

Distributional Properties of Nigerian Macroeconomic Indicators, 2008–2024: Less Non-Normal Than Assumed

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Abstract: Regression inference and many machine-learning loss functions assume, or at least work best with, errors that are not extremely fat-tailed or asymmetric. Emerging-market series are widely believed to violate this, and the belief is rarely tested carefully. This paper documents the distributional properties of ten Nigerian macroeconomic indicators over 67 quarters from 2008Q2 to 2024Q4, and finds a more mixed picture than the folklore suggests. Three of the ten do not reject normality at the 5% level: FDI itself (Jarque-Bera 2.11, $p = 0.348$), GDP (0.24, $p = 0.885$) and oil price (3.63, $p = 0.163$). Seven do reject, with exchange-rate volatility the most extreme (skewness 3.21, excess kurtosis 10.14). The result for FDI matters most, because FDI is the dependent variable in most Nigerian FDI research and is routinely assumed to be severely non-normal. An earlier version of this analysis, run on a longer sample in which everything before 2008 was interpolated from annual figures, found all ten variables rejecting normality and reported FDI with excess kurtosis of 7.95. On genuine data FDI has excess kurtosis of -0.17. The apparent fat tails were an artefact of splicing a smoothed series onto a noisy one.

Keywords: Non-Normality; Skewness; Kurtosis; Jarque-Bera; Nigerian Macroeconomic Data.

JEL Classification: C22; C46; E01; O55.

1. INTRODUCTION

Ordinary least squares inference, the classical linear regression model and squared-error loss all behave best when the data are not extremely asymmetric or fat-tailed. Emerging-market macroeconomic series are frequently described as violating these conditions, usually in passing and without a formal test. The consequences of getting this wrong run in both directions: assuming normality when it fails invalidates standard errors, and assuming severe non-normality when it holds leads researchers to discard efficient methods for no reason.

Nigeria makes a useful case. The 2008 to 2024 window covers the global financial crisis, the 2014-2016 oil collapse, two recessions, COVID-19 and the 2023 exchange-rate unification. If any macroeconomic series should show fat tails, these should.

1.1 What this paper contributes

- It gives a systematic ten-variable distributional audit with formal testing, not a passing remark.
- It reports a mixed result, including three variables that do not reject normality, where the literature generally assumes a uniform rejection.
- It shows that a previously reported finding of severe non-normality in Nigerian FDI was an artefact of interpolated data, and quantifies the difference.
- It states clearly what unconditional normality tests on trending series can and cannot establish.

2. LITERATURE REVIEW

2.1 Fat tails in economic series

Mandelbrot (1963) and Fama (1965) documented leptokurtosis in speculative price series, and Cont (2001) codifies fat tails, volatility clustering and gain-loss asymmetry as stylised facts across markets and frequencies. Nelson and Plosser (1982) established that macroeconomic aggregates are typically non-stationary, which by itself induces apparent non-normality in level series.

The finding is far better established for high-frequency financial returns than for quarterly macroeconomic aggregates. Temporal aggregation averages away much of the tail behaviour that daily data exhibit, so carrying the stylised facts of daily returns over to quarterly national accounts is an extrapolation, not an inference.

2.2 Why it matters for method

Non-normal errors leave OLS estimates unbiased but make finite-sample inference unreliable, and combined with heteroskedasticity they invalidate conventional standard errors (White, 1980; Newey & West, 1987). For machine learning, squared-error loss weights residuals quadratically, so a few extreme observations can dominate fitting, which is the documented advantage of insensitive and Huber-type losses in heavy-tailed settings (Vapnik, 1995; Hastie, Tibshirani & Friedman, 2009).

3. METHOD

The dataset behind this paper was originally assembled as 144 quarterly observations running from 1990Q1. Inspection showed that everything before 2008 was linearly interpolated from annual figures: FDI, GDP, the exchange rate, inflation and the trade series all change by a constant amount each quarter and then jump at the year boundary. Interpolation of that kind imposes autocorrelation by construction, so the earlier period has been dropped. Trade openness was also excluded, because the available series divides nominal trade by real GDP and tests as I(2). GDP is rebased in 2025 with an unadjusted splice, so 2025 is dropped as well. The working sample is 2008Q2 to 2024Q4.

For each of ten variables, descriptive statistics were computed on the level series, together with skewness, excess kurtosis and the Jarque-Bera statistic (Jarque & Bera, 1987), tested at 5%.

3.1 What these tests can and cannot show

One qualification bounds everything below. Jarque-Bera assumes independent, identically distributed observations. Applied to trending, strongly autocorrelated level series such as GDP, the exchange rate and the trade aggregates, it will reject almost by construction, because a trend produces a non-normal marginal distribution whatever the innovations look like. The rejections for those series say little about the shape of their shocks. The results carry more weight for the series that are closer to stationary in level, and more weight still for fitted model residuals, which is the quantity inference assumptions actually concern.

4. RESULTS

Table 1. Descriptive statistics, 2008Q2–2024Q4 (n = 67)

Variable	Mean	Std. dev.	Minimum	Median	Maximum
FDI (US\$m)	1,021.84	786.52	-558.45	1,006.00	3,084.90
ECH (NGN/US\$)	341.98	322.72	117.84	305.79	1,621.88
EXRVOL	0.0400	0.0900	0.0000	0.0090	0.5904
INF (%)	14.65	6.06	8.00	12.56	34.19
GDP (NGN m)	16,526,402	2,492,835	11,616,890	16,853,470	22,610,393
Export (NGN m)	4,992,287	4,257,454	1,065,830	3,668,890	19,004,320
Import (NGN m)	4,422,774	3,641,529	1,033,340	3,205,180	21,094,135
Trade (NGN m)	9,415,061	7,807,025	2,099,170	6,874,070	40,098,454
OILP (US\$/bbl)	78.06	24.62	30.79	76.98	122.39
INTEREST (%)	12.82	4.35	6.00	12.00	27.50

Table 2. Skewness, kurtosis and normality

Variable	Skewness	Excess kurtosis	Jarque-Bera	p	Normal at 5%?
FDI	0.426	-0.171	2.11	0.3479	Yes
GDP	-0.111	-0.196	0.24	0.8849	Yes
OILP	0.121	-1.114	3.63	0.1631	Yes
INF	1.505	1.981	36.25	<0.0001	No
INTEREST	1.320	2.991	44.43	<0.0001	No
Import	2.233	4.818	120.51	<0.0001	No
Trade	2.607	6.443	191.76	<0.0001	No
Export	2.779	7.311	235.48	<0.0001	No
ECH	2.775	7.401	238.94	<0.0001	No
EXRVOL	3.207	10.138	401.78	<0.0001	No

Three of ten do not reject normality. The four strongest rejections (ECH, Export, Import, Trade) are all strongly trending series, where Section 3.1 applies.

5. DISCUSSION

FDI is the headline. Skewness of 0.43 and excess kurtosis of -0.17 describe a distribution slightly right-skewed and marginally thinner-tailed than a normal, and Jarque-Bera does not come close to rejecting ($p = 0.348$). This is not what the Nigerian literature assumes, and it is not what an earlier version of this analysis found. On a sample where 1990 to 2007 was interpolated from annual figures, FDI showed excess kurtosis of 7.95 and a Jarque-Bera statistic of 153.66. The mechanism is straightforward once seen. Interpolation produces a smooth, low-variance series; genuine quarterly data produces a noisy one. Splicing them gives a distribution with a dense smooth centre and a scattering of genuine quarterly movements in the tails, which is exactly the shape that generates high kurtosis. The fat tails were a property of the join, not of Nigerian FDI.

Exchange-rate volatility remains genuinely extreme, with skewness 3.21 and excess kurtosis 10.14, and 24 of 67 quarters below 0.001. That pattern is real: the naira spent long stretches administratively pegged and then moved sharply, so a volatility measure built on it is near-zero most of the time and very large occasionally. Any model treating this variable as a smooth linear regressor is making a strong assumption.

The practical implication is narrower than the usual recommendation. Robust or HAC standard errors remain sensible as a default, and cost little when unnecessary. But the blanket claim that Nigerian macroeconomic series are so non-normal that ordinary methods cannot be trusted is not supported here for FDI, GDP or oil price. Researchers should test rather than assume, in both directions.

6. CONCLUSION

Across ten Nigerian macroeconomic indicators over 67 genuine quarters, seven reject normality and three do not. FDI, the dependent variable in most of this literature, is among those that do not. A previously reported finding of severe non-normality in FDI turned out to be an artefact of splicing interpolated data onto genuine data. Exchange-rate volatility is genuinely and severely non-normal, reflecting a currency that was administratively managed for long stretches and then moved sharply.

7. LIMITATIONS

Normality is tested unconditionally on level series. For the trending variables this mixes non-stationarity with tail behaviour, and repeating the tests on differences and on model residuals would separate the two.

Jarque-Bera assumes independence, which these series violate. Tests robust to serial dependence would give more defensible p-values.

The paper documents non-normality without characterising it parametrically. Fitting Student-t distributions and reporting degrees of freedom would quantify tail thickness instead of only rejecting a null.

Sixty-seven observations gives Jarque-Bera limited power, so a failure to reject is weaker evidence than a rejection.

REFERENCES

- [1]. Cont, R. (2001). Empirical properties of asset returns. *Quantitative Finance*, 1(2), 223–236.
- [2]. Fama, E. F. (1965). The behavior of stock-market prices. *Journal of Business*, 38(1), 34–105.
- [3]. Hastie, T., Tibshirani, R., & Friedman, J. (2009). *The elements of statistical learning* (2nd ed.). Springer.
- [4]. Jarque, C. M., & Bera, A. K. (1987). A test for normality of observations and regression residuals. *International Statistical Review*, 55(2), 163–172.
- [5]. Mandelbrot, B. (1963). The variation of certain speculative prices. *Journal of Business*, 36(4), 394–419.
- [6]. Nelson, C. R., & Plosser, C. I. (1982). Trends and random walks in macroeconomic time series. *Journal of Monetary Economics*, 10(2), 139–162.
- [7]. Newey, W. K., & West, K. D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55(3), 703–708.
- [8]. Vapnik, V. N. (1995). *The nature of statistical learning theory*. Springer.
- [9]. White, H. (1980). A heteroskedasticity-consistent covariance matrix estimator. *Econometrica*, 48(4), 817–838.