Available online at
https://journal.uitm.edu.my/ojs/index.php/jibe

ISSN: 2550-1429 (Online)

Pre-Press 2025

Journal of International Business, Economics and Entrepreneurship

Asymmetric Adjustment Pass-Through of Oil Price on Transportation Cost

Rabiu Maijamaa[1], Umar Bala[*2&3], Murtala Garba[4]

[1]Nigerian National Petroleum Company Limited
[2]School of Business and Economics, Universiti Putra Malaysia, Serdang, Selangor, Malaysia
[3]Department of Economics, Faculty of Social Sciences, Sa'adu Zungur University, Bauchi
[4]Faculty of Business Management and Accountancy, Gong Badak Campus, Sultan Zainal Abidin University, Kuala Terengganu, Terengganu, Malaysia

** Corresponding author e-mail: umarbala@upm.edu.my*

ARTICLE INFO

Article history:
Received 18 July 2025
Accepted 25 October 2025

Keywords:
Asymmetric Adjustment
Nigeria
Oil Price
Pass-Through
Transportation Cost

DOI
https://doi.org/10.24191/jibe.v11i1.7674

ABSTRACT

This study investigates how petroleum pump prices affect Nigeria's transportation costs asymmetrically. The momentum autoregressive (MTAR) and threshold autoregressive (TAR) models were used to analyse the monthly data from January 1995 to December 2023. Based on the findings, asymmetric cointegration was found in the MTAR consistent model. The influence of oil prices on transportation costs is signified as asymmetric in the nature of adjustment to the equilibrium position. Once oil prices fluctuate, increases in oil prices push the transportation cost upward, while decreases in oil prices have an insignificant effect on the cost of transportation. Furthermore, long-run results also reveal a positive correlation between oil prices and transportation cost, exchange rate, and GDP per capita. Based on the outcomes, the exchange rate is also a determinant of transportation cost. Once the exchange rate is depreciated, the effects will pass through to the high import costs of petroleum products. To stabilize the Nigerian transportation system, the government should consider both direct and indirect effects. Direct asymmetric effect through input cost, while the indirect effect is through the exchange rate.

1. Introduction

Global energy consumption is rapidly increasing; transportation, industrial, and residential sectors of the economy consume the most gasoline. As a result, the supply of gasoline for both current and future generations is jeopardized (Zohuri and Mossavar-Rahmani, 2024; Wang and Azam, 2024; Mitra et al., 2025). The transportation sector is the world's largest consumer of petroleum products, accounting for 58 percent of global final consumption in 2004, 52 percent in Iran in 2005, and more than 75 percent in the United States in 2006 (Department of Energy, 2007; Elekwachi et al., 2024). In Nigeria, transportation fuel accounts for more than 75 per cent of total energy consumption, indicating that Nigerians rely heavily on gasoline to power their automobiles (Ehinomen and Adeleke, 2012). Until 2014, when fluctuations in oil prices began, resulting in a drop in gasoline prices in many countries, gasoline prices in some countries had always been rising, raising the cost of transportation. High international crude oil prices, petrol taxes, capacity bottlenecks in the refining process, and the withdrawal of petroleum subsidies are all factors that contribute to high gasoline prices in Nigeria. The petroleum industry is critical to the Nigerian economy because it generates the majority of the foreign exchange earnings and total revenue required for the country's socioeconomic and political advancement. Domestic refined oil prices are increasingly volatile, raising the prices of transportation, food, and other goods (Siddig, Aguiar, Grethe, Minor, and Walmsley, 2014; Agri, Mailafia, and Umejiaku, 2017; Jack and Jack, 2022). When subsidies were removed in 2012, domestic oil was priced at N141 per liter, but a complaint led to a reduction to N97. From 2015 to 2016, the price increased to N145, which is a relatively high amount, driving up the cost of transportation. Oil prices for premium motor spirits, automatic gas oil, and dual-purpose kerosene in Nigeria increased significantly from 3.25 kobo, 0.70 kobo, and 0.50 kobo, respectively, in 1990, to N145.00, N160.00, and N83.00, respectively, at the start of 2019. According to the administration, the elimination of subsidies forced changes in the prices of these goods. Because of the inability to meet local demand for the products, large quantities of these products must be imported (Gbenga and Omo-Ojugo, 2022). Most of this expansion occurred between 1990 and 2007, when domestic oil prices increased three times in a single year. One major issue caused by this was the fluctuation in transportation costs, which resulted in rising food prices. When oil prices rise, it affects goods, services, and transportation.

Nigeria's economy has not yet advanced to the level of a developed country, due in part to a lack of fundamental economic transformation. It also mentions that the lack of economic diversification, which has resulted in the economy's heavy reliance on crude oil as a source of income and as its primary export good, is a critical factor in this lack of economic advancement. Before the 1970s, Nigeria's exports were primarily non-oil, with agricultural products accounting for the vast majority. However, as global crude oil prices rose in the 1970s, non-oil export shares began to fall and have since remained at low levels. This is largely because oil exports are highly profitable, making them more profitable than non-oil commodity exports. As a result, there is now a significant reliance on the oil industry and the revenue generated by crude oil exports. Because of this reliance, the country faces difficulties when the price of crude oil, a key export good, falls on the global market (Moses, 2011; Bala, Chin, Ranjanee, and Ismail, 2017; Orji, Abubakar, and Ogbuabor, 2021). As a result, the government enacted several policies to boost non-oil exports and stabilize the economy. Despite these efforts, the performance and contribution of the non-oil exports sector have remained inadequate. The industry's performance has remained below full potential. Therefore, this research was carried out to determine to extent the current performance of the non-oil sectors can be improved.

Even though the retail price of gasoline in Nigeria and other OPEC member countries is low due to petroleum subsidies, the pump price of gasoline varies greatly from one country to the next due to the differences mentioned. Meanwhile, developing countries such as Nigeria encourage the excessive use of gasoline in the transportation sector, whereas other developed countries try to reduce their consumption of the fuel due to the emissions it produces. These countries provide energy subsidies to their citizens primarily to protect them from the commodity's significant price volatility and to keep the price of the good affordable (Aminu, Meenagh, and Minford, 2018). As a result, a good transportation system enlarges the market by allowing goods to be delivered to final consumers. An efficient transportation system facilitates mass production and distribution. During the colonial era, the Nigerian transportation network was built, beginning with a railway and road system and later expanding to include a marine and aviation system (Bello, Maji, and Sanusi, 2016).

Table 1 shows the Nigerian transportation statistics, which include pipeline, railroad, river, and marine transportation. There are 195,000 kilometres of roads and highways. This is equivalent to 0.86 meters for the country's 227.88 million people. Nigeria is now rated 29th in the world. Asphalt roads account for 31 per cent of the total, or 60,000 kilometres. However, the nation's size and population density (about 247 persons per km²) must be considered. Despite having a smaller population, countries with fewer people living in the same or even bigger territory inevitably accumulate dramatically different numbers here and require transportation networks to connect remote parts. In 2021, there were 13.50 million automobiles in Nigeria, or around 0.06 per capita.

Table 1. Nigerian transport data

		Total	per 1 mio inhabitants	per km²
1	Roadways	195,000 km	855.70 km	21.11 cm
2	Railroads	3,798 km	16.67 km	0.41 cm
3	Waterways	8,600 km	37.74 km	0.93 cm
4	Number of Vehicles	13,500,000	59,241	14.61
5	Number of Airports	21	0.09	0.00002

Note: the data set are Roadways 2019, Railroads 2014, Waterways 2011, Airports 2024

Despite a brief drop in the price of oil, the patterns indicated that transportation costs were increasing. Furthermore, the price of oil shows a strong positive and fluctuating trend during the study period. The movement suggests that the fluctuation in oil prices is linked to rising transportation costs in Nigeria. Oil price volatility has taken center stage in the media globally, as higher oil prices are a drag on the world economy. The changes in oil prices affected transportation costs, as shown in Figure 1. The trends of oil price and transportation cost between 1995 to 2023 were oil price trend exhibited fluctuation. Travelers tend to spend more at the stations because of increasing oil costs, which means we have less money to spend on other goods and services (Li, Timmins and Haefen, 2009; Allcott and Wozny, 2014).

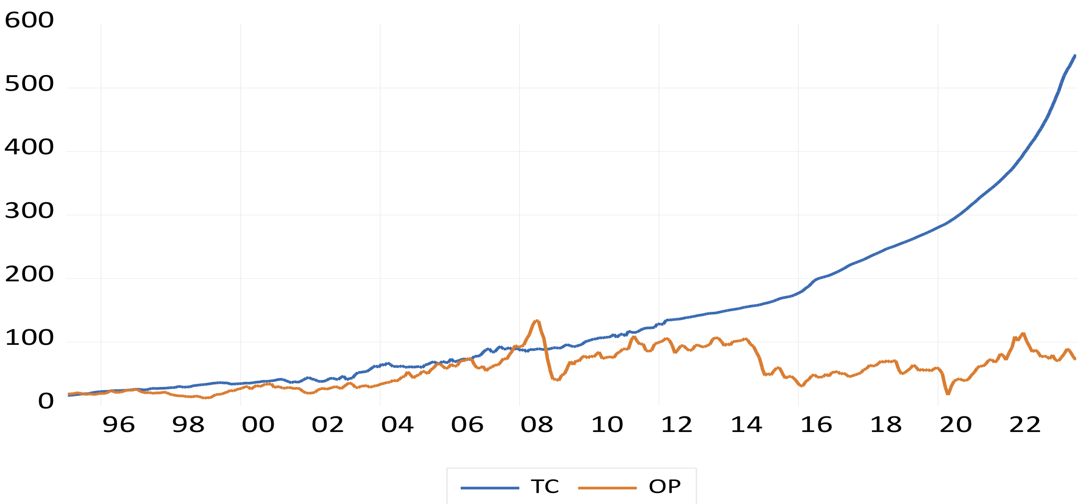

Figure 1. Trends of oil price and transportation cost in Nigeria
Source: National Bureau of Statistics and OPEC Databases

The transport cost incurred the burden of an increase in domestic oil prices and indeed the insurgency and banditry that have recently bedeviled the northwestern and northeastern parts of the country, respectively are also contribute to high prices, which are mostly in the food-producing areas of the country, especially during the national festivals of Christmas and the New Year holidays (Iwayemi and Fowowe, 2011). The shortage of refined oil products increased the price of petroleum products, which causes the increasing transportation cost and affects the non-oil sub-sector of the economy. When the petroleum products price decreases, the transportation cost and non-oil sub-sector remain stagnant and refuse to adjust back to the normal equilibrium.

The motivation for this study stems from the critical role of oil prices in shaping transportation costs and, consequently, economic activity. Despite extensive literature on oil price–transport cost linkages, most studies assume a linear relationship, overlooking the potential asymmetry in price transmission. In practice, transport operators may adjust fares upward quickly following oil price hikes but delay reductions when oil prices fall. Such asymmetric behavior can have significant implications for inflation dynamics, household welfare, and policy interventions. Therefore, this study seeks to investigate the asymmetric effects of oil price fluctuations on transportation costs using advanced econometric techniques, providing insights relevant for both policymakers and industry decision-makers.

2. Literature Review

Cost-push inflation theory accurately demonstrates how rising oil prices raise transport costs, causing broader inflationary pressures across economies. With a focus on what extent oil price fluctuations pass through transportation sectors via direct and indirect mechanisms. The framework explains how rising input prices (production costs) cause an increase in general prices. This theory demonstrates how increases in important operating expenses, such as fuel prices, can raise transportation costs, consequently influencing the larger economy (Ricci and Black, 2005). Direct Mechanisms, oil as the primary input of production, and the theory of oil prices have a direct impact on transportation costs since fuel (diesel, petrol, or jet fuel) is a significant operational expense in most modes of transportation, including road, air, marine, and rail. Higher oil prices boosted fuel expenses, which led to greater transportation costs, while lower oil prices cut fuel and transportation costs. Many transportation systems, including road, rail, air, and maritime, rely heavily on oil. When oil prices rise, the cost of producing transportation services increases because rising fuel expenses account for a large amount of operational costs (Dutta et al., 2024). The pass-through effect of oil costs from transportation industries results in increased operational costs for customers due to rising freight charges, ticket pricing, or delivery fees. The level of this passthrough is determined by the elasticity of demand for transport services (inelastic demand for critical products leads to greater direct cost transfers). Higher transportation expenses increase the cost of moving commodities across supply chains. This effect contributes to rising prices for goods and services throughout the economy, particularly for those with significant transportation costs (Inegbedion, 2020).

2.1 Empirical review

Randheer, AL-Motawa and Vijay (2011) claim that in today's globalized world, public transportation services necessitate careful attention to the level of service provided. The transportation system can accurately forecast economic progress. It acts as a driver of economic growth by creating jobs, improving the efficacy and efficiency of other firms, and encouraging national investment and development. Dubé, Rosiers, Thériault and Dib (2011) used a spatio-temporal study of changes in property prices and a quasi-experiment technique and difference-in-differences (DID) estimator. The study assesses the impact of rapid bus transportation (RBT) implementation in Quebec City, Canada. According to the findings, using public transportation has a positive social impact on urban environments by increasing access to employment opportunities and service infrastructure while decreasing travel costs. The development and implementation of transportation policies is complicated by both public authorities and transportation providers. Because public authorities and transit providers have competing agendas, regulation is critical, especially in the absence of competition.

Furthermore, Jenny (2013) a transportation system is good and reasonable, depending on the quality of public transport and the movement of goods with reasonable traveling fare. Setyawan (2014) used a 66 X 66 classification of domestic transactions based on producer prices to study the impact of fuel price increases on the economic sector in Indonesia. Specifically, the effects of 10 per cent, 20 per cent, and 30 per cent increases in fuel prices on the economy. The transportation industry, according to the estimate, would suffer greatly because of rising fuel prices. The government should protect industries that bore the brunt of the increase in fuel prices.

Used a survey tool for analysis, Olaniyi (2016) examined how the fourth industrial revolution has affected transportation in poor countries. Social integration, geographical interaction, and economic goals are all fundamental to transportation and cannot be separated from it. The fourth industrial change or shift, which can also be viewed as a sudden fundamental change in industrial organization, replaces the first, second, and third industrial changes. The fourth industrial revolution will raise the bar for developing countries in terms of developing reliable and efficient modes of transportation, as well as investing more in technology transfer, which will benefit the local manufacturing industry and agriculture.

Adeniran and Adeniran (2017) examined the passenger demand on international air travel to use regression analysis to analyse the relationship between demand for international travel in Nigerian airports and economic variables. According to the findings, the independent variables and unaccounted-for variables can explain 91.2 per cent of the dependent variable. The study discovered a strong relationship between changes in consumer inflation, the value of the naira against the dollar, GDP, and yearly international passenger traffic.

Researchers Olaniyi and Oniru (2017) examined the transportation sectors in the six named developed nations (Japan, Germany, India, China, Egypt, and South Africa) to reach that reasonable conclusion using a qualitative instrument of analysis. Train travel, according to the findings, outperforms all other modes of transportation in the developed nations studied. One of the suggested improvements is to the efficiency of the Nigerian transportation system. Oluwaseyi and Olaniyi (2018) the passenger satisfaction was assessed. The study used surveys and on-site observation to collect the necessary data at the Akure and Owo Park terminals during the investigation. Passengers at both terminals were given questionnaires totalling one hundred and twelve (112). The research applied gap analysis to generate descriptive statistics. According to the findings, transportation cost is among the major dissatisfactions of passengers on board.

Oluwakoya and Obasa (2020) examined the potential issues and recommendations in Nigerian and British transportation administration. The study compares the scope and mode of transport administration in Nigeria and Britain using panel regression analysis. The strategy includes a search for documentation on the transportation administration's policy interventions in both countries. The paper investigates the issues and difficulties associated with poor transportation administration, particularly in Nigeria, and makes pertinent recommendations to improve transportation administration for regional economic growth. Ajemunigbohun (2024) found that uninsured motorists in metropolitan Lagos, particularly commercial drivers, tend to exhibit riskier driving behaviours such as speeding and reckless driving, which pose significant threats to pedestrian safety.

The study of Olorunfemi and Adeniran (2020) looked at how the quality of road transport affected urban people's contentment in Nigeria's Kogi state. The survey research design and systematic sampling technique were used in the study to collect primary data from 1215 respondents via questionnaire, which was then analysed using regression analysis. It was discovered that poor road maintenance affects both the comfort of the passengers and the transportation rate charged for each journey. The availability of a transportation plan influences both the per-trip cost of transportation and the level of comfort in a road vehicle. Nafiu, Hassan and Alogwuja (2020) Researchers investigated Kogi State's public transportation system and discovered that, apart from transportation service, other factors are highly correlated with reported passenger pleasure.

Although several studies have examined the relationship between oil prices and transportation costs, most have assumed a symmetric and linear adjustment process, implying that transport costs respond equally to both increases and decreases in oil prices. However, transportation markets often display asymmetric price transmission due to market rigidity, fuel pricing policies, and differences in cost pass-through behaviour. Moreover, much of the existing literature focuses on developed economies or aggregate global data, with limited attention given to oil-dependent developing countries such as Nigeria, where exchange rate volatility and fuel import dependency can amplify these effects. Additionally, few studies have integrated exchange rate dynamics or employed nonlinear econometric models like the Momentum Threshold Autoregressive (MTAR) approach to capture these asymmetric adjustments (Bala et al., 2017; Bala et al., 2021). This gap highlights the need for country-specific and model-based analyses that can reveal the true nature of the asymmetric effects of oil price fluctuations on transportation costs and their broader economic implications.

3. Methodology

The empirical methodology is divided into stages; firstly, the study specified the model, conducted descriptive statistics tests, and unit root tests to determine the non-stationarity or integration characteristics. Since the variables are non-stationary integrated, the study looked for a long-run relationship. In the second section, following the discovery of cointegration, the study used dynamic ordinary least squares to further assess the long-run coefficient, level of significance, and sign of each variable with dynamic ordinary least squares (DOLS). The study also employs Enders and Granger's asymmetric cointegration tests, which assume that symmetry adjustment processes are ineffective in the presence of asymmetric adjustments (Enders and Siklos, 2001).

The study draws its conclusions from the pertinent literature analysis and decides to utilize a model by Ibrahim and Chancharoenchai (2014). We substitute the food price for the transportation cost. Lastly, the model shows the following variables: Transportation price (TP) as the dependent variable, oil price (OP) and the official exchange rate (EXR) and real gross domestic products (GDP) as independent variables.

$$TP = f(OP, EXR, GDP) \tag{1}$$

Where: TP denotes transportation cost, EXR denotes the Naira exchange rate to the US dollar, OP denotes the oil price and GDP denotes the economic growth. The study develops the following econometric model to examine the asymmetric effects of oil price on transportation cost.

$$ln\,TP_t = \alpha_0 + \beta_1\,ln\,OP_t + \beta_2\,ln\,EXR_t + \beta_3\,ln\,GDP_t + \varepsilon_t \tag{2}$$

α_0 is the constant parameter, $\beta_1, \beta_2, \beta_3$ are vectors of independent variables to be estimated ε_t is the respective error term in the equations.

3.1 Asymmetric threshold (TAR and M-TAR)

The logic behind the asymmetric threshold method is that when the variation occurring above the threshold level exceeds the variation occurring below the threshold level, TAR can detect a deep cycle process, while M-TAR can detect abrupt sequential movement. Enders and Siklos threshold is useful especially when the series has a higher velocity, more directed towards one direction than another. The threshold could be either zero or more than zero. Chan (1993) recommends checking for all possible thresholds and estimating them if they are more than 0. The threshold is based on the least residual sum of squares (RSS). Before doing a cointegration test, the long-run equation will be developed using the Ordinary Least Squares (OLS) technique. The residuals obtained from the OLS regression will be tested. The threshold cointegration requires that the residuals of the variables are stationary at the level. The residuals in future regressions are calculated using the $p1$ and $p2$ estimates.

$$\Delta\varepsilon_t = Itp1\varepsilon_{t-1} + (1 - I_t)p2\varepsilon_{t-1} + \varepsilon_t, \quad (3)$$

The Heaviside indicator function extracts the residuals ε_t from equations (2) and (3) into equations (4) and (5) for additional estimation when there is a white-noise disturbance.

$$I_t = \begin{cases} 1 if \varepsilon_{t-1} \geq \tau \\ 0 if \varepsilon_{t-1} \leq \tau \end{cases} \quad TAR\ model, (4) \qquad M_t = \begin{cases} 1 if \Delta\varepsilon_{t-1} \geq \tau \\ 0 if \Delta\varepsilon_{t-1} \leq \tau \end{cases} \quad MTAR\ model, (5)$$

The threshold value τ detected

The equation tested by:

$$\Delta\varepsilon_t = Itp1\varepsilon_{t-1} + (1 - It)p2\varepsilon_{t-1} + \sum_{i-1}^{p-1}.\gamma t\Delta\varepsilon_{t-1} + \varepsilon_t \quad (6)$$

When the adjustment coefficient is greater or less than the threshold, the TAR model records deviation from equilibrium over time or at a particular level, whereas MTAR represents the accumulation of variance changes over time. $p2\varepsilon_{t-1}$.

The symmetric and no-cointegration null hypothesis is determined by the F-statistic $P1 = P2 = 0$, and F-equal $P1 = P2$ respectively.

3.2 Data

The analysis was based on secondary monthly data on transportation CPI, oil price, exchange rate, and real GDP per capita. All statistics were compiled from the Central Bank of Nigeria 2024 Annual Statistical Bulletin. The data is accessible from January 1995 to December 2023. The variables have been transformed to natural logarithms.

4. Finding

Table 2. Data source and description

Variable	Description	Measurement unit	Source
TP	Transportation CPI	CPI 2010	Central Bank of Nigeria 2024 Annual Statistical Bulletin
OP	Crude oil price	USD	
EXR	Official exchange rate	Naira/USD	
GDP	Real GDP per capita	Constant USD	

Table 2 presents the descriptive statistics of the variables in the research, which comprise transportation cost (TP), oil price (OP), exchange rate (EXR), and gross domestic product per capita (GDP), respectively. The transportation cost, oil price, exchange rate, and GDP per capita have an average value of 94.5303, 56.1631, 136.2520, and 3.0411, respectively, within the period of 1995M1 to 2023M12. Their maximum and minimum values include transportation costs of 255.4400 and 15.9400, oil prices have 145.0000 and 11.0000, and exchange rates have 4.7911 and 1.4611 for GDP per capita. The standard deviation value of 64.5420, 41.8244, 75.4796, and 1.1711 for transportation cost, oil price, exchange rate, and GDP per capita implies lower deviation from their estimated mean values. This study considers skewness and kurtosis to determine the symmetry of the data. Each variable has a skewness value of zero, while the kurtosis value is close to three. According to this, the variables must be roughly regularly distributed (Gujarat and Porter, 2009). A Jacque Bera test statistic was used to determine whether the data's skewness and kurtosis matched a normal distribution. If the likelihood of the Jacque Bera statistic is less than 0.05, the data for the variable are assumed to be non-normally distributed. All the variables have a Jacque Bera probability of zero, and this is confirmation of the not normally distributed variables.

Table 3. Descriptive statistics

	TP	OP	EXR	GDP
Mean	94.5303	56.1631	136.2520	3.0411
Median	84.0200	40.0000	130.7200	2.9111
Maximum	255.4400	145.0000	309.7300	4.7911
Minimum	15.9400	11.0000	22.0000	1.4611
Std. Dev.	64.5420	41.8244	75.4796	1.1711
Skewness	0.7954	0.8668	0.6273	0.1104
Kurtosis	2.6263	2.6449	3.5817	1.5020
Jarque-Bera	32.0446	37.5792	22.9512	27.5118
Probability	0.0000	0.0000	0.0000	0.0000
Sum	27224.75	16175.00	39240.58	8.7513
Sum Sq. Dev.	1195549	502044	1635089	3.9324
Observations	288	288	288	288

4.1 Unit root test

The study employed two most recommended unit root tests, namely Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP), to assess the nature of stationarity of the variables. The results are presented in Table 3, which indicates that the transportation cost (TP) and oil price (OP), exchange rate (EXR) and gross domestic product (GDP) were found to be non-stationary at the level but became stationary after first differencing. These findings suggest that the variables in the model exhibit different orders of integration. The Engle and Siklos Asymmetric cointegration tests were run to confirm the order of integration being confirmed.

Table 4. Stationarity tests

	Level				**F-difference**			
	ADF		**PP**		**ADF**		**PP**	
	Constant	& Trend	Constant	& Trend	Constant	& Trend	Constant	& Trend
$lnOP$	-0.8066	-3.9469**	-0.7722	-3.8155**	-19.5482***	-19.5149***	-19.7682***	-19.7336***
	(0.8153)	(0.0115)	(0.8249)	(0.0170)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$lnTP$	-1.3546	-2.2678	-1.3906	-4.1379**	-18.4327***	-18.4769***	-18.4327***	-18.4769***
	(0.6045)	(0.0040)	(0.5870)	(0.0062)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$lnEXR$	-1.6009	-1.9323	-1.6050	-1.9858	-16.4534***	-16.4529***	-16.4538***	-16.4529***
	(0.4808)	(0.6349)	(0.4787)	(0.6062)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
$lnGDP$	-1.4335	-1.4130	-1.3217	-2.2866	-14.2150***	-14.4337***	-16.8484***	-16.8290***
	(0.5658)	(0.8554)	(0.3135)	(0.1770)	(0.0000)	(0.0000)	(0.0000)	(0.0000)

Note: *** 1 per cent significance level and ** 5 per cent significance level

4.2 Asymmetric cointegration test results

The Enders and Siklos (2001) test were applied to determine the existence of asymmetric cointegration, in contrast to the conventional symmetric methods such as the Johansen-Juselius and Engle-Granger procedures. The results are shown in **Table 4**. We used optimal of two lagged differences in all the regression residuals, and a Monte Carlo simulation was used to determine the critical values at the 5 percent significance level. The F-equal and F-joint statistics in the Threshold Autoregressive (TAR) model with a threshold value of 0 were 0.0203 and 5.2113, respectively; both were below the critical values of 2.6809 and 8.4679 at the 5 per cent level. This suggests the three is absence of cointegration. The ideal threshold value was then determined using Chan's (1993) method, and it turned out to be 0.1351. The F-joint statistic of 0.3508 was still below the 5 per cent essential value of 5.3827, indicating that cointegration was still not found. Furthermore, the study estimated the Momentum Threshold Autoregressive (MTAR) model using a threshold value of 0. The F-equal and F-joint statistics were 0.9796 and 0.5708, respectively, both below the critical values of 3.7152 and 9.0794 at the 5 percent significance level. Therefore, the null hypothesis of no cointegration could not be rejected. However, when applying Chan's threshold selection method, the MTAR model yielded F-equal and F-joint values of 15.0425 and 18.9809, which exceed the corresponding Monte Carlo critical values of 8.1820 and 10.7002 at the 5 per cent level. This indicates the presence of cointegration under a non-zero threshold. These results justify further analysis to determine whether the cointegration relationship is symmetric or asymmetric.

Table 5. TAR and MTAR cointegration and asymmetric cointegration results

	TAR	**TAR consistent**	**M-TAR**	**M-TAR consistent**
	-0.0812 (0.0350)	-0.1016 (0.0389)	-0.0983 (0.0296)	-0.2270 (0.0413)
	-0.0885 (0.0380)	-0.0714 (0.0343)	-0.0387 (0.0531)	-0.0017 (0.0317)
$Lags$	2	2	2	2
	0	0.1351	0	0.0166
$F-equal$	0.0203	0.3508	0.9796	15.0425**
$F-joint$	5.2113	5.3827	5.7087	18.9809**

Note: ** 5 per cent significance level

The study found that changes in oil prices do influence transportation costs, and the speed of adjustment is not necessarily constant over time. This conclusion is supported by the MTAR-consistent model, where the F-equal statistic exceeds the 5 percent critical value derived from the Monte Carlo simulation, indicating asymmetric adjustment. Table 4 presents the results of the asymmetric cointegration tests using the TAR, TAR-consistent, MTAR, and MTAR-consistent models. Standard F-statistics were employed to test the null hypothesis of symmetric adjustment ($H_0: \rho_1 = \rho_2 = 0$) against the alternative hypothesis, which allows for asymmetric adjustment dynamics.

4.3 Dynamic ordinary least squares result

The long-run coefficients were estimated using the Dynamic Ordinary Least Squares (DOLS) approach, which is illustrated in the equation below. The findings show that oil prices, GDP per capita, and exchange rates all have a positive and statistically significant effect on transportation costs. Specifically, a 1 per cent increase in oil prices, GDP per capita, and the exchange rate leads to long-run increases in transport costs of 0.4676 per cent, 1.0709 per cent, and 0.1226 per cent, respectively. Oil prices and GDP per capita are significant at the 1 per cent level, but the exchange rate is significant at the 5 per cent level. The R-squared value of 0.9795 indicates that these three variables explain around 98 per cent of the variation in transport costs, with the error term accounting for the remaining 2 per cent.

$$lnTP_t = -6.0495 + 0.4676\, lnOP_t + 1.0709\, lnGDP_t + 0.1226\, lnEXR_t + \mu_t$$

$$(4.7453) \qquad (4.8461) \qquad (2.0475)$$
$$R^2 = 0.9795$$

4.4 Asymmetric error correction modeling result

The asymmetric error correction adjustment is estimated using the momentum threshold value in both the MTAR and MTAR-consistent models. The study uses a general-to-specific approach, a commonly used technique to guarantee the most accurate and efficient prediction of asymmetric error correction dynamics, to ascertain the optimal lags. The findings, which are shown in Table 5, show that the influence of oil prices on transportation costs is asymmetrical, indicating that changes in oil prices have different effects on transportation costs. According to the findings, the price of oil has an uneven impact on transportation costs. According to the study, when oil prices fluctuate, transportation costs rise at a faster rate, and the MTAR-consistent model predicts a 2.27 percent rate of adjustment. Statistically, they are, nevertheless, inconsequential. Meanwhile, a decline in oil prices has a major, unfavorable impact on transportation costs. The MTAR-consistent model predicts an adjustment speed of 48.46 per cent at a 5 per cent significance level. This conclusion is in line with the actual, current reality in Nigeria. Oil prices have a favorable impact on transportation costs when they rise, but when they fall, they have a negative impact and cause the economy to revert to normal equilibrium. The results disagree with those of Aziz and Dahalan (2015) and Kriskkumar and Naseem (2019). This is not shocking because diverse methodologies were employed in these investigations. The ASEAN-5 nations—Indonesia, Malaysia, the Philippines, Singapore, and Thailand—were studied by Aziz and Dahalan (2015) using a panel VAR model. Overall, the findings imply that the ASEAN-5 scenario will have an asymmetrical effect. The R-square value of 0.7796 showed that variations in the oil price, the value of the local currency, and the GDP per capita, respectively, were responsible for 78 per cent, 22 per cent, and 22 per cent, respectively, of changes in transportation costs in Nigeria. The estimated value F-statistic 9.8280 is statistically significant at the 1 per cent level, which suggests that in the overall model, the rise in transportation costs over the research period was caused by increases in the oil price, the exchange rate, and the GDP per capita.

Table 6. Asymmetric error correction result

	MTAR-consistent
λ^+	-0.0227 (-0.1962)
λ^-	-0.4846** (-2.5897)
$R2$	0.7796
$Dw - statistic$	2.1062
$B - G$	(0.5754)
$B - P - G$	(0.3619)
$J - B$	(1.4896)
$F - statistics$	9.8280***

Note: *** 1 per cent significance level and ** 5 per cent significance level

The diagnostic tests of serial correlation, heteroscedasticity, and normality were all reported in the lower part of **Table 5**. From the serial correlation test, heteroscedasticity, and normality, all the estimated coefficients given in parentheses were statistically insignificant. This implies that the acceptance of the null hypothesis for serial correlation problems, the heteroscedasticity problem, and the normality problem, respectively. That means the estimated coefficients were not associated with serial correlation, heteroscedasticity, and normality problems.

5. Recommendation

Based on the findings, policies should aim to stabilize transportation costs by addressing both direct and indirect effects of oil price fluctuations. The government should implement measures to cushion the impact of rising oil prices, such as fuel price stabilization mechanisms and investment in local refining capacity to reduce dependence on imports. Ensuring exchange rate stability is crucial, as depreciation increases import costs and drives up transport expenses. Promoting energy-efficient technologies, alternative fuels, and transparent pricing mechanisms will help ensure that reductions in oil prices are effectively transmitted to consumers. Overall, an integrated approach combining energy policy, exchange rate management, and regulatory oversight is essential to minimize the asymmetric impact of oil price shocks on Nigeria's transportation sector and maintain economic stability.

Funding Declaration

This research received no external funding

Acknowledgement

The authors would like to express their heartfelt gratitude to every research assistant who assisted with this paper. We are also thankful to our cherished institutions for their support.

Conflict of Interest

The authors assert that there are no ongoing conflicts of interest.

References

Adeniran, A. O. & Adeniran, A. A. (2017). Econometric modeling of passenger demand for international air transport in Nigerian airports. *American Journal of Traffic and Transportation Engineering*, *2*(4), 39–44.

Agri, E. M., Mailafia, D., & Umejiaku, M. R. I. (2017). Impact of economic recession on macroeconomic stability and sustainable development in Nigeria. *Science Journal of Economics*, *2017*, 1–12.

Ajemunigbohun, S. S., Banjo, K. A., & Oluwaleye, T. O. (2024). Uninsured Motorists' Risk Attitudes and Pedestrian Road Safety: Evidence from Metropolitan Lagos, Nigeria. *Journal of International Business, Economics and Entrepreneurship*, *9*(2), 113–124. https://doi.org/10.24191//jibe.v9i2.3505

Allcott, H., & Wozny, N. (2014). Gasoline prices, fuel economy, and the energy paradox. *Review of Economics and Statistics*, *96*(5), 779-795.

Aminu, N., Meenagh, D., & Minford, P. (2018). The role of energy prices in the Great Recession—A two-sector model with unfiltered data. *Energy Economics*, *71*, 14–34.

Bala, U., Lee, C., & Maijama'a, R. (2021). Asymmetric pass-through effects of oil price on economic growth in Malaysia. *International Journal of Business and Society*, *22*(2), 753-764.

Bala, U., Chin, L., Ranjanee, S., & Ismail, N. W. (2017). The impacts of oil export and food production on inflation in African OPEC members. *International Journal of Economics and Management*, *11*(S3), 573–590.

Bala, U., Songsiengchai, P., & Chin, L. (2017). Asymmetric behavior of exchange rate pass-through in Thailand. *Economic Bulletin,* 37, 1289-1297.

Bello, U. A., Maji, I. K., & Sanusi, A. R. (2016). A threshold cointegration analysis of fuel pump price and the cost of transportation in Nigeria. *Ilorin Journal of Economic Policy*, *3*(1), 11-22.

Department of Energy (DOE) (2007). Annual energy review. Washington, DC.: Energy Information Administration.

Dubé, J., Rosiers, F. D., Thériault, M., & Dib, P. (2011). Economic impact of a supply change in mass transit in urban areas: A Canadian example. *Transportation Research Part A: Policy and Practice*, *45*(1), 46–62.

Dutta, A., Bouri, E., Rothovius, T., Azoury, N., & Uddin, G. S. (2024). Does oil price volatility matter for the US transportation industry?. *Energy*, *290*, 130194.

Ehinomen, C., & Adeleke, A. (2012). An assessment of the distribution of petroleum products in Nigeria. *Journal of Business Management and Economics*, *3*(6), 232–241.

Elekwachi, A. B., Akenbor, L. C., & Godwin, L. (2024). Fuel price fluctuation and transportation system in Rivers State (1981-2021). *BW Academic Journal*.

Enders, W., & Siklos, P. L. (2001). Cointegration and threshold adjustment. *Journal of Business & Economic Statistics*, *19*(2), 166–176. https://doi.org/10.1198/073500101316970395

Gbenga, O., & Omo-Ojugo, S. O. (2022). The effect of petroleum product prices adjustment on inflation rate in Nigeria (1980-2021). *Academic Journal of Digital Economics and Stability*, *15*, 164–175.

Ibrahim, M. H., & Chancharoenchai, K. (2014). How inflationary are oil price hikes? A disaggregated look at Thailand using symmetric and asymmetric cointegration models. *Journal of the Asia Pacific Economy*, *19*(3), 409–422.
https://doi.org/10.1080/13547860.2013.820470

Inegbedion, H. E., Inegbedion, E., Obadiaru, E., & Asaleye, A. (2020). Petroleum subsidy withdrawal, fuel price hikes and the Nigerian economy. *International journal of energy economics and policy*, *10*(4), 258-265.

Iwayemi, A., & Fowowe, B. (2011). Impact of oil price shocks on selected macroeconomic variables in Nigeria. *Energy Policy*, *39*(2), 603–612.
https://doi.org/10.1016/j.enpol.2010.10.033

Jack, J., & Jack, B. (2022). Nigeria's Energy crisis and the sustainability question. *Social and Health Sciences*, *20*(1), 1–19.

Jenny, K. E. L. (2013). Passengers' valuation of quality in public transport with focus on comfort. A study of local and regional buses in the city of Gothenburg. *Department of Civil and Environmental Engineering Chalmers University of Technology Göteborg, Sweden*.

Li, S., Timmins, C., & Von Haefen, R. H. (2009). How do gasoline prices affect fleet fuel economy? *American Economic Journal: Economic Policy*, *1*(21), 113–137.

Mitra, B., Pal, S., Reeve, H., & Kintner-Meyer, M. (2025). Unveiling sectoral coupling for resilient electrification of the transportation sector. *npj Sustainable Mobility and Transport*, *2*(1), 1-16.

Moses, E. (2011). Oil and nonoil FDI and economic growth in Nigeria. Journal of *Emerging Trends in Economics and Management Sciences,* *2*(4), 333–343. Retrieved from http://jetems.scholarlinkresearch.org/articles/Oil and Nonoil FDI and Economic Growth in Nigeria.pdf

Nafiu, A. T., Hassan, O. M., & Alogwuja, U. C. (2020). Public transport service and passengers' satisfaction in Kogi State: An Empirical Investigation. *Economic Insights–Trends and Challenges*, *7*(4), 57–71.

Olaniyi, A. A. (2016). Impacts of the fourth industrial revolution on transportation in the developing nations. *International Journal of African and Asian Studies*, *26*, 67–73.

Olaniyi, A. A., & Oniru, S. A. (2017). Efficiency of Nigerian transport system: Lessons. derived from the developed nations. *Studies Developing Country*, *7*(2), 87–93.

Olorunfemi, S. O., & Adeniran, A. O. (2020). Influence of road transport quality on urban dwellers' satisfaction. *International Journal of Human and Capital Urban Management, 5*(3), 231–240.

Oluwakoya, A. O., & Obasa, S. O. (2020). Transport administration in Nigeria and Britain: Prospects, issues and recommendations. *Journal of Public Administration and Governance*, *10*(4), 159–168.

Oluwaseyi, O. S., & Olaniyi, A. A. (2018). Assessment of passengers' satisfaction of public transport system in Akure-Owo axis, Nigeria. *American International Journal of Multidisciplinary Scientific Research*, *4*(1), 1–16.

Orji, A., Abubakar, M., & Ogbuabor, J. E. (2021). Non-oil export and exchange rate nexus in Nigeria: Another empirical verification. *Growth*, *8*(1), 39–47. https://doi.org/10.20448/journal.511.2021.81.39.47

Randheer, K., AL-Motawa, A. A., & Vijay, P. J. (2011). Measuring commuters' perception on service quality using SERVQUAL in public transportation. *International Journal of Marketing Studies*, *3*(1), 1–16.

Ricci, A., & Black, I. (2005). The social costs of intermodal freight transport. *Research in Transportation Economics*, *14*, 245-285.

Setyawan, D. (2014). The impacts of the domestic fuel increases on prices of the Indonesian economic sectors. *Energy Procedia*, *47*(47), 47–55.

Siddig, K., Aguiar, A., Grethe, H., Minor, P., & Walmsley, T. (2014). Impacts of removing fuel import subsidies in Nigeria on poverty. *Energy Policy*, *69*, 165–178.

Wang, J., & Azam, W. (2024). Natural resource scarcity, fossil fuel energy consumption, and total greenhouse gas emissions in top emitting countries. *Geoscience frontiers*, *15*(2), 101757.

Zohuri, B., & Mossavar-Rahmani, F. (2024). Balancing sustainability and innovation the future of global energy policy. *Journal of Economics & Management Research, 5*(6), 2-6.