Human Capital Development and Healthcare Outcomes in Nigeria

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ABSTRACT

Life expectancy induces uncertainty and health is wealth stock of a nation (NHIS 2025). Human capital consists of the knowledge, skills, and health that people accumulate throughout their lives, enabling them to realize their potentials as productive members of the society. Nigeria continues to struggle with inadequate infrastructure and poor healthcare financing resulting in medical professional migration abroad which depletes stock of healthcare value despite budgetary health provisions. The study uses the ARDL model of estimation with data covering the period, 1994-2024 to determine the health outcomes measured by life expectancy in Nigeria. The result of the estimation reveals that health outcomes have positive relationship with past value of life expectance, Current Healthcare Expenditure, citizens welfare and Urbanization. The study thus stresses the need for government to double policy strategy on preventive healthcare framework with improved efficiency.

Keywords: Life Expectancy, Healthcare Expenditure, Urbanization, Gross Domestic Product Per Capita.

JEL Classification: O15, O44, H51.

INTRODUCTION

Human capital consists of the knowledge, skills, and health that people accumulate throughout their lives, enabling them to realize their potentials as productive members of the society. We can end extreme poverty and create more inclusive societies by developing human capital. This requires investing in people through nutrition, health care, quality education, jobs and skills (World Bank, 2023). The cost of inaction on human capital development is increasing. Without human capital, countries cannot sustain economic growth and compete effectively in the global economy.

The world development indicators of the World Bank estimated Nigerian population to be about 250 million people as at 2023. This places Nigeria as the most populous black nation and the seventh largest nation in the world, (World Bank, 2025). One of the necessities for such a large population is the need for building human capital through sustainable healthcare system to enhance socioeconomic development of the nation. The significance of the health sector in the development of any nation is recognized in Article 3 of the United Nations 17 Sustainable Development Goals which is a key policy target for all economies of the world. According to the Article, all countries are to work towards ensuring healthy living and well-being for all members of the society. This global framework thus, provide the basis for countries of the world to adopt policies to achieve the overall goal and contribute to a healthy world. (United Nations, 2025).

Health promotion includes, education, communication, organizational changes, community development, fiscal measures, legislation, and local actions leading to healthy public policy for health improvement of the population based on the model of human ecosystem (Hancock and Perkin 2023).

The historical analysis of the Nigerian health sector can be in four different eras - the precolonial era, the colonial era, post-independence era, and the modern day. The precolonial era was characterized by traditional medicine and local health practitioners such as herbalists, divine healers, soothsayers, midwives, and bone settlers. These traditional health systems were practiced on a localized bases and due to the small population of most towns and villages. The health system was sustainable in terms of availability, however, the health practitioners then had little or no education which limited the extent they could provide solutions to health

challenges. The period was also characterized heavily by deep-rooted cultural beliefs and spirituality thus, the traditional health system was largely indigenous. The colonial era came with civilization in the health system. The emergence of colonial rulers and the early missionaries led to the introduction of western medicine and modern health practices in Nigeria. Through the church missionaries, the first organized health services were established with the first health structure notably a dispensary built by the Church Missionary Society in 1880. However, these facilities did not attend to the health needs of the general populace and thus, there was the need for government to establish health centers to cater for the general healthcare need of the public. The post-independence era saw the Nigerian health sector improve drastically with the government now more involved to resolve the dual structure of the health system created by medical schools built for the elite in the urban population. While a major proportion of the population has little or no access to health care. This era was characterized by huge government investment into the health sector to provide the needed infrastructure to expand and improve the healthcare system. The post-independence era featured the first five national development plans of Nigeria and each of these plans contributed to the development of the health sector. While the first three developmental plans (1962-1968, 1970-1975, and 1975-1980) which focused on improving the existing structures and facilities of the current health system. The fourth national development plan (1981-1985) led by Late President Shehu Shagari laid a landmark in the health sector through the introduction of the Basic Health Service Scheme (BHSS) which further led to the establishment of the 3 tiers of health care structures: the Comprehensive Health Centres, the Primary Health Centres, and the Health Clinics. These structures created a policy of shared responsibility for the health sector between the federal, state, and local governments. The fourth development plan built on the structure of the former to introduce the National Directorate of Health Planning as the centralized authority for health-related affairs. The Department of Health Planning Research and Statistics (DHPRS) is currently responsible for National Health Policy in Nigeria.

Healthcare Quality is foundational to achieving the goals of healthcare system worldwide: improving population health, enhancing patient experiences and controlling costs. But Nigeria continues to struggle with inadequate infrastructure and poor healthcare financing resulting in medical professional migration abroad which depletes stock of healthcare value despite health budgetary provisions.

Under the foregoing scenario, this paper seeks to examine the impact of human capital development on healthcare outcomes in Nigeria. Following the introductory section, section 2 clarifies some conceptual and theoretical issues that relate to the study. Section 3 reviews the related literature while section 4 presents the theoretical framework and research methodology. Section 5 discusses the empirical results and section 6 presents the concluding remarks.

Conceptual /Theoretical Issues

Health outcome is defined as event occurring due to health intervention (Oleske & Islam, 2019). This may be measured clinically (physical examination, laboratory testing, imaging), self-reported or observed (such as gait or movement fluctuations seen by a healthcare provider or caregiver). Some health outcomes require complex assessments to determine if they are present or absent.

Human life expectancy is a statistical measure of the estimate of the average remaining years of life at a given age. The most commonly used measure is life expectancy at birth (LEB). This can be defined in two ways. Cohort LEB is the mean length of life of a birth cohort (in this case, all individuals born in a given year) and can be computed only for cohorts born so long ago that all their members have died. Period LEB is the mean length of life of a hypothetical cohort assumed to be exposed, from birth through death, to the mortality rates observed at a given year. National LEB figures reported by national agencies and international organizations for human populations are estimates of period LEB.

Grossman Theory of Healthcare Demand

The Grossman model or theory of health demand is a model for studying the demand for health and medical care outlined by Michael Grossman in (1972). The model based the demand for medical care on the interaction between a demand function for health and a production function for health. In this theory, health is durable

capital good which is inherited and depreciates over time. Investment in health takes the form of medical care purchases and other inputs and depreciation is interpreted as natural deterioration of health over time. The model creates a dynamic system of equations which can be an optimization problem where utility is optimized over gross investment in health in each period, consumption of medical care, and time inputs in the gross investment function in each period. In this way, the length of life of the agent is partially endogenous to the model. Dynamic optimization problems are often optimized using comparative statics, setting partial derivatives of the outcome function of interest, in this case the utility function, equal to zero. Theoretical expansions of the Grossman model was extended in a number of directions and among the first to this includes, uncertainty in the model by Charles Phelps and Maureen Cropper. The relationship between education and health was expanded in the model by Isaac Ehrlich. Regarding the relationship between education and medical care demand, one important question is whether the marginal efficiency of capital elasticity with respect to education is less than or greater than one. If the curve is elastic (elasticity greater than one), education will increase medical care demand. On the other hand, if the curve is inelastic, education will decrease medical care demand.

Theories of Human Capital

The value of human capital theory is widely accepted in order to increase organizational performance, so an organization relies on employees' skill, knowledge and ability as a key concept of value creation. Adam Smith (1973) initiated an improvement in human capability that is to production, then a term of human capital was introduced by Theodore W. Schultz (1961) published in the American Economic Review, called investment in human capital. Human capital widely used after Gary Backer won the novel prizes which initiated "human capital theory" and stated that a different level of education and training contributes to a different level of wages and salaries, the more knowledge, skill and ability, the more likely to get a better job (Blair, 2012). According to Gary Backer (1964), human capital is a physical means of production. Organizations invest in human capital via education, training, and health.

Thomas Davenport (1999) advanced that the component of human capital consisted of abilities, knowledge, skill, personal talent, behavior, and effort, when those three components plus time, he extended that, knowledge included IQ, intelligence, specific and general knowledge to work. Skill is expertise used in working, including the physical body, and movement of the job. Talent is a personal characteristic which is innate and can be improved by development. Behavior is an expression and observable behavior, norm, ethics and personal belief. Effort is when people try to use their innate or personal resources including their talent, experience, knowledge and ability to work to be successful.

According to Becker (1964), human capital can be accumulated in different forms of education, training, migration, and health. Through such forms, employees gain knowledge, skills and abilities in different ways. Firms invest in human capital because these firm view humans as an asset and expect that what the firm has invested will be returned and provide a positive value in the future. In other words, infrastructural provision on education and healthcare plays a vital role in developing human capital, boosting productivity and innovation.

Lifespan Theories of Cognitive Development

Lifespan theories of cognitive development (LTCD) provide an integrative framework for the description, explanation, and optimization of cognitive development across different functional domains and age periods. Generally, LTCD make two central assumptions: (a) cognitive development reflects the operation of two components, one biological and the other cultural; (b) during development, the biological component is invested into various cultural domains, thereby leading to the acquisition of culturally transmitted bodies of knowledge. Based on the general lifespan dynamics between biology and culture, the biological component is expected to decline after maturity. In contrast, the cultural component is expected to increase with age as long as knowledge maintenance and knowledge acquisition outweigh age-based losses in biological potential. This prediction of multi-directionality in lifespan trajectories has gained ample empirical support.

REVIEW OF RELATED LITERATURE

Vast literature exists on the subject but a brief review would be undertaken. For instance, Albert (2021) investigated the impact of health status and human capital formation on regional performance using various measures of population health status, controlling for potential endogeneity between health and growth, employing instrumental variable regressions and dynamic panel data. He found a positive effect of a change in health status on regional output and a negative effect of proxy variables for health limitations on regional performance. This corroborates the importance of investing in health along with education with the aim of improving not only the well-being of individuals but the human capital and growth of a region.

Kelani et al., (2019) examined the role of health status and labour productivity on economic growth in Nigeria. The study employed annual time series data, covering the period, 1981-2017 and adopted the ARDL bound test along with co-integration test, and found that both health status and labour productivity impact growth positively. Thus, the study suggested the need for a well-developed health system and increased funding of the educational sector to improve labour productivity.

Ejedegba, Olele and Omotor (2017) examined the effect of human capital formation on economic growth process in Nigeria, using data covering the period 1970 to 2004 and employed the ARDL model to test for cointegration relationship. The study found a positive relationship between human capital indicators and economic growth and thus stresses the need for a conscious effort of government to adequately invest in health and education and also to establish more labour-intensive industries in Nigeria.

Akpata, J. U. and Ejedegba, R. U. (2024) employed data ranging from 1981to 2022 for Nigeria to examine the effects of human capital formation and aggregate domestic investment on economic growth and development. It explores the variables of expenditure on health, education and household welfare; domestic investment and economic growth. In the study, it ws found that education and health human capital positively relate with economic growth and household welfare. The study, therefore, stresses the need for improvement in the indicators of human capital formation for a sustained economic growth and development in Nigeria.

Linhartová (2020) in a study, investigates whether human capital development expenditure can promote human development in the Czech Republic with data spanning, 1995 to 2018.

Liljestrand et al., (2018), analysed the effect of quality health systems in the attainment of SDG's amongst low-income and middle-income countries. They found that high-quality health systems are a global need for all countries and will contribute significantly towards the development of the nations. Popp et al., (2012), employed the panel co-integration test in assessing the long-term impact of using population and food security on the health status of developing countries. The result reveals that the rising population has a negative impact on health status in developing nations due to the high rate of poverty and unemployment.

Akinwale et al., (2014), explored the public health status of Lagos metropolis and most industrial States of Nigeria. The study employed primary data covering 2,434 households and concluded that even in the urban region of the Nigerian state, there are various health challenges such as poor drainage and waste disposal system, natural climate disaster i.e., flooding, overpopulation, the outbreak of perennial diseases such as malaria, diarrhea, and so on, and poor house planning.

Vu (2022) in his study postulated that life expectancy augments incentives for human capital accumulation. Albert (2021) study shows a positive effect of a change in health status on regional output and a negative effect of proxy variables for health limitations. This corroborates the importance of investing in health and education with the aim of improving not only the well-being of individuals but the human capital.

Collectively, the empirical review of the health status and outcomes in developing nations, Nigeria included, justified the need for a revisit of the evidence.

THEORETICAL FRAMEWORK AND RESEARCH METHODOLOGY

Theoretical Framework

The purchasing power created by individuals acting on the motive of benefit maximization in terms of factor income over the expected lifetime constitutes the main constraint of the benefit function (Kök et al. 2018: 2-4). In this model, health is a durable capital good which is inherited and depreciates over time. Investment in health takes the form of medical care purchases and other inputs and depreciation is interpreted as natural deterioration of health over time. Therefore, in order to maintain health, individuals should maximize their expected life expectancy over a certain rate of depreciation (discount) over time. In this context, each individual wants to maximize the utility index over the basket of goods he or she consumes during his or her lifetime.

$$\mathbf{U}=U(\mathbf{q_{11}}\ldots, q_{nT}) + \lambda\sum_{t=1}^{T}\left(\mathbf{yt} - \sum_{j=1}^{n}\mathbf{pjtqjt}\right)(\mathbf{1} + \boldsymbol{\varepsilon}\mathbf{1t})^{-1} \text{ - (1)}$$

In equation 1, U refers to the utility index, $(q_{11}, \ldots, q_{nT})$ is manufactured consumer goods, λ common utility, which equates the rate of substitution between each pair of goods in two periods, y_t income constraint that each individual provides depending on the choice between free time and working hours in active working life, $p_{jjt}q_{jjt}$ expenditures on manufactured consumer goods, $(1 + \varepsilon_{1t})^{-1}$ discount rate defined over the depreciation, respectively. When we equate the partial derivative of (1) to zero and make a simplification:

$$\frac{\partial qjt}{\partial qk\tau} = \frac{\partial U/\partial qk\tau}{\partial U \partial qjt} = \frac{pk\tau(1+\varepsilon 1\tau)}{pjt(1+\varepsilon 1t)} \quad \text{---------- (2)}$$

where**, (j,k=1…,n) (t,τ=1…,T).**

We can associate the reduced-price phenomenon in the Equation 2 system with the reduced life expectancy with an analogical approach. The depreciation (discount) rate $(1 + \varepsilon_t)^{-1}$ that may arise in the health stock will cause a decrease in the goods produced/consumed during the lifetime of the individual, as well as a decrease in the life expectancy due to less consumption.

According to Grossman (1999), individuals' demand for healthcare services was evaluated as an effort to compensate for the health stock worn out by the effects of diseases and similar factors. Therefore, an average one-year additional increase in the expected life expectancy during life from the time of birth of each individual decreases at the marginal $(1+ \varepsilon\varepsilon_t)^{-1}$ discount rate. In order to gain additional life, the total return on an individual's investment in their own health can be expressed in an analogous approach as follows (Kök et al. 2018: 2-4)

The model specified for the study is based on the already established theoretical framework using the Grossman health demand theory.

The Autoregressive (Adaptive Expectation) model is given as;

$Y_t = \gamma B_0 + \gamma B_1 X_1 + (1-\gamma) Y_{t-1} + [U_t - (1- \gamma)U_{t-1}]$ ---- (3)

The common form of the model of equation (3) is expressed below as;

$Y_t = B_0 + B_1X_t + B_2Y_{t-1} + U_t$ ---------- (4)

Following this route, the model of Worinde Olalekan Bashir et al (2024) is given below as;

$$\mathbf{LE_t = B_0 + B_{11}FDI_t + B_{12}EDS_t + B_{13}HES_t + B_{14}URB_t + B_{15}GDP_t + U_t} \text{ - ……. (5)}$$

where, LE (life Expectancy), FDI (Foreign Direct Investment), EDS (Education spending), URB

(Urbanization), GDP (Gross Domestic Product).

The study adopted a model of adaptive expectation which is stated below as modified based on Grossman theoretical framework.

$$LE_t = B_0 + B_{11}LE_{t-1} + B_{12}CHE_t + B_{13}URB_t + B_{14}GDP_t + U_t \text{ --- (6)}$$

where, LE= life Expectancy, CHE= Current Healthcare Expenditure % of GDP, URB= Urbanization, GDP= GDP Per Capita.

A priori expectation is as contained in table 3

Table 3: Summary of the a priori expectation

Regressand	Relationship	Regressors
LE	+ (-)	GDP per Capita
	+	CHE
	+	URB

From table 3.1, shows a positive relationship between life expectancy and GDP per capita. But according to the Preston Curve Effect, at higher GDP per capita there exist a weaker and diminishing returns on the life expectancy. While there is a general positive relationship between Healthcare Spending, Urbanization and Life Expectancy.

The data for this study was sourced from the office of the National Bureau of statistics, World Development Indicators (WDI), 2024 issue and the Central Bank of Nigeria, 2024 issue.

Empirical Results and Analysis

Life expectancy which is the dependent variable has a mean value of 51.00870 as presented and GDP per Capita, which is an independent variable has a mean value of 30, 6986.7. The maximum and minimum values also conform to the data on the data set.

Table 4 in appendix, shows the summary of descriptive statistics of the variables included in the model. It shows the existence of wide variations in the variables as depicted by the mean values during the study period. For instance, LE, CHE, URB, and GDP per Capital shows 51.00870, 3.653043, 4.521304, and 306986.7 respectively with GDP per capital and URB having the highest mean values during the study period. This is a clear indication that current healthcare expenditure are among the major determining factors of life expectancy in Nigeria.

The skewness is a measure of the symmetry of the histogram. A variable with negative skewness is said to be far below the mean, while a variable with positive skewness is usually above the mean. All the distributions are negatively skewed but with the exception of current healthcare expenditure rate that is positively skewed. Variables with value of kurtosis less than three are called platykurtic (fat or short-tailed) and URB, and GDP

	level	P-value	1st difference	P- value	Order of integration
LE	-2.4625	0.1382	-4.9146	0.0032	1(0)
GDP Per C	-1.0765	0.7112	-2.4272	0.0172	1(1)
URB	-0.5337	0.4759	-4.2396	0.0000	1(1)
CHE	-2.4625	0.1382	-5.6643	0.0002	1(1)

per capital variables are short tailed. On the other hand, variables whose kurtosis value is greater than three are

called leptokurtic (slim or long tailed) and CHE variable qualified for this during the study period. That is they are slim or long tailed.

The goal of the study is to examine the life expectancy determinants and its impact both at short term and long run in Nigeria, which makes the analysis more comprehensive. In recognition of this, the study begins by examining the time series properties of the variables. Data analysis became very necessary to understand their statistical behavior.

Econometric studies have shown that most financial and macro-economic time series variables are non-stationary and using non-stationary variables leads to spurious regression (Engel & Granger, 1987). Thus, the variables were investigated for their stochastic properties using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP). The two tests were used to test for consistency and where conflicts exist, to decide on the most appropriate option. The results are shown in

Table 1: Test of Stationarity

From table 1 above, the result of the PP unit root test suggests that all the variables were non-stationary with the exception of LE that was stationary at level. They however became stationary after the first difference was taken.

The different order of integration of the variables necessitates the choice of the ARDL- Bounds testing approach to co-integration which is suitable for testing long-run relationship among variables that are of mixed order of integration. The result of the co-integration test is presented in Table 2 of the appendix. It shows the F-statistics is greater than the lower bound and upper critical values at 1%, 5% and 10% respectively. Hence the null hypothesis of no co-integration is rejected and long-run co-integration relationship is established among the variables. It can therefore be inferred that the variables are co-integrated. Therefore F-statistics is 9.52 which is greater than lower bound 1(0) values of 3.41, 4.01, 5.17 and the upper bound 1(1) with 4.45, 5.62, and 6.36 using the 1%, 5% and 10% levels of significant.

In view of the co-integration relationship between the dependent variable and the independent variables, we proceed to estimate the error correction and long-run model. The results of the estimations are presented in Table 3. From the result, 99% variation in the depended variable (LE) are explained by the independent variables, (that is CHE, URB and GDP per capita) as indicated. The regression results present a positive relationship between the dependent variable LE_t (life expectancy) and LE_{t-1} (Lag of LE), CHE_{t-1} (Current Healthcare Expenditure % of GDP Lag), GDP_t (per capita) and URB_t (Urbanization). This simplifies that a unit increase in the level of the outlined independent variables is associated with a positive change in the dependent variable (LE) in the short run. But GDP_t, GDP_{t-1} (per capita) and URB_t (Urbanization) are positively related to LE_t at long run. While an inverse relationship between LE_t, CHE_t (Current Healthcare Expenditure % of GDP), CHE_{t-1} (Current Healthcare Expenditure % of GDP) Lag and URB_{t-1} indicating that a unit increase in these variables will bring about a negative change in the dependent variable LE in the long run. The result of Error Correction Model is given in table 3 in the appendix, showing coefficient of error correction is significant at 1 percent with negative sign. The coefficient of ECM is (-0.896) which shows high speed of adjustment from short run fluctuations to long run equilibrium (89% discrepancy is corrected each year) approximately 89 percent of disequilibrium from the previous year's shock convergence back to the long run equilibrium in the current year. This is a further indication of the existence of long-run relationship between the dependent variable and the independent variables. The R^2 value of 0.90 shows that 90% variance in the dependent variable explained by the explanatory variables. The D.W value of 2.2 shows fair absence of auto-correlation. The F-statistic value of 14.9 is greater than the Probability (F-statistic) or p-value of 0.000039 affirming the overall statistical significance of the model for inference.

The outcomes of the Granger Causality test in table 4 in the appendix indicate that only URB and GDP per capita have bi-directional causality, while LE has a unidirectional causality with URB, based on their p-values. We therefore reject H0 for the two variables above and conclude that URB granger causes GDP per capital and vice versa, and LE grange causes URB in a unidirectional. For the other variables, since the p-values is greater

than 0.05, we do not reject the Null hypothesis and conclude that those variables do not granger cause each other.

CONCLUSIONS

The study in conclusion found gross domestic product per capita, current healthcare expenditure and urbanization as contributory variables to variation in life expectancy in Nigeria. The regression result as outlined in 5.1 summary of findings above in the case of positive relationship between the dependent variable LE_t (life expectancy) and LE_{t-1} (Lag of LE), $CHEt_{t-1}$ (Current Healthcare Expenditure % of GDP Lag), GDP (per capita) and URB_t (Urbanization), conforms to the a prior expectation. The study noted a deviation from a prior expectation of the Grossman Model of healthcare demand. This suggest that high healthcare expenditure dose not translate into improved health outcomes if the system is inefficient, quality of care is poor and lack of framework for preventive care.

POLICY RECOMMENDATIONS

1. Based on the findings from this research, it is necessary to provide a set of policy recommendations that would be applicable to the Nigerian economy. The research therefore suggests the following policy options based on our empirical findings:
2. The study recommends that federal, state and local government via Federal Ministry of Health and National Primary Healthcare Development Agency should increase policy strategy on preventive care framework.
3. The study recommends that government at all tiers should invest in human capital specifically on education and skills to increase capital formation on health and labor productivity.
4. The study recommends that government at all tiers should protect for integrated urban master planning to encourage environment development for quality life.

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Table 3: The Error Correction Model.

ARDL Error Correction Regression
Dependent Variable: D(LE)
Selected Model: ARDL(1, 2, 2, 2)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 05/28/25 Time: 09:25
Sample: 1994 2024
Included observations: 21

ECM Regression
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	30.27117	4.185825	7.231830	0.0000
@TREND	0.489357	0.068652	7.128108	0.0001
D(GDP_PER_C)	7.25E-07	2.61E-06	0.277768	0.7875
D(GDP_PER_C(-1))	8.32E-06	3.05E-06	2.729885	0.0232
D(CHE)	-0.127131	0.038729	-3.282617	0.0095
D(CHE(-1))	-0.073460	0.029908	-2.456239	0.0364
D(URB)	3.634115	0.498486	7.290300	0.0000
D(URB(-1))	-0.756447	0.154861	-4.884677	0.0009
CointEq(-1)*	-0.896706	0.125816	-7.127138	0.0001

R-squared	0.908564	Mean dependent var	0.310952
Adjusted R-squared	0.847606	S.D. dependent var	0.171491
S.E. of regression	0.066946	Akaike info criterion	-2.272336
Sum squared resid	0.053781	Schwarz criterion	-1.824683
Log likelihood	32.85952	Hannan-Quinn criter.	-2.175184
F-statistic	14.90486	Durbin-Watson stat	2.232316
Prob(F-statistic)	0.000038		

Table 4: Granger Causality Test.

Dependent Variable: LE
Method: ARDL
Date: 05/28/25 Time: 09:32
Sample (adjusted): 2002 2022
Included observations: 21 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic): GDP_PER_C CHE URB
Fixed regressors: C @TREND
Number of models evaluated: 27
Selected Model: ARDL(1, 2, 2, 2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LE(-1)	0.103294	0.237505	0.434913	0.6739
GDP_PER_C	7.25E-07	4.63E-06	0.156675	0.8790
GDP_PER_C(-1)	-3.13E-06	4.85E-06	-0.646094	0.5343
GDP_PER_C(-2)	-8.32E-06	3.74E-06	-2.221909	0.0534
CHE	-0.127131	0.086487	-1.469945	0.1756
CHE(-1)	0.080080	0.042144	1.900136	0.0899
CHE(-2)	0.073460	0.040063	1.833616	0.0999
URB	3.634115	1.069490	3.397988	0.0079
URB(-1)	-2.113847	1.315197	-1.607247	0.1425
URB(-2)	0.756447	0.319457	2.367914	0.0421
C	30.27117	8.334337	3.632103	0.0055
@TREND	0.489357	0.139251	3.514209	0.0066

R-squared	0.998974	Mean dependent var	51.35762
Adjusted R-squared	0.997720	S.D. dependent var	1.619006
S.E. of regression	0.077303	Akaike info criterion	-1.986621
Sum squared resid	0.053781	Schwarz criterion	-1.389751
Log likelihood	32.85952	Hannan-Quinn criter.	-1.857085
F-statistic	796.7115	Durbin-Watson stat	2.232316
Prob(F-statistic)	0.000000		

Pairwise Granger Causality Tests
Date: 05/26/25 Time: 22:16
Sample: 1994 2024
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
GDP_PER_C does not Granger Cause LE	28	2.51187	0.1031
LE does not Granger Cause GDP_PER_C		1.50913	0.2422
CHE does not Granger Cause LE	21	0.28281	0.7574
LE does not Granger Cause CHE		0.86582	0.4395
URB does not Granger Cause LE	28	0.42784	0.6570
LE does not Granger Cause URB		5.61003	0.0104
CHE does not Granger Cause GDP_PER_C	21	0.10790	0.8984
GDP_PER_C does not Granger Cause CHE		1.13491	0.3460
URB does not Granger Cause GDP_PER_C	28	7.23757	0.0036
GDP_PER_C does not Granger Cause URB		3.76313	0.0386
URB does not Granger Cause CHE	21	1.74026	0.2071
CHE does not Granger Cause URB		1.19678	0.3278

Table 2: Co-Integration Test.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	9.524268	10%	3.47	4.45
k	3	5%	4.01	5.07
		2.5%	4.52	5.62
		1%	5.17	6.36
Actual Sample Size	21		Finite Sample: n=35	
		10%	3.8	4.888
		5%	4.568	5.795
		1%	6.38	7.73
			Finite Sample: n=30	
		10%	3.868	4.965
		5%	4.683	5.98
		1%	6.643	8.313

ARDL Error Correction Regression
Dependent Variable: D(LE)
Selected Model: ARDL(1, 2, 2, 2)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 05/28/25 Time: 09:25
Sample: 1994 2024
Included observations: 21

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Case 5: Unrestricted Constant and Unrestricted Trend

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D(CHE)	-0.127131	0.038729	-3.282617	0.0095
D(CHE(-1))	-0.073460	0.029908	-2.456239	0.0364
D(URB)	3.634115	0.498486	7.290300	0.0000
D(URB(-1))	-0.756447	0.154861	-4.884677	0.0009
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R-squared	0.908564	Mean dependent var	0.310952
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S.E. of regression	0.066946	Akaike info criterion	-2.272336
Sum squared resid	0.053781	Schwarz criterion	-1.824683
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