probability values of all variables: industrial value-added, oil rent, oil price, and exchange rate in both countries are greater than the 5% critical values levels. It implies they all have a unit root at levels because the null hypothesis is “there is a unit root". And they are all stationary at first difference. It implies that if there is any shock on any of the variables, the impact of the shock will be transitory and not permanent.

Cointegration test

In order to determine the long-run relationship among the variables, a cointegration test was performed. The model for the cointegration test is specified below:

$IVA = f\,(OR, EXR, OPV)$

The model is re-written as:

$IVA_t = \beta_0 + \beta_1 OR_t + \beta_2\, EXR + \beta_3 OPV_t + U_t$

The data for oil price volatility has been generated from the fitted values of oil price, and the Augmented Dickey-Fuller test has been performed on it to test for the unit root. The result shows that oil price volatility is integrated with order 1. Therefore, the Johansen Cointegration test would be done to check if the variables have a long-run relationship. But before the cointegration test, the optimal lag to be used would be selected by the lag length Criteria.

Optimal lag selection

An optimal lag length test was conducted to avoid the risk associated with the under-specification or over-specification of the model. The result for the two countries is tabulated in Table 6.

Table 6. Optimal lag selection for Nigeria and Egypt

Lag	Nigeria		Egypt	
	AIC	SC	AIC	SC
0	33.34	33.53	21.45	21.63
1	27.64	28.55	16.09	17.60
2	27.53	29.18	16.07	17.70

According to the lag selection criteria, lag"2" is the optimal lag to be used in Nigeria and Egypt because of its lowest AIC value. Therefore, the cointegration analysis would be done using lag "2"

Table 7. Johansen cointegration test for Nigeria and Egypt

Hypothesized No of CE(s)	Trace Statistics	5% Critical Value	Probability	Max. Eigen Statistics	5% Critical Value	Probability
Nigeria						
None*	57.2114	47.8561	0.0052	29.1342	27.5843	0.0314
At most 1	28.0772	29.7971	0.0779	23.4201	21.1316	0.0234
At most 2	4.6571	15.4947	0.8441	4.5091	14.2646	0.8021
At most 3	0.1480	3.8415	0.7005	0.1480	3.8415	0.7005
Egypt						
None*	53.1287	47.8561	0.0147	26.5582	27.5843	0.0672
At most 1	26.5705	29.7971	0.1126	17.1109	21.1316	0.1668
At most 2	9.4596	15.4947	0.3246	6.6489	14.2646	0.5315
At most 3	2.8415	3.8415	0.0936	2.8107	3.8415	0.0936

According to Table 7, the cointegration test shows that there is a long-run relationship between industrial value-added, oil rent, exchange rate, and oil price volatility in both Nigeria and Egypt since both trace and maximum Eigen test reject the null hypothesis of “there is no cointegrating equation”, because the probability values are less than 5% "none" and "at most 1". Hence, there are two cointegrating equations among the variables in Nigeria and one cointegrating equation among that of Egypt. Therefore, the alternative hypothesis of a long-run relationship among the variables is accepted.

Table 8. The long-run relationship

Variable	Nigeria				Egypt			
	Coeff	Standard error	t-Statistics	Prob. value	Coeff	Standard error	t-Statistics	Prob. value
Constant	-276.23				71.83			
IVA	1.00				1.00			
OR	-4.78	0.98	4.90	0.2827	3.18	1.09	-2.91	0.1731
EXR	-0.97	0.144	6.73	0.00428	20.85	4.47	-4.67	0.0549
OPV	-0.73	0.36	0.36	0.0019	-0.22	0.25	0.86	0.0495

Table 8 indicates that oil rent achieved Nigeria's expected negative coefficient sign. Oil rent has an insignificant negative relationship with industrial value-added, which means the higher the Oil rent, the lower the Industrial Value added. Thus, in Nigeria, a percentage increase in Oil rent caused a 4.78% decrease in industrial value-added. But in Egypt, Oil rent has a significant positive relationship with industrial value-added, and a percentage increase in Oil rent led to a 3.18 percent increase in industrial value-added.

Then, the exchange rate in Nigeria has a significant negative relationship with industrial value-added, and a % increase in the exchange rate led to a 97% decrease in industrial value-added. In Egypt, the reverse is the case, 20.85 percent increase in the industrial value-added is caused by a percentage increase in the exchange rate.

Also, oil price volatility achieved the expected negative sign in both Nigeria and Egypt. Oil price volatility significantly negatively impacts industrial value-added in both countries. The higher the oil price volatility, the lower the industrial value-added. A percentage decrease in oil price volatility in Nigeria increased the industrial value-added by 73%. While in Egypt, a percentage decrease in oil price volatility increased the industrial value-added by 22%.

Error correction model

The error correction model is constructed only if the variables are cointegrated. Variables are said to be cointegrated when there is a long-run relationship among them. Error Correction Model is constructed to examine the short-run dynamics of the cointegrated series. Based on the Johansen cointegration test, which suggested the existence of long-run cointegration among variables and coupled with I (1) order condition in the series, I further employed ECM estimation to analyze the short-run dynamics in the variables. The short-run analysis was run on the dependent variable" industrial value-added and the independent variables oil rent, exchange rate, and oil price volatility to find out the short-run effect of oil price volatility on industrial productivity in both Nigeria and Egypt.

Table 9. Summary of short-run analysis

Variable	Nigeria				Egypt			
	Coeff	Standard error	t-statistics	Prob Value	Coeff	Standard error	t-statistics	Prob Value
D(IVA1)	-0.0968	0.1532	-0.6321	0.5328	0.1141	0.1492	0.7644	0.4518
D(OR1)	-0.0999	0.0911	-1.0970	0.2827	0.1161	0.828	1.4022	0.1731
D(EXR1)	-0.1880	0.0883	-2.1294	0.0428	1.5936	0.7914	2.0137	0.0549
D(OPV)	**0.**2576	0.0746	3.4532	0.0019	0.0484	0.0234	2.0642	0.0495
ECM (-1)	-0.3438	0.1338	-2.5683	0.0163	-0.5676	0.2576	0.0746	3.4532
C	-2.2403	0.9445	-2.3718	0.0254	-0.2459	0.2773	-0.8869	0.3835

From the table above, the short-run relationships are estimated as shown. The term ECM (-1) represents the speed of adjustment to restore equilibrium in the dynamic model. The coefficient of the lag error correction model is - 0.3438, negative and significant at a 5% significant level, which confirms the existence of the cointegrating relationship. This indicates that about 34% of deviations from the long-term industrial productivity caused by previous years' shocks converge to the long-run equilibrium in the current year. In Nigeria and Egypt, the short-run effect of oil rent and exchange rate on industrial productivity was the same as the long-run relationships. But the short-run effect of oil price volatility on industrial value-added differs from the long-run effect in both countries. In the short run, oil price volatility has a positive effect on industrial value-added, but in the long run, it has a negative effect on both countries.

A Series of diagnostic tests are conducted within the ECM framework. This ensures the estimate's reliability and validity in the Error Correction Model. Therefore, tests for normality, serial correlation, and heteroskedasticity were carried out on the model.

Table 10. Series of diagnostic test

	Nigeria	Egypt
Autocorrellation test	Breusch Godfrey test P Value = 0.2096	Breusch Godfrey test P Value = 0.2010
Heteroskedasticity test	Breusch Pagan Godfrey test P Value = 0.6924	Breusch Pagan Godfrey test P Value = 0.0643
Normality test	Jacque – Bera test P Value = 0.9382	Jacque – Bera test P Value = 0.3556

Jacque Bera test was used to check the residuals of the estimate if they are normally distributed or not. The null hypothesis (HO) is that "residuals are normally distributed". According to the table above, the probability value of the Jacque Bera test is more than 5% critical value. Therefore, the null hypothesis was accepted, and the alternative hypothesis was rejected. It means the residuals are normally distributed both in Nigeria and Egypt.

The Breach Godfrey autocorrelation LM test was employed to check the serial correlation among the residuals. From the table, the probability value is more than 5%, so the null hypothesis of “no serial correlation" was accepted. This is a relief.

Finally, the residuals of the estimates are checked for the presence of heteroskedasticity. The probability value is greater than 5%, indicating that the residuals are not heteroskedastic.

Discussion

The study investigated the relationship between oil price volatility and industrial productivity in Nigeria and Egypt (1980-2020). The study used the unit root test to check the stationarity of the data. The unit root test results show that all the variables used in the model are stationary after the first difference. Also, the heteroskedasticity test reveals that there was a presence of Autoregressive Conditional Heteroskedasticity ARCH) effect on oil price and the residual graph made the volatility clustering obvious as low clustering was being followed by low clustering and high clustering by high clustering. The GARCH (1,1) model result generated data for oil price volatility. The results show that oil price significantly affects industrial productivity in Nigeria. A heteroskedasticity test using the ARCH approach was done to validate the model's reliability. The expected result is that our model should not have an ARCH effect again.

According to the diagnostic test performed on the GARCH (1.1) model, the null hypothesis is that there is no heteroskedasticity, the residuals were normally distributed, and there is no more ARCH effect in the residual since the probability value is greater than the critical value. Therefore, the results of these diagnostic tests validate the fitness of the result.

The Cointegration test showed that the variables involved have a long-run relationship. It means there is a long-run relationship between total industrial value-added, oil rent, oil price, and exchange rate in Nigeria.

In order to determine the nature of the long-run relationship by the reversed coefficient using the normalized Johansen Cointegration equation, it can be seen that oil rent has a significant negative relationship with industrial value-added in Nigeria. It means the higher the oil rent, the lower the industrial value-added. Meaning that a 1% increase in oil rent caused a 47.8% decrease in industrial value-added. The neglect of the industrial sector may explain this at the discovery of oil. This confirmed the apriori expectation and the existing literature. Ayadi (2000) said the boom in the oil sector made the economy depend heavily on it, thereby causing neglect in other sectors like industrial and agricultural sectors. Many manufacturers and industries have been denied their source of raw materials. Import

Substitution and promotion of export earnings are affected by the absence of locally sourced input, which is the main industrialization strategy. Therefore, an increase in Oil rent does not increase industrial productivity. Komonen & Jurikalla (2007) said an increase in oil earnings spells doom for net oil-importing countries because an increase in oil price affects the Gross Domestic Product of the importing countries

In the case of the exchange rate, the result established a significant negative relationship with industrial value-added. The higher the exchange rate, the lower the industrial value-added. A percentage increase in the exchange rate led to a 97% decrease in industrial value-added and vice versa.

The result established that oil price volatility also achieved an expected negative coefficient, which significantly negatively affected industrial value-added. The cointegration test revealed that a percentage increase in oil price volatility led to a 73% decrease in industrial value-added. This was also in line with the works of Ojapinwa & Ejumedia (2012) and Riman et al. (2013). Loto (2012) and Finn (2000) found a significant negative response of Industrial productivity to oil price volatility. The implication of this is that whenever there is a rise or fall in oil price, the cost of production is not stable, leading to a reduction in output pressure on prices of goods and services and consequently resulting in the reduction of aggregate demand.

Also, the cointegration test in Egypt revealed a long-run relationship among the variables. The reversed coefficient of the normalized Johansen Cointegration equation revealed a long-run relationship between industrial value-added, Oil rent, and exchange rate in Egypt. Oil rent has an insignificant positive relationship with industrial value-added. From the findings, a percentage increase in Oil rent increased the industrial value-added by 31.8%. It implies that within the period studied, Egypt, as an oil-exporting country, generated more revenue from the oil sector, forming a large share of their Gross Domestic Product and positively influencing their industrial value-added. That is why the Industrial sector is the second largest sector in Egypt. Also, the exchange rate had a significant positive effect on the industrial value-added of Egypt. A unit increase in the exchange rate led to a 20% increase in industrial value-added. This confirmed the work of Nawaz. (2012), Al-Risheq (2016), whose work was on the impact of oil prices on Industrial production in developing countries, found that an increase in the exchange rate makes the price of domestic products relatively cheaper. Therefore, an increase in the international competition of domestic industries increases the country's exports of domestically produced goods and improves output levels.

Depreciating currency makes a country's export relatively cheaper. And on the other hand, when there is currency appreciation, everything, including the raw materials used in industrial production, escalates; this will increase the cost of production, thereby reducing industrial productivity.

When it comes to oil price volatility, the contrary is the case. Oil price volatility significantly negatively affected industrial value-added in Egypt. An increase in oil price volatility led to a 22% decrease in the economy's industrial value-added. It is also in line with previous researchers like Al-Risheq (1970-2012), and Am Saber Alghari (1970 - 2010) assessed Egypt's oil and natural gas sector and found that volatility in oil prices had an advert effect on industrial productivity.

CONCLUSION AND RECOMMENDATION

Conclusions

The study concluded that oil price volatility negatively affected industrial value-added in Nigeria and Egypt. An increase in oil price volatility significantly reduced industrial productivity in both countries. Although the two countries under study were from different cartels, the direction of the effect of oil price volatility on their industrial productivity is the same. Still, the magnitude of the effect is higher in Nigeria than in Egypt. Two main reasons can be ascribed to this. One of the reasons is that Egypt is a net exporter of oil (Egypt exports refined oil). While Nigeria exports crude oil and imports refined oil, Nigeria is a net importer of oil. Also, the total effect of oil price increase on each sector of the economy depends on what the oil-producing nation does with the additional revenue. Therefore, it is concluded that oil price volatility is an ill wind that blows no one any good.

Recommendations

The study recommends some policies that may help lessen the effect of oil price volatility on industrial productivity.

Firstly, it is essential to improve the oil reserve system in developing countries to reduce vulnerability to oil volatility as most developing economies are dependent on oil imports. Then most importantly, alternative sources of energy such as biofuel and solar power plants should be developed to reduce dependence on oil and consumption of oil.

Industrial-based developing economies should be made strong. The measure should be taken to keep the real exchange rate at a level that benefits developing economies' domestic productions and export activities.

The interest rate should be kept low to boost investment for production purposes. To sustain industrialization in Nigeria, the manufacturing sector should begin to focus on producing capital goods. The government should deliberate effort to negotiate and acquire available technology in specific areas like the industrial sector.

National security should be strengthened and tightened to curb insurgency, armed robbers, kidnappers, and ethnic militants to protect and encourage investment in the country.

Above all, the country should diversify its export revenue to minimize reliance on oil and petroleum products. This will further cushion the effect of od price volatility in the economy.

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