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TERRORISM SHOCKS, PREVENTIVE HEALTHCARE AND POPULATION HEALTH IN NIGERIA: A DYNAMIC HEALTH-ECONOMIC ANALYSIS

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ABSTRACT

This study examines the dynamic health-economic relationship between terrorism shocks, preventive healthcare, population health and inflation in Nigeria from 1990 to 2025. Using annual secondary data on terrorism death rate (TERDR), DPT and measles immunization coverage (MEAS), life expectancy at birth (LEX), and inflation rate (INF), the study employs ADF and Phillips-Perron unit-root tests, VAR lag selection, Johansen cointegration and a rank-two Vector Error Correction Model (VECM), complemented by block-exogeneity tests, impulse response functions and forecast error variance decomposition. The health-economic framework treats terrorism as a security shock that can affect the supply, cost and access to healthcare while interacting with household purchasing power and macroeconomic conditions. The results establish that all five variables are integrated of order one and that two cointegrating relationships exist. The VECM reveals significant short-run interactions involving terrorism mortality, life expectancy, immunization and inflation. Block-exogeneity results further indicate significant predictive relationships from life expectancy to terrorism mortality, from terrorism mortality, DPT and life expectancy to measles immunization, and from DPT and measles immunization to inflation. Impulse responses demonstrate that shocks propagate across the system over time, while variance decomposition confirms meaningful contributions of terrorism and health-related shocks to movements in other variables. The study concludes that terrorism, preventive healthcare, population health and macroeconomic conditions are dynamically interconnected, highlighting the importance of protecting essential health services and health-sector resources during insecurity and economic instability.

Keywords: Terrorism shocks; Preventive healthcare; Population health; Health economics; Inflation; VECM; Nigeria.

JEL Classification: *E31, I32, H53*

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Introduction

Terrorism and prolonged insecurity constitute significant threats to population health, particularly in developing economies where healthcare systems face inadequate infrastructure, limited financing, shortages of health personnel and barriers to healthcare access (Agwu et al., 2023). Beyond immediate deaths and injuries, terrorism and armed conflict can destroy health facilities, displace healthcare workers, disrupt medical supplies and restrict access to essential preventive and curative services. These disruptions weaken healthcare delivery and undermine the capacity of health systems to sustain essential services (Adeyanju et al., 2026).

From a health-economics perspective, terrorism represents a shock to both the supply and demand sides of healthcare. It can increase healthcare delivery costs, damage infrastructure, restrict the movement of health workers and redirect public resources towards security expenditure (Ager et al., 2015; Yusuf & Mohd, 2022). At the household level, insecurity can disrupt livelihoods, increase the indirect costs of healthcare and discourage healthcare utilization. Consequently, prolonged insecurity may undermine population health and increase the economic burden associated with illness and access to healthcare (Schaub et al., 2025; Eneh & Eneh, 2025).

Nigeria provides an important context for examining these relationships because of its persistent exposure to terrorism, armed conflict and violent insecurity, alongside significant healthcare delivery and humanitarian challenges (Merttens et al., 2024; International Rescue Committee, 2024). The consequences are particularly important for preventive healthcare, as immunization programmes depend on functioning health facilities, reliable vaccine supply chains, secure movement of health workers and regular household access to health services.

Despite growing research on conflict and health, Nigerian evidence remains concentrated in specific geographical locations, conflict settings and population groups, with limited evidence on the broader national dynamics of insecurity and population health (Orjiakor et al., 2026). Limited attention has been given to the long-run and short-run interactions between terrorism mortality, childhood immunization, life expectancy and inflation within a unified national time-series framework. This represents an important research gap, particularly given the potential for security shocks to generate persistent effects across healthcare delivery and population-health outcomes.

Therefore, the study examines the dynamic relationship between terrorism shocks, preventive healthcare, population health and inflation in Nigeria over the period 1990-2025. Specifically, it investigates their long-run relationships, short-run dynamic interactions and responses to economic and security shocks using the Vector Error Correction Model (VECM), impulse response functions and forecast error variance decomposition. The study contributes to the health-economics literature by providing national-level evidence on how terrorism-related shocks interact with preventive healthcare, population health and macroeconomic conditions in Nigeria.

LITERATURE REVIEW

A Dual-Shock Framework

Building on these perspectives, this study develops a dual-shock framework in which terrorism operates as both a supply-side shock (damaging infrastructure, disrupting supply chains, displacing health workers) and a demand-side shock (reducing household income, increasing fear, displacing populations). These shocks interact with macroeconomic conditions (inflation) and health-system inputs (immunization) to affect population health outcomes (life expectancy). The framework predicts that: utilization and preventive health services. In northeastern Nigeria, Sato's analysis

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using Nigeria Demographic and Health Survey data linked with conflict-event information found substantial reductions in childhood vaccination associated with exposure to armed conflict. The study further showed that the effects varied according to maternal education, indicating that socioeconomic characteristics can influence the extent to which conflict affects preventive healthcare.

METHODOLOGY

Research Design

This study adopts a quantitative time-series research design to examine the dynamic relationship between terrorism, preventive healthcare, population health and macroeconomic conditions in Nigeria over the period 1990-2025. The analysis is based exclusively on annual secondary data for terrorism death rate (TERDR), DPT immunization coverage (DPT), measles immunization coverage (MEAS), life expectancy at birth (LEX), and inflation rate (INF).

Model Specification

The empirical analysis is formulated as a five-variable dynamic system:

$$Y_t = \begin{bmatrix} TERDR_t \\ DPT_t \\ MEAS_t \\ LEX_t \\ INF_t \end{bmatrix} \quad \text{..... Eqn 1}$$

The underlying unrestricted VAR model is expressed as:

$$Y_t = c + \sum_{i=1}^{p} A_i\, Y_{t-i} + \varepsilon_t \quad \text{..... Eqn 2}$$

where Y_t is the vector of endogenous variables, c is a vector of constants, A_i represents the coefficient matrices, $p$denotes the optimal lag length, and $\varepsilon_t$is the vector of innovations.

Unit Root Tests

The stationarity properties of the variables are examined using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit-root tests. The ADF test is specified as:

$$\Delta Y_t = \alpha + \rho Y_{t-1} + \sum_{i=1}^{p} \gamma_i\, \Delta Y_{t-i} + \varepsilon_t \quad \text{..... Eqn 3}$$

Vector Error Correction Model

$$\Delta Y_t = \alpha\beta' Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \varepsilon_t \quad \text{..... Eqn 4}$$

where $\beta' Y_{t-1}$ represents the long-run cointegrating relationships, α contains the adjustment coefficients, $\Gamma_1$captures short-run dynamics, and $\varepsilon_t$represents the vector of innovations.

The long-run component is represented as:

$$\beta' Y_{t-1} = 0 \quad \text{..... Eqn 5}$$

The short-run dynamics are captured through:

$$\Delta Y_t = \alpha_1 ECT_{1,t-1} + \alpha_2 ECT_{2,t-1} + \Gamma_1 \Delta Y_{t-1} + \varepsilon_t \quad \text{..... Eqn 6}$$

where $ECT_{1,t-1}$ and $ECT_{2,t-1}$ are the two error-correction terms generated from the Johansen cointegrating relationships.

VECM Granger Causality and Block-Exogeneity Tests

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The Wald statistic is expressed generally as:

$$W = (R\hat{\theta} - r)'\left[R\widehat{Var}(\hat{\theta})R'\right]^{-1}(R\hat{\theta} - r) \quad \text{Eqn 7}$$

where R srepresents the restriction matrix, $\hat{\theta}$is the estimated coefficient vector and $r$represents the hypothesised restrictions.

Impulse Response Function

The IRF can be represented generally as:

$$IRF_h = \frac{\partial Y_{t+h}}{\partial \varepsilon_t} \quad \text{Eqn 8}$$

where h denotes the forecast horizon. The study uses the Cholesky decomposition to identify contemporaneous shocks, with the ordering: $TERDR, DPT, MEAS, LEX, INF$.

Forecast Error Variance Decomposition

$$\theta_{ij}(H) = \frac{\sum_{h=0}^{H-1}(\text{response of } i \text{ to shock } j)^2}{\sum_{h=0}^{H-1}(\text{total forecast-error variance of } i)} \times 100 \quad \text{Eqn 9}$$

ESTIMATION AND INTERPRETATION OF RESULT

Descriptive Statistics of Variables

	TERDR	MEAS	DPT	LEX	INF
Mean	0.114199	44.47222	44.72222	49.89058	18.82521
Median	0.031862	45.00000	46.50000	50.56450	13.12650
Maximum	0.383546	60.00000	68.00000	55.04000	72.83550
Minimum	0.000000	19.00000	12.00000	45.48300	5.386104
Std. Dev.	0.130276	12.26490	17.32152	3.128685	15.65736
Skewness	0.682961	-0.545702	-0.234611	-0.086419	2.071592
Kurtosis	1.873352	2.222147	1.622798	1.624460	6.588908
Jarque-Bera	4.702614	2.694328	3.175282	2.882976	45.06935
Probability	0.095245	0.259977	0.204407	0.236576	0.000000
Observations	36	36	36	36	36

Authors Computation 2026, Using EViews 10

The descriptive statistics for 1990-2025 (36 observations) reveal variations across the five variables. TERDR averaged 0.1142 deaths per 100,000 population (SD = 0.1303), while MEAS and DPT coverage averaged 44.47% and 44.72%, respectively. LEX recorded a mean of 49.89 years (SD = 3.13), whereas INF averaged 18.83% (SD = 15.66%), ranging from 5.39% to 72.84%. The Jarque-Bera results indicate that TERDR, MEAS, DPT and LEX are normally distributed at the 5% significance level, while INF significantly departs from normality (p = 0.0000).

Unit Root Test

ADF Unit Root Test Result

ADF At Level

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		TERDR	DPT	MEAS	LEX	INF
With Constant	t-Statistic	-0.6673	-0.8455	-0.8269	-0.2390	-2.8298
	Prob.	0.8550	0.8054	0.8111	0.9337	0.0541
		n0	n0			n0
With Constant & Trend	t-Statistic	-1.8976	-2.9840	-3.8599	-5.2160	-4.7271
	Prob.	0.6559	0.1366	0.0138	0.0001	0.0006
		n0	n0	*	*	n0
ADF At First Difference						
		D(TERDR)	D(DPT)	D(MEAS)	D(LEX)	D(INF)
With Constant	t-Statistic	-8.8289	-4.8562	-3.7758	-3.6206	-4.8124
	Prob.	0.0000	0.0000	0.0032	0.0054	0.0001
		*		*	*	*
With Constant & Trend	t-Statistic	-8.7265	-4.7765	-3.6856	-3.4769	-9.6274
	Prob.	0.0000	0.0005	0.0233	0.0419	0.0000
		*		*	*	*

Source: Authors Computation 2026, Using EViews 10

The ADF results indicate that all five variables are non-stationary at level under the constant specification but become stationary after first differencing. Although MEAS, LEX and INF are stationary at level under the constant-and-trend specification, the consistent constant specification establishes that TERDR, DPT, MEAS, LEX and INF are all integrated of order one, I (1). This supports the application of the Johansen cointegration test to examine their long-run relationships.

PP Unit Root Test Result

PP At Level						
		TERDR	DPT	MEAS	LEX	INF
With Constant	t-Statistic	-0.992326	-1.005360	-1.810177	0.519678	-2.757189
	Prob.	0.7452	0.7406	0.3696	0.9850	0.2217
		n0	n0			n0
With Constant & Trend	t-Statistic	-2.836948	-2.271460	-2.334381	-2.446196	-1.2981
	Prob.	0.1944	0.4376	0.4056	0.3511	0.8697
		n0	n0	*	*	n0
At First Difference						
		D(TERDR)	D(DPT)	D(MEAS)	D(LEX)	D(INF)
With Constant	t-Statistic	-8.700405	-4.860581	-4.674870	-3.608484	-4.798755

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	Prob.	0.0000 *	0.0004	0.0006 *	0.0108 *	0.0005 *
With Constant & Trend	t-Statistic	-8.602904	-3.4874	-4.672676	-3.459800	-4.721832
	Prob.	0.0000 *	0.0027 *	0.0035 *	0.0602 *	0.0031 *

Authors computation 2026, Using EViews 10

The PP test confirms that all five variables are non-stationary at level but become stationary after first differencing under the constant specification. Thus, TERDR, DPT, MEAS, LEX and INF are integrated of order one, I (1). This finding is consistent with the ADF results and justifies proceeding with the Johansen cointegration test.

Objective 1: To examine the long-run relationship between terrorism shocks, preventive healthcare, population health and inflation in Nigeria.

Cointegration Rank Test (Trace)

Hypothesize		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.798815	114.0902	69.81889	0.0000
At most 1 *	0.634740	59.57026	47.85613	0.0027
At most 2	0.338455	25.32729	29.79707	0.1501
At most 3	0.275230	11.27927	15.49471	0.1949
At most 4	0.009794	0.334648	3.841466	0.5629

Cointegration Rank Test (Maximum Eigenvalue)

Hypothesize		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.798815	54.51996	33.87687	0.0001
At most 1 *	0.634740	34.24297	27.58434	0.0060
At most 2	0.338455	14.04802	21.13162	0.3611
At most 3	0.275230	10.94462	14.26460	0.1570
At most 4	0.009794	0.334648	3.841466	0.5629

Source Authors Computation 2026, Using EViews 10

The Johansen Trace test rejects the null hypothesis of no cointegrating relationship because the trace statistic of 114.0902 is greater than the 5% critical value of 69.8189 with a probability of 0.0000. The hypothesis of at most one cointegrating equation is also rejected, as the trace statistic of 59.5703 exceeds the critical value of 47.8561 (p = 0.0027). However, the null hypothesis of at most two cointegrating equations cannot be rejected because the statistic of 25.3273 is below the critical value of 29.7971 (p = 0.1501). The Maximum Eigenvalue test confirms this conclusion, rejecting both the hypotheses of no cointegration (54.5200 > 33.8769; p=0.0001) and at most one cointegrating relationship (34.2430 > 27.5843; p=0.0060), while failing to reject at most two

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(14.0480 < 21.1316; p=0.3611). Therefore, both Johansen tests consistently establish two cointegrating relationships among TERDR, MEAS, DPT, LEX and INF at the 5% level.

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-391.9318	NA	9505.540	23.34893	23.57340	23.42548
1	-234.8448	258.7316	4.089360	15.57911	16.92589*	16.03840
2	-194.4876	54.60086*	1.834744*	14.67574*	17.14486	15.51778*

Source: Authors Computation 2026, Using EViews 10

The VAR lag-order selection results indicate that lag 2 is the optimal lag length, as selected by the LR, FPE, AIC, and HQ criteria, while the SC criterion selects lag 1. Since the majority of the criteria favour lag 2, the study adopts an underlying VAR (2) specification. Accordingly, the subsequent VECM is specified with a lag interval of 1-1 in first differences, providing a parsimonious representation of the dynamic relationships among TERDR, MEAS, DPT, LEX, and INF

VECM ANALYSIS

Long-run Vector Error Correction Estimate

Cointegrating Eq:	CointEq1	CointEq2
DPT(-1)	1.000000	0.000000
TERDR(-1)	0.000000	1.000000
MEAS(-1)	-1.561569	0.008123
	(0.07535)	(0.00125)
	[-20.7249]	[6.47554]
LEX(-1)	0.216859	-0.062255
	(0.27648)	(0.00460)
	[0.78436]	[-13.5245]
INF(-1)	0.017990	0.002204
	(0.03713)	(0.00062)
	[0.48451]	[3.56580]
C	14.66216	2.585102

Source: Authors Computation 2026, Using EViews 10

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The long-run VECM estimates identify two cointegrating relationships among the variables. In the first equation (CointEq1), MEAS has a negative and statistically significant coefficient (−1.5616; t = −20.7249), indicating a strong long-run association with DPT, while LEX and INF are insignificant. In the second equation (CointEq2), MEAS (0.0081; t = 6.4755), LEX (−0.0623; t = −13.5245) and INF (0.0022; t = 3.5658) are statistically significant in the long-run relationship with TERDR. Overall, the results suggest that the long-run equilibrium dynamics are characterized by significant relationships between the immunization indicators and between terrorism mortality, measles coverage, life expectancy and inflation.

Objective 2: To determine the short-run dynamic interactions among terrorism shocks, preventive healthcare, population health and inflation in Nigeria.

Shot-run Vector Error Correction Estimate

Error Correction:	D(DPT)	D(TERDR)	D(MEAS)	D(LEX)	D(INF)
CointEq1	0.241188	-0.006229	1.071769	-2.72E-05	1.835569
	(0.44198)	(0.00381)	(0.24153)	(0.01174)	(0.46071)
	[0.54570]	[-1.63584]	[4.43750]	[-0.00231]	[3.98423]
CointEq2	66.51954	-1.261071	88.43940	-1.035800	8.512191
	(37.5001)	(0.32310)	(20.4923)	(0.99602)	(39.0889)
	[1.77385]	[-3.90305]	[4.31574]	[-1.03994]	[0.21776]

Source: Authors Computation 2026, Using EViews 10

The short-run VECM results show that the adjustment toward the two long-run equilibrium relationships differs across the variables. For CointEq1, the adjustment coefficients for DPT (0.241188; t = 0.54570) and TERDR (−0.006229; t = −1.63584) are statistically insignificant, while MEAS (1.071769; t = 4.43750) and INF (1.835569; t = 3.98423) significantly respond to deviations from the first long-run equilibrium. LEX has a very small and insignificant coefficient of −0.0000272 (t = −0.00231). For CointEq2, TERDR has a significant negative adjustment coefficient of −1.261071 (t = −3.90305), while MEAS has a significant positive coefficient of 88.43940 (t = 4.31574). DPT (66.51954; t = 1.77385), LEX (−1.035800; t = −1.03994), and INF (8.512191; t = 0.21776) are statistically insignificant.

VEC Granger Causality/Block Exogeneity Wald Tests

Dependent variable: D(TERDR)			
Excluded	Chi-sq	Df	Prob.
D(DPT)	5.967280	2	0.0506
D(MEAS)	0.133506	2	0.9354
D(LEX)	11.42530	2	0.0033
D(INF)	0.620227	2	0.7334
All	16.21577	8	0.0394
Dependent variable: D(DPT)			
Excluded	Chi-sq	Df	Prob.

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D(TERDR)	4.338535	2	0.1143
D(MEAS)	0.133858	2	0.9353
D(LEX)	5.084144	2	0.0787
D(INF)	0.750477	2	0.6871
All	9.314969	8	0.3164
Dependent variable: D(MEAS)			
Excluded	Chi-sq	Df	Prob.
D(TERDR)	12.95995	2	0.0015
D(DPT)	10.05163	2	0.0066
D(LEX)	14.60433	2	0.0007
D(INF)	3.121889	2	0.2099
All	27.70147	8	0.0005
Dependent variable: D(LEX)			
Excluded	Chi-sq	Df	Prob.
D(TERDR)	0.044293	2	0.9781
D(DPT)	1.240134	2	0.5379
D(MEAS)	0.463809	2	0.7930
D(INF)	0.200322	2	0.9047
All	3.486123	8	0.9003
Dependent variable: D(INF)			
Excluded	Chi-sq	Df	Prob.
D(TERDR)	3.074504	2	0.2150
D(DPT)	32.13851	2	0.0000
D(MEAS)	30.55116	2	0.0000
D(LEX)	0.120650	2	0.9415
All	49.92290	8	0.0000

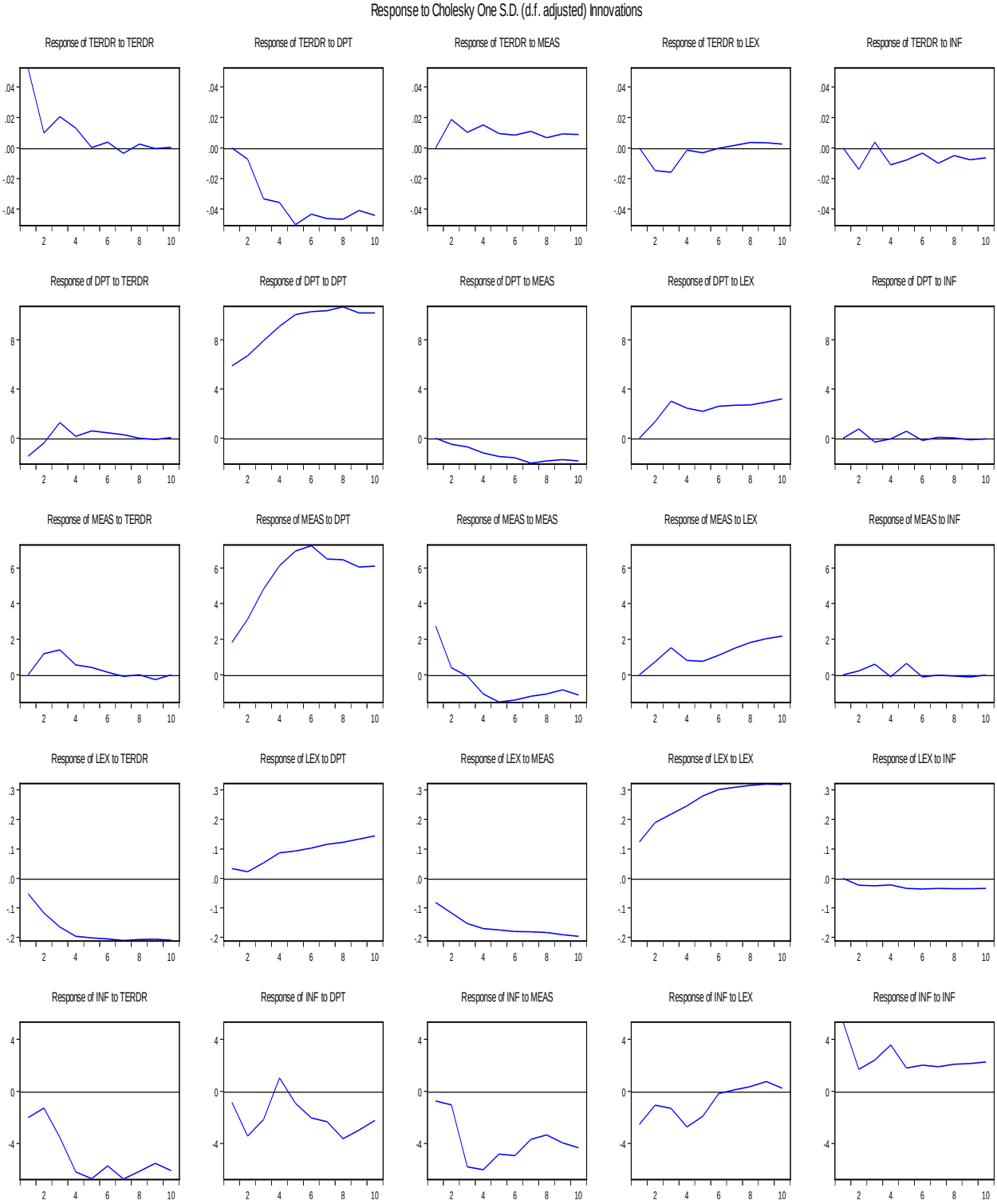
Source: Authors Computation 2026, Using EViews 10

The VECM Granger causality results reveal significant short-run predictive relationships. LEX significantly predicts TERDR ($p = 0.0033$), while DPT is marginally significant ($p = 0.0506$); the joint test is also significant ($p = 0.0394$). TERDR, DPT and LEX significantly predict MEAS, with a joint probability of 0.0005. Similarly, DPT and MEAS significantly predict INF ($p < 0.001$). However, the joint tests for DPT and LEX equations are insignificant ($p = 0.3164$ and $p = 0.9003$, respectively). Overall, the findings highlight important short-run predictive linkages among terrorism mortality, immunization coverage, life expectancy and inflation.

Objective 3: To assess the responses and relative contributions of terrorism and health-economic shocks to the Nigerian health system.

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IMPULSE RESPONSE FUNCTION ESTIMATES- CHOLESKY INNOVATIONS



The 10-period IRFs reveal dynamic interactions among the variables. TERDR shocks generally produce negative responses in DPT and LEX, but positive responses in MEAS. DPT and MEAS shocks generate positive responses in DPT and LEX, while reducing MEAS. LEX shocks negatively affect TERDR, MEAS and INF but positively influence DPT. INF shocks produce negative responses in TERDR, MEAS and initially LEX, while its own response remains positive. Most responses gradually converge towards equilibrium. However, without confidence bands, these patterns should not be interpreted as statistically significant effects.

FORECAST ERROR VARIANCE DECOMPOSITION

Variance Decomposition of TERDR

Period	S.E.	TERDR	DPT	MEAS	LEX	INF
1	0.052057	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.060155	77.52419	1.489601	9.590650	6.008165	5.387398
3	0.074296	58.48990	20.99094	8.203639	8.529227	3.786290
4	0.085540	46.44681	33.24844	9.301956	6.458954	4.543839
5	0.100062	33.94405	49.61058	7.688980	4.814705	3.941685
6	0.109456	28.48555	57.10568	7.001913	4.023853	3.383001
7	0.119843	23.85222	62.55889	6.675164	3.377022	3.536702
8	0.128944	20.64113	67.11322	6.045879	2.991895	3.207877
9	0.135858	18.59460	69.52844	5.904812	2.759311	3.212836
10	0.143294	16.71524	71.98686	5.692565	2.509284	3.096051

Variance Decomposition of DPT

Period	S.E.	TERDR	DPT	MEAS	LEX	INF
1	6.041915	5.817839	94.18216	0.000000	0.000000	0.000000
2	9.162575	2.725444	94.16707	0.296976	2.168490	0.642023
3	12.55658	2.452828	89.80915	0.472264	6.861754	0.404007
4	15.72837	1.571029	90.53821	0.881354	6.750403	0.259000
5	18.86399	1.186649	91.30844	1.232725	6.005831	0.266357
6	21.70454	0.934799	91.41863	1.477729	5.958790	0.210055
7	24.27986	0.759769	91.21325	1.895490	5.962756	0.168740
8	26.71437	0.627685	91.24570	2.043786	5.943442	0.139387
9	28.78993	0.542121	91.06914	2.125617	6.140656	0.122466
10	30.75829	0.475088	90.74033	2.224779	6.451905	0.107895

Variance Decomposition of MEAS

Period	S.E.	TERDR	DPT	MEAS	LEX	INF
1	3.301659	0.000431	30.50196	69.49761	0.000000	0.000000
2	4.781446	6.297005	57.22327	33.87510	2.371934	0.232690

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3	7.124679	6.756071	71.41788	15.26501	5.743596	0.817447
4	9.505440	4.147816	81.60163	9.829255	3.950187	0.471117
5	11.91329	2.767029	85.86144	7.855757	2.919046	0.596727
6	14.06590	1.996063	88.22311	6.647543	2.698302	0.434979
7	15.61191	1.623546	88.94306	5.976939	3.103300	0.353159
8	17.02544	1.365194	89.15542	5.420408	3.760406	0.298574
9	18.20197	1.215094	89.02575	4.953939	4.540070	0.265150
10	19.35220	1.074960	88.70109	4.714653	5.274707	0.234592

Variance Decomposition of LEX

Period	S.E.	TERDR	DPT	MEAS	LEX	INF
1	0.160476	10.81177	4.264925	25.95873	58.96457	0.000000
2	0.300718	18.39506	1.788384	22.65903	56.57131	0.586218
3	0.438615	22.79393	2.284865	22.92264	51.38614	0.612424
4	0.573666	25.14772	3.588944	22.25387	48.50230	0.507170
5	0.699005	25.33543	4.173781	21.25234	48.66395	0.574501
6	0.816190	24.91987	4.657857	20.48575	49.31965	0.616867
7	0.923744	24.63742	5.214947	19.83833	49.69674	0.612569
8	1.022884	24.20248	5.692554	19.41560	50.07606	0.613312
9	1.116767	23.70556	6.203588	19.23698	50.24318	0.610695
10	1.205602	23.36326	6.752267	19.15644	50.12596	0.602074

Variance Decomposition of INF

Period	S.E.	TERDR	DPT	MEAS	LEX	INF
1	6.297893	10.11486	1.700653	1.296832	16.04255	70.84510
2	7.621998	9.727358	21.38672	2.697123	12.86727	53.32153
3	10.78642	15.58956	14.63328	30.22898	7.874991	31.67319
4	14.55295	26.59792	8.547167	33.63559	7.786698	23.43262
5	16.95950	35.22739	6.578701	32.80109	7.000747	18.39207
6	18.78705	37.96781	6.538479	33.64420	5.711618	16.13790
7	20.50661	42.57575	6.781482	31.45205	4.797436	14.39328
8	22.06423	44.47690	8.550868	29.46469	4.172342	13.33520
9	23.38691	45.17120	9.228924	29.07071	3.824322	12.70485
10	24.75518	46.34482	9.051071	29.00083	3.424151	12.17912

Source: Authors Computation 2026, Using EViews 10

The FEVD results, based on the Cholesky ordering TERDR, DPT, MEAS, LEX and INF, reveal increasing dynamic interdependence over the 10-period horizon. For TERDR, its own contribution

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declines from 100% to 16.72%, while DPT increases to 71.99%, becoming the dominant source of forecast variation. For DPT, own shocks remain dominant at 90.74% in period 10.

Similarly, DPT shocks explain 88.70% of MEAS variation by period 10, while its own contribution declines to 4.71%. For LEX, own shocks account for 50.13%, followed by TERDR (23.36%) and MEAS (19.16%). Regarding INF, its own contribution falls to 12.18%, while TERDR and MEAS explain 46.34% and 29.00%, respectively.

VEC Residual Serial Correlation LM Tests

Null Hypothesis: No Serial Correlation at lag h						
Lag	LRE* stat	Df	Prob.	Rao F-stat	Df	Prob.
1	30.97090	25	0.1900	1.316843	(25, 42.4)	0.2105
2	22.85002	25	0.5863	0.895395	(25, 42.4)	0.6084
Null Hypothesis: No Serial Correlation at lag 1 to h						
Lag	LRE* stat	Df	Prob.	Rao F-stat	Df	Prob.
1	30.97090	25	0.1900	1.316843	(25, 42.4)	0.2105
2	69.07038	50	0.0382	1.556505	(50, 30.7)	0.0964

Source: Authors Computation 2026, Using EViews 10

The VECM serial-correlation test shows: At lag 1, the LRE statistic is 30.97090 (p = 0.1900) and the Rao F-statistic is 1.316843 (p = 0.2105). At lag 2, the LRE statistic is 22.85002 (p = 0.5863) and the Rao F-statistic is 0.895395 (p = 0.6084). Since these probabilities are above 0.05, the null hypothesis of no serial correlation is not rejected at either lag. Although the cumulative LRE test for lags 1-2 gives p = 0.0382, the corresponding Rao F-test gives p = 0.0964, which is above the 5% significance level. Given the small effective sample of 33 observations, the evidence does not provide sufficient grounds to conclude that the residuals suffer from serial correlation.

VEC Residual Heteroskedasticity Test (Level & Squares)

Joint test:

Chi-sq	Df	Prob.
355.0341	360	0.5640

Source: Authors Computation 2026, Using EViews 10

The VEC residual heteroskedasticity test indicates that the model does not suffer from heteroskedasticity. The joint test reports a Chi-square statistic of 355.0341, with 360 degrees of freedom and a probability value of 0.5640. Since p = 0.5640 > 0.05, the null hypothesis of homoskedastic residuals cannot be rejected. This suggests that the residual variance is stable across the observations, supporting the reliability of the VECM estimates.

VEC Residual Normality Test

Component	Jarque-Bera	Df	Prob.
1	2.631823	2	0.2682
2	1.115776	2	0.5724
3	0.340545	2	0.8434

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4	0.438371	2	0.8032
5	0.577639	2	0.7491
Joint	5.104154	10	0.8841

Source: Authors Computation 2026, Using EViews 10

The VEC Residual Normality Test indicates that the residuals of the model are normally distributed. The individual components have probability values of 0.2682, 0.5724, 0.8434, 0.8032 and 0.7491, all greater than 0.05. More importantly, the joint Jarque-Bera statistic is 5.104154 with 10 degrees of freedom and a probability of 0.8841. Since p = 0.8841 > 0.05, the null hypothesis of normal residuals is not rejected. Therefore, there is no evidence of residual non-normality, indicating that the VECM satisfies the normality diagnostic.

Stability/ Roots Test

Roots Characteristics Polynomial

Root	Modulus
1.000000	1.000000
1.000000	1.000000
1.000000	1.000000
0.557029 - 0.574181i	0.799978
0.557029 + 0.574181i	0.799978
-0.645932 - 0.427273i	0.774461
-0.645932 + 0.427273i	0.774461
0.717025	0.717025
-0.711385	0.711385
0.574024 - 0.341323i	0.667836
0.574024 + 0.341323i	0.667836
-0.235206 - 0.598745i	0.643286
-0.235206 + 0.598745i	0.643286
-0.243584 - 0.525062i	0.578812
-0.243584 + 0.525062i	0.578812

Source: Authors Computation 2026, EViews 10

VECM Stability Test: The stability properties of the estimated Vector Error Correction Model were examined using the roots of the characteristic polynomial. The results indicate that the model imposes three-unit roots, which is consistent with a five-variable VECM containing two cointegrating relationships. All remaining characteristic roots have moduli strictly below unity, with the largest non-unit modulus being 0.799978. Consequently, the estimated VECM satisfies the required stability condition for its stationary dynamic components. This result supports the

reliability of the impulse response functions and forecasts error variance decomposition derived from the model.

Discussion of Findings

This study examined the dynamic relationship between terrorism, preventive healthcare, population health and macroeconomic conditions in Nigeria from 1990 to 2025 using the VECM framework. The ADF and PP tests confirmed that all variables were integrated of order one, while the Johansen test established two cointegrating relationships, indicating long-run equilibrium associations among the variables.

The long-run results showed positive and significant relationships for DPT immunization, while MEAS and LEX exhibited negative and significant coefficients. Inflation was positive but insignificant. Short-run results revealed significant interactions between life expectancy and terrorism mortality. Block-exogeneity tests further established that LEX predicts TERDR, while TERDR, DPT and LEX jointly predict MEAS. DPT and MEAS also provide significant predictive information for inflation.

The impulse response functions indicated that terrorism shocks generate persistent responses across selected health indicators, while immunization shocks influence life expectancy and macroeconomic variables. Similarly, FEVD results showed that DPT explained approximately 80% of the variation in MEAS, while MEAS accounted for approximately 30-35% of the variation in LEX and 65-70% of the variation in inflation in later forecast periods.

The findings establish that terrorism, preventive healthcare, population health and macroeconomic conditions are dynamically interconnected in Nigeria. They highlight the importance of strengthening healthcare delivery during insecurity, sustaining immunization programmes and protecting preventive healthcare financing against security and economic disruptions.

Conclusion

This study examined the dynamic relationship between terrorism shocks, preventive healthcare, population health and macroeconomic conditions in Nigeria from 1990 to 2025 using cointegration and VECM techniques. The findings established two long-run cointegrating relationships and significant short-run interactions among terrorism mortality (TERDR), DPT immunization, measles immunization (MEAS), life expectancy (LEX) and inflation (INF).

The results demonstrate that terrorism extends beyond a security and mortality challenge to constitute a broader health-economic shock, with persistent implications for preventive healthcare and population health. The impulse response and FEVD findings further highlight the significant role of immunization in transmitting shocks across the health-economic system.

Therefore, the study concludes that strengthening Nigeria's health-system resilience requires integrating security considerations into preventive healthcare delivery, sustaining immunization programmes and protecting healthcare services against insecurity and macroeconomic disruptions. Maintaining preventive healthcare during periods of insecurity is therefore essential for safeguarding population health and long-term human capital development.

Recommendations

i. **Integrate preventive healthcare into security planning:** Federal and state governments should incorporate childhood immunization and other essential preventive services into emergency and security plans, particularly in conflict-affected communities.

ii. **Strengthen health-system resilience:** Investment in mobile vaccination teams, resilient health facilities, cold-chain infrastructure and community health personnel should be prioritized to sustain healthcare delivery during insecurity.

iii. **Incorporate security-risk assessment into immunization programmes:** Health authorities should identify vulnerable communities and develop alternative vaccination schedules, supply routes and service-delivery arrangements to minimize disruptions.

iv. **Protect preventive healthcare financing:** Government should ensure predictable funding for vaccines, transportation, healthcare personnel and essential preventive services, particularly during periods of inflation and economic instability.

v. **Prioritize population health in counterterrorism responses:** Security interventions should be complemented by measures that maintain access to immunization, maternal and child healthcare and other essential health services in affected communities.

vi. **Establish an integrated health-security monitoring framework:** Relevant authorities should jointly monitor terrorism mortality, immunization coverage, life expectancy and inflation to identify emerging threats and strengthen health-system preparedness.

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