A THRESHOLD COINTEGRATION ANALYSIS OF FUEL PUMP PRICE AND THE COST OF TRANSPORTATION IN NIGERIA

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Abstract

This study examined the existence of the asymmetric relationship between fuel pump price and the cost of transportation in Nigeria, and how these asymmetric price movements adjust to equilibrium in the long-run. Using the monthly data for the periods between the months of January 1995 and July 2014, the Threshold Asymmetric Cointegration Analysis and the Self-Exciting Threshold Autoregressive Model (SETAR), the result obtained indicated a significant evidence of asymmetric cointegration between fuel pump prices and the cost of transportation with a threshold value of 67.7 naira that represented the value that triggers regime change. The results of asymmetric adjustment also indicated a significant negative deviation of fuel pump price in the long-run, while the positive asymmetric of fuel pump price exhibited high level of persistence in the long-run. Precisely, the negative deviation provided evidence of a speed of adjustment that is 14 times that of the positive speed of adjustment for fuel pump price. This thus triggers asymmetric effect on the transportation cost with a persistent tendency to revert to equilibrium in the long-run. The findings also revealed evidence of short-run positive and significant asymmetric of fuel pump price on the cost of transportation, while that of negative deviation was persistent during the same period. These results indicate the tendency for transport fares to remain high even if the new liberalisation policy in the downstream petroleum sector succeeds in reducing the fuel pump price, thereby impacting negatively on the welfare of the people. The study thus suggests among other measures, a collaboration/agreement between the government and transport workers'/owners' unions in ensuring that transport users benefit from any price reduction that may result from the liberalisation of the downstream petroleum sector.

Key Words: Asymmetry, Cointegration, Fuel Price, Cost of Transportation, Threshold, Nigeria
JEL Classification: E31, L11, L71, L91, M38, R48,

Introduction

There have been variations in the subsidy regimes over the years and most of these variations appeared to have occurred between November, 1998 and January, 2012. Also there were associated costs which were observed to accompany each regime change that came as a rise in fuel pump price. For instance, the fuel pump price increased from 11 naira to 97 naira between the observed periods. In addition, most recently in 2016, the government announced a total withdrawal of the subsidy which leaves the fuel pump price at 143 naira. The consequence of this increase is that it could lead to the increase in the cost of transportation which subsequently tends to place a heavy financial burden on transport users considering the importance of the transport services to mobility of labour and other factors of input (see National Bureau Statistics, 2016).

It is also pertinent to note that, prior to the full implementation of deregulation policy, observation had shown that changes in subsidy that are accompanied by increase in fuel pump prices translate to rise in the cost of transportation. Conversely, changes that are accompanied by a decline in fuel pump prices are usually ignored and the costs of transportation are not returned to their original levels whenever the pump price falls back. This may appear to suggest the existence of some asymmetry in the relationship between the fuel pump price and the cost of transportation in Nigeria. The existence of this asymmetry also has far- reaching impact on the consumers, transport users and the economy in general.

Furthermore, the decision to free the downstream sector of the oil industry is expected not to only trigger competition but to suppress prices downward and to make product available in the market. More so, given the significance of the transport sector to economic growth, it becomes very imperative to stabilise the market in order to ensure that any disequilibrium that is accentuated by subsidy removal is equilibrated with corresponding adjustment in the cost of transportation. For instance, the transport sector in Nigeria grew in nominal terms by 9.43 per cent during the fourth quarter of 2014, representing a decline by 7.58 per cent from the fourth quarter of 2013. The fastest growing sectors were the transport services (repair and maintenance), road transport and pipelines. The sector growth was driven by road transport and transport services, which grew by 5.14 per cent and 23.37 per cent respectively. The overall contribution of transportation to Gross Domestic Product (GDP) in real terms was about 1.12 per cent during the fourth quarter of 2014, compared with 1.21 per cent in the fourth quarter of 2013 (NBS, 2015). By implication, the increase in fuel pump price will continue to affect the transport sector negatively.

Against this backdrop, this study therefore examined the existence of price regime in transportation to unravel the threshold value that triggers the regime change in the cost of transportation and the accompanied transition variables that are responsible for this. In addition, the study examined the asymmetric relationship between fuel pump price and the cost of transportation in Nigeria.

Review of Related Literature

Owing to the importance of oil price as a determinant of cost of production to most sectors of an economy, a number of studies have investigated the relationship between oil price and price of its derivatives (such as gasoline, diesel and kerosene) and the prices of goods and services in the non-oil sector of the economy. Apart from these relationships, studies have also been carried out on the asymmetric impact of shocks arising from oil price increase on the prices of its derivatives and the prices of non-oil products including the cost of transportation. For example, Chen *et al*., 2005; Serra and Gil, 2012; Berument, Sahin and Sahin, 2014; Ibrahim and Chancharoenchai, 2014; Cook *et al*., 2015; Ogunlowo and Sohail, 2015; Asane-Otoo and Schneider, 2015, investigated fuel price stability, its efficiency and its effect on retail prices of other derivatives of oil such as gasoline, diesel, kerosene and its effect on the prices of non-oil items, such as, food, housing and furniture.

Furthermore, Asane-Otoo and Schneider (2015) examined the retail fuel price adjustment in Germany using a threshold cointegration and found positive asymmetric response of gasoline and diesel for weekly price and negative asymmetry for daily diesel and gasoline prices. Serra and Gil (2012) found that blending biodiesel with diesel protected consumers from extreme crude oil price increases, while Cook *et al*. (2015) revealed that vehicle distance-coverage and fuel consumption distributions were not linearly distributed, thus varied significant within transportation planning regions.

On a similar note, Berument *et al*. (2014) investigated the influence of crude oil price and exchange rate on petroleum product prices and provided evidence that a one percent increase in exchange rate increases petroleum products' prices and crude oil by less than one percent in the long-run, while Aggarwal, Akhigbe and Mohanty (2012) provided evidence of negative impact of oil price increase on the returns of transportation firm.

Dahl (2012), Polemisa and Fotis, (2013), Fullerton, Jiménez and Walke (2015), Koto, (2015), Alderighia and Baudino, (2015) focused mainly on asymmetric effect of oil price on retail gasoline and diesel prices.

For instance, Fullerton *et al*. (2015) assessed retail gasoline prices in a border metropolitan economy and found that border metropolitan economy has a fairly substantial barrier to normal trade and buying patterns for gasoline and diesel within a specific region.

Polemisa and Fotis (2013) also revealed the presence of asymmetric response in the retail and wholesale of gasoline prices in the Euro zone area. Dahl (2012) evaluated global gasoline, diesel price and income elasticities. The result indicated that income and price elasticities for gasoline and diesel fuel varied at high and low prices and at high and low incomes. This finding is also consistent with Chen, Finney and Lai, (2005) and Siddig *et al*. (2014). Based on this study thus examined the asymmetric effect of fuel pump price on the cost of transportation in Nigeria using a threshold cointegration model advanced by Enders and Siklos (2001).

Methodology: Data Source and Model Specification

Data Source

The analysis of the relationship between fuel pump price and the cost of transportation in Nigeria was carried out using a monthly data set between the month of January 1995 and the month of July 2014, with a total of 235 observations. The data were collected from the Central Bank of Nigeria's (CBN) Website (2015). The price measurements of the two variables were in Naira (Nigeria's local currency) and the variables were transformed into log-linear specification.

Model Specification

The empirical model of this paper is anchored on the Keynesian postulate of sticky price which suggests that prices of commodities and wages are sticky downward. In other words, the theory which came as a backlash to the classical idea of instantaneous adjustment of prices tries to justify why economic agents (individual, labor union and producer) advocates for higher wages and prices. Therefore, a cost push factor (like fuel pump price) which drives prices upward, according to Keynes, is rather persistent upwards than downward. This notion is consistent with the price stickiness/rigidity as advocated in Keynesian general theory.

The suggestion that short-run price adjustments in markets are influenced by changes in the variable cost and that of the long-run adjusts to both variables and fixed cost is assumed in the cost of transportation dynamics. This expression is captured as:

$$TC = f(FP) \qquad (1)$$

Equation (1) is the functional relationship between the cost of transport services and fuel pump prices. Thus the model subscribes to the Keynesian postulates that prices are rigid downward, hence it follows that current cost of transportation adjusts upward relative to the previous cost of transportation (which connotes persistence in the cost of transportation) and the current fuel pump price dynamics. Therefore the model is further express as:

$$lnTC_t = \alpha_0 + \alpha_1 lnTC_{t-i} + \alpha_2 lnFP_t + \varepsilon_t \qquad (2)$$

Having internalised the lag of the dependent variable (cost of transportation) in equation (2), hence equation (1) becomes a Self-Exciting Threshold Model (SETM) with a *delay"d"* in the spirit of Hansen (1999), (2011); Potter (2003). Using the indicator function ***1(.),*** if and only if the expression is true and 0 if otherwise. We then have the expression as:

$$lnTC_t = \alpha_0 + \alpha_1 lnTC_{t-i} + \alpha_2 lnFP_t + \sum_{j=0}^{m} 1_j(q_t, \gamma).\delta_j Z_t + \varepsilon_t \qquad (3)$$

Where; q_t is the threshold variable, FP_t represent the fuel pump price, Z_t represents variable(s) whose coefficients could change across regime, while $lnTC_{t-i}$ denotes the variable whose coefficient could not change across regimes and γ represents the threshold values. In a condense back-shift operator equation (3) is same as equation (4):

$$lnTC_t = X_t^{'}\alpha + \sum_{j=0}^{m} 1_j(q_t,\gamma).\,\delta_j Z_t + \varepsilon_t \qquad (4)$$

The non-linear parameters $\alpha_0, \alpha_1, \alpha_2,\ \delta, \gamma$ from equation (3) are now condensed as α, δ, γ which can be estimated as:

$$\varepsilon_t(\alpha,\delta,\gamma) = \sum_{t=1}^{T}\left(lnTC_t - X_t^{'}\alpha - \sum_{j=0}^{m} 1_j(q_t,\gamma).\,\delta_j Z_t\right)^n \qquad (5)$$

Data Analysis, Results and Discussions

Unit Root Test and Descriptive Statistic

After standardising the variables by converting them into logarithm form, we proceed to test for unit root to avoid spurious results. The unit root test was carried out using the Augmented Dickey-Fuller (ADF) and Phillip Perron (PP) as found in Maddala, and Wu, (1999) and Wooldridge (2006). The result of the test as indicated in Table 1 showed that the two variables (fuel pump price and the cost of transportation) were stationary at first difference [I(1)] suggesting that both fuel pump price and cost of transportation were consistent which was in line with that of Asane-Otoo and Schneider (2015). Table 1 also contains the outcome of the descriptive statistic of the variables (mean, standard deviations, skewness and total observations). The descriptive statistic shows that the mean (averages) of the two variables are far apart. The deviations from the mean values of the two variables are both less than one. By implication, the distribution of the cost of transportation away from the mean or average value is less than one. The distribution around this is approximately the same for the fuel pump price.

Table 1: Result of Unit Root Test and Descriptive Statistic of Fuel Pump Price and Cost of Transportation in Nigeria

Variable	ADF	PP	Disc. Stat.	ln TC	ln FP
LnTC	(-1.560)	(-1.778)	Mean	4.0649	3.4777
LnFP	(-1.164)	(-1.1603)	Std. Dev.	0.6253	0.7098
Δ lnTC	(-16.678)***	(-16.846)***	Skewness	-0.1498	-0.1340
Δ ln FP	(-18.31)7***	(-18.511)***	Observation	235	235

Note: t-statistic are in parenthesis and *** denotes 1per cent level of significance
Source: Authors' computation (2016)

Similarly, the distributions of both the cost of transportation and fuel pump price were skewed to the left of their mean values. That is they are both negatively skewed. This result shows that the measure of central tendency of the two variables is not far apart.

Optimal Number of Regimes (Model Search Selection Criteria)

Starting by estimating the optimal number of regimes using a model search selection criteria that minimises the Sum of Square Residual (SSR), the outcome is presented in Table 2.

The information in Table 2 shows that the best structure of the Self-Exciting Threshold Model (SETM) is one with optimal lag of three periods, and that there are two regimes over the entire study period.

Table 2: Results of the Optimal number of Regimes using a Model Search Selection Criteria in the Price of Fuel and Cost of Transportation in Nigeria

Threshold Variable	SSR	Regime
TC(-3)	828.758531	2
TC(-5)	886.354440	1
TC(-4)	886.354440	1
TC(-2)	886.354440	1

Source: Authors' computation (2016)

This means that over the entire period the SSR criteria suggest there were two (2) regime changes in the cost of transportation, which were triggered by changes in the fuel pump price. As a corollary it was established that asymmetry and non-linearity exist in the relationship between fuel price and cost of transportation, thereby providing impetus to proceed with further analysis.

Test for Asymmetric Cointegration, Threshold Autoregressive (TAR) and Momentum Autoregressive (M-TAR)

The next step is to test for the asymmetric cointegration relationship between fuel pump price and cost of transportation using the Enders and Siklos (2001) threshold cointegration method. The Enders and Siklos (2001), non-linear approach to bound test was an extension to Granger's (1987) that assumes symmetric transmission of prices. This test focused on residuals estimated from the long-run equilibrium relationship between the fuel pump price and cost of transportation. As a result, the cointegration and long-run equilibrium relationship was expressed as in equation (2) re-produced as follows:

$$lnTC_t = \alpha_0 + \alpha_1 lnTC_{t-i} + \alpha_2 lnFP_t + \varepsilon_t \qquad (2*)$$

Where TC_t and FP_t are the cost of transportation and fuel pump prices respectively; α_0 and α_1 indicate intercept and the slope of fuel pump prices respectively; while ε_t is the residual that measures deviation or any shock from the long-run equilibrium relationship. It is required that the residual be stationary for fuel pump price and cost of transportation to be linearly co-integrated. In other to capture the model of our interest that requires incorporating asymmetric adjustment dynamic, the deviation from equilibrium relationship ε_t was specified as a threshold autoregressive (TAR) in equation (2) as:

$$\Delta\varepsilon_t = \rho_1 I_t \varepsilon_{t-1} + \rho_2 (1 - I_t)\varepsilon_{t-1} + \sum_{i=1}^{n} \varphi_i \Delta\varepsilon_{t-i} + \xi_t \qquad (6)$$

Where ρ_1, ρ_2 and φ_i are the parameters of the coefficients with ρ_1, ρ_2 representing positive and negative deviation from long-run equilibrium adjustment respectively. I_t denotes the Heaviside indicator function that depends on the lagged value of the residual in equation (2). The lagged difference of the residual was also augmented in equation (6) to control for serially correlated residuals with an optimal lag length selection based on Schwarz criterion (SC). Therefore, we specify the threshold autoregressive (TAR) and momentum autoregressive (M-TAR) in equation (7) and (8) following (Enders & Siklos, 2001 and Asane-Otoo & Schneider, 2015).

$$I_t = 1\, if\ \varepsilon_{t-1} \geq \tau,\ 0\ otherwise;\ or \tag{7}$$

$$M_t = 1\, if\ \Delta\varepsilon_{t-1} \geq \tau,\ 0\ otherwise; \tag{8}$$

The specifications $\varepsilon_{t-1} \geq \tau$ and $\Delta\varepsilon_{t-1} \geq \tau$ capture positive deviation above the threshold level. On the other hand, the specifications $\varepsilon_{t-1} < \tau$ and $\Delta\varepsilon_{t-1} < \tau$ capture negative deviations below the threshold level. Thus, a positive deviation represents a price above the equilibrium, while a negative deviation denotes a price below the equilibrium in the model. As postulated by Enders and Siklos (2001), the TAR specification measures asymmetric deep movements, while the M-TAR measures steep variations in the model. Hence, M-TAR model also measures the transmissions if the deviation of cost of transportation to fuel pump price changes suggests momentum in a particular direction.

As such, estimations with equations (2, 6 and 7) are called threshold autoregressive (TAR), while estimations employing equation (2, 6 and 8) are called momentum threshold autoregressive (M-TAR). To verify the existence of asymmetric cointegration between the variables (fuel pump price and cost of transportation) using the TAR and M-TAR, a null hypothesis of no asymmetric cointegration $\rho_1 = \rho_2 = 0$ was tested against an alternative hypothesis $\rho_1 \neq \rho_2 \neq 0$, and the value of the F-statistic generated from the estimated hypothesis was then compared with the critical values as provided by Enders and Siklos (2001). If the F-statistic exceed the critical value, asymmetric cointegration exists, otherwise the null hypothesis of symmetric cointegration is accepted.

Table 3 shows the asymmetric cointegration results of fuel pump price and cost of transportation for TAR and M-TAR estimated from equation (6), representing the threshold value by τ while ρ_1 and ρ_2 denoting positive and negative deviations respectively. We have chosen to use consistent threshold values for TAR and M-TAR in testing for the cointegration because these thresholds were empirically estimated rather than by assuming zero as the threshold. Their t-values and the F-values for the null hypothesis of no asymmetric cointegration, as reported in Table 3 suggest its rejection. This therefore means that there was asymmetric cointegration between fuel pump price and the cost of transportation. This appears to support the hypothesis that long-run impact of changes in the fuel pump price on the cost of transportation was asymmetric, so that reductions in the cost of transportation caused by a given fall in fuel pump price was not as much as the corresponding rise in the cost of transportation caused by an equivalent rise in fuel pump price.

Table 3: Results of Enders and Siklos Cointegration Test of Price of Fuel and Cost of Transportation in Nigeria

		Estimates		F-statistic
Model	τ	ρ_1	ρ_2	
TAR	0.215	-0.157(-3.464)	-0.068(-1.670)	7.309**
MTAR	0.016	-0.229(-5.106)	-0.012(-0.309)	13.083***

Note: t-statistic are in parenthesis; *** and ** denote 1 per cent and 5 per cent significance; 7.08 and 6.86 are critical values for TAR and MTAR at 5 per cent.
Source: Authors' computation (2016)

The existence of asymmetric cointegration between fuel pump price and cost of transportation implies that we can estimate the asymmetric error correction dynamics by extending symmetric error correction model to capture the asymmetric deviations. Here, the error correction term and the first differences of the variables were partitioned into positive and negative deviations (see, Granger & Lee, 1989; Asane-Otoo & Schneider, 2015). The asymmetric error correction dynamic model was further extended to include threshold effect where the error correction term incorporates decomposition based on deviation from long-run equilibrium. Thus, the asymmetric error correction dynamic model was given in equation (9) as:

$$\Delta \ln TC_t = \theta + \delta^{+} \varepsilon^{+}_{t-1} + \delta^{-} \varepsilon^{-}_{t-1} + \sum_{i=1}^{n} \phi_i^{+} \Delta \ln FP^{+}_{t-i} + \sum_{i=1}^{n} \phi_i^{-} \Delta \ln FP^{-}_{t-i} + \sum_{i=1}^{n} \lambda_i^{+} \Delta \ln TC^{+}_{t-i}$$

$$+ \sum_{i=1}^{n} \lambda_i^{-} \Delta \ln TC^{-}_{t-i} + \upsilon_t \qquad (9)$$

Where; $\Delta \ln FP_t$ and $\Delta lnTC_t$ were the first differences of fuel pump price and the cost of transportation respectively. These were further partition into positive $FP^{+}_{t-i} = FP_t - FP_{t-1} > 0$ and negative $FP^{-}_{t-i} = FP_t - FP_{t-1} < 0$ for fuel pump price and then positive $TC^{+}_{t-i} = TC_t - TC_{t-1} > 0$ and $TC^{+}_{t-i} = TC_t - TC_{t-1} < 0$ for cost of transportation respectively. The estimates δ^{+} and δ^{-} denote the long-run deviations of the cost of transportation, while the estimates ϕ_i^{+} and ϕ_i^{-} along with λ_i^{+} and λ_i^{-} are the short-run deviation for fuel pump price and the cost of transportation respectively. The positive error term ε^{-}_{t-1} and negative error term ε^{-}_{t-1} were generated from equation (6). On this ground, we then estimated the TAR and M-TAR error correction model to ascertain the nature of the asymmetric adjustment using equation (9). The decision of the appropriate adjustment was based on the model with the smallest value of Schwarz criterion (SC). As such, the specification in model (9) permits us to conduct a hypothesis test for long and short-run adjustment.

The Threshold Effects

The result of the Self-Exciting Regression Model as specified in equation (5) is presented in Table 4. The result indicates that a threshold value of 67.7 naira triggers a regime change in the cost of transportation. This means that whenever the cost of transportation reaches this threshold value the cost of transportation switched completely into a new regime and the transition variable that switched was the three period lags of the endogenous variable. The result indicates that the first regime exists at two transport-costs vicinity. The first was when the lag of cost of transportation was less than the threshold price value of 67.7 naira and the second was at region where the threshold price value was equal to 67.7naira

The result shows statistically that both the fuel pump price and the previous cost of transportation trigger regime change in the cost of transportation. At the first regime (where the price threshold was less than 67.7 naira) the fuel pump price accounted for only 18 per cent for the price regime change, while persistence accounted for about 85 per cent. This indicated that asymmetry existed between the two explanatory variables (i.e. fuel pump price and previous cost of transport) in terms of their contribution and how they trigger regime change in the cost of transportation. This therefore means that relative to previous cost of transportation, the current cost of transportation changes whenever subsidy was removed and the rise in fuel pump price approached a threshold of less than 67.7 naira for every litre, meaning that changes in fuel pump price that were much less than this ought not to result in more cost of transportation. By implication, the welfare of transport users tends to be eroded (by transferring their consumption surpluses to the transport workers' surpluses) whenever transport workers take advantage of negligible change in fuel pump price that is much less than 67.7 naira.

Table 4: Regression Result of Self-Exciting Threshold of the Relationship between Fuel Pump Price and the Cost of Transportation in Nigeria

Variable	Coefficient	Std. Error	t-Statistic	Prob.
		TC (-3) <67.719999 -- 129 obs.		
FP	0.180893	0.058009	3.118373	0.0021
$\mathrm{TC}(-1)$	0.850958	0.042523	20.01194	0.0000
		67.719999<= TC (-3) -- 95 obs.		
FP	0.041366	0.020467	2.021104	0.0445
$\mathrm{TC}(-1)$	0.964489	0.014995	64.32204	0.0000
		Non-Threshold Variables		
α_0	2.095558	0.540990	3.873561	0.0001

Source: Authors' computation (2016)

Similarly, the result indicates that at the second regime both the fuel pump prices and the previous cost of transportation statistically contributed to the cost regime in transportation. In this case, the fuel pump price only triggers 4.1 per cent of the price regime change, while incessant increase in fuel pump price accounted for more than 96 per cent of the change in the regime of the cost of transportation. This result therefore showed that price regime change in the cost of transportation is more likely to be triggered by the change in the previous cost of transportation than change in the fuel pump price. In order words, price dynamics in the transport services, above the 67.7 naira threshold, is attributed to inflationary pressure due to general price changes than fuel pump price change. This also follows the same analogy with a contrasting view that transportation cost changes relative to previous prices whenever subsidy was removed and the rise in fuel pump price exceeded the initial 67.7 naira for every liter. It should be borne in mind that changes in transportation cost that occurred at this higher threshold level was less attributable to fuel pump prices but rather it was a result of persistence in the cost of transportation. Therefore fuel pump price changes were less likely to contribute more to this higher threshold than general price change.

M-TAR Dynamic Asymmetric Adjustment

The result of the dynamic asymmetric adjustment estimated from equation (9) provided basis for passing judgment on the speed of adjustment of the relationship between the price of fuel and the cost of transportation in Nigeria in the long-run equilibrium. The result of the TAR error correction does not provide evidence of asymmetric adjustment. This could be owing to the fact that the TAR model possesses lower power compared to the M-TAR (see, Ibrahim & Chancharoenchai, 2014; Koto, 2015). As such we proceeded to the estimation of the M-TAR asymmetric error correction deviations of the relationship between fuel pump price and the cost transportation, with the results presented in Table 5.

Table 5: Results of Asymmetric Error Correction of the Relationship between Fuel Pump Price and the Cost of Transportation in Nigeria

Deviation	Coefficient	Std. error	t-statistic	P-value
δ^{+}	0.0080	0.0073	1.0923	0.2764
δ^{-}	-0.1483	0.0564	-2.628	0.0095***
ϕ_2^{+}	-0.0401	0.0212	-1.8869	0.0611*
λ_1^{+}	0.0171	0.0348	0.4922	0.6233
λ_1^{-}	0.0237	0.0351	0.6750	0.5007
θ	-0.0201	0.0608	-0.3308	0.7412
Hypothesis			Diagnostic test	
$\delta^{+}=\delta^{-}$	6.5013***	---	X^2sc	2.0536[0.109]
$\delta^{+}=\delta^{-}=0$	7.4240**	---	X^2arch	1.3432[0.248]
Φ	7.08	---	X^2rms	2.6392[0.106]

Note: ***, **, and *are p-values significance at 1 percent, 5 percent, and 10 percent respectively. X^2sc, X^2arch *and* X^2rms are diagnostic test for serial correlation, heteroscedasticity and Ramsey reset test respectively with their p-values in parenthesis

Source: Authors' computation (2016)

Using the Hendry's General-to-specific procedure of the general unrestricted specification, the M-TAR model provides evidence of asymmetric positive and negative deviations. Arising from the result, the symmetric adjustment hypothesis $\delta^{+}=\delta^{-}$ was rejected at 1 per cent level of significance as suggested by the F-statistic valued at 6.5013. The cointegration test for $\delta^{+}=\delta^{-}=0$ is a confirmation of the robustness of the test for $\rho_1 = \rho_2 = 0$ earlier carried out using equation (6), while Φ referred to the critical values (see, Enders & Siklos, 2001).

The M-TAR model reveals that the long-run coefficient for the negative deviation was greater than that of the positive deviation in absolute terms. To be more precise, the long-run estimate of negative adjustment from equilibrium was significant, while that of positive adjustment was not. The insignificance of the positive deviation does not signify symmetric adjustment but rather suggests persistence of shocks and its reluctance to converge back to long-run equilibrium. This was consistent with the observed tendencies for higher price to be more reluctant to converge back to equilibrium as compared with price shocks below equilibrium. Asymmetric adjustment exists in the long-run since at least one of either the positive or negative deviations was rejected in the test of symmetric hypothesis.

The long-run coefficients for asymmetric adjustment for positive and negative adjustment shocks were 0.0080 and -0.1483 respectively. This shows that less 0.8 per cent of positive deviation from the equilibrium was eliminated per month. This also indicates that positive deviations were highly persistent.

The equilibrium threshold value for the positive asymmetric adjustment was given by $(\Delta\varepsilon_{t-1} \geq -0.229)$. One possible interpretation of this finding is that when the cost transportation is caused to overshoot its equilibrium values, say, due to rising fuel prices, the lower the cost of transportation tends to persist as transporters will be reluctant to reduce their fares back to the initial equilibrium value. This finding thus supports the Keynesian idea of downward price rigidity. It also means that transport users will not get fair value following the reductions in the price of fuel. The welfare implication of this finding to the society is that the reluctance of transport owners to reduce transport fare back to the initial equilibrium value creates economic rent, which in turn amounts to a transfer of the welfare gains of the fuel price reduction to the transport owners, rather than transport users.

Similarly, the negative asymmetric value provides evidence of a relatively faster convergence. As indicated in Table 5, a 14 per cent of the negative deviation from equilibrium is eliminated per month with the threshold given as $(\Delta\varepsilon_{t-1} \leq -0.012)$. Therefore, the speed of adjustment of the negative deviation is 14 times faster than the speed of adjustment of positive deviation; thus the negative deviation shows faster convergence when shocks are below the equilibrium. This means that whenever the fuel pump price rises, it takes significantly shorter time for transporters to adjust their transport fare upwards compared to reducing it whenever there is a reduction in the fuel pump price. The findings of the long-run adjusted coefficients are consistent with the studies by Chen *et al*, (2005), Ibrahim and Chancharoenchai, (2014), Koto, (2015) and Aliyu and Tijjani (2015). The long-run insignificant positive asymmetric adjustment is in consonance with the findings of Asane-Otoo and Schneider (2015) The negative asymmetric adjustment is also consistent with the finding of Enders and Siklos (2001).

On the contrary the long-run and the short-run positive asymmetric adjustment are significant at lag two, suggesting a 4.0 per cent negative transmission in the short-run. The asymmetric coefficients of the positive and negative deviations for cost of transportation are persistent as suggested by the insignificance of their statistical coefficient. Asymmetric adjustments exist in both cases with very high reluctance of shocks to converge to equilibrium. This provides evidence of the existence of the Keynesian idea of downward price rigidity in the transport sector.

Conclusions and Recommendations

The findings have shown the existence of asymmetric relationship between fuel pump price and the cost of transportation. Although, positive and negative deviations exist in both short and long-run situations, the long-run result is more robust as compared to the short-run result. First, the absolute value of the negative deviation is greater than that of its corresponding positive deviation. Second, the negative deviation is significance at 1 per cent level, while the positive deviation, although asymmetric in nature, but not significant in the long-run. The implication is judged by the size of their coefficients. The long-run negative deviation indicates that about 14 per cent of the negative adjustment from equilibrium was eliminated per month. Since the positive adjustment from equilibrium only possesses less than 1 per cent of monthly elimination, it then indicate that the negative deviation is 14 times faster than the adjustment speed of the positive deviation. Thus, it takes approximately 7.2 months for the negative shocks to be completely transmitted into the economy.

Apart from being consistent with literature, this result is also consistent with practical experience of the movements of price of fuel and cost of transportation in Nigeria. Increase in price of fuel and cost of transportation often show evidence of persistence and rigidity to return to their equilibrium position. Furthermore, we found evidence of positive asymmetric deviation in the short-run with 4 per cent transmission capacity within the period of one month. In conclusion, the results have indicated the tendency for transport cost to remain high even if the new liberalisation policy in the downstream petroleum sector succeeds in reducing the fuel pump price, thereby negatively affecting the welfare of the people.

Given the above, for transport users to benefit from any price reduction that may result from the liberalisation of the downstream petroleum sector, the study recommends a collaboration/agreement between the government and the transport workers'/owners' unions across the country to ensure that whenever fuel price falls, without a significant increase in other associated costs, such cost reductions are promptly reflected in the cost of transportation.

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