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# Sinusoidal Predictive Model of Nigeria Petroleum Motor Spirit (PMS) Price

**Akpienbi I. O.[1], Bello M.I.[2], Atureta M.S.[3], Barde A.[4]**
[1]Federal University Wukari, Taraba State, Nigeria
[2,3,4]Abubarka Tafawa Belawa University, Bauchi, Nigeria
akpienbi4u@gmail.com

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## Abstract

Petroleum Motor Spirit (PMS) prices in Nigeria exhibit substantial fluctuations that challenge conventional linear forecasting approaches and complicate policy and market planning. This study applies a seventh-order sinusoidal wave-function model to analyze and predict PMS price dynamics in Nigeria. Annual PMS price data were modeled using a sinusoidal framework designed to capture the recurring oscillatory behavior associated with regulated fuel-pricing systems. A logarithmic transformation and the Least Squares Method (LSM) were employed to reduce data dispersion and obtain robust parameter estimates. Model performance was validated through correlation analysis between observed and predicted prices, while pilot testing was conducted to assess the model's reliability, stability, and predictive relevance. The results demonstrate a high degree of association between actual PMS prices and model estimates, indicating that the sinusoidal structure adequately represents the cyclical behavior of PMS prices during the study period. The findings further suggest that PMS price variations are not explained primarily by linear temporal progression but follow a wave-like pattern consistent with periodic policy adjustments, market interventions, and regulatory decisions. The proposed model therefore provides a useful analytical framework for interpreting PMS price fluctuations and forecasting future price movements within Nigeria's fuel-pricing regime. This study contributes a nonlinear modeling approach that may support evidence-based fuel-pricing analysis, regulatory planning, and policy decision-making.

**Keywords:** Cyclical Price Behavior; Fuel Price Forecasting; Least Squares Method; Petroleum Motor Spirit; Sinusoidal Modeling

## INTRODUCTION

Persistent fluctuations in the price of Premium Motor Spirit (PMS) in Nigeria have emerged as a critical national issue due to their far-reaching economic and social consequences. As an oil-dependent economy, Nigeria remains highly exposed to disruptions in petroleum pricing, which directly affect government revenue, production costs, and household welfare (Omoregie, 2019). This vulnerability has been further accentuated by structural challenges within the oil sector, including Nigeria's temporary loss of its position as Africa's leading oil producer to Angola, before later reclaiming the status (Ndigwe, 2022). Such production instability has amplified uncertainty within the domestic fuel market and intensified price volatility.

Escalating PMS prices have deepened economic inequality and contributed significantly to rising poverty levels across the country (Egbewole and James, 2018). Given the central role of PMS in transportation, manufacturing, and power generation, fluctuations in fuel prices exert a direct influence on industrial costs, profitability, and overall productivity (Isyaka, 2014). At the global level, fuel price instability has been shown to transmit shocks across transportation systems, commodity prices, and energy consumption patterns (Bosler, 2010).

In Nigeria, the heavy reliance on PMS for energy generation and heating limits substitution possibilities, rendering the economy particularly sensitive to abrupt fuel price increases (Tuo *et al.,* 2011; Moshiri *et al.,* 2006). Compounding this challenge is the persistent problem of pipeline vandalism, which has disrupted production, weakened supply capacity, and undermined Nigeria's position as a major petroleum producer (Balogun, 2015; Okere, 2017). These disruptions have also generated severe environmental consequences, including pollution of farmlands and water resources (Adati, 2012).

Recent literature emphasizes that accurate prediction of PMS prices requires advanced modelling frameworks capable of capturing strong nonlinearities, volatility, and policy-induced shocks inherent in petroleum markets. Empirical evidence shows that machine-learning and hybrid mathematical models outperform conventional econometric approaches in forecasting accuracy (Kumar, 2025; Nguyen et al., 2025). Reservoir Computing models, in particular, have demonstrated significantly lower forecast errors relative to classical and deep-learning benchmarks (Kumar, 2025). The integration of news-based sentiment indicators has further improved predictive performance by incorporating information shocks and policy signals that shape market expectations (Li *et al.,* 2025). Additionally, hybrid frameworks combining LSTM, GRU, ANN, regression techniques, and volatility-sensitive components have been shown to enhance explanatory power and reduce forecast error, especially in short-term horizons (Bharathi and Sujatha, 2025; Amelia and Wulandhari, 2025; Cohen, 2025). Integrating deep learning with econometric volatility models has also yielded superior performance under conditions of heightened market uncertainty (Rao *et al.,* 2025). Collectively, these studies highlight the necessity of robust modelling approaches that explicitly account for volatility and policy shocks in Nigeria's deregulated and highly sensitive PMS pricing environment.

## METHODS

This research, aim on developing mathematical predictive model of Nigeria petroleum motor spirit (PMS) price by extending Ogwumu and Ataribu, (2022) research work and adopt (Ogwumu *et al.,* 2025) method of analysis. Nigeria PMS Price has sinusoidal function behavior and has relationship with respect to time; since it fluctuates yearly and periodically. Hence, the considered seventh order function model for the Nigeria PMS Price prediction.

$$I_{\min} = \min \sum_{i=1}^{33} P_i(t) = a\sin t_i^7 + b\sin t_i^6 + c\sin t_i^5 + d\sin t_i^4 + e\sin t_i^3 + f\sin t_i^2 + g\sin t_i + h \quad (0.1)$$

Let take the partial derivatives with respect to each constants to obtain the coefficients values. But at turning point of the minimized LSM, the coefficient best fit the model and the source data providing a robust foundation for the LSM analysis where

$$\frac{\partial I}{\partial a} = \frac{\partial I}{\partial b} = \frac{\partial I}{\partial c} = \frac{\partial I}{\partial d} = \frac{\partial I}{\partial e} = \frac{\partial I}{\partial f} = \frac{\partial I}{\partial g} = \frac{\partial I}{\partial h} = 0$$

Then expand to have

$$\begin{cases}\sum_{i=1}^{33}\left(P_{i(\ )}(t)\sin t_i^7 = a\sin t_i^{14} + b\sin t_i^{13} + c\sin t_i^{12} + d\sin t_i^{11} + e\sin t_i^{10} + f\sin t_i^{9} + g\sin t_i^{8} + h\sin t_i^{7}\right)\\ \sum_{i=1}^{33}\left(P_i(t)\sin t_i^6 = a\sin t_i^{13} + b\sin t_i^{12} + c\sin t_i^{11} + d\sin t_i^{10} + e\sin t_i^{9} + f\sin t_i^{8} + g\sin t_i^{7} + h\sin t_i^{6}\right)\\ \sum_{i=1}^{33}\left(P_i(t)\sin t_i^5 = a\sin t_i^{12} + b\sin t_i^{11} + c\sin t_i^{10} + d\sin t_i^{9} + e\sin t_i^{8} + f\sin t_i^{7} + g\sin t_i^{6} + h\sin t_i^{5}\right)\\ \sum_{i=1}^{33}\left(P_i(t)\sin t_i^4 = a\sin t_i^{11} + b\sin t_i^{10} + c\sin t_i^{9} + d\sin t_i^{8} + e\sin t_i^{7} + f\sin t_i^{6} + g\sin t_i^{5} + h\sin t_i^{4}\right)\\ \sum_{i=1}^{33}\left(P_i(t)\sin t_i^3 = a\sin t_i^{10} + b\sin t_i^{9} + c\sin t_i^{8} + d\sin t_i^{7} + e\sin t_i^{6} + f\sin t_i^{5} + g\sin t_i^{4} + h\sin t_i^{3}\right)\\ \sum_{i=1}^{33}\left(P_i(t)\sin t_i^2 = a\sin t_i^{9} + b\sin t_i^{8} + c\sin t_i^{7} + d\sin t_i^{6} + e\sin t_i^{5} + f\sin t_i^{4} + g\sin t_i^{3} + h\sin t_i^{2}\right)\\ \sum_{i=1}^{33}\left(P_i(t)\sin t_i^1 = a\sin t_i^{8} + b\sin t_i^{7} + c\sin t_i^{6} + d\sin t_i^{5} + e\sin t_i^{4} + f\sin t_i^{3} + g\sin t_i^{2} + h\sin t_i^{1}\right)\\ \sum_{i=1}^{33}\left(P_i(t) = a\sin t_i^{7} + b\sin t_i^{6} + c\sin t_i^{5} + d\sin t_i^{4} + e\sin t_i^{3} + f\sin t_i^{2} + g\sin t_i^{1} + h\right)\end{cases} \quad (0.2)$$

Solving simultaneously, using the source data from the year 1990 to 2022 period of PMS Price volatility in Nigeria to obtain the constant coefficients $a,b,c,d,e,f,g,h$ by using Maple 18 software

**Table 1:** *Computed sinusoidal analysis*

| $(t)$ | $p(t)$ | $\sin t^{14}$ | $\sin t^{13}$ | $\sin t^{12}$ | $\sin t^{11}$ | $\sin t^{10}$ | $\sin t^{9}$ |
|---|---|---|---|---|---|---|---|
| 0 | 0.7 | 0 | 0 | 0 | 0 | 0 | 0 |
| 1 | 0.7 | 2.44736E-25 | 1.4E-23 | 8.03E-22 | 4.6E-20 | 2.63E-18 | 1.51E-16 |
| 2 | 3.25 | 4.0012E-21 | 1.15E-19 | 3.28E-18 | 9.4E-17 | 2.69E-15 | 7.71E-14 |
| 3 | 11 | 1.16392E-18 | 2.22E-17 | 4.25E-16 | 8.11E-15 | 1.55E-13 | 2.96E-12 |
| 4 | 11 | 6.49983E-17 | 9.31E-16 | 1.33E-14 | 1.91E-13 | 2.74E-12 | 3.93E-11 |
| 5 | 11 | 1.46845E-15 | 1.68E-14 | 1.93E-13 | 2.22E-12 | 2.54E-11 | 2.91E-10 |
| 6 | 11 | 1.87067E-14 | 1.79E-13 | 1.71E-12 | 1.64E-11 | 1.56E-10 | 1.5E-09 |
| 7 | 11 | 1.6041E-13 | 1.32E-12 | 1.08E-11 | 8.85E-11 | 7.26E-10 | 5.95E-09 |
| 8 | 11 | 1.02915E-12 | 7.39E-12 | 5.31E-11 | 3.81E-10 | 2.74E-09 | 1.97E-08 |
| 9 | 20 | 5.28877E-12 | 3.38E-11 | 2.16E-10 | 1.38E-09 | 8.82E-09 | 5.63E-08 |
| 10 | 22 | 2.28075E-11 | 1.31E-10 | 7.56E-10 | 4.35E-09 | 2.5E-08 | 1.44E-07 |
| 11 | 26 | 8.53244E-11 | 4.47E-10 | 2.34E-09 | 1.23E-08 | 6.43E-08 | 3.37E-07 |
| 12 | 30 | 2.83784E-10 | 1.36E-09 | 6.56E-09 | 3.15E-08 | 1.52E-07 | 7.29E-07 |
| 13 | 40 | 8.54887E-10 | 3.8E-09 | 1.69E-08 | 7.5E-08 | 3.33E-07 | 1.48E-06 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 14 | 55 | 2.36658E-09 | 9.78E-09 | 4.04E-08 | 1.67E-07 | 6.9E-07 | 2.85E-06 |
| 15 | 60 | 6.08987E-09 | 2.35E-08 | 9.08E-08 | 3.51E-07 | 1.35E-06 | 5.23E-06 |
| 16 | 65 | 1.47023E-08 | 5.33E-08 | 1.93E-07 | 7.01E-07 | 2.54E-06 | 9.22E-06 |
| 17 | 70 | 3.35535E-08 | 1.15E-07 | 3.92E-07 | 1.34E-06 | 4.58E-06 | 1.57E-05 |
| 18 | 65 | 7.28427E-08 | 2.36E-07 | 7.62E-07 | 2.47E-06 | 7.97E-06 | 2.58E-05 |
| 19 | 65 | 1.5122E-07 | 4.64E-07 | 1.43E-06 | 4.38E-06 | 1.34E-05 | 4.13E-05 |
| 20 | 65 | 3.01533E-07 | 8.81E-07 | 2.58E-06 | 7.53E-06 | 2.2E-05 | 6.43E-05 |
| 21 | 65 | 5.79707E-07 | 1.62E-06 | 4.51E-06 | 1.26E-05 | 3.51E-05 | 9.79E-05 |
| 22 | 141 | 1.07806E-06 | 2.88E-06 | 7.68E-06 | 2.05E-05 | 5.47E-05 | 0.000146 |
| 23 | 97 | 1.94477E-06 | 4.98E-06 | 1.27E-05 | 3.26E-05 | 8.33E-05 | 0.000213 |
| 24 | 97 | 3.41152E-06 | 8.38E-06 | 2.06E-05 | 5.06E-05 | 0.000124 | 0.000306 |
| 25 | 87 | 5.83208E-06 | 1.38E-05 | 3.26E-05 | 7.72E-05 | 0.000183 | 0.000432 |
| 26 | 86.50 | 9.73466E-06 | 2.22E-05 | 5.06E-05 | 0.000115 | 0.000263 | 0.0006 |
| 27 | 86.5 | 1.58918E-05 | 3.5E-05 | 7.7E-05 | 0.00017 | 0.000373 | 0.000822 |
| 28 | 86.5 | 2.54116E-05 | 5.41E-05 | 0.000115 | 0.000245 | 0.000522 | 0.001112 |
| 29 | 145 | 3.98551E-05 | 8.22E-05 | 0.000169 | 0.000349 | 0.00072 | 0.001485 |
| 30 | 145 | 6.13832E-05 | 0.000123 | 0.000245 | 0.00049 | 0.000981 | 0.00196 |
| 31 | 165 | 9.294E-05 | 0.00018 | 0.00035 | 0.000679 | 0.001319 | 0.002559 |
| 32 | 198.7 | 0.000138474 | 0.000261 | 0.000493 | 0.000929 | 0.001753 | 0.003307 |
| $\sum =$ | 2053.85 | 0.000397121 | 0.000791 | 0.001584 | 0.003189 | 0.006465 | 0.013208 |

**Table 2** *Continuation* of sinusoidal model computational analysis

| $\sin t^8$ | $\sin t^7$ | $\sin t^6$ | $\sin t^5$ | $\sin t^4$ | $\sin t^3$ | $\sin t^2$ | $\sin t$ |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 8.64E-15 | 4.95E-13 | 2.83E-11 | 1.62E-09 | 9.29E-08 | 5.32E-06 | 0.000305 | 0.01746 |
| 2.21E-12 | 6.33E-11 | 1.81E-09 | 5.19E-08 | 1.49E-06 | 4.26E-05 | 0.001219 | 0.034915 |
| 5.65E-11 | 1.08E-09 | 2.06E-08 | 3.94E-07 | 7.52E-06 | 0.000144 | 0.002742 | 0.052359 |
| 5.63E-10 | 8.06E-09 | 1.16E-07 | 1.66E-06 | 2.37E-05 | 0.00034 | 0.00487 | 0.069788 |
| 3.34E-09 | 3.83E-08 | 4.39E-07 | 5.04E-06 | 5.78E-05 | 0.000663 | 0.007603 | 0.087195 |
| 1.43E-08 | 1.37E-07 | 1.31E-06 | 1.25E-05 | 0.00012 | 0.001144 | 0.010936 | 0.104575 |
| 4.88E-08 | 4.01E-07 | 3.28E-06 | 2.69E-05 | 0.000221 | 0.001812 | 0.014865 | 0.121924 |
| 1.41E-07 | 1.01E-06 | 7.29E-06 | 5.23E-05 | 0.000376 | 0.002699 | 0.019386 | 0.139235 |
| 3.6E-07 | 2.3E-06 | 1.47E-05 | 9.39E-05 | 0.0006 | 0.003833 | 0.024493 | 0.156504 |
| 8.3E-07 | 4.78E-06 | 2.75E-05 | 0.000158 | 0.000911 | 0.005243 | 0.03018 | 0.173725 |
| 1.76E-06 | 9.24E-06 | 4.84E-05 | 0.000253 | 0.001328 | 0.006956 | 0.03644 | 0.190893 |
| 3.5E-06 | 1.68E-05 | 8.1E-05 | 0.000389 | 0.001872 | 0.008999 | 0.043265 | 0.208003 |
| 6.58E-06 | 2.92E-05 | 0.00013 | 0.000577 | 0.002565 | 0.011398 | 0.050648 | 0.22505 |
| 1.18E-05 | 4.86E-05 | 0.000201 | 0.00083 | 0.003431 | 0.014177 | 0.058578 | 0.242028 |
| 2.02E-05 | 7.8E-05 | 0.000301 | 0.001164 | 0.004495 | 0.01736 | 0.067046 | 0.258932 |
| 3.34E-05 | 0.000121 | 0.00044 | 0.001595 | 0.005782 | 0.020969 | 0.076042 | 0.275758 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 5.36E-05 | 0.000183 | 0.000626 | 0.002141 | 0.00732 | 0.025025 | 0.085556 | 0.292499 |
| 8.34E-05 | 0.00027 | 0.000873 | 0.002824 | 0.009134 | 0.029547 | 0.095574 | 0.309151 |
| 0.000127 | 0.000389 | 0.001194 | 0.003666 | 0.011254 | 0.034553 | 0.106086 | 0.325709 |
| 0.000188 | 0.000549 | 0.001605 | 0.00469 | 0.013707 | 0.04006 | 0.117078 | 0.342167 |
| 0.000273 | 0.000761 | 0.002124 | 0.005923 | 0.016522 | 0.046083 | 0.128537 | 0.358521 |
| 0.000389 | 0.001038 | 0.002771 | 0.007393 | 0.019726 | 0.052636 | 0.14045 | 0.374766 |
| 0.000545 | 0.001395 | 0.003568 | 0.009127 | 0.023348 | 0.059729 | 0.1528 | 0.390897 |
| 0.000752 | 0.001847 | 0.004539 | 0.011155 | 0.027415 | 0.067373 | 0.165574 | 0.406908 |
| 0.001021 | 0.002415 | 0.005712 | 0.01351 | 0.031954 | 0.075577 | 0.178756 | 0.422795 |
| 0.001368 | 0.00312 | 0.007114 | 0.016222 | 0.036991 | 0.084347 | 0.192329 | 0.438554 |
| 0.001811 | 0.003986 | 0.008777 | 0.019326 | 0.042551 | 0.093687 | 0.206278 | 0.454179 |
| 0.002368 | 0.005041 | 0.010733 | 0.022853 | 0.048658 | 0.103601 | 0.220585 | 0.469665 |
| 0.003062 | 0.006313 | 0.013016 | 0.026838 | 0.055334 | 0.11409 | 0.235233 | 0.485008 |
| 0.003919 | 0.007835 | 0.015663 | 0.031314 | 0.062602 | 0.125152 | 0.250203 | 0.500203 |
| 0.004967 | 0.009641 | 0.018711 | 0.036314 | 0.070479 | 0.136787 | 0.265478 | 0.515246 |
| 0.006238 | 0.011768 | 0.022197 | 0.041871 | 0.078983 | 0.148988 | 0.281039 | 0.530131 |
| 0.027243 | 0.056863 | 0.120479 | 0.260326 | 0.577769 | 1.333022 | 3.270177 | 8.974743 |

**Table 3:** *Continuation sinusoidal model computational analysis*

| $P(t)\sin t^7$ | $P(t)\sin t^6$ | $P(t)\sin t^5$ | $P(t)\sin t^4$ | $P(t)\sin t^3$ | $P(t)\sin t^2$ | $P(t)\sin t$ |
|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 3.46E-13 | 1.98E-11 | 1.14E-09 | 6.51E-08 | 3.73E-06 | 0.000213 | 0.012222 |
| 2.06E-10 | 5.89E-09 | 1.69E-07 | 4.83E-06 | 0.000138 | 0.003962 | 0.113474 |
| 1.19E-08 | 2.27E-07 | 4.33E-06 | 8.27E-05 | 0.001579 | 0.030157 | 0.575953 |
| 8.87E-08 | 1.27E-06 | 1.82E-05 | 0.000261 | 0.003739 | 0.053574 | 0.767664 |
| 4.22E-07 | 4.83E-06 | 5.54E-05 | 0.000636 | 0.007292 | 0.083632 | 0.959142 |
| 1.5E-06 | 1.44E-05 | 0.000138 | 0.001316 | 0.01258 | 0.120296 | 1.150326 |
| 4.41E-06 | 3.61E-05 | 0.000296 | 0.002431 | 0.019937 | 0.163519 | 1.34116 |
| 1.12E-05 | 8.01E-05 | 0.000576 | 0.004134 | 0.029692 | 0.21325 | 1.531585 |
| 4.6E-05 | 0.000294 | 0.001878 | 0.011999 | 0.076667 | 0.48987 | 3.130079 |
| 0.000105 | 0.000605 | 0.003481 | 0.020039 | 0.115348 | 0.66397 | 3.821954 |
| 0.00024 | 0.001258 | 0.006591 | 0.034525 | 0.180862 | 0.947448 | 4.963229 |
| 0.000505 | 0.00243 | 0.011681 | 0.056157 | 0.269981 | 1.297963 | 6.240104 |
| 0.00117 | 0.005197 | 0.023092 | 0.102607 | 0.455929 | 2.025902 | 9.002004 |
| 0.002676 | 0.011055 | 0.045676 | 0.188723 | 0.779758 | 3.221768 | 13.31155 |
| 0.004682 | 0.018083 | 0.069837 | 0.26971 | 1.041622 | 4.022757 | 15.53594 |
| 0.007881 | 0.028581 | 0.103646 | 0.375858 | 1.363 | 4.942747 | 17.92424 |
| 0.012822 | 0.043837 | 0.149871 | 0.512383 | 1.751743 | 5.988889 | 20.47492 |
| 0.017543 | 0.056746 | 0.183555 | 0.593738 | 1.920546 | 6.212326 | 20.0948 |
| 0.025277 | 0.077605 | 0.238265 | 0.731527 | 2.245955 | 6.895596 | 21.17106 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 0.035693 | 0.104314 | 0.304863 | 0.890977 | 2.603922 | 7.61009 | 22.24086 |
| 0.04949 | 0.138039 | 0.385024 | 1.073922 | 2.995422 | 8.354936 | 23.30388 |
| 0.1464 | 0.390644 | 1.042367 | 2.781379 | 7.42164 | 19.80339 | 52.84202 |
| 0.135271 | 0.346054 | 0.885282 | 2.264746 | 5.793721 | 14.82162 | 37.91698 |
| 0.179162 | 0.440301 | 1.082065 | 2.659236 | 6.535226 | 16.06069 | 39.47008 |
| 0.210102 | 0.496936 | 1.175359 | 2.779971 | 6.575216 | 15.55177 | 36.7832 |
| 0.269884 | 0.615395 | 1.403236 | 3.199689 | 7.296001 | 16.6365 | 37.93491 |
| 0.344828 | 0.759235 | 1.671665 | 3.680635 | 8.103937 | 17.84306 | 39.28645 |
| 0.436046 | 0.92842 | 1.976771 | 4.208897 | 8.961491 | 19.08061 | 40.62601 |
| 0.915398 | 1.887387 | 3.891456 | 8.02349 | 16.54301 | 34.10874 | 70.32615 |
| 1.136038 | 2.271153 | 4.540461 | 9.077235 | 18.1471 | 36.27946 | 72.52945 |
| 1.590689 | 3.087243 | 5.991786 | 11.62899 | 22.56978 | 43.80391 | 85.01556 |
| 2.338206 | 4.410615 | 8.319852 | 15.69394 | 29.60387 | 55.84251 | 105.3371 |
| 7.860171 | 16.12156 | 33.50885 | 70.86924 | 153.4267 | 343.1751 | 805.7341 |

$$P(t) = 4648.409 + 2017.63 - 6847.29 - 19665.4 + 33189.9 - 14331.2 + 3085.826 - 1.3337 = 2096.528$$

**Validation of the model**

To test the authenticity of the sinusoidal model, a pilot test was considered to ensure if the model confirms to reality. In order to achieve this, we compare the generated model data with the actual source data in table 4 below

**Table 4. Validation of the sinusoidal model result**

| Year(s) | (t) | P(t) | P(t) model | Absolute Error |
|---|---|---|---|---|
| 1990 | 0 | 0.7 | -1.3337 | 2.0337 |
| 1991 | 1 | 0.7 | 3.46303 | 2.76303 |
| 1992 | 2 | 3.25 | 6.33674 | 3.08674 |
| 1993 | 3 | 11 | 7.96313 | 3.03687 |
| 1994 | 4 | 11 | 8.93233 | 2.06767 |
| 1995 | 5 | 11 | 9.74415 | 1.25586 |
| 1996 | 6 | 11 | 10.8049 | 0.19509 |
| 1997 | 7 | 11 | 12.4261 | 1.42605 |
| 1998 | 8 | 11 | 14.8245 | 3.82453 |
| 1999 | 9 | 20 | 18.1253 | 1.87467 |
| 2000 | 10 | 22 | 22.3662 | 0.36618 |
| 2001 | 11 | 26 | 27.5043 | 1.50431 |
| 2002 | 12 | 30 | 33.4256 | 3.42557 |
| 2003 | 13 | 40 | 39.9557 | 0.04429 |
| 2004 | 14 | 55 | 46.8738 | 8.12623 |
| 2005 | 15 | 60 | 53.9274 | 6.07256 |
| 2006 | 16 | 65 | 60.8504 | 4.14961 |

| | | | | |
|---|---|---|---|---|
| 2007 | 17 | 70 | 67.3811 | 2.61892 |
| 2008 | 18 | 65 | 73.2831 | 8.28309 |
| 2009 | 19 | 65 | 78.3665 | 13.3665 |
| 2010 | 20 | 65 | 82.5099 | 17.5099 |
| 2011 | 21 | 65 | 85.6834 | 20.6834 |
| 2012 | 22 | 141 | 87.9707 | 53.0294 |
| 2013 | 23 | 97 | 89.5917 | 7.40828 |
| 2014 | 24 | 97 | 90.9243 | 6.07573 |
| 2015 | 25 | 87 | 92.5241 | 5.52408 |
| 2016 | 26 | 86.50 | 95.1437 | 8.64369 |
| 2017 | 27 | 86.5 | 99.7492 | 13.2492 |
| 2018 | 28 | 86.5 | 107.535 | 21.0348 |
| 2019 | 29 | 145 | 119.934 | 25.0663 |
| 2020 | 30 | 145 | 138.627 | 6.37282 |
| 2021 | 31 | 165 | 165.549 | 0.54926 |
| 2022 | 32 | 198.7 | 202.888 | 4.18767 |
| | | | | $\cong$ 258.856 |

The result of the sinusoidal model is confirms to reality and suitable to be use for prediction of premium motor spirit (PMS) price hike, since the absolute error is approximately less and negligible when compare with the source data. In fact, the result indicates vividly that time is not an influencing factor in the pricing of PMS and do not strictly follow a sinusoidal pattern. It is obvious that PMS is influence by a complex set of factor beyond time. Also, we can remark that the model conforms to reality because of the nature of Nigerian fuel price is always ever fluctuating inconsistent and behave in the form of sine wave function.

### *Correlation between fuel price and sinusoidal model prediction*

The computed tabulation of the sinusoidal model results and the sourced data correlation is shown in the table below. The sourced data is represented as $P(t) = x$ and model results $P(t)\,\text{model} = y$ respectively.

**Table 3 Computation of the sinusoidal Model correlation**

| $x$ | $y$ | $xy$ | $y^2$ | $x^2$ |
|---|---|---|---|---|
| 0.7 | -1.3337 | -0.93359 | 1.778756 | 0.49 |
| 0.7 | 3.46303 | 2.424122 | 11.99259 | 0.49 |
| 3.25 | 6.33674 | 20.59439 | 40.15422 | 10.5625 |
| 11 | 7.96313 | 87.59442 | 63.41142 | 121 |

| | | | | |
|---|---|---|---|---|
| 11 | 8.93233 | 98.25561 | 79.78648 | 121 |
| 11 | 9.74415 | 107.1856 | 94.94836 | 121 |
| 11 | 10.8049 | 118.854 | 116.7461 | 121 |
| 11 | 12.4261 | 136.6866 | 154.4067 | 121 |
| 11 | 14.8245 | 163.0697 | 219.7664 | 121 |
| 20 | 18.1253 | 362.5066 | 328.5276 | 400 |
| 22 | 22.3662 | 492.056 | 500.246 | 484 |
| 26 | 27.5043 | 715.1121 | 756.4871 | 676 |
| 30 | 33.4256 | 1002.767 | 1117.269 | 900 |
| 40 | 39.9557 | 1598.228 | 1596.459 | 1600 |
| 55 | 46.8738 | 2578.057 | 2197.15 | 3025 |
| 60 | 53.9274 | 3235.646 | 2908.169 | 3600 |
| 65 | 60.8504 | 3955.275 | 3702.77 | 4225 |
| 70 | 67.3811 | 4716.676 | 4540.21 | 4900 |
| 65 | 73.2831 | 4763.401 | 5370.411 | 4225 |
| 65 | 78.3665 | 5093.821 | 6141.304 | 4225 |
| 65 | 82.5099 | 5363.145 | 6807.887 | 4225 |
| 65 | 85.6834 | 5569.419 | 7341.64 | 4225 |
| 141 | 87.9707 | 12403.86 | 7738.835 | 19881 |
| 97 | 89.5917 | 8690.397 | 8026.676 | 9409 |
| 97 | 90.9243 | 8819.655 | 8267.225 | 9409 |
| 87 | 92.5241 | 8049.595 | 8560.705 | 7569 |
| 86.50 | 95.1437 | 8229.929 | 9052.322 | 7482.25 |
| 86.5 | 99.7492 | 8628.309 | 9949.911 | 7482.25 |
| 86.5 | 107.535 | 9301.76 | 11563.73 | 7482.25 |
| 145 | 119.934 | 17390.39 | 14384.09 | 21025 |
| 145 | 138.627 | 20100.94 | 19217.5 | 21025 |
| 165 | 165.549 | 27315.63 | 27406.57 | 27225 |
| 198.7 | 202.888 | 40313.79 | 41163.42 | 39481.69 |
| $\sum = 2053.85$ | $\sum = 2053.85$ | $\sum = 209424.1$ | $\sum = 209422.5$ | $\sum = 214919$ |

The calculation of the sinusoidal model correlation of the source data and model data are shown below.

The correlation coefficient $(r) = \dfrac{n\sum xy - \sum x \sum y}{\sqrt{\left(n\sum x^2 - \left(\sum x\right)^2\right)\left(n\sum y^2 - \left(\sum y\right)^2\right)}}$

$\therefore r = 0.96797$

The sinusoidal model, with a correlation of 0.96797, is a reliable tool for predicting the cyclical aspects of PMS prices in Nigeria. It aligns well with reality by capturing the recurring patterns in the data and can be effectively used for forecasting under typical market conditions. However, for a more comprehensive and accurate prediction, especially in the volatile PMS market in Nigeria, the model may need to be complemented with additional approaches that consider sudden and non-cyclical

## DISCUSSION

The sinusoidal function model reveals that PMS prices in Nigeria display a clear cyclical pattern over the period 1990–2022. The fitted seventh-order sinusoidal function effectively captures the recurring phases of price stability and escalation observed in the data. Strong alignment between predicted and actual prices, supported by validation and correlation results, confirms the model's ability to explain a substantial portion of PMS price variation, particularly during periods of relative economic stability

The findings indicate that PMS prices are influenced by recurring time-dependent cycles linked to repeated policy interventions and market conditions. While the sinusoidal model successfully captures long-term oscillatory behaviour, deviations arise during abrupt policy shifts and economic shocks. Despite these limitations, the model remains a reliable framework for understanding medium- to long-term price trends

## CONCLUSION

The study shows that Nigeria's PMS prices exhibit a strong cyclical pattern that can be effectively modeled using a seventh-order sinusoidal function. The application of the Least Squares Method enabled the model to closely track long-term price oscillations, with validation and correlation analyses confirming strong agreement between predicted and observed prices, particularly during periods of policy stability. Although the model does not fully capture abrupt price changes caused by subsidy reforms, deregulation, and global oil market shocks, it remains a reliable baseline tool for medium to long term forecasting. Overall, the sinusoidal model provides valuable insight into the periodic nature of PMS pricing in Nigeria, with improved performance achievable when combined with policy and macroeconomic variables.

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**Conflict of Interests**

The authors declare that there is no conflict of interests

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## APPENDICES

**APPENDIX Table (A)**

| Time (t) | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Petrol Price P(t) | 0.7 | 0.7 | 3.25 | 11 | 11 | 11 | 11 | 11 | 11 | 20 | 22 | 26 | 30 |

| Time (t) | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Petrol Price P(t) | 40 | 55 | 60 | 65 | 70 | 65 | 65 | 65 | 65 | 141 | 97 |

| Time (t) | 24 | 25 | 26 | 27 | 28 | 29 | 30 | 31 | 32 |
|---|---|---|---|---|---|---|---|---|---|
| Petrol Price P(t) | 97 | 87 | 86.5 | 86.5 | 86.5 | 145 | 145 | 165 | 198.7 |

## APPENDIX (B)

> **Non Sinusoidal (Polynomial) model**

The maple simultaneous analysis of the constant coefficients

>*restart*

> $f1 := (0.000397121 \cdot a + 0.000791207 \cdot b + 0.001584076 \cdot c + 0.003189486 \cdot d + 0.00646476\cdot e + 0.013207553 \cdot f + 0.027242939 \cdot g + 0.056862605 \cdot h = 7.860171461);$

$$f1 := 0.000397121\, a + 0.000791207\, b + 0.001584076\, c + 0.003189486\, d + 0.006464763\, e + 0.013207553\, f + 0.027242939\, g + 0.056862605\, h = 7.860171461$$

> $f2 := (0.000791207 \cdot a + 0.001584076 \cdot b + 0.003189486 \cdot c + 0.006464763 \cdot d + 0.013207553 \cdot e + 0.027242939 \cdot f + 0.056862605 \cdot g + 0.120479257 \cdot h = 16.1215621);$

$$f2 := 0.000791207\, a + 0.001584076\, b + 0.003189486\, c + 0.006464763\, d + 0.013207553\, e + 0.027242939\, f + 0.056862605\, g + 0.120479257\, h = 16.1215621$$

> $f3 := (0.001584076 \cdot a + 0.003189486 \cdot b + 0.006464763 \cdot c + 0.013207553 \cdot d + 0.027242939 \cdot e + 0.056862605 \cdot f + 0.120479257 \cdot g + 0.260326092 \cdot h = 33.50884643);$

$$f3 := 0.001584076\, a + 0.003189486\, b + 0.006464763\, c + 0.013207553\, d + 0.027242939\, e + 0.056862605\, f + 0.120479257\, g + 0.260326092\, h = 33.50884643$$

> $f4 := (0.003189486 \cdot a + 0.006464763 \cdot b + 0.013207553 \cdot c + 0.027242939 \cdot d + 0.056862605 \cdot e + 0.120479257 \cdot f + 0.260326092 \cdot g + 0.577768784 \cdot h = 70.86923644);$

$$f4 := 0.003189486\, a + 0.006464763\, b + 0.013207553\, c + 0.027242939\, d + 0.056862605\, e + 0.120479257\, f + 0.260326092\, g + 0.577768784\, h = 70.86923644$$

> $f5 := (0.006464763 \cdot a + 0.013207553 \cdot b + 0.027242939 \cdot c + 0.056862605 \cdot d + 0.120479257 \cdot e + 0.260326092 \cdot f + 0.577768784 \cdot g + 1.333022477 \cdot h = 153.4267087);$

$$f5 := 0.006464763\, a + 0.013207553\, b + 0.027242939\, c + 0.056862605\, d + 0.120479257\, e + 0.260326092\, f + 0.577768784\, g + 1.333022477\, h = 153.4267087$$

> $f6 := (0.013207553 \cdot a + 0.027242939 \cdot b + 0.056862605 \cdot c + 0.120479257 \cdot d + 0.260326092 \cdot e + 0.577768784 \cdot f + 1.333022477 \cdot g + 3.270177167 \cdot h = 343.1751334);$

$$f6 := 0.013207553\, a + 0.027242939\, b + 0.056862605\, c + 0.120479257\, d + 0.260326092\, e + 0.577768784\, f + 1.333022477\, g + 3.270177167\, h = 343.1751334$$

> $f7 := (0.027242939 \cdot a + 0.056862605 \cdot b + 0.120479257 \cdot c + 0.260326092 \cdot d + 0.577768784 \cdot e + 1.333022477 \cdot f + 3.270177167 \cdot g + 8.974743373 \cdot h = 805.7340601);$

$$f7 := 0.027242939\, a + 0.056862605\, b + 0.120479257\, c + 0.260326092\, d + 0.577768784\, e + 1.333022477\, f + 3.270177167\, g + 8.974743373\, h = 805.7340601$$

> $f8 := (0.056862605 \cdot a + 0.120479257 \cdot b + 0.260326092 \cdot c + 0.577768784 \cdot d + 1.333022477 \cdot e + 3.270177167 \cdot f + 8.974743373 \cdot g + 33 \cdot h = 2053.85);$

$$f8 := 0.056862605\, a + 0.120479257\, b + 0.260326092\, c + 0.577768784\, d + 1.333022477\, e + 3.270177167\, f + 8.974743373\, g + 33\, h = 2053.85$$

>