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Trade Shock, Inflation, Exchange Rate and Economic Growth: Empirical Evidence from OPEC Countries Using Panel Vector Autoregression

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Abstract

The study is empirically motivated to analyze the link between trade openness, inflation, exchange rate and economic growth among the OPEC countries by using key macroeconomic variables across member countries. The study utilizes quarterly time series data for variables including economic growth, trade openness, exchange rate, consumer price index and oil price as exogenous variable in the system for over 164 quarterly data points. Utilizing the recently introduced model of Ambrigo and Inessa (2015), the study uses panel vector autoregression model and analyze how various shocks affect macroeconomic stability of the member countries. Trading shock as well as oil price shock are analyzed and responses of other macroeconomic indicators are evaluated. Based on the estimated result for impulse response and forecasted error variance decomposition result, the study established statistically significant link between trading shock and economic growth of the member countries while oil price shock is found to have significant but weak relationship with economic growth. Babed on the finding established, the study recommends that trading shocks is the main driver of cyclical fluctuation of the OPEC's member countries economic growth. Policies are therefore prescribed to smoothen the impact of trading shocks on the economic growth of the member countries.

Keywords: time series data; trade openness; inflation; economic growth; exchange rate; oil price

1. Introduction

Globalization and liberalization of trade have expanded the rate of economic growth among economies in the world market. Trading in oil has become the dominant pattern of trade in the oil exporting countries. The significance of trade in supporting economic growth has sparked a growing number of economic studies since the works of Grossman and Helpman (1990), Romer and Young (1990). The question is whether trade, as stated by the trade-led growth theory, functions as an engine for economic expansion. Trade openness has been proved to increase economic growth in the long run by offering access to commodities and services, increasing resource efficiency, and enhancing total factor productivity through technological diffusion and knowledge dissemination (Barro & Sala-i-Martin, 1997; Rivera-Batiz & Romer, 1991). As a result, it is projected that countries with more open trade policies will outperform those with less open policies

From this standpoint, trading with advanced countries has a lot of benefits for developing countries. International institutions and donor nations often promote trade liberalization measures to developing countries in the hopes of opening up and integrating them into the global economy because of these anticipated benefits. The failure of the import-substitution industrialization model, as well as evidence from empirical studies demonstrating that more outward-oriented nations have greater economic growth rates, spurred these strategies. Furthermore, East Asian countries' exceptional performance can be credited in part to their early trade liberalization (Stiglitz, 1996; World Bank, 1993). It is unsurprising that many developing countries pursued trade liberalization policies in the late 1970s, including lower import, export taxes and non tariff baarriars.

Another school of thought contends that greater trade openness is harmful to economic growth because it raises inflation and lowers exchange rates (Cooke, 2010; Jafari Samimi, Ghaderi, Hosseinzadeh, & Nademi, 2012). For countries that specialize in the manufacture of low-quality goods, trade openness may have a negative influence on economic growth (Haussmann, Hwang, & Rodrik, 2007). Countries exporting primary products, for example, are subject to changes in trade terms. Despite these divergent viewpoints, the general consensus is that international trade openness is advantageous to economic development, particularly in developing nations.

The nature of the economy of OPEC countries is that they are highly imported dependent, and one commodity (oil) export dependent. The major source of revenue is mainly from oil revenue and crude export constitutes majority share of their export commodities. The major source of foreign earnings is crude oil export and the non-oil sectors have contributed less to foreign earnings. The transmission mechanism from trading partners of OPEC countries are due to the fact that they import heavily from other larger economies. As such, fluctuation in commodity prices and volatility of trade will directly induce these economies as the economies of OPEC are very open. This was noted by Francisco and Luis (2002) who posited that high volatility of the trade terms in a small but open economy such as that of OPE which are induced by imbalances in terms of trade. This is because oil exports account for a significant portion of commerce in these economies, and oil price fluctuations are linked to oil prices changes. This was also the case of most African countries which exhibit similar characteristics of OPEC countries as small open economy. Kose and Riezman (2000) indicated that trade had cause adverse economic fluctuation in African countries; this is because African countries import heavily from larger economies and this has caused macroeconomic fluctuation in most African markets.

The empirical objective of the study is to examine how trading shocks impacts on the oil exporting countries. Specifically, the study uses all the countries in OPEC as a reference point to ascertain how trading shocks affect the growth performance of the member countries. For this objective to be empirically assessed, the study employs the recently introduced methodology of panel vector autoregression of Ambrigo and Inessa (2015). Hence to contribute empirically to literature, this study explores the interaction between trade shocks and macro-economic dynamics among OPEC countries. The study used the Panel Vector Autoregression (PVAR) of

Abrigo and Love (2015) to investigate how trade shocks and macro-economic fluctuations among OPEC countries and employed the dynamic panel data models to study the relationship among trade-openness and economic growth in OPEC countries. This study was motivated by considering the nature of the economy of OPEC countries that are highly imported dependent, and one commodity (oil) export dependent.

2. Empirical Evidence

From 2002Q1 to 2016Q4, Blagrave and Vesperoni (2018) looked at the cross-border spillovers from China's slowing growth onto partner nation exports for 48 advanced and emerging market economies. The study employed the Panel VAR technique to examine the contemporaneous relationship between GDP, real exchange rates, and export-intensity. According to the study, the amount of spillover to different trading partners will be determined by their sectoral ties to the Chinese economy. At the regional level, the study indicates that nations with the strongest trade ties to China, such as those in Asia, will be the hardest hit.

Ali and Anwar (2017) investigated the effects of expected and unexpected Terms of Trade (ToT) shocks on aggregate output, inflation, and trade balance (TB). The study examined the contemporaneous link between GDP, real exchange rates, inflation, and monetary policy tools based on the Taylor rule using the Dynamic Stochastic General Equilibrium (DSGE) model. The J-curve phenomenon, according to the study, persists even when the premise of rational expectations about the ToT is loosened. The presence of a monetary policy cost channel increases the strength of the J-curve impact, according to further investigation.

Fatih and Sevda (2014) investigated the effects of institutions, openness, and macroeconomic stability on economic growth: a panel data analysis on middle-income countries. The study concluded that, while the positive effects of indirect determinants on economic growth are small, the indirect determinants in middle-income countries catch the trend of a continuous and steady growth together with the direct determinants are among the important cases which can approach middle-income countries.

Ghironi and Meltiz (2014) propose a two-country stochastic general equilibrium model of trade and macroeconomic dynamics. Each country's productivity varies by individual, monopolistically competitive enterprises. In the domestic market, firms must pay a sunk entrance cost as well as fixed and per-unit export charges. Only the more productive companies export. Exogenous shocks to aggregate productivity and entry or trade costs cause firms to enter and depart both domestic and export markets, changing the composition of consumption baskets over time. The model generates endogenously persistent departures from PPP in a world of flexible prices that would not exist if our microeconomic structure with heterogeneous enterprises did not exist. Finally, the model accurately predicts numerous points in the US and global business cycles.

Cakir and Kabundi (2013) investigated South Africa's trade ties with the BRIC (Brazil, Russia, India, and China) countries. Over the period 1995Q1–2009Q4, the study used a global vector autoregressive model (GVAR) to evaluate the degree of trade links and shock transmission between South Africa and the BRIC countries. Their model has 32 countries and two different

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estimations: the first has 24 countries and one region, with the euro area's eight countries treated as a single economy; the second estimation has 20 countries and two regions, with the BRIC and euro area countries treated as a single economy, respectively. The findings imply that there are trade ties between these economies; however, the extent of these ties varies each country. Each BRIC country's shocks are shown to have a significant impact on South Africa's real imports and output.

In a two-country, stochastic, general equilibrium model of trade and macroeconomic dynamics with heterogeneous businesses, endogenous producer entry, and frictional labor markets, Cacciatore and Montréal (2012) investigated how labor market frictions affect the effects of trade integration. Important empirical regularities that characterize trade integration in the long term and during the business cycle are successfully reproduced by the model. There are two major findings. To begin with, trade integration is always favorable to welfare because it increases productivity, but when trade barriers are reduced, unemployment may rise momentarily. As production shifts toward more flexible economies, trade gains are fewer in nations with more inflexible labor markets. Second, trade integration has significant implications for the business cycle.

According to Haddad et al. (2010), the impact of trade openness on growth volatility decreases as export diversity increases, both across products and markets. According to them, market diversification (number of destination markets) is just as significant as product diversification (number of items exported) in reducing the volatility effects of trade openness on growth.

With a sample of 159 countries from 1970 to 2006, Funke, Granziera, and Imam (2008) investigated the macroeconomic impact of negative terms of trade shocks and attempted to find characteristics that contribute to a rapid rebound in growth following persistent negative shocks. They utilized a probit model to determine which economic strategies distinguished countries that recovered successfully from those that did not. The analysis concentrates on shocks over the 10 percent barrier because there are relatively few observations beyond the 30 percent threshold; there are only five occurrences of countries rebounding from the 30 percent level seven if the threshold is lowered to 20 percent. They look at the connections between GDP, the real exchange rate, the budget balance, trade, aid, and the law. The findings imply that policies are important. Fast recoveries are strongly linked to depreciation of the real exchange rate as well as improvements in government stability and the institutional environment. An increase in aid at the right moment could also help with recuperation.

Giovanni and Levchenko (2006) examined the processes via which trade can effect output volatility using an industry-level panel dataset of 59 nations with 28 manufacturing sectors from 1970 to 1999. At the industry level, they discovered that trade openness is positively connected with volatility. When exports and imports are separated, the results demonstrate that importing increases volatility in a sector more than exporting. They calculated that an increase in trade openness of one standard deviation boosts aggregate volatility by around 15% of the average aggregate variance. In reality, an industry's vulnerability to global supply and demand shocks increases when an economy is open to foreign commerce. Because trade openness leads to specialization and consequently a less diverse economy, it raises overall volatility.

Larger trade openness, according to Loayza and Raddatz (2006), intensifies the output impact of external shocks, particularly negative ones. "More trade openness appears to enhance the cumulative impact of terms-of-trade shocks," they concluded. More trade openness correlates to higher trade volume, which acts as a magnifier for terms-of-trade shocks. The output impact of a one-standard-deviation terms-of-trade shock is 1.4 percentage points higher in the third quartile of trade openness than in the first quartile, according to the authors. However, the impact is much lesser when the openness is increased in a country with well-developed local financial markets.

Canova (2005) looked into how shocks in the United States were transmitted to Latin America. The amount and characteristics of shock transmission from the United States to Mexico, Panama, Brazil, Chile, Ecuador, Argentina, Uruguay, and Peru were investigated using a bivariate block VAR model. Sign constraints are used to identify US shocks, which are viewed as exogenous to Latin American economies. Individual and average impacts are created using posterior estimates. In Latin America, monetary shocks from the United States cause large swings, while real demand and supply shocks do not. Floaters and currency boarders produce comparable results, but their inflation and interest rate responses are different. In the transmission, the financial channel is critical. US disruptions account for a significant percentage of the variability in Latin American macro variables, causing continental cyclical swings and destabilizing nominal exchange rate effects in two episodes.

From 1950 to 1995, Francisco and Luis (2002) investigated the effect of trade shocks in influencing aggregate fluctuations in Venezuela. The researchers used a dynamic stochastic general equilibrium (DSGE) model for a small open economy that was enhanced to include oil industry income. When the income effect of consumption more than offsets the substitution effect that causes the oil transfer and there is imperfect capital mobility, the analysis found that this technique offers predictions that are consistent with the time series features of Venezuela.

Razin et al. (2003) looked at the influence of trade openness on investment adjustment costs. They noted that, in the presence of economies of scale trade, openness may produce volatility in the setup cost of investment due to fluctuations in the terms of trade, resulting in instability in the form of "boom-bust investment cycles" fueled by self-fulfilling expectations. The country will enjoy a boom in the investment cycle during a period of 'excellent' terms of trade with reduced investment setup costs, whereas the investment cycle would collapse during a period of 'poor' terms of trade due to increasing higher setup costs. Due to limited infrastructure (communication, transportation, etc.) and a scarcity of skilled labor, enterprises in developing nations suffer significantly higher startup costs. In comparison to industrialized countries, such countries' trade openness will result in more significant investment cycle oscillations.

External shocks have a role in explaining macroeconomic volatility in African countries, according to Kose and Riezman (2000). They build a multi-sector equilibrium model of a small open economy that is calibrated to simulate a typical African economy that is quantitative, stochastic, and dynamic. The analysis was based on external shocks, which were modeled as changes in the prices of exported primary commodities, imported capital goods, and intermediate inputs, as well as a financial shock, which was treated as fluctuations in the global real interest rate. Using annual data from twenty-two non-oil exporting African nations from 1970 to 1990, they investigate the cyclical pattern of trade shocks and their comovement with aggregate output and the trade balance. While trade shocks account for around 45 percent of economic changes in aggregate output, financial shocks play a negligible effect, according to the findings. Their research also shows that negative trade shocks cause long-term recessions.

3. Methodology

3.1 Introduction

This section explains in-depth, the procedures that will be followed in conducting inferences in this research work. Research decision is the framework for investigating a research problem or the methods used in collecting data, which are to be used in investigating and analyzing a research problem. It also highlights the sources of data, variables on which the data was collected, model specification and parameters estimation techniques.

3.2 Research Design

The experimental research design was used to conduct this study. The reason for this is that experimental study design incorporates both theoretical and empirical considerations.

3.3 Data and Measurement of Variables

The type of data to be used in this study is basically secondary data, given that the data on the variables of interest (macroeconomic and financial policy indicators) are already sourced and documented. Data on macroeconomic and financial policy indicators will be sourced from the World Development Indicators (WDI). The data would be collected on the study variables for the period of the study for all the selected countries and will be arranged in a panel format for analysis.

Oil price data is sourced from trading economics

Table 3.1: Measurement of Variables and Sources

Variables	Measure	Sources of Data
GDPc	GDP Per capita in thousands of US dollars	Website data base of the United Nations Conference on Trade and Development (UNCTAD) and World Bank Development Indicator (WDI)
TO	Trade openness {degree of openness} in index form	Website data base of the United Nations Conference on Trade and Development (UNCTAD) and World Bank Development Indicator (WDI)
CPI	Consumer Price Index. Country's all price index.	To complete the data set, use the World Bank Development Indicator (WDI) internet data base and the International Monetary Funds (IMF) website data source.
EX	Real Effective Exchange Rates. In country's currency units after relative price adjustments	Data from the World Bank's Development Indicator (WDI) and the International Monetary Fund's (IMF) website.
OP	Brent price measured	Trending Economics (TE)

3.4 Method of Data Analysis

This study proposes to use a Panel VAR to evaluate trading shocks on macroeconomic stability of the OPEC countries. There will be a descriptive analysis of the data before the regression analysis to provides an overview of the study variables and show the trends of the variables under investigation. Data is standardized to achieve stability of the estimates. The importance of conducting this test is to avoid spurious regression results from non-stationary series. Moreover, with a panel information evaluation using the Hausman test, we will figure out whether to run a random or fixed model.

3.5 Model Specification

Following the works of Oleschak (2021) and Kumar and Kumar (2016), the functional relationships between financial inclusion and monetary policy effectives in terms of economic growth, price stability, unemployment and exchange rate is specified as;

$GDP = f(TO, CPI, EX, OP)$ -- (1)

$TO = f(GDP, CPI, EX, OP)$--- (2)

$CPI = f(GDP, TO, EX, OP)$--- (3)

$EX = f(GDP, TO, CPI, OP)$--- (4)

$OP = f(GDP, TO, CPI, EX)$………………………………………….……..…. (5)

A PVAR model's reduced form is defined as follows:

$$Y_{i,t} = \alpha_i + \Gamma(L)Y_{i,t} + \varepsilon_{i,t} \qquad (5)$$

where i (i=1, N) denotes the country, and t (t=1, T) the time. $Y_{i,t}$ is the vector of endogenous stationary variables, Γ(L) represents the matrix polynomial in the lag operator *L*, α_i denotes the vector of country-fixed effects and $\varepsilon_{i,t}$ is a vector of errors.

3.5.1 Autoregressive Panel Vector Model (PVAR)

The Panel VAR model can be used to meet the study's objective. VAR models are useful for analyzing the dynamic behavior of endogenous and interdependent macroeconomic variables (Lennman, 2016). Recently, an increase in the availability of internationally standardized datasets and the gradual increase of global economic interdependencies have led to the use of a panel dimension in a VAR framework (Lennman, 2016).

3.5.2 Econometric Panel VAR (PVAR) Model

The PVAR method for solving a system of linear equations using a Panel VAR of lag order p is as follows;

$$y_{it} = A_1 y_{it-1} + A_2 y_{it-2} + \ldots\ldots + A_{p-1} y_{it-p+1} + A_p y_{it-p} + \beta x_{it} + c_i + \varepsilon_{i,t} \qquad (6)$$

The dynamic form presented by Lennman (2016) is stated as follows;

$$y_{it} = \rho y_{i,t-1} + \beta x_{it} + c_i + \varepsilon_{i,t} \qquad (7)$$

When multiplier dependent variables are taken into account, the dynamic model is changed into a panel VAR model with lag order p and k variables. The study illustrates this in equation (7), which is a panel VAR model representation in matrix form, with k variables but just one lag length, similar to equation (8). The addition of extra rho matrixes and a yt_{-p} matrix to the matrix form with greater lag durations is both space-consuming and redundant.

$$\begin{pmatrix} y_{1,t} \\ y_{2,t} \\ \vdots \\ y_{k,t} \end{pmatrix} = \begin{bmatrix} \rho_{11} & \rho_{12}\cdots & \rho_{1k} \\ \rho_{21} & \rho_{22}\cdots & \rho_{2k} \\ \vdots & \vdots \ \ddots & \vdots \\ \rho_{k1} & \rho_{k2}\cdots & \rho_{kk} \end{bmatrix} \begin{pmatrix} y_{1,t-1} \\ y_{2,t-1} \\ \vdots \\ y_{k,t-1} \end{pmatrix} + \begin{bmatrix} \beta_{11} & \beta_{12}\cdots & \beta_{1k} \\ \beta_{21} & \beta_{22}\cdots & \beta_{2k} \\ \vdots & \vdots \ \ddots & \vdots \\ \beta_{k1} & \beta_{k2}\cdots & \beta_{kk} \end{bmatrix} (x_{1,t}, x_{2,t}, \ldots, x_{j,t}) + \begin{pmatrix} c_i \\ c_i \\ \vdots \\ c_i \end{pmatrix} + \begin{pmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \vdots \\ \varepsilon_{k,t} \end{pmatrix} \qquad (8)$$

On the left-hand side of equation (4), we have a vector of dependent variables, which are likewise included with a lag on the right-hand side. The exogenous variables are represented by x_{it}, which is a column vector, and the panel fixed effects and error term are represented by c_i and ε_{it}, respectively. This is essentially a matrix representation of a panel VAR model with a varying number of lags on the dependent variable list and a list of exogenous variables.

3.5.3 Abrigo and Love (2015) Panel VAR Technique

The shocks transmission among variables was investigated using the panel VAR technique developed by Abrigo and Love (2015).

The analysis is based on Love and Zicchino's panel data vector autoregressive (panel VAR) model (2006). The method combines the standard VAR approach, which assumes all system variables as endogenous, with the panel data approach, which accommodates unobserved individual variability. This technique was improved by Abrigo and Love (2015).

The following k-variate panel VAR of order p is described by Abrigo and Love (2015), with panel specific fixed effects represented by the following system of linear equations:

$$Y_{it} = Y_{it-1}A_1 + Y_{it-2}A_2 + \ldots + Y_{it-p+1}A_{p-1} + Y_{it-p}A_p + X_{it}B + u_{it} + e_{it} \quad (9)$$

$i \in \{1,2,\ldots N\}$, $t \in \{1,2\ldots T_i\}$

where Y_{it} is a (lxK) vector of dependent variables; X_{it} is a (lxl) vector of exogenous covariates; u_{it} and e_{it} are (lxk) vectors of dependent variable-specific fixed-effects and idiosyncratic errors. The (kxk) matrices $A_{1,2,\ldots,}A_{p-1},A_p$ and the (lxk) matrix B are parameters to be estimated. The authors are assuming that the innovations have the following characteristics $E[e_{it}]=0, E[e'it,e_{it}]=\Sigma$ and $E[e'_{it},e_{is}]= 0$, for all $t>s$.

The above parameters can be estimated together with the fixed effects, or separately, after some adjustments, using OLS. However, with the lagged variables on the right side of the equation, the findings would be skewed for a large number of N (Abrigo & Love, 2015). Abrigo and Love (2015), are describing in the above-mentioned paper, the estimating methodology, through GMM (Belingher, 2015).

3.5.4 Functions of Impulse Response

An impulse response function (IRF) is merely a demonstration of how a stable model in equilibrium reacts to shocks on any of the regressors included in the model (Lennman, 2016). The impulse dissipates across the model, showing how the response variable returns to equilibrium following the disruption, whether temporary or permanent. This is merely a strategy for making the regression output intuitively accessible and calculating the long-run multiplier effect (Lennman, 2016).

3.5.5 Condition of Eigenvalue Stability

To determine whether a VAR model is stable, all eigen values from the output must have a modulus of less than one (Pattersson, 2000). This simply means that the model is stable in the sense that the dynamics of the model converge towards a point. If any of the modulus on the eigenvalues is more than 1, there will be no long term equilibrium and the values will continue to rise in the future.

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4. Empirical Analysis

4.1 Introduction

The essence of this chapter is for presentation, evaluation and analysis of estimated results of the models postulated as well as verification of the various working hypothesis of this research which is drawn from the objective of the study. The analyses of the results were used to evaluate the working hypotheses of the study and draw some policy implication of the findings. The parameters estimates were subjected to various economic, statistical and econometric tests, using STATA 14 and E-view 10 versions.

4.2 Descriptive Statistics

It is necessary condition to examine the descriptive characteristics and features of the variables used in this study. The descriptive features of the variables is presented below in table 4.1

Table 1: Descriptive Statistic

Variable		**Mean**	**Std. Dev.**	**Min**	**Max**	**Observations**
GDP	Overall	1.8996	2.62	-5.22	6.26	N = 2624
	Between		2.12	-2.34	4.54	n = 16
	within		1.62	-2.09	6.54	T = 164
CPI	Overall	1.0027	2.26	-5.00	5.10	N = 2624
	Between		1.84	-2.35	4.53	n = 16
	within		1.39	-2.69	4.61	T = 164
EXCH	Overall	1.1590	2.44	-4.86	5.52	N = 2624
	Between		2.19	-2.97	4.56	n = 16
	within		1.20	-3.18	8.91	T = 164
OP	Overall	0.8493	2.49	-4.87	5.10	N = 2624
	Between		2.14	-3.77	3.59	n = 16
	within		1.38	-2.75	5.46	T = 164
TO	Overall	1.6266	2.51	-5.24	5.52	N = 2624
	Between		1.78	-1.15	4.53	n = 16
	within		1.83	-3.40	7.87	T = 164

Source computed by the researcher using STATA (2021)

Analysis of Table 1 shows that the overall is calculated based on 2624 country-year observations while the between is calculated over 16 groups and the within is observed from 164 quarters. The overall panel means GDP is 1.90 approximately. The average value of GDP fluctuates among the individual groups, ranging between -2.34 and 4.54. Observation of GDP within the groups shows value between -2.09 and 6.54.

Similarly, CPI has a sample mean of 1.00, while the lowest between values -2.35 and the highest is 4.53. The within-country lowest value is -2.69 and the highest is 4.61. EXCH overall mean is 1.26 approximately. The between-country has the lowest value of -2.97 and the highest value of 4.56. For the within-country values, the lowest is -3.18 and the highest is 8.91. OP overall mean

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is 0.85 approximately, with a between-country lowest of -3.77 and highest of 3.59. The within-country lowest for OP is -2.75 and the highest is 5.46. for TO, the overall mean is 1.63 approximately, with a between-country lowest of -1.15 and highest of 4.53. The within-country lowest is -3.40 and the highest is 7.87.

4.3 Panel Unit Root Analysis

One prerequisite in panel data analysis is the test of stationarity of variables within the panel. The panel unit root test is conducted to test presence of unit root and stationary process of the variables.

Table 2: Panel Unit Root Test

		MW Panel Unit Root Test				**CIPS Unit Root Test**			
		Without trend		**With trend**		**Without trend**		**With trend**	
variable	Lags	Chi_sq	p-value	Chi_sq	p-value	Zt-bar	p-value	Zt-bar	p-value
GDP	0	28.28	0.66	17.506	0.982	19.556	1.00	19.556	1.00
	1	30.98	0.52	19.797	0.955	19.556	1.00	19.556	1.00
CPI	0	44.96	0.06	39.272	0.176	19.556	1.00	19.556	1.00
	1	36.32	0.27	27.086	0.714	19.556	1.00	19.556	1.00
EXCH	0	66.75	0.00	51.378	0.176	19.556	1.00	19.556	1.00
	1	57.10	0.00	42.336	0.105	19.556	1.00	19.556	1.00
OP	0	15.90	0.99	11.481	1.000	19.556	1.00	19.556	1.00
	1	18.19	0.97	14.089	0.997	19.556	1.00	19.556	1.00
TO	0	53.01	0.01	60.119	0.002	19.556	1.00	19.556	1.00
	1	29.65	0.59	31.609	0.486	19.556	1.00	19.556	1.00

Source computed by the researcher using STATA (2021)

Table 2 reveals two types of panel unit root test adopted. The first generation panel unit root test of Maddala and Wu (1999) (MW) and the second generation panel unit root test of Pesaran (2007) (CIPS). Both tests are known to have the same null that a series is I(1). Conducting the tests without and with trend in the series and using an optimal lag of 1, revealed mixed result for the MW test. While, the null of I(1) series is accepted only for the GDP and OP series without trend inclusion, the null is rejected for the CPI, EXCH and TO series. However, with trend inclusion, the null is accepted for all the series except for TO at 0 lag. CIPS unit root test on the other hand, has the null accepted for all the series either without or with a trend at 0 and 1 lag.

4.4 Panel Cointegration Tests

In order to examine the long-run equilibrium relationships among variables, it is required to examine the existence of cointergration among the variables. Table 3 below provides the results of panel cointegration test.

Table 3: Panel Cointegration Test

Cointegration Test	Statistic	P-value
Kao Test Ho: No cointegration – Ha: All panels are cointegrated		
1. Modified Dickey-Fuller regression 2. Dickey-Fuller regression 3. Augmented Dickey-Fuller regression 4. Unadjusted modified Dickey-Fuller regression 5. Unadjusted Dickey-Fuller regression	(1.47) (2.04) (1.78) (1.49) (2.05)	0.07* 0.02** 0.04** 0.07* 0.02**
Pedroni Test Ho: No cointegration – Ha: All panels are cointegrated		
1. Modified Phillips-Perron regression 2. Phillips-Perron regression 3. Augmented Dickey-Fuller regression	-5.85 -5.79 -4.56	0.00*** 0.00*** 0.00***
Westerlund Test Ho: No cointegration – Ha: Some panels are cointegrated		
1. variance-ratio	-0.23	0.41

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

Table 4 reveals the result for three cointegration tests conducted on the series. The first test is the Kao test which uses five test criteria. The low p-values for its five cointegration test criteria, shows that the null of no cointegration is rejected at the 10 percent significance level for the modified Dickey-Fuller and unadjusted modified Dickey-Fuller regressions; and at 5 percent significance level for the Dickey-Fuller, Augmented Dickey-Fuller and unadjusted Dickey-Fuller regressions. Hence, the conclusion that the variables are cointegrated.

The second test is the Pedroni test which make use of three cointegration test criteria which are the Modified Phillips-Perron, the Phillips-Perron and the Augmented Dickey-Fuller regressions. Judging by the very low p-value for each of the criterion, the null of no cointegration is also rejected at the 1 percent significance level.

The third cointegration test is the Westerlund test with the same null as the first two cointegration tests. The test variance ratio of -0.23 is not significant, indicating that the null of no cointegration cannot be rejected.

4.5 Panel VAR

The discovery of short-run and causal relations between variables is necessitated by the presence of a long-run cointegration vector between variables (Granger, 1969). Because the empirical data are cointegrated into the same order of one and the initial difference of variables is stationary, the short-run relationship dynamics between cointegrating panel variables will be estimated.

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To estimate the result of the stationarity of variables in the first difference, the first-order panel VAR model was employed. Table 4 below shows the results of estimating the first-order panel VAR model in the GMM pattern.

Table 4: First-order Panel VAR model estimated output

		Dependent Variables			
Independent Variables	(1) GDP	(2) CPI	(3) EXCH	(4) OP	(5) TO
L. GPD	1.03*** (0.01)	-0.01 (0.01)	-0.001 (0.01)	-0.03*** (0.01)	-0.01* (0.01)
L. CPI	0.003 (0.01)	1.01*** (0.01)	-0.01 (0.01)	0.01 (0.01)	0.01 (0.01)
L. EXCH	0.01 (0.01)	-0.01 (0.01)	1.00*** (0.11)	-0.01 (0.01)	-0.01 (0.01)
L. OP	-0.01 (0.01)	0.005 (0.01)	-0.0004 (0.01)	1.02*** (0.01)	-0.01*** (0.01)
L. TO	-0.01 (0.01)	0.01* (0.004)	-0.004 (0.01)	0.01** (0.01)	1.02*** (0.01)

Note: *, **, and *** indicate significance at 10%, 5% and 1% respectively. Standard error in parenthesis *Source computed by the researcher using STATA (2021)*

The estimated first-order panel VAR model in the GMM pattern are contained in Table 4. Evidence from the result shows that a unit rise in one year lagged GDP significantly impacted current GDP by 1.03 unit. On the contrary, a unit rise in one year lagged GDP significantly impacted OP and TO adversely by 0.03 and 0.01 unit respectively. A one year lagged CPI is revealed to have a positive impact on current CPI. Specifically, a unit rise in the former, will result in a 1.01 unit rise in the latter. Similarly, a unit rise in one year lagged EXCH is revealed to positively impact current EXCH by 1 unit. A unit increase in one year lagged OP is reported to yield a 1.02-unit appreciation in current OP and a 0.01-unit decline in current TO.

Having a unit rise in the one year lagged TO reveals a 0.01 unit rise in current CPI and OP, and a 1.02-unit increase in current TO.

4.5.1 Impulse Response Analysis

All IRF graphs are within the 95 percent confidence interval. The impulse response graphs can be seen in the appendix section.

A unit standard deviation (SD) shock from TO will lead to a positive response from TO which grows from 30 percent in the first period to about 37 percent in the tenth period. Similarly, OP responds positively to unit SD shock from TO, rising from 0 in the first period to 6 percent in the tenth period. However, EXCH responded adversely to unit SD shock from TO by falling from 0 in the first period to -2 percent the tenth period. CPI's response to shock from TO is positive, rising from 0 to 3 percent within the 10 periods. On the other hand, response from GDP to shocks from TO is negative, declining from 0 in period one to 4.5 percent in period ten.

A unit SD shock from OP to TO is negative, as it declined from 6.5 percent in period one to 4 percent in the tenth period. Response by OP to shock from itself is positive, growing from 2.5 percent in period one to 27 percent in period ten. EXCH's response to shock from OP is relatively neutral all through the ten periods. However, CPI's response to shocks from OP is positive, growing from 0 in period one to almost 2 percent in period ten. Conversely, GDP responded to shocks from OP adversely by declining from 0 in period one to about -4 percent in period ten.

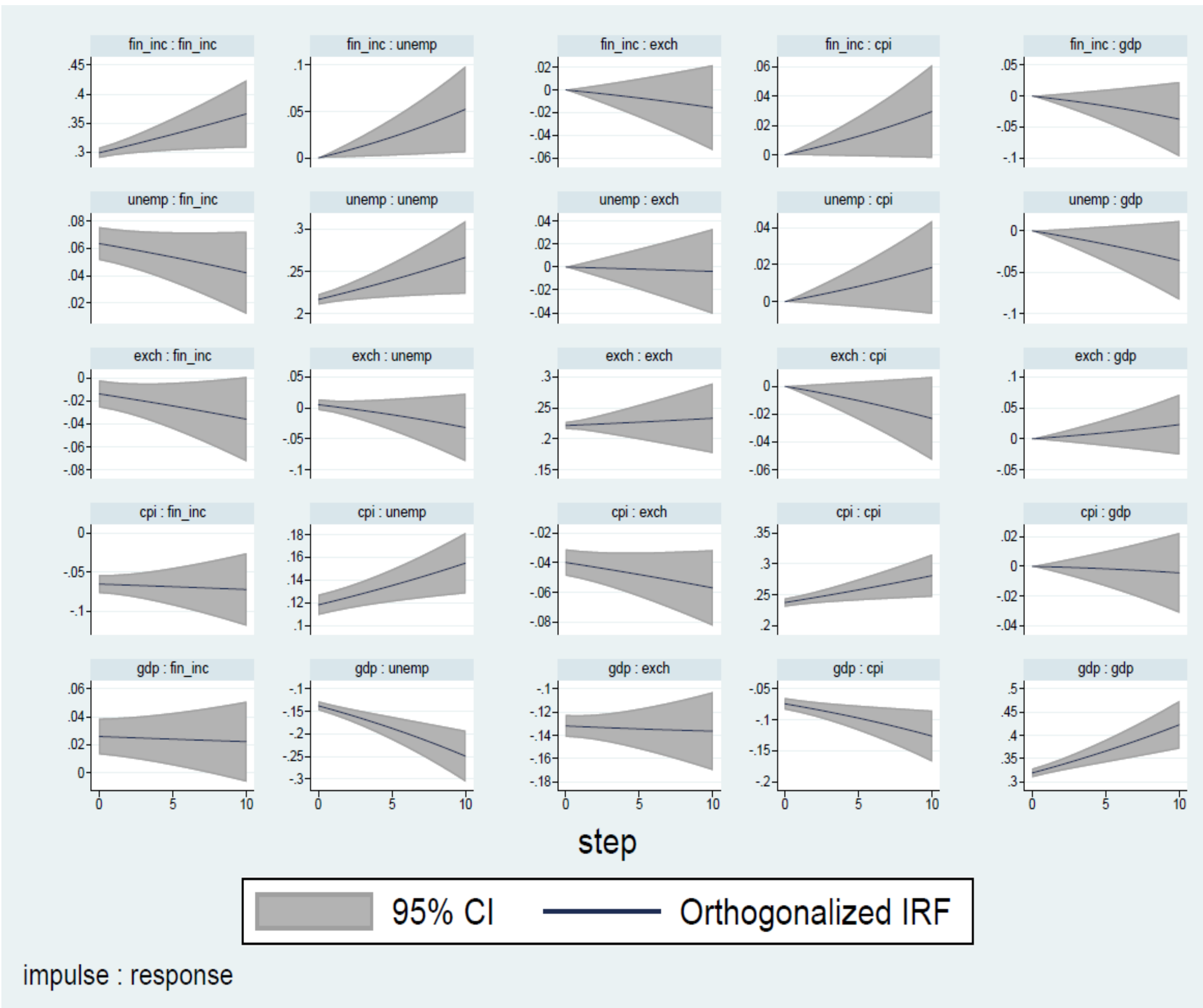

Figure 4.1: Orthogonalized Impulse Response Function

Response from TO to shocks from EXCH is negative, declining from about -1.8 percent in the first period to about 3.8 percent in the tenth period. Similarly, OP responded adversely to shocks from EXCH by declining from 1 percent in the first period to about -4 percent in the tenth period. The response of EXCH to shocks from itself is relatively stable at about 22 percent all through the ten periods. However, CPI responded adversely to shocks from EXCH by declining from 0 in the first period to about -2.5 percent in the tenth period. The response of GDP to shocks from EXCH is positive, rising from 0 in period one to about 2.5 percent in period ten.

Response from TO to shocks from CPI is stable at about 3.5 percent through the ten periods. On the other hand, OP responded positively to shocks from CPI, rising by 11 percent in period one to 15.5 percent in period ten. EXCH however responded negatively to shocks from CPI by dipping marginally from -4 percent in the first period to about -5 percent in the tenth period. CPI's response to shocks emanating from itself is positive, rising from about 24 percent in period one to about 27 percent in the tenth period. GDP responded negatively to shocks from CPI, dipping marginally from 0 in period one to about -0.5 percent in the tenth period.

TO's response to shocks from GDP is relatively stable at 3 percent all through the ten periods. While OP responded adversely to shocks from GDP by declining from -14 percent in period one to -25 percent in the tenth period. EXCH had a steady negative response to shocks from GDP by maintaining a -13 percent drop all through the ten periods. The response from CPI to shock from GDP was negative, as it dipped further from -3 percent in the first period to -8 percent in the tenth period. Response of GDP to shocks emanating from itself was positive, rising from about 32 percent in the first period to about 47 percent in the tenth period.

4.5.2 Decomposition of Forecast Error Variance

The aim of the forecast variance decomposition technique is to determine the fraction of prediction error variance for each of the variables under examination in relation to its shocks as well as other variables' shocks. The findings of the PVAR forecast variance decomposition with both direct and indirect shock effects are shown in table 5.

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Table 5: FEVD

Response variable & forecast horizon	GDP	CPI	EXCH	OP	TO
GDP					
0	0	0	0	0	0
1	1	0	0	0	0
2	0.9999	3.10e-07	0.00002	0.00004	0.00004
3	0.9997	1.12e-0.6	0.00005	0.00015	0.00013
4	0.9993	2.54e-0.6	0.00011	0.00031	0.00028
5	0.9988	4.67e-06	0.00019	0.00052	0.00048
6	0.9981	7.65e-06	0.00029	0.00080	0.00075
7	0.9973	0.00001	0.00042	0.00113	0.00109
8	0.9964	0.00002	0.00058	0.00152	0.00149
9	0.9953	0.00002	0.00076	0.00196	0.00197
10	0.9940	0.00003	0.00096	0.00245	0.00251
11	0.9926	0.00004	0.00120	0.00300	0.00314
12	0.9911	0.00005	0.00146	0.00360	0.00384
CPI					
0	0	0	0	0	0
1	0.089	0.911	0	0	0
2	0.092	0.908	0.00003	0.00002	0.00004
3	0.095	0.904	0.00009	0.00006	0.00013
4	0.099	0.900	0.00020	0.00013	0.00029
5	0.103	0.896	0.00035	0.00023	0.00051
6	0.107	0.892	0.00054	0.00035	0.00080
7	0.111	0.887	0.00078	0.00050	0.00116
8	0.115	0.882	0.00106	0.00069	0.00160
9	0.119	0.876	0.00139	0.00090	0.00213
10	0.124	0.871	0.00177	0.00114	0.00274
11	0.128	0.865	0.0022	0.00141	0.00344
12	0.133	0.858	0.00268	0.00172	0.00424
EXCH					
0	0	0	0	0	0
1	0.256	0.023	0.721	0	0
2	0.255	0.024	0.720	1.05e-06	0.00001
3	0.255	0.025	0.720	3.49e-06	0.00004
4	0.255	0.026	0.719	7.31e-06	0.00010
5	0.254	0.027	0.719	0.00001	0.00017
6	0.254	0.028	0.718	0.00002	0.00026
7	0.253	0.029	0.718	0.00003	0.00038
8	0.253	0.030	0.717	0.00004	0.00052
9	0.252	0.031	0.717	0.00005	0.00069
10	0.251	0.032	0.716	0.00006	0.00088
11	0.250	0.033	0.716	0.00007	0.00111
12	0.250	0.034	0.715	0.00009	0.00137
OP					
0	0	0	0	0	0
1	0.236	0.175	0.0003	0.588	0
2	0.245	0.174	0.0002	0.581	0.00009
3	0.253	0.173	0.0001	0.574	0.00032
4	0.262	0.172	0.0001	0.566	0.00068
5	0.270	0.171	0.0002	0.558	0.00119
6	0.279	0.169	0.0004	0.549	0.00184

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7	0.288	0.168	0.0006	0.541	0.00264
8	0.297	0.166	0.0010	0.532	0.00359
9	0.306	0.165	0.0014	0.523	0.00469
10	0.315	0.163	0.0019	0.514	0.00595
11	0.324	0.161	0.0024	0.505	0.00736
12	0.333	0.159	0.0030	0.496	0.00893
TO					
0	0	0	0	0	0
1	0.007	0.044	0.002	0.041	0.906
2	0.007	0.043	0.002	0.039	0.909
3	0.006	0.043	0.003	0.037	0.911
4	0.006	0.043	0.003	0.035	0.913
5	0.006	0.042	0.003	0.034	0.915
6	0.006	0.042	0.003	0.032	0.917
7	0.006	0.041	0.004	0.030	0.919
8	0.005	0.041	0.004	0.029	0.921
9	0.005	0.041	0.005	0.027	0.922
10	0.005	0.040	0.005	0.026	0.924
11	0.005	0.040	0.005	0.024	0.925
12	0.005	0.040	0.006	0.023	0.927

About 100 percent of the variation in GDP emanated from shocks from itself up to the ninth period, before declining marginally to 99 percent from the tenth to the twelfth period. The shocks from CPI, EXCH, OP, and TO aggregately constitute 1 percent variation in GDP from the tenth to the twelfth period.

The effect of exogenous shocks to GDP resulted to steady increase in CPI variation from 9 percent in the first period to 13 percent in the twelfth period. However, variation in CPI due to exogenous shocks to CPI itself declined from 91 percent in the first period to 86 percent in the twelfth period. Exogenous shocks to EXCH, OP, and TO accounted for less than 1 percent variation in CPI from the first to the twelfth period.

Variations in EXCH from exogenous shocks to GDP was approximately 26 percent in the first three periods before stabilizing at 25 percent from the fourth to the twelfth period. Exogenous shocks to CPI accounted for about 3 percent variations in EXCH from the third to the twelfth period, after marginally rising from 2 percent in the first two periods. 72 percent of variations in EXCH from the first to the twelfth period came from exogenous shocks to EXCH itself. While shocks to OP and TO both accounted for less than 1 percent variation in EXCH.

Variations in OP increased steadily from 24 percent to 33 percent from the first to the twelfth period due to exogenous shocks to GDP. However, shocks to CPI resulted in a 17 percent variation in OP which was stable within the first eight periods, before a marginal decline to approximately 16 percent from the ninth to the twelfth period. Shocks to EXCH resulted in less than 1 percent variation in OP. While variation to OP from exogenous shocks to itself declined steadily from 59 percent in the first period to approximately 50 percent in the twelfth period. The variation in OP from shocks to TO accounted for less than 1 percent from the first to the twelfth period.

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Shocks to GDP accounted for less than 1 percent variation in TO from the first to the twelfth period. However, shocks to CPI resulted in a stable 4 percent variation in TO all through the twelve periods. Shocks to EXCH comprised less than a percentage variation in TO all through the twelve periods; while shocks to OP resulted in a marginal decline in the variation to TO from 4 percent to 2 percent from the first to the twelfth period. On the other hand, variations in TO from exogenous shocks to itself was steady at 91 percent for the first five periods, before increasing marginally to 93 percent from the sixth to the twelfth period.

4.5.3 Causality Result

The panel Granger causality analysis is used to test whether two different variables used in this study has mutual links or not.

Table 6: Causality Output

Equation	Chi-sq	df	Prob. Chi-sq
GDP			
CPI	0.226	1	0.634
EXCH	0.568	1	0.451
OP	1.531	1	0.216
TO	1.151	1	0.283
ALL	2.041	4	0.728
CPI			
GDP	2.440	1	0.118
EXCH	1.880	1	0.170
OP	0.684	1	0.408
TO	3.063	1	0.080*
ALL	6.878	4	0.142
EXCH			
GDP	0.033	1	0.857
CPI	1.511	1	0.219
OP	0.003	1	0.953
TO	0.611	1	0.434
ALL	2.875	4	0.579
OP			
GDP	9.238	1	0.002***
CPI	0.968	1	0.325
EXCH	1.687	1	0.194
TO	5.336	1	0.021**
ALL	18.142	4	0.001***
TO			
GDP	3.347	1	0.067*
CPI	1.084	1	0.298
EXCH	1.050	1	0.305
OP	7.274	1	0.007***
ALL	8.905	4	0.064*

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

Table 6 contains the causality output for the variable. In the first panel, CPI, EXCH, OP and TO do not granger cause GDP judging by the high p-values which lie above the 1%, 5% and 10% significance levels. In the second penal, only TO does granger cause CPI at the 10 percent significance level, while GDP, EXCH, OP do not granger cause CPI. In the third panel, GDP, CPI, OP, and TO does not granger cause EXCH.

In the fourth panel, GDP and TO both granger cause OP at the 1 percent and 5 percent significance levels, while CPI and EXCH do not granger OP. Furthermore, all the variables (GDP, CPI, EXCH, and TO) jointly ganger cause OP at the 1 percent significance level.

In the fifth panel, GDP and OP both granger cause TO at the 10 percent and 1 percent significance level respectively. Although CPI and EXCH do not granger cause TO, taking all the variables jointly (GDP, CPI, EXCH and OP) do granger cause TO at the 10 percent significance level.

4.5.4 Stability Graph

The result shows that the eigenvalues still lie within the unit circle, hence, the VAR model is stable and the inferences can be relied upon**.**

5. Conclusion and Recommendation

The empirical aim of the study is to assess the role of trade on cyclical fluctuations of the OPEC countries utilizing the panel data econometric model. The empirical analysis demonstrated that trade shock, rather than oil shock, account for significant contribution in the macroeconomic stability or instability among member of the OPEC countries. Thus, the policy towards harmonizing trade differentials among the OPEC countries need to be robustly examined and implemented in the management of the economies of the member countries. Based on the result, the study established statistically significant relationship between trade shock and economic growth of the member countries while oil price shock is found to have significant but weak relationship with economic growth. It howeer established that trade shocks are the main driver of cyclical fluctuation of the OPEC member countries economic growth. On the basis of this findings, the study recommends a uniform trade policy to smoothen the impact of trade shocks on the economic growth of the OPEC member countries.

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