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The Effect of Fuel Subsidy Reforms on Cargo Throughput, Ship Traffic and BRV Traffic of marine terminal operations in Nigeria: A Correlation and Stochastic Frontier Model estimation.

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ABSTRACT

Perennial fuel scarcity has remained a norm in the Nigeria polity even when the country is a net exporter of petroleum. This scenario has left doubts on the mind of the citizenry concerning the contributory impact of fuel subsidy reforms of government to fuel scarcity in Nigeria. The aim of this study is to evaluate the relationship between fuel subsidy reforms and port performance indicators namely cargo throughput of refine petroleum oil terminal (RPOT), ship calls and BRV Calls involved in maritime terminal operations in Nigeria hence justifying or declining on the assertion that fuel subsidy reforms is associated with the performance of the marine terminals in Nigeria. The data used for the study covered a period from 2012 to 2020. The variables were analyzed using both correlation and stochastic frontier regression tests. The results of the tests revealed that there is significant relationship between fuel subsidy reforms and cargo throughput of refine petroleum oil terminal (RPOT), ship calls and BRV Calls involved in maritime terminal operations in Nigeria. Therefore, it is recommended that decisions on fuel subsidy reforms by government should be holistic in approach whereby all stake holders are part of the policy initiation and execution to promote national cohesion and economic efficiency in developmental resource allocation.

1. INTRODUCTION

Nigeria have been subjected to perennial fuel scarcity since the 1970s, hence the introduction of fuel subsidy reforms by successive governments. This scenario has led to the further distortions and neglect of the supply chain infrastructure which have further hindered the smooth delivery of refined petroleum in Nigeria. Outstanding of all the infrastructural decays, is the moribund status of the country's refineries and its connecting pipelines. This have led to huge transactional costs which culminates to high cost of product and its attendant product scarcity.

Though the situation has led to the gross patronage of foreign long range and medium range vessels for the transportation of the imported refined petroleum, patronage of tank farms, liquid bulk jetties and Bulk Road Vehicles. These patronages do not seem to abate the consistent fuel scarcity, notwithstanding the fuel subsidy reforms by successive government which is primarily for the purposes of making the petrol affordable to the poorest of the poor in the society. The perennial fuel scarcity scenario has elicited public outcry on the authenticity of the subsidy claims/payment. It has also questioned the efficacy of the fuel subsidy reforms in solving the fuel scarcity challenge.

This paper therefore, is billed to evaluate the relationship between fuel subsidy reforms proxies (such as annual subsidy payment, Official pump price, number of vendors, daily swap import) and supply chain performance of marine terminal operations using Cargo Throughput, Ship Traffic, Bulk Road Vehicle traffic as performance indicators. The study will attempt to appraise the cargo throughput, ship traffic and Bulk Road Vehicle Traffic of 6 selected (publicly-managed and privately-managed) marine terminals in Nigeria subject to fuel subsidy reforms as implemented by the administrations of former presidents Goodluck Jonathan and Muhammadu Buhari.

The paper is arranged into 4 sections; section 1 is the introduction, section 2 is the literature review, section 3 is the methodology and section 4 is the results, discussion and conclusion.

2. LITERATURE REVIEW

According to Olanrewaju (2021), fuel subsidy reform is a process to lessen the financial burden or cost of fuel for certain demography of the country. Rentschler & Bazilian (2017) viewed the concept of fuel subsidy reforms as the fiscal approaches that reduces the price of petroleum products below their supply cost (international market price) thereby making the petroleum more affordable to end users (IMF 2022). Omotosho (2019), saw it as a system geared towards the protection of the low-income earner households and promoting domestic enterprise of certain goods and services.

Rugare and Nyasha (2021) studied the impact of Zimbabwean government policy interventions on the survival strategies being implemented by companies in the countries petroleum sector. Sayne (2017) espoused on securing fair value from natural Nigeria's DSDP contract which gave details of the fuel subsidy reforms of former president M. Buhari's administration. Sayne, Gillies & Katsouris (2015), In their earlier studies on fuel subsidy reforms dealt also on the inside NNPC Oil Sales methods based on the fuel subsidy reform in Nigeria. Most of these studies could not relate the effects of the reforms to marine terminal operations and their performance indicators.

The execution of these reforms was for the purposes of providing consistent fuel to the low-income earners. Cargo throughput, ship traffic and BRV Traffic at the marine terminals remain veritable performance indicators that will show how much of the subsidized product is supplied and distributed to Nigerians within the period under review.

Theophilus (2017), posits that cargo throughput is one of the determinant factors applied in the long-term forecasting of financial performance of terminal operators and ports authority. The performance rating of the marine terminal is also a function of the volume of Ship traffic and BRV traffic at the terminals for evacuation of the imported petrol. Hence, its application in assessing these supply and distribution nodes that could ascertain fuel availability.

Chukwuebuka Godfrey Osondu-Okoro et al (2022), asserts that the ship traffic and cargo throughput in any given port can be confirmed as proves to indicate the shippers, importers, and government demand for port services in that particular port within that particular period or season.

Therefore, the correlation of fuel subsidy reforms of government and the performance of the marine terminals is not farfetched given that the supply and distribution of the subsidized petrol is legitimately anchored by the ports as the main nexus of the system in Nigeria where pipeline and inhouse refineries are in comatose. However, the purpose of this study is to empirically justify or decline if there exists any form of relationship between the fuel subsidy reform proxies and the supply chain performance indicators of marine terminals or ports in Nigeria.

Theoretical Framework

This study is approached from the context of Contingency theory otherwise referred to as situational theory or "it all depends" theory or "if" and "then" theory. Contingency theory is considered as a leading branch of management thought made up of an integration of the principles of different schools of thought such as the classical, behavioral and systemic approaches, contingent in tackling situations. Contingency theory is of the opinion that under different conditions different solutions can be effective (Omoluabi, E.T. 2016). It is

pragmatic in addressing solutions to problems after careful analysis of the problem. It adapts to the principles of continuous improvement as it provides insights into organizations' adaptability to both internal and external environments.

In other words, it is the "if" and "then" approach to situation or organizational management. The "if" represents the independent variables and the" then" represents the dependent variables. For instance, in this study, if fuel subsidy reforms are adjusted by government by way of product price control, daily quantity supplied, number of product suppliers, and amount budgeted and paid as subsidy, then records of the ports on cargo throughput, tanker vessel traffic and BRV traffic will respond in a certain way to show their effects and relationships. Given that fuel supply and distribution in Nigeria is anchored mainly and legitimately in Nigeria through the ports. Hence, the justification or decline of the relationship or association of fuel subsidy reforms and marine terminal performance will avert time and resource wastages but foster system reengineering through scientific continuous adjustments which will further lead to the desired objective or goal of government if policies are approached situationally or contingently.

Contingency theory was developed through the development of other concepts of Tayler, Fayol and Weber. Contingency theory was first mentioned in the works of Lawrence and Lersch in 1967, in the context of organizational structure, but was made popular by Fiedlier, Hersey and Blanchard.

Empirical review

Researches on Fuel subsidy reforms are vast and have also covered different class of countries while undergoing different approaches by these countries. The peculiarity of these countries has also led to the unique and common grounds in variable application in achieving the objectives of the countries' subsidy reforms.

In the study conducted by Omotosho (2019), he mentioned official pump price control by government in relation to the expected open market price- reference price as key variables in fuel subsidy reforms in Nigeria. Nwachukwu and Chike (2011) also buttressed this point by asserting that government control of petroleum pricing stands as a variable for fuel reforms. In a research work by Ochuonu (2013), he disclosed that petroleum consumption quantity, domestic pump price, amount spent on petroleum subsidy payments and GDP were important variables in the computation of fuel subsidies.

In the works of Opeyemi et al (2015) which examined the impact of Fuel Subsidy Reforms on environmental quality in Nigeria, using the 2 step cointegration procedure techniques (the Johansen and the Engle-Granger). The study estimated 3 scenarios of the subsidy payment, case of effective subsidy and the case of no subsidy payments. The research in testing the hypotheses on impact of fuel subsidy on environment, applied the model specification that included variables such as emissions from liquid fuel consumption which is proxied for measurement for environmental damage. It discovered that case scenario one of subsidy payment and case scenario three of no subsidy payments do not significantly influence environmental quality. In otherwords, the study claimed that subsidy payment does not enhance quantity of fuel consumption in Nigeria.

OECD also carried out numerous researches on countries that had embarked on fuel subsidy reforms, and the key variables monitored and evaluated in the research especially in their report on Ukraine were variables such as budgetary allocation and transfers, government revenue foregone (or tax expenditure- tax breaks) induced transfers in the form of cross subsidies-regulated price for the poor households, residential consumers, or below market tariffs and risk transfers to government- financial supports to government energy sector-renewable or alternative energy sources, taxation, and energy pricing (Nelly and Krzysztof (2023),OECD (2023)

Globally, as disclosed in the reviewed literature on fuel subsidies using price gap approach, reference price, consumed quantity and end users' price- Official pump price have always remained constant variables in executing subsidy reforms in the petroleum industry. (Coady et al. 2010; Kosmo 1987).

Hence, the basic calculation of subsidy for a product is: Subsidy = {(Absolute Supply Cost or reference Price minus Official Pump price or End-user Price) multiplied by Quantity Consumed}. The reference price is actually the international oil price.

In the application of price gap approach in estimating consumption subsidies,

For net importers, "reference prices are based on the import parity price: the price of a product at the nearest international hub, adjusted for quality differences, if necessary, plus the cost of freight and insurance to the net importer, plus the cost of internal distribution and marketing and any value-added tax (VAT). VAT was added to the reference price where the tax is levied on final energy sales, as a proxy for the tax on economic activities levied across an economy. Other taxes, including excise duties, are not included in the reference price." (Coady et al. 2010).

For example, the standard variables in fuel subsidy template as reported by PPPRA 2020 for Nigeria, a net importer of gasoline, consists of FOB Rotterdam Barge, Freight Rate = Cost of petrol plus freight (offshore Nigeria), Lightering Expenses, Insurance Cost, NPA Cost, NIMASA Cost, Jetty Throughput Charges, Storage Charge, Financing/Cost of Fund, Landing Cost at terminal, Wholesale Margin and the Distribution Margin components which are Transporters Allowance (NTA), Retailer Margin, Dealer margin, Bridging Fund, Marine Transport Average (MTA), NMDPRA Administrative Charge (PPPRA report 2020).

The relationship of the fuel subsidy reform variables with cargo throughput, ship calls, and BRV

Calls cannot be far-fetched, as it is also identified as one of the indicators as captured by PPPRA subsidy legends (i.e. jetty throughput charges, storage charges, NPA Cost, Transport allowance and bridging funds) amongst other charges.

Based on the reviewed literature, there seems to be an empirical need for studies on fuel subsidy reforms and its relationship with cargo throughput, ship calls, and BRV Calls and other marine terminal performance indicators as adapted in Nigeria. The revelation will further justify an urgent shift of researches on the impact of fuel subsidy reforms on the supply chain performance of marine terminal operations in Nigeria. This endeavor will empirically support decisions as taken by policy makers in Nigeria concerning national challenge like fuel scarcity and price hike that has elicited international interest.

3. METHODOLOGY

Data and Methods

The research adopted an explanatory research design method. Secondary panel data were gotten from Nigerian National Petroleum Corporation (NNPC) on fuel subsidy reform proxies such as official pump price, daily swap import, number of supply vendors, annual subsidy payments while Nigerian Ports Authority (NPA), Nigerian Midstream and Downstream Petroleum Regulatory Agency (NMDPRA) and terminal managers provided statistical records on cargo throughput, ship calls, and BRV Calls of the 6 selected marine terminals codenamed Terminal=A, Terminal=B, Terminal=C, Terminal=D, Terminal=E and Terminal=F.

The dataset for each of the marine terminals' performance indicators and fuel subsidy reforms proxies for years 2012 to 2020 are represented. Correlation analysis and Stochastic frontier regression model estimation was applied in the assessment of the statistical dataset to confirm the relationship between fuel subsidy reforms and the cargo throughput, ship calls, and BRV Calls in 6 selected marine terminals in Nigeria.

Correlation analysis is a statistical tool used in assessing the degree of association between two variables. In this study, Pearsons r formular was employed to execute the correlation test. The result of the relationship or association of 2 variables is expressed in the value of the coefficient of the correlation test, symbolized as + or -1. Plus 1 (positive relationship) or minus 1 (negative relationship) values signify perfect degree of relationship or association exists between the comparing variables, while 0 indicate no correlation. If the correlation coefficient tends toward 0, then it indicates that the relationship between the variables is weak.

Pearson coefficient of correlation is expressed as:

$$r = N\sum xy - \sum(x)(y) / \sqrt{[N \sum x^2 - \sum (x^2)] [[N \sum y^2 - \sum (y^2)]}$$

Where,

r = Pearson r correlation coefficient.
N = number of observations = 9.
Σxy = sum of the products of paired scores of Official Pump Price, Number of Supply Vendors, Daily Swap Import, Annual Subsidy Payment and Cargo Throughput, Ship Traffic, BRV Traffic of the port.
Σy = sum of y scores of each Cargo Throughput, Ship Traffic, BRV Traffic of each marine terminal under investigation.
Σx2= sum of squared x scores of Official Pump Price, Number of Supply Vendors, Daily Swap Import, Annual Subsidy Payment of each year under investigation.
Σy2= sum of squared y scores of cargo throughput, ship traffic, BRV Traffic.

The stochastic frontier model was further applied as a second test. The stochastic frontier model is a type of efficiency analysis model developed by Aigner, Lovell and Schmidt (1977), given as

$$y = \beta'X + v-u, u = /U/$$

where

y is the observed outcome
β'X + v is the optional frontier goal
β'X is the deterministic part of the frontier
u is the amount by which the observed individual fails, it is called the inefficiency.

4. RESULTS, CONCLUSIONS AND RECOMMENDATIONS

Table 1: Compilation of the Fuel Subsidy Reform Variables Over the Years under Consideration

YEAR	2012	2013	2014	2015	2016	2017	2018	2019	2020
Official Pump Price (=N/ltr)	65	86	86	86	145	145	145	165	165
Daily Swap Import (bpd)	286,166	294,095	327,010	441,000	428,000	391,000	442,000	442,000	583,012
Number of Supply Vendors	7	7	7	3	27	39	34	76	79
Annual Subsidy Payment (US$)	$8.55 bn	$8.30 bn	$7.31 bn	$3.34 bn	$944.9m	$473.9m	$3.89bn	$4.67m	$3.98bn

Sources: Researchers compilation from PwC, CBN, NPA, NNPC, NEITI, PPPRA Reports

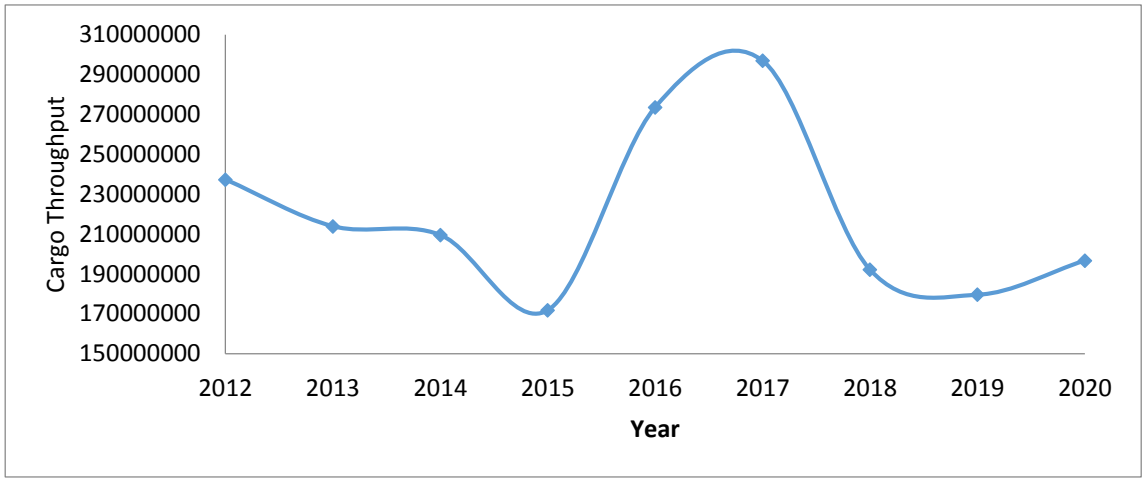

Figure 2a: Line graph of Cargo Throughput over the fuel subsidy reform study period under review

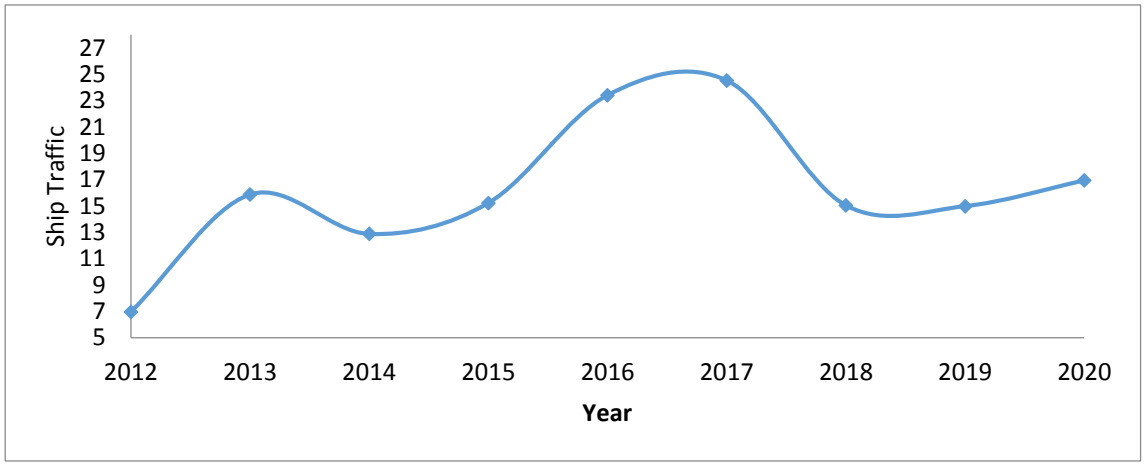

Fig.2b: Line graph of Ship Traffic over time

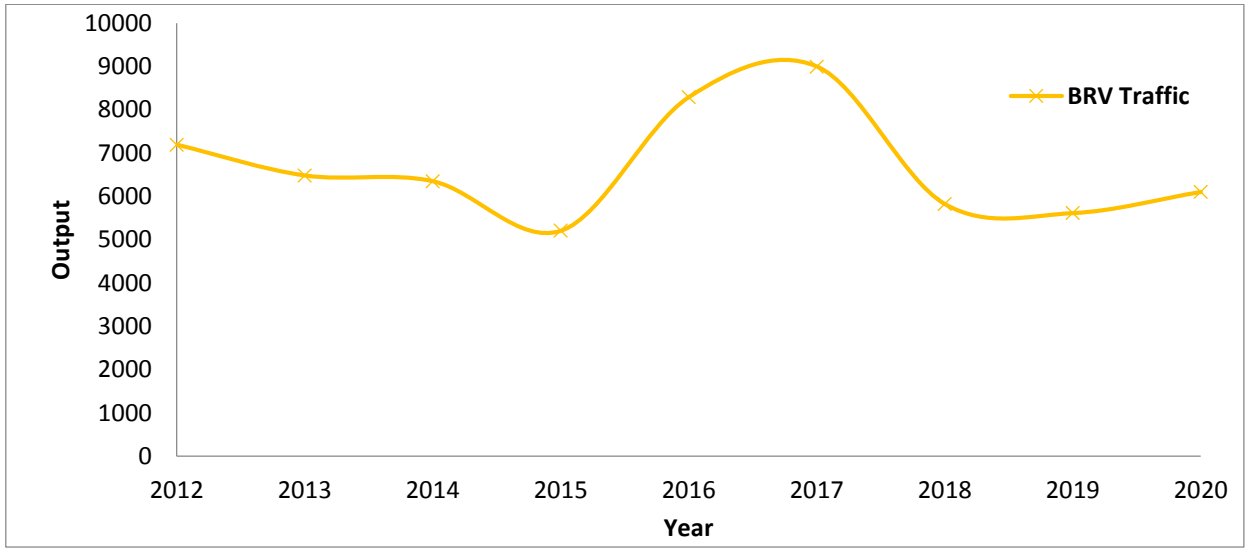

Fig.2c.: Line graph of BRV Traffic over time

Table 2: Result of the statistics summary of cargo throughput, Ship Traffic and BRV Traffic over the years under consideration

YEAR	2012 Mean(SD)	2013 Mean(SD)	2014 Mean(SD)	2015 Mean(SD)	2016 Mean(SD)	2017 Mean(SD)	2018 Mean(SD)	2019 Mean(SD)	2020 Mean(SD)	Overall Mean(SD)
Cargo Throughput	237351028.77	213927132.50	209561653.17	171822798.63	273533298.98	296906416.92	192219391.04	179590438.87	196726562.94	208741508.75
BRV Traffic	7192.48	6482.63	6350.43	5206.58	8288.90	8996.85	5824.56	5613.92	6101.03	6349.53
Ship Traffic	6.96	15.87	12.88	15.23	23.41	24.52	15.04	14.99	16.94	15.77

Multivariate Profile Analysis test for Mean Difference across the years
Wilks's Lambda = 0.448, F= 0.914, p=0.622
Source: authors' calculation.

Table 3: Result of the correlation analysis between fuel subsidy reform proxies and cargo throughput, Ship Traffic and BRV Traffic

		Number of supply vendors	Daily swap import	Official pump price	Annual subsidy payment
Cargo Throughput	R	-0.135	-0.028	-0.100	0.658
	p-value	0.329	0.842	0.471	0.055
BRV Traffic	R	-0.120	-0.009	-0.078	0.056
	p-value	0.387	0.951	0.577	0.686
Ship Traffic	R	-0.060	0.007	-0.036	-0.003
	p-value	0.669	0.958	0.797	0.985

***= indicates significance at 0.05, **= indicates significance at 0.001**

Table 3 represents the result of the correlation analysis between fuel subsidy reforms proxies (Number of Supply Vendors (NSV), Daily Swap Import (DSI), Official Pump Price (OPP), Annual Subsidy Payment (ASP)) and supply chain performance indicators for marine terminal operations (Cargo Throughput, Ship Traffic and BRV Traffic) under review.

The result revealed that the Number of Supply Vendors, Daily Swap Import, and Official Pump Price have a negative relationship with Cargo Throughput while Annual Subsidy Payment has positive relationship with Cargo Throughput.

The result also shows that none of the fuel subsidy reforms variables under consideration is significant at the p 0.05 with Cargo throughput.

As regards the BRV Traffic, the result of table 3 reveal that BRV Traffic has negative relationship with Number of Supply Vendors, Daily Swap Import, and Official Pump Price but have a positive relationship with Annual Subsidy Payment. The result further disclosed that none of the fuel subsidy reforms variables under consideration is significant at the p 0.05 with the BRV Traffic.

Ship Traffic has a negative relationship with Number of Supply Vendors, Official Pump Price and Annual Subsidy Payments. But, has a positive relationship with Daily Swap Import. The result also shows that none of the fuel subsidy reforms variables under consideration is significant at the p 0.05 with Ship Traffic.

This elicited a further probe using stochastic frontier model estimate on the relationship between fuel subsidy reforms and marine terminal operations performance indicators.

Table 4: Stochastic Frontier Model Estimate Fuel Subsidy Reforms on Supply Chain Performance of Marine terminals (CARGO THROUGHPUT)

Variables	B	Z	p-value	95 % CI for β Lower	Upper
Constant	-29.058	-1.830	0.068	-60.260	2.144
Annual Subsidy Pay (US$)	0.365	2.021	0.043	0.011	0.718
Goodness of Fit Measure					
Error Variances (σ_{ω}^{2})			1.348		
Wald chi-Square			31.56(p<0.001)		
R^2-between			0.96		

CI = confidence interval, β = model coefficients, p<0.05 indicates significance.

Table 4 represents the results of the estimate of Panel data Stochastic Frontier Model of CARGO THROUGHPUT on the Annual Subsidy Payment. The result shows that a 1% increase in Annual Subsidy Payment will lead to 0.365% increase in CARGO THROUGHPUT.

Table 5: Stochastic Frontier Model Estimate of Fuel Subsidy Reforms on Supply Chain Performance of Marine Terminals (Bulk Road Vehicle Traffic)

Variables	B	Z	p-value	95 % CI for β	
				Lower	Upper
Constant	-70.350	-3.160	0.002	-114.005	-26.696
Daily Swap Import (bpd)	2.631	1.700	0.008	-0.402	5.665
Annual Subsidy Pay (US$)	0.265	1.770	0.007	-0.029	0.559
Goodness of Fit Measure					
Error Variances (σ_{ω}^2)			0.921		
Wald Chi-Square			54.08(<0.001)		
R^2-between			0.96		

CI = confidence interval, β = model coefficients, p<0.05 indicates significance.

Table 5 is the result of Stochastic Frontier model estimate of BULK ROAD VEHICLE (BRV) TRAFFIC on (Daily Swap Import and Annual Subsidy Payments). The result discloses that Daily Swap Import has a positive significant relationship with BRV Traffic. A one percent increment in Daily Swap Import will bring about a 2.63% increase in BRV Traffic. Annual Subsidy Payment has also a positive significant effect on Bulk Road Traffic of which a 1% increment in Annual Subsidy Payment will elicit a 0.3% increment on BRV Traffic.

Table 6: Stochastic Frontier Model Estimate Fuel Subsidy Reforms on Supply Chain Performance of Marine Terminals (SHIP TRAFFIC)

Variables	B	p-value	95 % CI for β	
			Lower	Upper
Constant	-34.946	<0.001	-51.955	-17.936
Number of Supply Vendors	-0.128	0.043	-0.253	-0.004
Goodness of Fit Measure				
Error Variances (σ_{ω}^2)		0.440		
Wald Chi-Square		113.78(P<0.001)		
R^2-between		0.99		

CI = confidence interval, β = model coefficients, p<0.05 indicates significance.

Table 6 is the result of the estimation of the Panel Data Stochastic Frontier model showing that Number of Supply Vendors has a negative relationship on Ship Traffic and at the same time has a significant effect on Ship Traffic. For every 1% increment in Number of Supply Vendors, there is a significant negative effect of 0.12% reduction on Ship Traffic.

CONCLUSION

This study was about empirically confirming the relationship between Fuel Subsidy Reforms and Cargo Throughput, Ship Traffic and BRV Traffic of marine terminal operations in Nigeria, whereby Correlation analysis and Stochastic frontier regression model estimation was applied in the assessment of the statistical dataset to confirm their relationship using the dataset as gotten from the marine terminal operations of 6 selected marine terminals in Nigeria codenamed Terminal=A, Terminal=B, Terminal=C, Terminal=D, Terminal=E and Terminal=F.

The correlation test results of table 3 revealed that:

(1.) For Cargo Throughput;

a. Number of Supply Vendors, Daily Swap Import, and Official Pump Price have a negative relationship with Cargo Throughput while Annual Subsidy Payment have positive relationship with Cargo Throughput.
b. None of the fuel subsidy reforms variables under consideration is significant at the p 0.05 with Cargo throughput.

(2.) For Bulk Road Vehicle (BRV)Traffic;

a. Number of Supply Vendors, Daily Swap Import, and Official Pump Price have a negative

relationship with Cargo Throughput while Annual Subsidy Payment have positive relationship BRV Traffic.

b. None of the fuel subsidy reforms variables under consideration is significant at the p 0.05 with BRV Traffic.

(3.) For Ship Traffic;

a. Number of Supply Vendors, Annual Subsidy Payments, and Official Pump Price have a negative relationship with Ship Traffic while Daily Swap Import have positive relationship BRV Traffic.

b. None of the fuel subsidy reforms variables under consideration is significant at the p 0.05 with Ship Traffic.

A further probe of the relationship between fuel subsidy reforms and marine terminal operations performance indicators, using stochastic frontier regression analysis was conducted and the findings were;

The result in table 4 shows that a 1% increase in Annual Subsidy payment will lead to 0.365% increase in CARGO THROUGHPUT. The result in table 5 discloses that a 1% increment in Annual Subsidy Payment will elicit a 0.3% increment on BRV TRAFFIC, the result contrary to the correlation test confirmed Daily Swap Import as having a positive relationship with BRV Traffic, of which a one percent increment in Daily Swap Import will bring about a 2.63% increase in BRV TRAFFIC. Hence, there is need for further probe. The result in summary discloses that Annual Subsidy Payment promotes Cargo throughput, BRV traffic while Daily Swap Import promotes Ship Traffic and BRV Traffic.

Recommendation

Going by the conflicting results from correlation and regression test on Daily Swap Import relationship with BRV Traffic, we suggest an in depth research on the reasons for this discrepancy.

We also recommend that the government in making policies should involve the industry practitioners and scholars in analyzing and monitoring of the pilot test-run of the initiated policies before they are given full resource allocation to avert resource wastages in the long run. In other words, in formulating fuel policy reforms, which also includes the scraping of an existing policy, proper analysis and monitoring of the performance indicators that will reflect the effect of the reforms should be empirically evaluated first in the short run and then in the long run before full resource allocation is disbursed for the purpose.

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