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Asymmetric Effects of Oil Price Volatility on Government Expenditure in Oil-Importing African Countries: Evidence from Zambia

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ABSTRACT

This paper examines the impact of disaggregated oil price shocks the government expenditure in oil-importing African countries using the case of Zambia. The analysis utilizes a"Structural Vector Autoregressive (SVAR) Model" to evaluate the short-run effects, while a "Vector Error Correction Model (VECM) is employed to analyze the relationship over the long-run. Results of the short-run analysis reveal a notable positive influence of oil price shocks"on government expenditure that emanates from global aggregate and precautionary demand factors. The aforementioned results are clarified by the effects that increased global aggregate demand has on copper prices, which in turn influences government revenue derived from taxes. Additionally, the transmission of "financial contagion and volatility spillovers" from the oil to the copper market clarifies the influence of precautionary demand on government expenditure. The findings obtained from the VECM indicate that global aggregate demand has positive effects on public sector spending in the long run. Additionally, the analysis demonstrates that the rate at which public sector spending recovers to its equilibrium level after a temporary deviation is both monotonic and statistically significant. Moreover, among the three categories of oil price hikes, Forecast Error Variance Decomposition analysis reveals that shocks related to precautionary demand have the most significant impact, accounting for 11.7% of the observed variation in public sector spending.

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Introduction

Since oil and its products are utilized in the manufacture and delivery of products and services, governments and other economic agents throughout the world have been curious about how oil price shocks affect macroeconomic indicators. According to Lin et al., "elevated oil prices have diverse implications for the global economy, including the transfer of wealth from oil consumers to oil producers, surges in costs associated with producing goods and services, direct and indirect impacts on inflation, inducing changes in consumer confidence, and an alteration of expectations in financial markets" [1]. Recent empirical evidence provides support for the existence of transmission channels that link oil price volatility to economic variables. These channels operate by reallocating capital and factoring in the risk associated with uncertainty associated with oil prices. However, as Hamilton argues, there potentially exists an asymmetry in the relationship between oil price shocks and income reallocation [2]. This is mainly because the effects of a change in oil prices on wealth transfer and real balance are distinct from those using allocative channels." Moreover, it is seen that governments exhibit asymmetric responses when monetary authorities implement contractionary monetary policies as a means of responding to increases in oil prices but fail to do the opposite in response to reductions in oil prices, further amplifying their asymmetric responses to oil price hikes, thus restricting growth.

Studies on the macroeconomic consequences of oil price hikes have been inconclusive due to contradictions in the findings of various researchers. According to Barder, one of the reasons for contradictory findings in the case of oil exporters is referred to as "Dutch Disease" which characterizes a decline in exports due to the rise in value of the local currency following the increase in the global price of its primary export commodities or exploitation of newly discovered resources [3]. Granted that the oil price – government spending nexus has been extensively researched from the standpoint of oil exporters, country-specific studies on the case of developing, oil-importing countries are scarce, but equally important because significant rises in oil prices may severely impact the availability of revenue for social spending.

The Zambian case is of particular interest since it is symptomatic of many developing African countries that are characterized by oil-import dependency, low energy diversification, volatile exchange rates, fiscal budget deficits, widespread sovereign debt burden and inadequate delivery of social services like health and transport infrastructure. Since the relationship between revenue and expenditure in Zambia is best described as fiscal synchronization, where revenue and spending determine each other, the government has the freedom to choose the most appropriate policy direction to mitigate the fiscal consequences of oil price hikes.

Given the limited availability of literature on the consequences of petroleum price hikes on oil importing African economies, the extent and homogeneity of its influence on government expenditure remained uncertain. This knowledge gap persisted due to the absence of country-specific analyses that undertook a structural disaggregation of oil prices in investigating specific cases. The susceptibility of "Southern African" economies to oil price hikes was examined in previous studies by scholars like Moyo and Nkomo, but their effects on the components of Gross Domestic Product (GDP), particularly government spending, were not examined [4,5]. Moreover, Kilian & Park demonstrated the inadequacies of the methodologies employed in such investigations [6]. They achieved this by illustrating that supply, global aggregate, and precautionary (oil-specific) demand shocks had distinct qualitative and quantitative characteristics which resulted in varying effects on economic variables. Also, these studies utilized models that didn't differentiate between the short and long-run effects and made the assumption that oil prices were exogenous.

It is widely acknowledged that stylized facts regarding oil-importing countries are dynamic due to factors such as the amount of oil imported, oil dependency, efficiency in the use of energy, affordability of oil products by consumers, exchange rate dynamics, and availability of alternatives to oil products, to mention a few. Due to worries about rising poverty levels, African governments have traditionally found it difficult to execute measures targeted at passing on oil price increases to consumers. For instance, if rises in oil prices were permitted to be directly linked to Zambia's inflation rate, as would have occurred if fuel subsidies, price controls, and exchange rate regulations had not been imposed during the second republic , inflation and its pass-through effects would have necessitated frequent tightening of monetary policy, which would have stifled growth and exacerbated poverty. According to Hassan, this makes it hard for governments to eliminate subsidies in efforts aimed at synchronizing domestic fuel prices to the global market prices [7]. In Zambia's case, maintaining fuel subsidies to insulate households and companies from rising oil prices became a challenge due to the deterioration of the government's fiscal balance, the balance of payments, and debt levels, thus making the prevailing structure of fuel subsidies unsustainable. This situation contributed to the implementation of the Structural Adjustment Programme which created a framework where domestic fuel prices could be adjusted by market forces like fluctuations in foreign exchange rates and global petroleum prices.

Hence, the primary contribution of this study is in the examination of the oil price-government expenditure nexus in oil-importing African nations by the structural disaggregation of oil price hikes and the differentiation of their impacts in the short and long-run. This research presents empirical evidence that might potentially aid governments of oil-importing African nations in devising fiscal policies that are targeted at the mitigation of negative social and economic consequences arising from fluctuations in oil prices.

Historical Government Spending and Oil Prices

Since Zambia's independence, public sector spending has fluctuated due to global factors, copper price dynamics, social infrastructure needs, and government policy, to mention a few. Figure 1 below highlights the evolution of Zambia's government spending and global petroleum prices from 1985 to 2019.

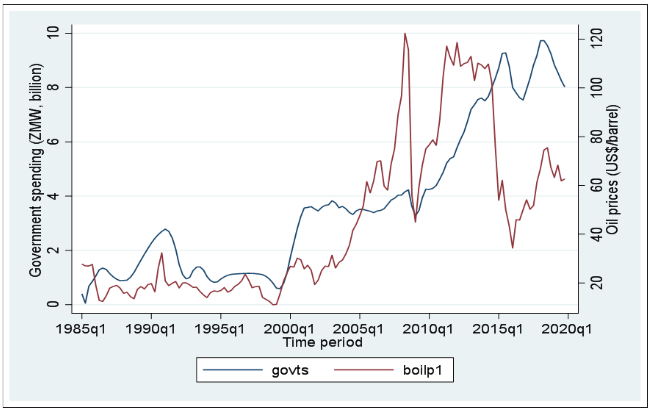

Figure 1: Global Oil Prices and Government Spending in Zambia (1985-2019)

Figure 1 demonstrates that average petroleum prices fell to $27.75/barrel in quarter 1 of 1985 on the backdrop of a collapse of global commodity prices during that period. In the words of Abdel-Latif et al., "Saudi Arabia unilaterally closed 75% of its production capacity due to falling oil prices in order to raise [8] oil prices by creating an artificial shortage on the global market as well as hysteresis effects of the Iran-Iraq war of 1980-81." This period corresponded to low copper prices, and subsequently, relatively low government spending. According to Ingle, due to increasing poverty; unemployment; illiteracy; social unrest; food shortages; and political instability in Zambia, multi-party democracy was introduced in 1990, followed by the subsequent undertaking of an IMF tailored Structural Adjustment Programme (SAP) that was aimed at macro-economic stability; public reforms in the public sector; economic liberalization; privatization of state assets; and agricultural reforms [9]. In 1998, public sector spending significantly increased due to infrastructure development programmes, particularly the Presidential Housing Initiative which targeted the construction of 4,000 housing units for the low/middle class, as well as widespread road infrastructure development.

During this economic dispensation, Zambia's economic fundamentals continued to decline despite government efforts to stabilize the economy, until the country met the criteria for the "Highly Indebted Poor Countries Initiative (HIPC) in 2005. As a result of this IMF-sponsored intervention, funds were provided for public spending in sectors including healthcare, education, and agriculture. According to Popova et al., "the price of oil surged to $111/barrel in 2011 as a result of various geopolitical events that reduced oil production, such as the 9/11 terrorist attacks on the United States and the subsequent invasion of Iraq; the Arab Spring uprising; the Venezuelan crisis; and the civil war in Libya" [10]. Since both government spending in Zambia and oil prices are shown to rise during times of domestic and global shocks, Figure 1 agrees with Kilian's observation that this argument does not fit the data because oil prices historically remained stable during periods of global economic shocks [11]. According to Rasmussen et al., "Zambia faced economic challenges in 2016 following another year of low copper prices, widespread drought, and crippling electricity supply deficits that severely affected the economy, coupled with its skyrocketing public debt, estimated to have exceeded 56% of GDP in 2016 and 94.5% in 2019 [12]."

In 2015, there was a reduction in fuel subsidies, a trend that was consolidated in 2017 when the government detached itself from the procurement of diesel, kerosene and petrol, thus allowing private sector involvement.

Methods and data

Sample

This "study utilizes quarterly data spanning from 1985 to 2019. The selection of this period was based on the availability of data and the distinctive nature of the mid-1980s which witnessed notable transformations in the global petroleum market and its governing dynamics. These changes included shifts in the oil elasticity of demand, as highlighted by researchers such as Hamilton and Chundama [2,13].

Description of Variables and Sources of Data

The dataset comprises of 140 observations of all variables from the period sampled. Table 1 below reports the descriptive statistics of all the variables used in this study, particularly the means, standard deviations, minimum and maximum values.

Table 1: Descriptive Statistics

Variable	# of Observations	Mean	Standard. Dev.	Minimum	Maximum
Global Oil Production	140	68.85	8.12	52.77	84.47
Global Oil Prices	140	44.85	32.26	11.09	122.39
Global Economic Activity	140	1858.16	1638.13	358	10128
Government Spending	140	3.68	2.75	.05	9.73

The data sources and justification for the variables used (where necessary) are discussed below

- **Global Oil Supply:** Statistics on global oil output were sourced from the "U.S. Energy Information Administration (EIA)," and were utilized as a proxy measure for the historical global supply of oil.
- **Oil Prices:** To proxy precautionary demand, real "Brent Crude prices" were employed following Chundama, and sourced from the EIA [13].
- **Global Aggregate Demand:** The "Baltic Dry Index (BDI)" was utilized as a proxy for global aggregate demand. The rationale for employing this index was supported by the argument that hikes in dry cargo ocean shipping rates are indicative of a growing "demand" for shipping services stemming from expansions in "global economic activity". This is attributed to the limited flexibility in the supply of cargo vessels [6]. Furthermore, Klovland documented that the shipping industry runs at nearly maximum capacity, causing the supply curve for shipping that is essentially vertical [14]. Put simply, when there is a rise in economic activity in comparison to the amount of goods being transported, it is seen that freight rates tend to experience an upward trend. According to the findings of Kilian & Zhou, this index is more suitable, compared to alternative indicators of global economic activity like the Industrial Output Index of the "Organisation for Economic Co-operation and Development (OECD) which fail to incorporate real activity from emerging economies such as Brazil, China, and India." The data set was acquired from the Baltic Exchange [15]".
- **Government Spending:** Government expenditure statistics for Zambia were acquired from the United Nations (UNData)." In order to account for inflation, government expenditure was adjusted using the Consumer Price Index (CPI) data obtained from the "Zambia Statistical Agency (ZSA)"". The Proportional "First Difference Benchmarking technique, as established by Denton, was employed to convert the annual data on government expenditure into quarterly frequency. In this process, copper prices were utilized as the predictor in the temporal disaggregation process [16,17].

Short-Run Model Specification

To measure the contemporaneous effect of disaggregated petroleum prices on government expenditure, a recursively identified SVAR model, which was adapted from Kilian & Park, was employed for data analysis. Therefore, to construct the SVAR, restrictions were imposed on matrix A, as illustrated below [6].

$$Az_t = \phi_0 + \sum_{i=1}^{p} \Tau_i \, z_{t-i} + e_t, \qquad (1)$$

Where" ϕ_i is a matrix of constants; e_t is white noise ; A is a matrix (4x4) of contemporaneous associations between the variables; z_{t-i} are lagged variables."

According to Kilian & Park (2009), "applying constraints on matrix A also entails putting constraints on its inverse." Therefore, the reduced form of the VAR is produced by the multiplication of the right and left sides of the SVAR by A^{-1} as follows [6]

$$X_t = A^{-1} A Z_t, \qquad (2)$$

$$e_t = A^{-1} v_t \qquad (3)$$

Notably, Equation (3) describes the association between structural innovations and FEVD.

The SVAR model was chosen because it enables the examination of bi-directional feedback effects among the variables in the system by treating oil prices as endogenously determined. Moreover, the "structural decomposition" of oil price shocks enabled an examination of the effects of specific innovations on government expenditure, namely: aggregate demand, oil supply, and precautionary (oil-specific) demand shocks.

The SVAR model was specified using the "Cholesky decomposition "where $\frac{n^2-n}{2}$ exclusion restrictions were imposed, resulting in the following representation

$$e_t \equiv \begin{bmatrix} e_{1t}^{\Delta\, global\ oil\ production} \\ e_{2t}^{\Delta\, global\ real\ economic\ activity} \\ e_{3t}^{\Delta\, real\ price\ of\ oil} \\ e_{4t}^{\Delta\, in\ government\ spending} \end{bmatrix} = \begin{bmatrix} a_{11} & 0 & 0 & 0 \\ a_{21} & a_{22} & 0 & 0 \\ a_{31} & a_{32} & a_{33} & 0 \\ a_{41} & a_{42} & a_{43} & a_{44} \end{bmatrix} \begin{bmatrix} \varepsilon_{1t}^{oil\ supply\ shock} \\ \varepsilon_{2t}^{aggregate\ demand\ shock} \\ \varepsilon_{3t}^{oil\ specific\ demand\ shock} \\ \varepsilon_{4t}^{government\ spending\ shock} \end{bmatrix} \qquad (4)$$

The significance of variable ordering in the construction of an SVAR model is crucial due to its potential impact on the findings. "For example, the model suggests that if a variable in the SVAR receives a shock, other variables will also be affected, contingent on the degree of correlation between the residuals [18]. Hence, it is crucial to establish an ordering that ensures that every prospective impulse to the system influences the variables in a direction that is logical and consistent with economic theory." Hence, the derived Cholesky decomposition stems from economic theory and the recognition that Zambia is a "small" open economy with insignificant "market power" in the global petroleum market.

With the aforementioned, the first identifying assumption, following Kilian & Park, is that large changes in the world's petroleum output reflect shocks to petroleum supply and that the latter is contemporaneously exogenous [6]. In other words, the supply of petroleum lags behind changes in demand by at least (t+1). "The second assumption is that variations in dry ocean cargo transportation prices reflect variations in real economic activity, thus aggregate demand, and may only be contemporaneously affected by oil supply changes. Thirdly, it is held that fluctuations in oil prices induced by variables other than supply and global aggregate demand are driven by precautionary demand, and may be contemporaneously affected by both petroleum supply and global aggregate demand changes." Lastly, this study assumed that government expenditure does not affect decomposed oil price shocks.

By applying the SVAR model, the equations below show the contemporaneous effect of disaggregated oil price shocks on government expenditure

$$woilp_t = \text{ɰ} + \sum_{i=1}^{k} \beta_1\, woilp_{t-i} + \varepsilon_{1t} \quad (5)$$

$$bdi_t = \alpha + \sum_{i=1}^{k} \beta_2\, woilp_{t-i} + \sum_{l=1}^{k} \psi_1\, bdi_{t-l} + \varepsilon_{2t} \quad (6)$$

$$boilp_t = \Omega + \sum_{i=1}^{k} \beta_3\, woilp_{t-i} + \sum_{l=1}^{k} \psi_2\, bdi_{t-l} + \sum_{m=1}^{k} \phi_1\, boilp_{t-m} + \varepsilon_{3t} \quad (7)$$

$$gov_t = \text{ƴ} + \sum_{i=1}^{k} \beta_4\, woilp_{t-i} + \sum_{l=1}^{k} \psi_3\, bdi_{t-l} + \sum_{m=1}^{k} \phi_2\, boilp_{t-m} + \sum_{n=1}^{k} \sigma_1\, gov_{t-n} + \varepsilon_{4t} \quad (8)$$

where "k is the optimal lag length; ɰ, α, Ω, and ƴ are constants; β_i, ψ_i, ϕ_i, and σ_i are short-run coefficients; ε_{it} are residuals; bdi is the Baltic dry index; woilp is the global oil production; gov is government expenditure; and boilp is brent crude oil prices."

Specification of Vector Error Correction Model

A VECM was developed to determine a long-run nexus after the fulfilment of cointegration conditions, following the work of Johansen & Juselius [19]. "The study conducted by Gujarati & Porter provided evidence that causality tests alone may not always indicate the presence of a long-term connection between variables [20]." Therefore, the utilization of cointegration tests becomes imperative in order to ascertain the existence of long-run links. Hence, the VECM that has been formulated is presented as follows

$$\Delta woilp_t = \text{ɰ} + \sum_{i=1}^{k-1} \beta_1\, \Delta woilp_{t-i} + \sum_{l=1}^{k-1} \psi_1\, \Delta bdi_{t-l} + \sum_{m=1}^{k-1} \phi_1\, \Delta boilp_{t-m} + \sum_{z=1}^{k-1} \text{ɖ}_1\, \Delta govt_{t-z} + \Omega_1 ECT_{t-1} + \varepsilon_{1t} \quad (9)$$

$$\Delta bdi_t = \alpha + \sum_{i=1}^{k-1} \beta_2\, \Delta woilp_{t-i} + \sum_{l=1}^{k-1} \psi_2\, \Delta bdi_{t-l} + \sum_{m=1}^{k-1} \phi_2\, \Delta boilp_{t-m} + \sum_{z=1}^{k-1} \text{ɖ}_2\, \Delta govt_{t-z} + \Omega_2 ECT_{t-1} + \varepsilon_{2t} \quad (10)$$

$$\Delta boilp_t = \Omega + \sum_{i=1}^{k-1} \beta_3\, \Delta woilp_{t-i} + \sum_{l=1}^{k-1} \psi_3\, \Delta bdi_{t-l} + \sum_{m=1}^{k-1} \phi_3\, \Delta boilp_{t-m} + \sum_{z=1}^{k-1} \text{ɖ}_3\, \Delta govt_{t-z} + \Omega_3 ECT_{t-1} + \varepsilon_{3t} \quad (11)$$

$$\Delta govt_t = \text{ʎ} + \sum_{i=1}^{k-1} \beta_4\, \Delta woilp_{t-i} + \sum_{l=1}^{k-1} \psi_4\, \Delta bdi_{t-l} + \sum_{m=1}^{k-1} \phi_4\, \Delta boilp_{t-m} + \sum_{z=1}^{k-1} \text{ɖ}_4\, \Delta govt_{t-z} + \Omega_4 ECT_{t-1} + \varepsilon_{4t} \quad (12)$$

In Equations (9 – 12), "k-1 is the optimal lag length; ɰ, α, Ω, and ʎ are constants; β_i, ψ_l, ϕ_m and ɖ_z, are short-run coefficients; Ω_i is the coefficient which represents the speed of adjustment when converging back to long-run equilibrium; ECT_{t-1} is the error correction term; ε_{it} are residuals; bdi is the Baltic dry index; woilp is the global oil production; govt is government spending; and boilp is Brent oil prices."

Results and Discussion

Diagnostic Tests

The optimal lag length was estimated using the "Final Prediction Error (FPE), Schwarz Information Criterion (SBIC), Hannan-Quinn Information Criterion (HQIC) and the "Akaike's Information Criterion (AIC). Any one of the aforementioned criteria may be exclusively used to choose an optimal lag length, although the "modern convention" is to consider the results of at least 2 of them. In that regard, the decision rule was to select the lag length recommended by the AIC criteria plus either the HQIC, SBIC, or FPE criteria. As reported in Table 7 of Appendix 1, a lag length of 3 was selected following the recommendations of both the AIC and FPE.

The outputs of other diagnostic tests, namely: the "Augmented Dickey Fuller Test" for stationarity, Breusch-Pagan/Cook Weisberg Test" for heteroscedasticity," the "SWald Test" for structural breaks, Durbin-Watson" and "Lagrange Multiplier Tests" for autocorrelation, "Eigen Value Stability Test", Johansen Cointegration Test", and "Variance Inflation Factor (VIF) Test" for multicollinearity are reported in Appendix 1 by Tables 6, 8, 9, 10-11, 12, 13, and 14, respectively.

Short-Run Contemporaneous Effect of Decomposed Oil Price Shocks on Government Expenditure
The significance of the short-run contemporaneous effect of disaggregated oil price innovations on government spending is reported in Table 2 below

Table 2: Selected Outputs of the SVAR Model

Response	Impulse	Coefficient	Standard. Err.	z	P>z	[95% Bootstrap Confid. Interval]	
Government Spending	Oil Supply	-.41	.40	-1.01	0.31	-0.84	2.61
Government Spending	Aggregate Demand	-.04	.02	-2.33	0.02	-.04	.06
Government Spending	Oil –Specific Demand	-.09	.04	-2.57	0.01	-0.02	0.18

The results presented in Table 2 indicate that there is no statistically significant contemporaneous effect of oil supply on real government spending at a significance level of 5%. Notably, it has been shown that both precautionary (oil-specific) and global aggregate demand exert a substantial contemporaneous influence on government expenditure. Further analysis of these results follows using"IRFs", "Granger Causality tests and "FEVDs.

Impulse Response Functions
The reaction of a variable to a shock from other variables may only be inferred to a limited extent from model coefficients, as indicated by Verbeek and other VAR literature [21]. To describe the evolution of a standard deviation innovation in disaggregated petroleum price shocks to government spending, IRFs were created to bridge the information gap, as shown in Figure 2 below.

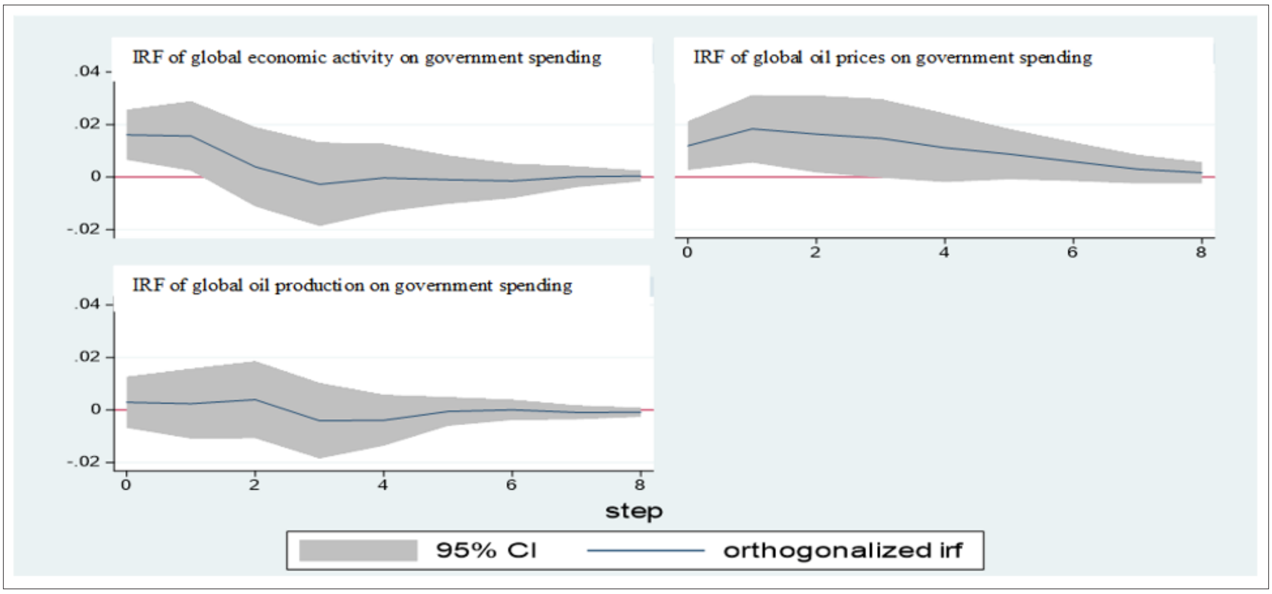

Figure 2: Impulse Response Functions

The findings in Figure 2 and Table 2 " show that oil supply has no short-run contemporaneous impact on government spending, although a unit innovation in global aggregate demand was shown to have a positive contemporaneous impact on government expenditure, at the 5% level." Government expenditure rises by 1.8 percentage points as a result of the impact of the shock during the first quarter of the shock, after which it starts to decline gradually and eventually "dissipates" after 3 quarters. This finding was further clarified by Cali & Velde in their ground-breaking article on the "Dutch Disease" in Zambia [22]. The authors argued that rises in international copper demand due to increased economic activity spurred a significant increase in Zambia's copper production and exports, thus increasing Government revenue through direct effects i.e. more taxes collected from the Mining sector. Given the high dependence of Zambian exports on copper, such a large copper price boom may have the same potential effects on the economy as exploiting newly discovered natural resources. An analysis of the structure of Zambia's fiscal income reveals that indirect effects play a more important role than direct effects in determining increases in revenues. They argued that recent increases in public revenue were mainly derived from tax revenues related to GDP growth and a rise in external grants and sovereign debt. According to their argument, the growth of excise taxes, which include royalties on copper production, has been slower than that of other tax receipts. "They attributed this to several factors, including the low rate of mining royalties, the 25% corporation tax rate , and the exemption of mining companies from dividend payments." Consequently, they found that the government had few benefits from copper price booms.

Notably, Figure 2 and Table 2 showed that, at the 5% level,"oil-specific demand"had a positive contemporaneous effect on government expenditure. Government expenditure rises by 1 percentage point as a result of a unit precautionary demand shock, with the effect of the innovation increasing for 1 quarter before it starts to decline before disappearing after 8 quarters. Notwithstanding its status as a net-oil importer, oil-specific demand was found to positively affect Zambia's government spending due to "volatility spillovers" and "financial contagion" between global copper and oil markets, which in turn causes an increase in government revenue from taxation [23,24]. Vast amounts of literature have shown that commodity prices move together, so when oil prices increase, copper prices are likely to also increase, which causes an increase in copper revenue and taxes collected by the Government. Additionally, this conclusion is in line with a wide range of other studies, including one by Lorde & Thomas on Trinidad and Tobago, "which found that rising oil prices have a positive effect on government revenue and consumer spending [25]. This finding emphasized the significance of government revenues as one the main channels through which oil prices affect fiscal policy decisions in oil-dependent countries."

Granger Causality

Granger Causality tests were carried out to establish if disaggregated petroleum price shocks contain information that aids in the prediction of government expenditure. "The Granger Causality Test findings are shown in Table 3 below

Table 3: Selected Results of Granger Causality Tests

Direction of causality			Chi2	df	Prob > chi2
Government Spending	⟵	Oil Supply	3.35	3	0.34
Government Spending	⟵	Aggregate Demand	5	3	0.17
Government Spending	⟵	Oil –Specific Demand	2.57	3	0.46
Government Spending	⟵	All	10.38	9	0.32

Table 3 above shows that neither oil supply, aggregate demand, nor oil-specific demand granger-causes government spending at the 5% level. Furthermore, "the total effect of all variables in the system was shown to have no granger-causal influence on government expenditure, meaning that decomposed oil price shocks do not contain information which can be used to forecast government expenditure."

Variance Decomposition of Government Spending

FEVD was conducted to determine the "proportion of variation" in government spending which was caused by disaggregated oil price shocks. The main findings of the FEVD after 8 quarters of the shock are reported in Table 4 below.

Table 4: Results of Forecast Error Variance Decomposition

Horizon	Oil Supply (%)	Global Aggregate Demand (%)	Oil-Specific Demand (%)	Other Shocks (%)
0	0	0	0	0
1	0.23	7.73	4.27	87.74
2	0.20	7.85	7.48	84.45
3	0.35	6.17	8.89	84.59
4	0.49	5.54	10.16	83.82
5	0.62	5.23	10.9	83.21
6	0.61	5.17	11.42	82.8
7	0.61	5.15	11.67	82.57
8	0.61	5.14	11.74	82.51

The findings shown in Table 4 indicate that the variance in government expenditure is partially attributed to precautionary demand which explains 11.7% of the variance, while global aggregate demand explains 5.1%. On the other hand, the influence of oil supply on government spending is found to be minimal, accounting for just 0.6% of the variance. The aforementioned observation aligns with the empirical findings presented by Cashin et al. and Kilian which indicated that demand shocks are the primary drivers of fluctuations in oil prices [26,27].

Long-Run Effects of Disaggregated Oil Price Shocks on Government Expenditure

As reported in Table 13 (Appendix 1), the findings of the "Johansen cointegration test" reveal the existence of at least 1 cointegrating vector when government spending is restricted, so a VECM was constructed. Selected outputs of the VECM are shown in Table 5 below.

Table 5: Selected Results of the VECM

Cointegrating Equation Parms.		Coefficient.	Standard.Err	z	p>z	95% Cont. Interval	
Government spending	ECT	-0.26	0.03	-9.23	0	-0.32	-0.21
Government spending	Oil supply	-0.38	-0.36	-0.36	0.72	-2.44	1.68
Government spending	Aggregate demand	0.12	0.05	2.2	0.03	0.01	0.22
Government spending Government spending	Oil-specific demand cons	0 0	0.11 0.2	-0.04 0.18	0.9 0.86	-0.21 -0.03	0.20 0.03

Table 5 above shows that neither oil supply nor oil-specific demand has a long-run effect on government expenditure at the 5% level. Having said that, "global aggregate demand" was revealed to have a positive effect on government expenditure. Moreover, the "ECT", whose coefficient indicates the rate of correction back to long-run equilibrium after a short-run disturbance, was found to be stable, significant and monotonic. In particular, the ECT term shows that the system corrects disturbances at a speed of convergence of 26% per quarter, so the system will take 3.85 quarters to converge to long-run equilibrium after a disturbance.

This finding is in accordance with economic reasoning since higher commodity prices erode long-run global growth by causing inflation, supply disruptions and increases in the cost of production, notwithstanding the marginal growth of commodity exporters whose increased export revenue partially offsets the global output losses of commodity importers [28]. Igan et al. proved that "in the long-run, sustained periods of global growth are associated with low commodity prices, while Hamilton showed that recent global economic recessions were caused by oil price shocks [2]." In the case of the Zambian economy, low copper prices translate into reduced government earnings from taxation given the commodity-intensive structure of its economy. According to Gorajek & Rees, "recent declines in bulk commodity prices have reduced the growth of household income, company profits and government revenues since the declines have been associated with a contraction in mining investment and, by lowering the growth of aggregate demand, have restrained non-mining business investment" [29].

Conclusion

This study diverges from the majority of existing literature which primarily examined the effects of "oil price shocks" on macroeconomic variables in industrialized countries and oil exporters and often treated oil price shocks as homogenous. In contrast, this study explores the "oil price shocks" - government spending nexus in Zambia, a country that relies entirely on imported oil and is symptomatic of most African countries. "Hence, an SVAR model was employed to assess the impact of oil price increases on government expenditure in the short term, while a VECM was utilized for the examination of long-run dynamics."

The findings show that both precautionary and global aggregate demand shocks have a positive impact on government expenditure in the short-run. Significantly, among the 3 categories of oil price shocks, FEVD analysis indicates that oil-specific demand shocks exerts the most substantial impact, accounting for 11.7% of the observed "variation" in government expenditure. This result is attributed to the favorable impact of global aggregate demand on copper prices, subsequently leading to an expansion in government income through taxation. Additionally, the positive effect of precautionary demand shocks stems from contagion and volatility spillovers between copper and oil markets. The study also reveals that government spending is influenced by both "global aggregate" and "oil-specific demand shocks" in the long-run. "Global aggregate demand" was found to have a negative effect on government spending since higher commodity prices hinder global growth. On the other hand, oil-specific demand had a positive effect on government spending due to "financial contagion" and "volatility spillovers" between copper and oil markets.

The findings imply that short-run oil price shocks that are caused by demand factors signal forthcoming increases in government revenue from increased taxes due to higher commodity prices (copper prices for Zambia), therefore governments may enjoy additional fiscal space for developmental programmes such as social spending on health and education. In the long-run, the negative impact of oil-specific demand shocks on government spending suggests that governments of oil-importing countries need to utilize the short-run gains of oil price hikes to bolster strategic oil reserves to cushion the negative long-run impacts. Lastly, the heterogeneous effects of decomposed shocks motivate the need for governments to develop active early warning and economic surveillance systems to determine the underlying causes of shocks, thus facilitating appropriate fiscal responses.

Appendix 1: Diagnostic Tests

Table 6: Results of ADF Stationarity Test

Variable	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value	P > (t)
Government Spending	-19.55	-3.50	-2.90	-2.58	0.00
Oil production	-12.59	-4.03	-3.45	-3.15	0.00
Oil prices	-9.49	-4.03	-3.45	-3.15	0.00
Global economic activity	-11.91	-4.03	-3.45	-3.15	0.00

Where H_0: series is not stationary

Table 7: Results of Lag-Length Selection Tests

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	548.70	3.7e-09		-8.07		-8.03	-7.98	
1	634.95	172.49	16	0.00	1.3e-09	-9.11	-8.94	8.68
2	684.48	99.07	16	0.00	7.9e-10	-9.61	-9.29*	8.83*
3	671.43	33.38*	16	0.01	7.8e-10*	-9.62*	-9.16	8.50
4	711.71	21.07	16	0.18	8.5e-10	-9.54	-8.94	8.07

Table 8: Results of the Heteroscedasticity Test

Test	chi2	Prob > chi2
Breusch-Pagan / Cook-Weisberg Test for Heteroscedasticity”	0.01	0.94

Where H_0: series is not heteroscedastic

Table 9: Results of SWald Test for Structural Breaks

Test	Statistic	P-Value
SWald	6.55	0.78

Where H_0: series does not have structural breaks

Table 10: Results of the Durbin-Watson Test

Test	Name of Statistic	Number of Variables	Sample Size	Value
“Durbin-Watson”	d-statistic	4	139	2.22

Table 11: Lagrange Multiplier Test

Lag	Chi2	df	Prob>chi2
1	58.92	16	0
2	22.05	16	0.14
3	26.24	16	0.2

Where H_0: no autocorrelation at lag order”

Table 12: Eigen Value Stability Test

EigenValue	Modulus
-.147734 + .6611401i	.677445
-.147734 - .6611401i	.677445
.6320643 + .1922118i	.660644
.6320643 - .1922118i	.660644
.07500293 + .6298686i	.634318
.07500293 - .6298686i	.634318
.3814787 + .3966969i	.550358
.3814787 - .3966969i	.550358
-.2307876 + .4715838i	.525028
-.2307876 - .4715838i	.525028

-.2544908 + .147324i	.294058
-.2544908 - .147324i	.294058

Note: "All the eigenvalues lie inside the unit circle so VAR satisfies the stability condition."

Table 13: Results of Johansen's Cointegration Test

Maximum Rank	Parms	LL	Eigenvalue	Trace Statistic	5% Critical Value
0	20	463.97	.	98.46	47.21
1	27	502.08	0.42	22.23*	29.68
2	32	509.10	0.10	8.21	15.41
3	35	512.81	0.05	0.78	3.76
4	36	513.20	0.01		

Table 14: Results of the VIF Test for Multicollinearity

Variable	VIF	1/VIF
Oil Prices	1.14	0.88
Global Aggregate Demand	1.14	0.88
Government Spending	1.00	0.99

References

1. Lin B, Wesseh P, Appiah M (2014) Oil price fluctuation, volatility spillover and the Ghanaian equity market effectiveness: Implication for portfolio management and hedging. Energy Economics 42: 172-182.
2. Hamilton JD (2003) What is an oil shock? Journal of Econometrics 113: 363-398.
3. Barder OM (2006) A policymakers' guide to Dutch disease. Center for Global Development Working Paper. Available at: https://www.cgdev.org/sites/default/files/8709_file_WP91.pdf.
4. Moyo A (2019) Evaluating the impact of global oil prices on the SADC and the potential for increased trade in biofuels and natural gas within the region. WIDER Working Paper. https://www.econstor.eu/bitstream/10419/211267/1/1665712023.pdf.
5. Nkomo JC (2006) The impact of higher oil prices on Southern African countries. Journal of Energy in Southern Africa 17: 10-17.
6. Kilian L, Park C (2009) The Impact of Oil Price Shocks on the U.S. Stock Market. International Economic Review 50: 1267-1287.
7. Hassan AS (2021) Asymmetric effects of oil revenue on government expenditure: insights from oil-exporting developing countries. OPEC Energy Review 45: 257-274.
8. Abdel-Latif H, Osman RA, Ahmed H (2018) Asymmetric impacts of oil price shocks on government expenditures: Evidence from Saudi Arabia. Cogent Economics & Finance 6: 1512835.
9. Ingle M (2012) Unbalanced Growth and Dependency Theory in Zambia: A post-Independence Survey. African Journal of Business Management 6: 5467-5471.
10. Popova, L, Jabalameli F, Rasoulinezhad E (2017) Oil price shocks and Russia's economic growth: the impacts and policies for overcoming them. World Sociopolitical Studies 1: 1-31.
11. Kilian L (2009) The economic effects of energy price shocks. Journal of Economic Literature 46: 871-909.
12. Rasmussen T, Chiyaba, Grivas (2015) Pricing of Petroleum Products in Zambia. IMF Country Report No. 15/153, International Monetary Fund, Washington, DC.
13. Chundama S (2023) Inflationary Pass-through Effects of Oil Price Shocks on the Zambian Economy (1985–2019). International Journal of Empirical Economics 2: 2350001.
14. Klovland JT (2009) New evidence on the fluctuations in ocean freight rates in the 1850s. Explorations in Economic History 46: 266-284.
15. Kilian L, Zhou X (2018) Modelling fluctuations in the global demand for commodities. Journal of International Money and Finance 88: 54-78.
16. Denton FT (1971) Adjustment of monthly or quarterly series to annual totals: an approach based on quadratic minimization. Journal of the American Statistical Association 66: 99-102.
17. Chundama SZ (2022) Impact of Oil Price Shocks on Economic Growth and Financial Markets: The Case of The Zambian Economy (Doctoral dissertation). https://www.worldscientific.com/doi/pdf/10.1142/S2810943023500014.
18. Brooks C (2008) RATS Handbook to accompany introductory econometrics for finance. Cambridge Books. https://ideas.repec.org/b/cup/cbooks/9780521721684.html.
19. Johansen S, Juselius K (1990) Maximum likelihood estimation and inference on cointegration-with applications to the demand for money. Oxford Bulletin of Economics and Statistics 52: 169-210.
20. Gujarati DN, Porter DC (2010) Econometría, McGrawHill, México. https://www.cbpbu.ac.in/userfiles/file/2020/STUDY_MAT/ECO/1.pdf.
21. Verbeek M (2008) A guide to modern econometrics. John Wiley & Sons, Queensland, Australia. https://thenigerianprofessionalaccountant.files.wordpress.com/2013/04/modern-econometrics.pdf.
22. Cali M, Velde DWT (2007) Is Zambia Contracting Dutch Disease? Overseas Development Institute. https://www.files.ethz.ch/isn/45349/wp279.pdf.
23. Tang K, Xiong W (2010) The financialisation of commodities. Vox EU. V November 30. https://voxeu.org/article/financialisation-commodities.
24. Roy RP, Saikat RS (2017) Financial contagion and volatility spillover: An exploration into Indian commodity derivative market. Economic Modelling 67: 368-380.
25. Lorde T, Jackman M, Thomas C (2009) The macroeconomic effects of oil price fluctuations on a small open oil-producing country: The case of Trinidad and Tobago. Energy Policy 37: 2708-2716.

26. Cashin P, Mohaddes K, Raissi M (2014) The differential effects of oil demand and supply shocks on the global economy. IMF working paper WP/12/253. https://www.imf.org/external/pubs/ft/wp/2012/wp12253.pdf.
27. Kilian L (20090 The economic effects of energy price shocks. Journal of Economic Literature 46: 871-909.
28. Igan D, Kohlscheen E, Nodari G, Rees D (2022) Commodity market disruptions, growth and inflation, Bank of International Settlements Bulletin, No. 54. https://www.bis.org/publ/bisbull54.pdf.
29. Gorajek A, Rees D (2015) bulk commodity prices and their effect on economic activity. RBA Bulletin. https://www.rba.gov.au/publications/bulletin/2015/sep/pdf/bu-0915-4.pdf.