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RESEARCH ARTICLE

LINEA R REGRESSION ANALYSIS ON THE IMPACT OF DEFENCE EXPENDITURE ON HUMAN CAPITAL DEVELOPMENT IN U.S.A.:A TIME SERIES ECONOMETRICS STUDY

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Abstract

The main task of any effective government is the safety of people and their properties, which can be done through continuous investments in defense and military forces. The budget for the army of any country shows how much it cares about security and how important it is for its national policy. For many years, the USA has been the leader in military spending in the world and it constitutes about 37% of total military spending and in 2024 it reached approximately \$997 billion, which accounts for about 3.4% of GDP. In times of peace after the Cold War era, the main events that influenced US defense spending were the Gulf War, the war in Afghanistan and the war in Iraq. These wars caused the increase in military budget, which increased sharply from approximately \$413 billion in 2001 to \$833 billion in 2011 because of the operations after September 11. From 1974 to present day, the US has conducted many military interventions which include Lebanon intervention, Invasion of Grenada, Invasion of Panama, Somalia Intervention, Bosnian War Intervention, Kosovo War, and Libya intervention. Research reveals that military involvement by the US has been quite significant with more than 250 military interventions since 1991. Global military spending hit an all-time high of \$2.7 trillion in 2024 amid rising geopolitical tensions and increasing defense spending in various countries. These developments illustrate the strong relationship between geopolitical disputes and increased military spending.

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Introduction:-

Defense expenditures have both positive and negative effects on the economy and economic development. On one hand, they increase security and can lead to technological innovation; however, on the other hand, they might deprive essential sectors of funds like health and welfare. These are some of the important aspects of human capital development that are taken into consideration in this paper. They are considered under the proxy measure of life expectancy. Although the US economy is very strong, and public expenditure is high, the life expectancy of the country stands at around 78 years, which is quite low in comparison to other developed countries.

Overview of The Study:-

In an attempt to find out whether continuous military spending helps or hinders long term socio-economic development, this paper looks into the effects of military expenditure on human capital development. In order to understand better the issue at hand, this research utilizes statistical analysis, in particular, Ordinary Least Squares Method. The variables of concern here are: Life Expectancy at Birth (Total for the United States; no. of years) (Proxy for Human Capital Development); (1) National Defence Consumption Expenditures and Gross Investment (Billions of Dollars); (2) Government Total Revenue (Percent of Gross Domestic Product); (3) Population Growth Rate (Percent Change at Annual Rate); (4) Gross Fixed Capital Formation (trillions of Dollars). This paper makes use of the Time Series method. It enables to analyze data collected during different periods of time, thus allowing for identification of the relationship between dependent and independent variables. The variables are extracted as secondary data from 1974 -2024 , Annually (51 observations).

Taking into account the complex nature of this project, it is aimed to use statistical methods and data analysis in order to:-

1. Find out what determines human capital development measured by Life Expectancy at Birth in the United States.
2. Identify and quantify the relationship between life expectancy and macroeconomic variables with particular attention paid to military expenditures.
3. Military expenditures are a part of governmental policy and are always justified in terms of national security. At the same time, any military expenditures have their cost in terms of opportunity cost – in case when the government spends a lot of money on national defence, there is not enough money left to spend on such things as healthcare, education, infrastructure. Although high levels of defence expenditures indicate economic prosperity in some cases, it may happen that it means just less funding for sectors which can influence human development indirectly and in complicated manner.
4. The results of this project will be highly useful for the policymakers, economists and development experts, who will be able to see the whole picture of defense expenditure and its implications for human development.

Motivation:-**Base Papers for Reference:-**

“Military Expenditure and Human Capital Development in Nigeria” by Obasi C.N.* , Asogwa F. O., Nwafée F. I. from Department of Economics, University of Nigeria, Nsukka, Nigeria (2018)

Military spending has been widely recognized as a factor that leads to a crowding out effect in terms of investing in human capital. This paper seeks to determine the effect of military spending on the development of human capital in Nigeria, using yearly data from 1970 to 2014. The findings reveal that military spending has no significant effect on education (gross school enrollment) but has a significant effect on health (infant mortality). Hence, military spending has negative implications for human capital development.

“Military Expenditures And Health Outcomes: A Global Perspective” by Seemab Gillani, Muhammad Nouman Shafiq, Tusawar Iftikhar Ahmad (2019)

In this research, cross-country panel data from 156 nations (1970-2014) are used to investigate the connection between the military expenditure of a country and its health status in terms of the country's life expectancy. The effect of the military expenditure on health capacity and life expectancy is not always negative. Rather, the connection between military expenditure and health capacity is conditional. Military expenditure is positively correlated with increased health capacity in certain circumstances.

”Military Expenditure and Economic Growth: A Meta-Analysis” by Aynur Alptekin from School of Economics, University of Surrey, Surrey, UK (2012)

The meta-analysis includes 32 studies analyzing the link between military expenditure and economic growth. The results of the analysis reveal that the effect of defense expenditure on economic growth differs from one country to another. Specifically, military expenditure may lead to economic growth in developed nations but can be insignificant elsewhere. Given that economic growth is strongly associated with increases in the level of income, health care, and public service provision, the meta-analysis indicates how military expenditure might indirectly affect human development outcomes such as life expectancy. These papers gave me the motivation to find out more about this field and it made me think whether I would want to challenge or study it for a developed country such as the United States. The researchers used different independent variables that helped me identify the right ones for this study.

Variables:-**Dependent Variable:-**

Life Expectancy at Birth, Total (Years) in the United States of America (Proxy for Human Capital Development): This metric obtained from the Federal Reserve Economic Data (FRED) database, represents the average number of years a newborn is expected to live assuming current mortality rates remain constant throughout their lifetime. It reflects overall population health and captures the combined effects of healthcare access, living standards and socio-economic conditions. Life expectancy is widely used as a proxy for human capital development because it represents a key component of human capital health alongside education and skills. Higher life expectancy indicates better healthcare, nutrition, and living conditions, which enhance individuals' productivity, longevity in the workforce, and capacity to invest in skills. In this analysis, it serves as the dependent variable, representing changes in human development and overall well-being. (Source: FRED)

Independent Variables:-

Federal Government: National Defence Consumption Expenditures and Gross Investment (Billions of Dollars): This metric, obtained from the Federal Reserve Economic Data (FRED) database measures total federal government spending on national defence including both consumption expenditures and gross investment expressed in billions of dollars. It reflects the scale of military-related economic activity and resource allocation toward defence. In this analysis, it serves as a key independent variable to examine the impact of defence spending on life expectancy (Source: FRED)

Federal Receipts as Percent of Gross Domestic Product (Percent of GDP): This variable, sourced from FRED, represents total federal government receipts (including taxes and other revenues) expressed as a percentage of GDP. It indicates the government's revenue-generating capacity relative to the size of the economy. In this study, it is included as an independent variable to capture the role of fiscal capacity in influencing life expectancy. (Source: FRED)

Population Growth for the United States (Percent Change at Annual Rate): This metric, obtained from FRED, measures the annual percentage change in the total population of the United States. It reflects demographic dynamics that can influence resource allocation, healthcare demand, and overall economic conditions. In this analysis, it is used as an independent variable to assess how population changes affect life expectancy. (Source: FRED)

Gross Fixed Capital Formation in the United States (Trillions of Dollars): This variable, sourced from FRED, represents the total value of investment in fixed assets such as infrastructure, machinery, and buildings. It serves as an indicator of long-term economic development and productive capacity. In this study, it is included as an independent variable to evaluate the influence of investment on life expectancy. (Source: FRED)

Methodology:-**What is Regression Analysis?:-**

Regression analysis is a statistical technique used to explore the relationship between a dependent variable and one or more independent variables. It is commonly used to model the relationship between variables and to make predictions based on that relationship. In a simple linear regression analysis, the relationship between two variables is modelled as a straight line, where the dependent variable is predicted based on the independent variable. In multiple regression analysis, several independent variables are used to predict the dependent variable. The most widely used method of linear regression is known as the method of ordinary least squares, wherein the regression analysis produces a unique line that minimises the sum of squared differences/residuals between actual/observed values of the dependent variable and the estimated values of the dependent variable (obtained as output from the hypothesised model). The closer the actual values are to the regression line, the better fit the model proves to be.

Why Regression Analysis?

Here are several reasons why regression analysis is a particularly suitable choice for the project investigating factors affecting the human capital development index proxied by life expectancy:-

Identifying Relationships and Quantifying Effects: Regression analysis excels at uncovering the relationships between variables and quantifying their influence. In our case, it allows us to assess how changes in national defence consumption expenditures and gross investment, government total revenue, population growth rate, gross fixed capital formation are statistically associated with variations in human capital development proxied by life

expectancy at birth. By estimating the coefficients (β), we could determine the average magnitude and direction of these effects (positive or negative).

Handling Multiple Independent Variables: Unlike simpler techniques that only analyse one independent variable at a time, regression analysis can handle multiple independent variables simultaneously. This is crucial for our study, as we're interested in the combined influence of several factors on the human capital development proxied by life expectancy at birth. Regression helps us to isolate the effect of each variable while controlling for the effects of the others.

Making Predictions: Once we've estimated the regression equation, we can use it to make predictions about the life expectancy at birth based on specific values of the independent variables. This could help estimate how changes in defence expenditures might affect future human capital development proxied by life expectancy.

Testing Hypotheses: Regression analysis facilitates the testing of specific hypotheses about the relationships between variables. For instance, we might hypothesise that a rise in defence expenditures leads to an increase in the human capital development proxied by life expectancy (positive β_1). The regression analysis will provide statistical evidence to support or refute such hypotheses.

The Goodness of Fit: Regression analysis provides a measure of how well the model fits the data. This can help assess the model's reliability and accuracy and determine whether further analysis is needed. Overall, regression analysis is a powerful tool for untangling the complex interplay of factors that shape the human capital development proxied by life expectancy in the United States. It allows us to move beyond simple correlations and establish statistically robust relationships to gain a deeper understanding of this crucial aspect of the human development.

The relationship between two variables is modelled by a simple linear regression equation which is, $Y_i = \beta_0 + \beta_1 X_i + \epsilon$ where, Y is the dependent variable, the variable which depends on another independent variable.

β_0 (beta-nought): This is the intercept, representing the average value of Y when all the independent variables (X) are equal to zero (often not a realistic scenario, but it provides a reference point).

β_1 (beta-one): This is the slope coefficient, indicating the average change in Y for a one-unit increase in X, holding all other independent variables constant.

ϵ (epsilon): This represents the error term, capturing the random, unexplained variation in Y that is not accounted for by the independent variables.

The goal of the simple linear regression analysis is to estimate the values of β_0 and β_1 that best fit the data and also minimise the error term. Once the values of β_0 and β_1 are estimated, we can use the equation to predict the value of Y for any given value of X.

In a **multiple regression analysis**, there are more than one independent variable and they are collectively used to predict the value of the dependent variable.

The equation is as follows- $Y_i = \beta_0 + \beta_1 X_{2i} + \beta_2 X_{3i} + \dots + \beta_n X_{ni} + \epsilon$, where $X_{2i}, X_{3i}, \dots, X_{ni}$ are the n independent variables. The goal is to estimate the $\beta_0, \beta_1, \beta_2, \dots, \beta_n$ values of $\beta_0, \beta_1, \beta_2, \beta_n$ that best fit the data and minimise the error term, so that we can use the equation to make predictions based on the values of the independent variables. **GretL**, the statistical software used to run the tests that are important for a regression analysis.

Note: All the tests in the model are conducted at a 5% level of significance.

Summary Statistics:-

The data in the image shows the summary statistics of the dependent variable and all the independent variables used in the data. It is used to study the basic statistical terms of a variable.

	Mean	Median	Minimum	Maximum
NationalDefenceE~	513.37	406.46	109.89	1082.7
FederalReceiptsa~	17.050	17.058	14.371	19.756
PopulationGrowth	0.92768	0.92780	0.15732	1.3869
GrossFixedCapita~	2.6430	2.7922	0.92710	5.1000
LifeExpectancyat~	76.282	76.580	71.956	79.000
	Std. Dev.	C.V.	Skewness	Ex. kurtosis
NationalDefenceE~	265.25	0.51669	0.28282	-1.0511
FederalReceiptsa~	1.1584	0.067938	-0.13689	0.072229
PopulationGrowth	0.22588	0.24349	-0.75569	1.8239
GrossFixedCapita~	1.1996	0.45389	0.29072	-1.1025
LifeExpectancyat~	1.9690	0.025812	-0.30442	-1.0170
	5% perc.	95% perc.	IQ range	Missing obs.
NationalDefenceE~	122.16	959.35	397.98	0
FederalReceiptsa~	14.675	18.984	1.1884	0
PopulationGrowth	0.47244	1.3257	0.22808	0
GrossFixedCapita~	1.0010	4.7181	1.8475	0
LifeExpectancyat~	72.756	78.809	3.7707	0

Summary Statistics, using the observations 1974 to 2024:-

The summary statistics helped us to find the Mean, Median, Minimum, Maximum, Standard Deviation, Coefficient of Variation, Skewness, Ex. Kurtosis, 5% percentile, 95% Percentile, Interquartile Range and Missing Observations of all the variables used in the regression analysis.

Coefficient of Variation:-

The Coefficient of Variation (CV) is a measure of relative variability or dispersion of a variable, expressed as a percentage of the meanX. It is calculated by dividing the standard deviation of the variable by the mean of the variable and then multiplying by 100 to express it as a percentage. Variability refers to the extent to which data points in a dataset or a variable deviate or differ from each other. It is a measure of how spread out or dispersed the values of a variable are and it quantifies the degree of diversity or heterogeneity in the data. It is typically assessed using measures such as the range, variance, standard deviation, and coefficient of variation (CV). A larger variability indicates that the values of the variable are more spread out or dispersed, having greater uncertainty while a smaller variability indicates that the values are more closely packed or clustered together, meaning more stable and predictable.

	C.V.
NationalDefenceE~	0.51669
FederalReceiptsa~	0.067938
PopulationGrowth	0.24349
GrossFixedCapita~	0.45389
LifeExpectancyat~	0.025812

Interpretation of Coefficient of Variation:-

- Lower CV (less than 10%): The data points are tightly clustered around the mean, indicating low variability.
- Moderate CV (between 10% and 30%): The data exhibits some variability but isn't excessively high.
- Higher CV (greater than 30%):

The data is significantly spread out, suggesting high variability relative to the mean.

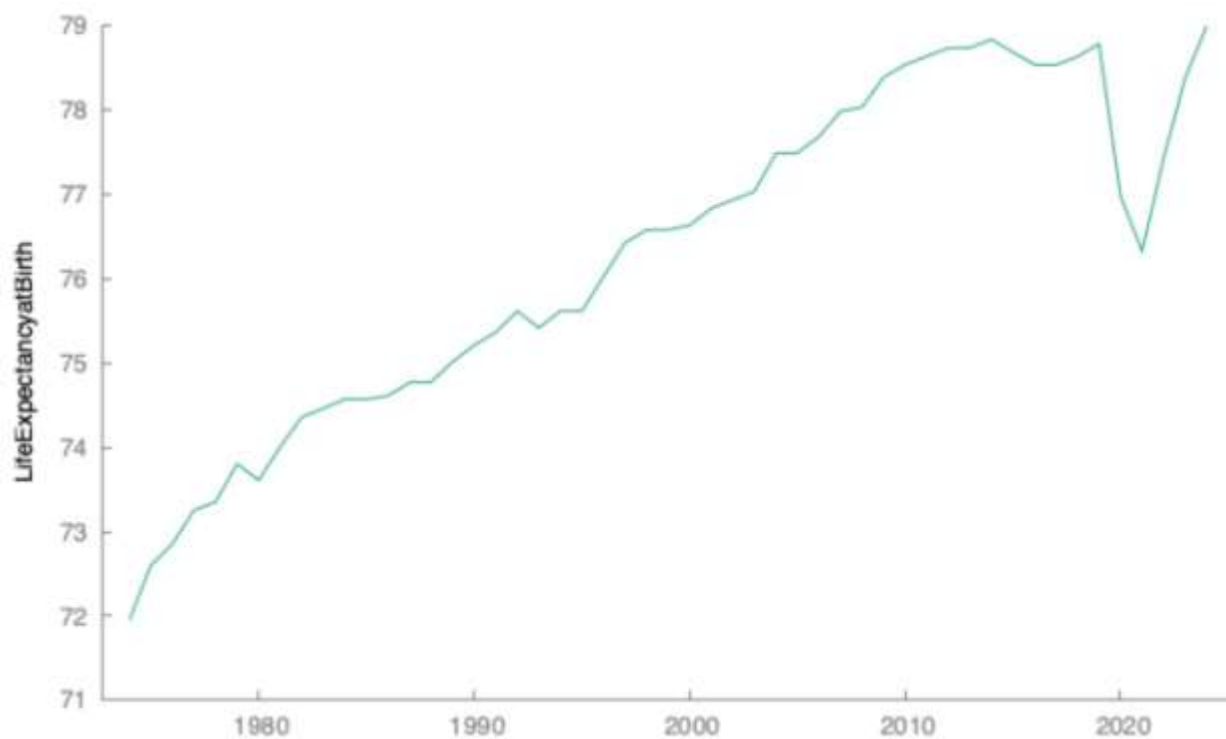
In this data:-

1. The coefficient of variation of the Federal Receipts as Percentage of GDP and Life Expectancy at Birth has low variability since its CV value is less than 10%.
2. The coefficient of variation of the Population Growth (Percent Change at Annual Rate) have moderate variability since they lie between 10% to 30% CV value.
3. The coefficients of variation of the National Defence Expenditures (Billions of Dollars) and Gross Fixed Capital Formation (Trillions of Dollars) has high variability since its CV value is just above 30%.

Time Series Analysis:-

Time series analysis is a statistical tool used to analyse any given data that is collected over a period of time. It delves into understanding the:-

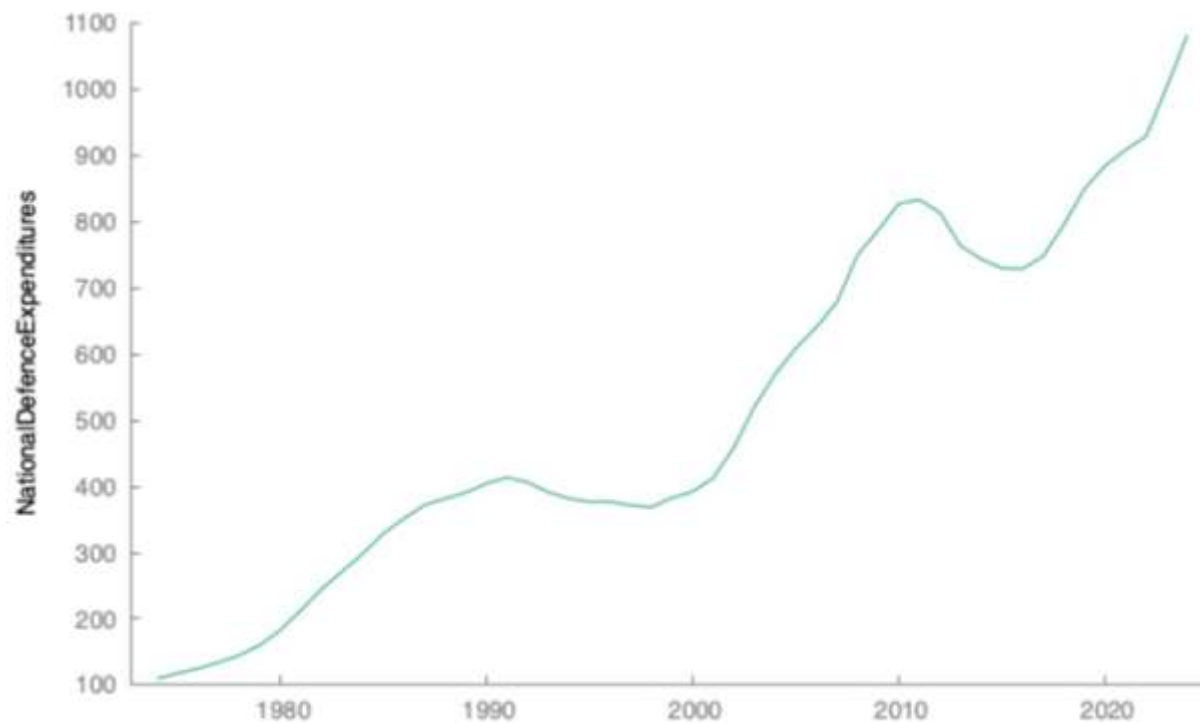
1. Nature of the sequence of data.
2. Identifying the data's repeated behaviour.
3. Long term trends in the data.



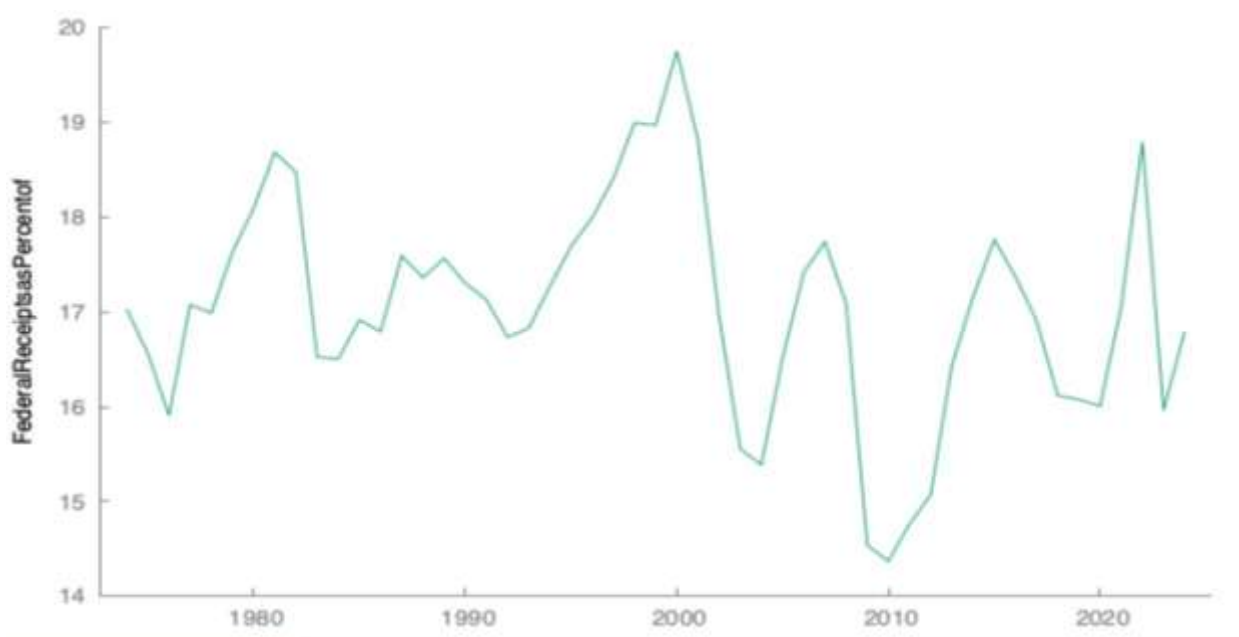
This is the time series plot of Life Expectancy at Birth with time in years.

Life Expectancy at Birth is taken on Y-axis whereas time is taken on X-axis.

The graph shows a steady increase in life expectancy from the late 1970s up to around 2019, indicating continuous improvements over time. There are minor fluctuations in the early 1990s but the overall trend remains upward. Around 2020, there is a sharp decline after which the value rebounds quickly showing a strong recovery. Post-2021, the trend resumes its upward movement reaching its highest level by the end of the period.

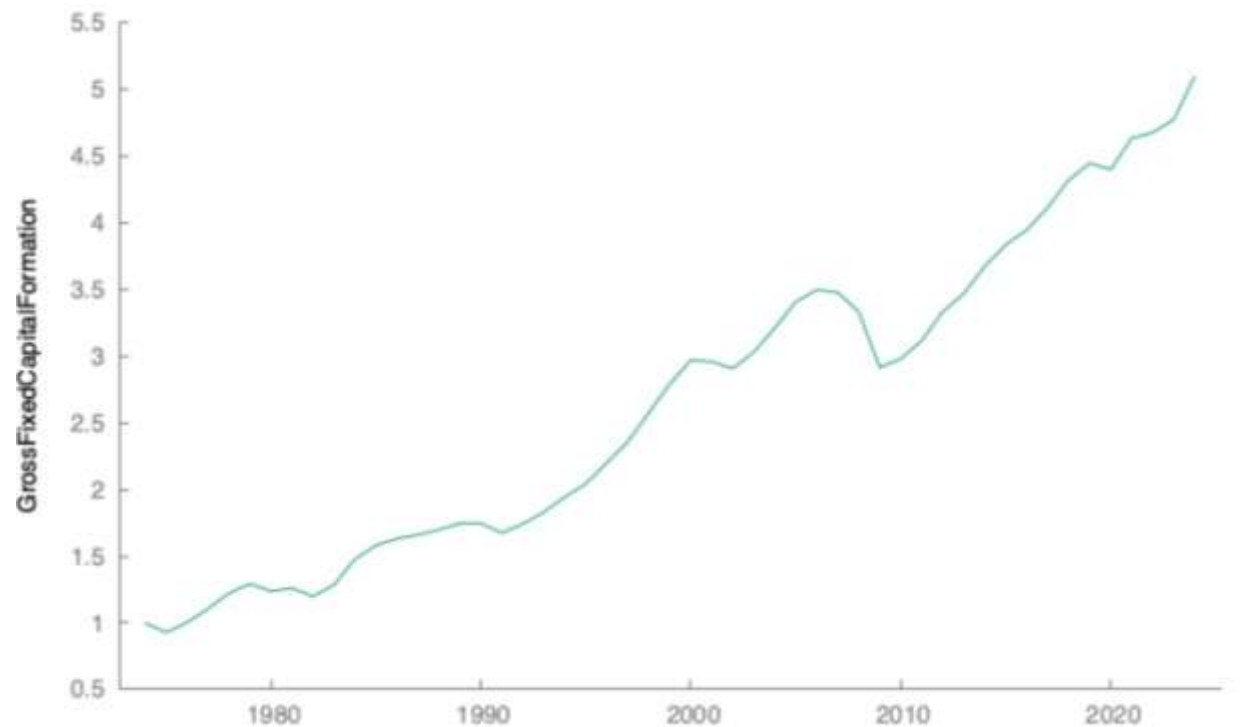


This is the time series plot of National Defence Expenditures (Billions of Dollars) with time in years. National Defence Expenditures (Billions of Dollars) is taken on Y-axis whereas time is taken on X-axis. The graph shows defence spending rising steadily in the early years with strong growth through the 1980s and a peak in the early 1990s. This is followed by a slight decline and a period of stability. From the early 2000s, spending increases sharply, dips briefly after 2010 and then rises again. The most recent years show a steep surge indicating a strong push in defence investment.



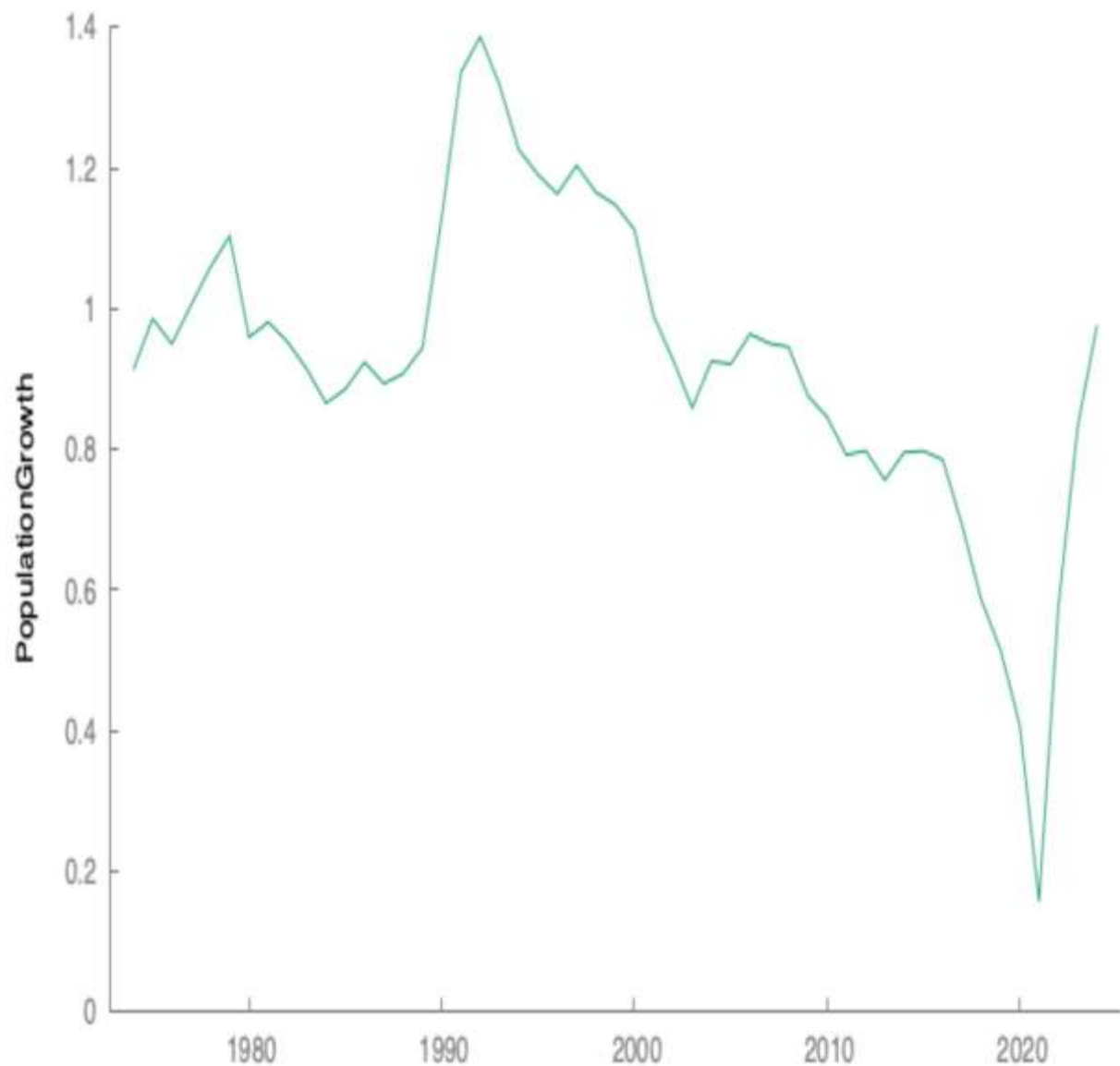
This is the time series plot of Federal Receipts as Percentage of GDP with time in years. Federal Receipts as Percentage of GDP is taken on Y-axis whereas time is taken on X-axis.

The graph shows Federal Receipts as Percentage of GDP fluctuates over time rather than following a steady trend. In the late 1970s to early 1980s, there is a general rise, reaching a peak around the early 1980s followed by a sharp drop mid-decade. Through the late 1980s and 1990s, the values move within a relatively stable range with moderate ups and downs. Around 2000, receipts peak again before falling sharply in the early 2000s. The most significant decline occurs around the 2008–2010 period, after which there is a gradual recovery. In recent years, the graph shows continued fluctuations with occasional sharp increases, indicating instability but no clear long-term upward or downward trend.



This is the time series plot of Gross Fixed Capital Formation (Trillions of Dollars) with time in years. Gross Fixed Capital Formation (Trillions of Dollars) is taken on Y-axis whereas time is taken on X-axis.

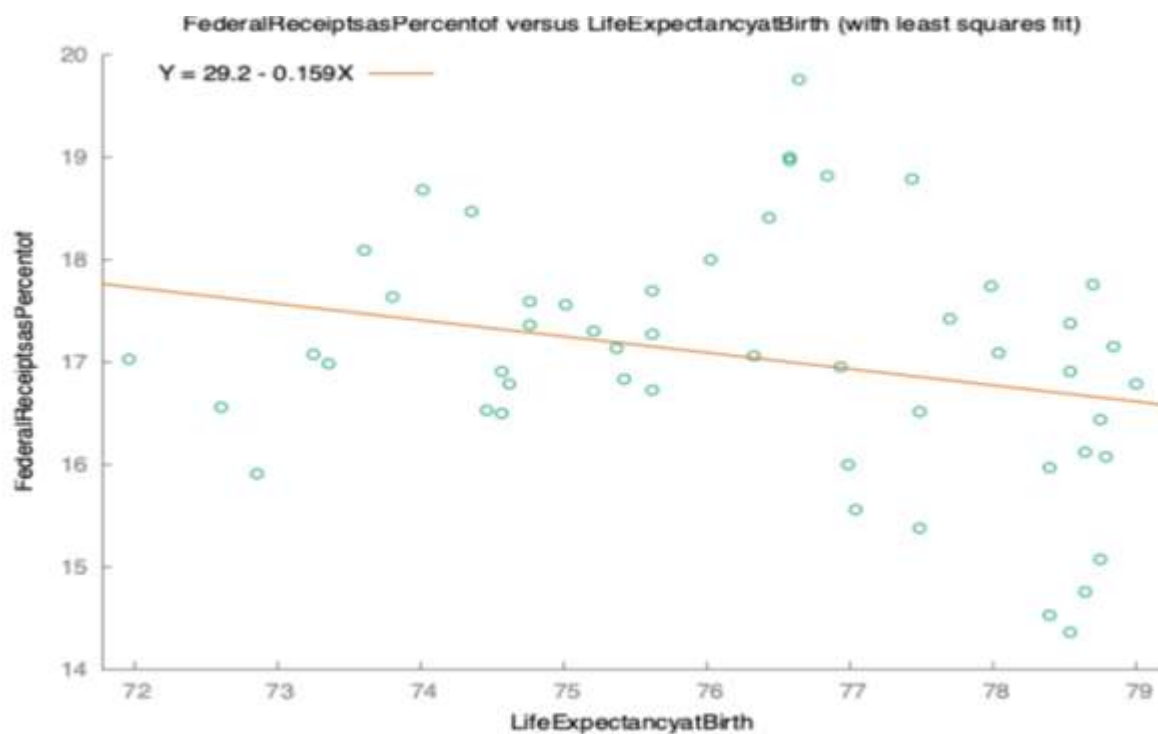
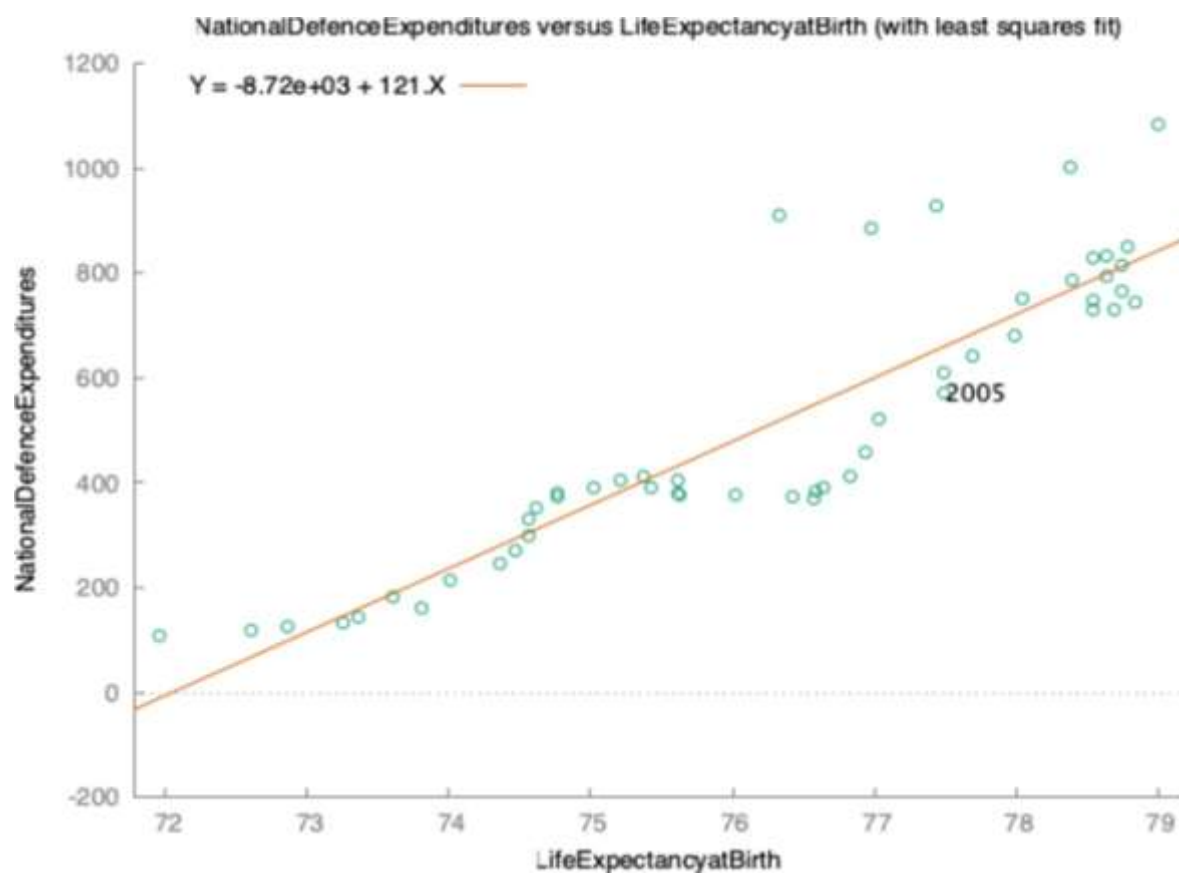
The graph shows a consistent upward trend signalling long-term growth in infrastructure and asset investment. Notable dips around 2000 and 2008 highlight the impact the global financial crisis. However, a sharp recovery after 2010 shows accelerated investment with the value quintupling over the 50-year period to reach its current peak.

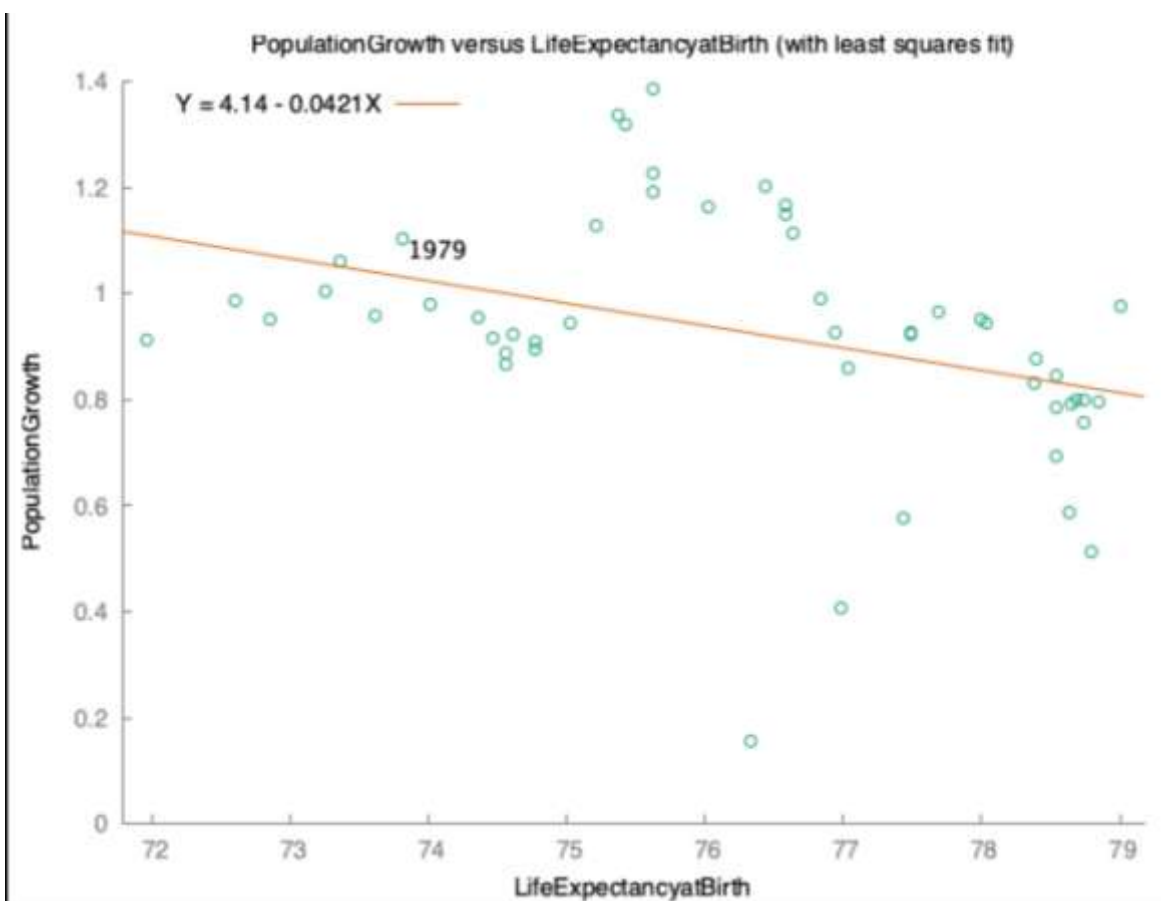
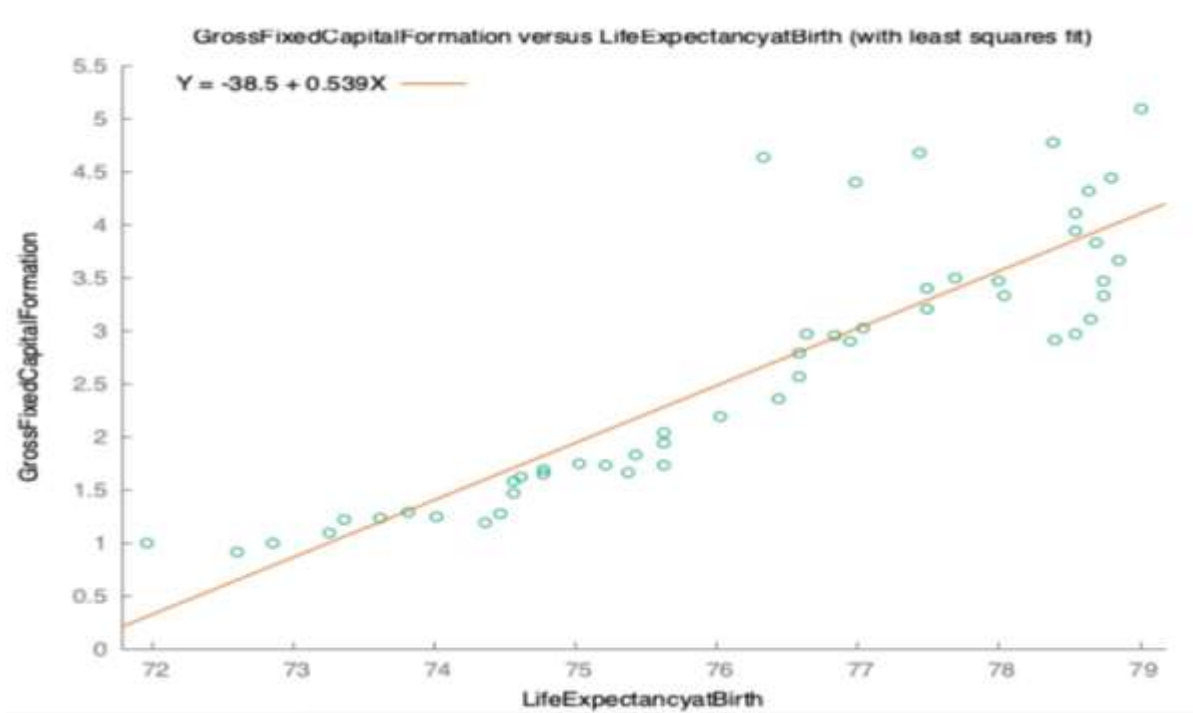


This is the time series plot of Population Growth (Percent Change at Annual Rate) with time in years. Population Growth (Percent Change at Annual Rate) is taken on Y-axis whereas time is taken on X-axis.

This graph illustrates the annual percentage change in Population Growth. The data reveals a generally declining trend over the decades, punctuated by a significant peak in the early 1990s where growth reached approximately 1.4%. Most notably, there is a dramatic sharp collapse around 2020 where the growth rate plummeted to near 0%, likely reflecting the demographic impact of the global pandemic. However, the tail end of the graph shows a rapid steep recovery with the growth rate surging back toward 0.8% by 2024.

Scatter Plots:-





Setting Up The Model & Hypothesis:-

Log_Life Expectancy at Birth = $\beta_1 + \beta_2$ (Log_National Defence Expenditures) - β_3 (Log_Federal Receipts as Percentage of GDP) + β_4 (Population Growth) + β_5 (Gross Fixed Capital Formation) + U_i Setting the Hypothesis,
 $H_0 : \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = 0$ $H_A : \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq 0$

Model 1: OLS, using observations 1974–2024 (T = 51)

Dependent variable: l_LifeExpectancyatBirth

	coefficient	std. error	t-ratio	p-value	
const	4.22481	0.0621234	68.01	8.27e-48	***
l_NationalDefenc~	0.0253078	0.00451009	5.611	1.10e-06	***
l_FederalReceipt~	-0.0335601	0.0185045	-1.814	0.0763	*
PopulationGrowth	0.0258288	0.00664747	3.886	0.0003	***
GrossFixedCapita~	0.0100527	0.00249981	4.021	0.0002	***
Mean dependent var	4.334114	S.D. dependent var	0.025926		
Sum squared resid	0.002820	S.E. of regression	0.007830		
R-squared	0.916079	Adjusted R-squared	0.908782		
F(4, 46)	125.5343	P-value(F)	3.92e-24		
Log-likelihood	177.6040	Akaike criterion	-345.2081		
Schwarz criterion	-335.5489	Hannan-Quinn	-341.5170		
rho	0.870109	Durbin-Watson	0.297712		

Through the method of Ordinary Least Squares (OLS),

$$Y_i = \beta_1 + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \beta_5 X_{5i} + \epsilon_i$$

Here,

$$Y_i = 4.22481 + 0.0253078 X_{2i} - 0.0335601 X_{3i} + 0.0258288 X_{4i} + 0.0100527 X_{5i} + U_i$$

where,

Y_i = Log_Life Expectancy at Birth

Intercept:-

$$\beta_1 = 4.22481$$

Slopes:-

X_{2i} = Log_National Defence Expenditures ($\beta_2 = 0.0253078$)

X_{3i} = Log_Federal Receipts as Percentage of GDP ($\beta_3 = -0.0335601$)

X_{4i} = Population Growth (Percent Change at Annual Rate) ($\beta_4 = 0.0258288$)

X_{5i} = Gross Fixed Capital Formation ($\beta_5 = 0.0100527$)

Significance Explanations:-

1. p-value: if the p-value is less than or equal to 0.05, then we can reject the null hypothesis and the variable will be statistically significant.
2. t-ratio: if the absolute value of the t-ratio is more than 2, then we can reject the null hypothesis and the variable will be statistically significant.
3. star signs (level of significance - LOS),
 - one star: rejecting the null hypothesis at 10% LOS.
 - two stars: rejecting the null hypothesis at 5% & 10% LOS.

- three stars: rejecting the null hypothesis at 1%, 5% & 10% LOS.

Interpretations:-

$$Y_i = 4.22481 + 0.0253078 X_{2i} - 0.0335601 X_{3i} + 0.0258288 X_{4i} + 0.0100527 X_{5i} U_i$$

- **$\beta_1 = 4.22481$ (intercept value)** - When all independent variables are equal to zero, the expected value of log life expectancy is 4.22481. Converting this into levels, the predicted life expectancy is $e^{4.22481}$ years. The intercept is statistically significant, as indicated by an extremely low p-value (8.27×10^{-48}), a very high t-statistic (68.01), and the presence of three stars. This implies that the intercept is significantly different from zero, though it does not provide evidence regarding omitted variables.
- **$\beta_2 = 0.0253078$ (Log_National Defence Expenditures)**- The coefficient represents an elasticity. A 1% increase in National Defence Expenditures is associated with an approximate 0.0253078% increase in Life Expectancy at Birth, ceteris paribus. The coefficient is positive, indicating a direct relationship between defence expenditure and life expectancy. The coefficient is statistically significant at conventional levels, as indicated by a very low p-value (1.10×10^{-6}), a t-statistic greater than 2 (5.611), and the presence of three significance stars. Thus, the null hypothesis of no effect can be rejected with high confidence. While the coefficient is statistically significant, its magnitude suggests that the economic impact is relatively small, implying that changes in defence expenditure have a limited effect on life expectancy and hence Human Capital Development. Higher defence expenditure may be associated with higher life expectancy because it often proxies for greater state capacity, economic development and security conditions that indirectly improve health outcomes.
- **$\beta_3 = -0.0335601$ (Log_Federal Receipts as Percentage of GDP)**- The coefficient represents an elasticity. A 1% increase in Federal Receipts as a percentage of GDP is associated with an approximate 0.0336% decrease in Life Expectancy at Birth, ceteris paribus. The coefficient is negative, indicating an inverse relationship between Federal Receipts and life expectancy. The coefficient is weakly statistically significant at the 10% level (p-value = 0.0763, t-statistic = -1.814) as indicated by one significance star. Therefore, the null hypothesis of no effect can be rejected only at the 10% level, but not at the 5% level. Although statistically weakly significant, the magnitude of the coefficient suggests a very small economic effect implying that changes in Federal Receipts as a share of GDP have a limited impact on life expectancy and hence Human Capital Development. It is also consistent with fiscal burden and distortionary taxation literature, higher government revenue (as a share of GDP) may reflect increased tax pressures that can reduce disposable income, private consumption and private investment in health and welfare thereby potentially exerting a negative effect on long-run human capital outcomes.
- **$\beta_4 = 0.0258288$ (Population Growth (Percent Change at Annual Rate))**- The coefficient represents a semi-elasticity (given the log-lin functional form), implying that a 1 unit increase in population growth at annual rate in percentage terms is associated with an approximate 2.58288% increase in Life Expectancy at Birth, ceteris paribus. The coefficient is positive, indicating a direct relationship between population growth and life expectancy. The coefficient is highly statistically significant (p-value = 0.0003, t-statistic = 3.886, three significance stars) implying rejection of the null hypothesis at the 1% level. This confirms a robust relationship between population growth and life expectancy in the model. Although statistically significant, the magnitude of the coefficient suggests that the economic effect is relatively small indicating that population growth has a limited impact on life expectancy in percentage terms. Higher population growth is associated with improvements in human capital development (proxied by life expectancy), likely reflecting demographic transition effects where better health conditions simultaneously raise both survival rates and population growth.
- **$\beta_5 = 0.0100527$ (Gross Fixed Capital Formation (Trillions of Dollars))**- The coefficient represents a semi-elasticity (given the log-lin functional form), implying that a 1 trillion increase in Gross Fixed Capital Formation is associated with an approximate 1.00527% increase in Life Expectancy at Birth, ceteris paribus. The coefficient is positive, indicating a direct relationship between capital formation and life expectancy. The coefficient is highly statistically significant (p-value = 0.0002, t-statistic = 4.021, three significance stars), implying rejection of the null hypothesis at the 1% level. This confirms a robust relationship between Gross Fixed Capital Formation and life expectancy in the model. Although statistically significant, the magnitude of the coefficient suggests that the economic effect is relatively small indicating that increases in capital formation have a limited impact on life expectancy in percentage terms. The positive relationship is consistent with endogenous growth and development literature which argues that higher gross fixed capital formation promotes

economic growth and income levels thereby indirectly improving human development outcomes and life expectancy.

- **R-squared (0.916079):** This is a measurement of the percentage of the dependent variable's overall variation that the regression model explains. A better match between the model and the data is indicated by a higher R-squared value.
- **F-statistic (125.5343) and p-value (3.92e-24):** The regression model's overall significance is gauged by the F-statistic. Here, the regression model is very statistically significant because the p-value is very low and the F-statistic is quite high.

Anova:-

Analysis of Variance:

	Sum of squares	df	Mean square
Regression	0.0307864	4	0.00769659
Residual	0.00282029	46	6.13107e-05
Total	0.0336067	50	0.000672133

$$R^2 = 0.0307864 / 0.0336067 = 0.916079$$

$$F(4, 46) = 0.00769659 / 6.13107e-05 = 125.534 \text{ [p-value } 3.92e-24]$$

Mean Squares: The mean square for regression is 0.00769659, while the mean square for residuals is 6.13107e-5. The large disparity between these two values contributes to the high F-statistic and further reinforces the conclusion that the model explains a significant portion of the variation in Log_Life Expectancy at Birth.

Confidence Interval:-

95% confidence intervals

$$t(46, 0.025) = 2.013$$

	coefficient	low	high
const	4.22481	4.09976	4.34985
l_NationalDefenceExpenditures	0.0253078	0.0162294	0.0343861
l_FederalReceiptsasPercentof	-0.0335601	-0.0708077	0.00368758
PopulationGrowth	0.0258288	0.0124481	0.0392094
GrossFixedCapitalFormation	0.0100527	0.00502085	0.0150846

The results show that National Defence Expenditures, Population Growth and Gross Fixed Capital Formation significantly increase the dependent variable. All three are statistically significant at the 95% level, as their confidence intervals do not contain zero. In contrast, Federal Receipts as a Percentage of GDP is not statistically significant ($p > 0.05$), meaning its effect is not clearly established. The model is highly robust, explaining 91.6% of the total variation with a highly significant overall F-test ($p < 0.001$). These findings suggest that defence and capital investment are the primary drivers in this model.

Correlation Matrix:-

A correlation matrix is a square table that summarises the relationship between all pairs of variables within a dataset. It uses a statistical measure called the correlation coefficient, which ranges from -1 to 1.

Interpretation:-

- Values closer to 1: Indicate a strong positive correlation. This means as one variable increases, the other tends to increase as well.
- Values closer to -1: Indicate a strong negative correlation. This means as one variable increases, the other tends to decrease.
- Values closer to 0: Indicate a weak or no correlation. There's little to no relationship between the changes in the two variables.

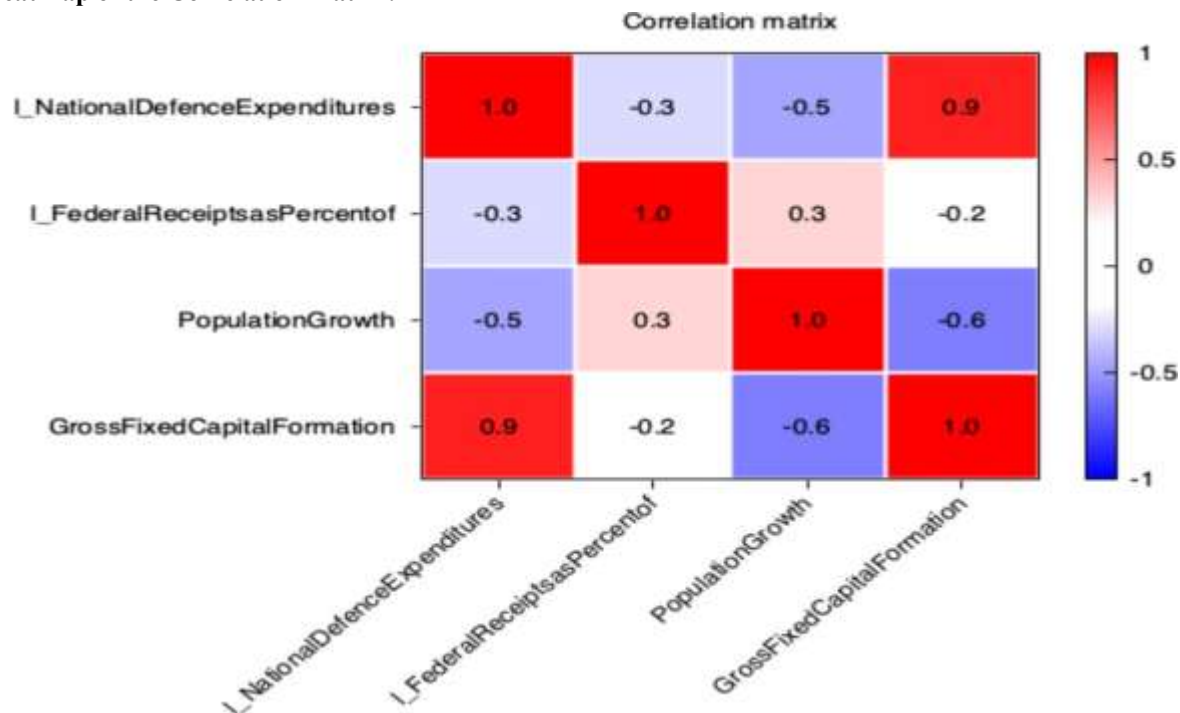
Correlation Coefficients, using the 51 observations 1974 - 2024

Two-tailed critical values for n = 51: 5% 0.2759, 1% 0.3575

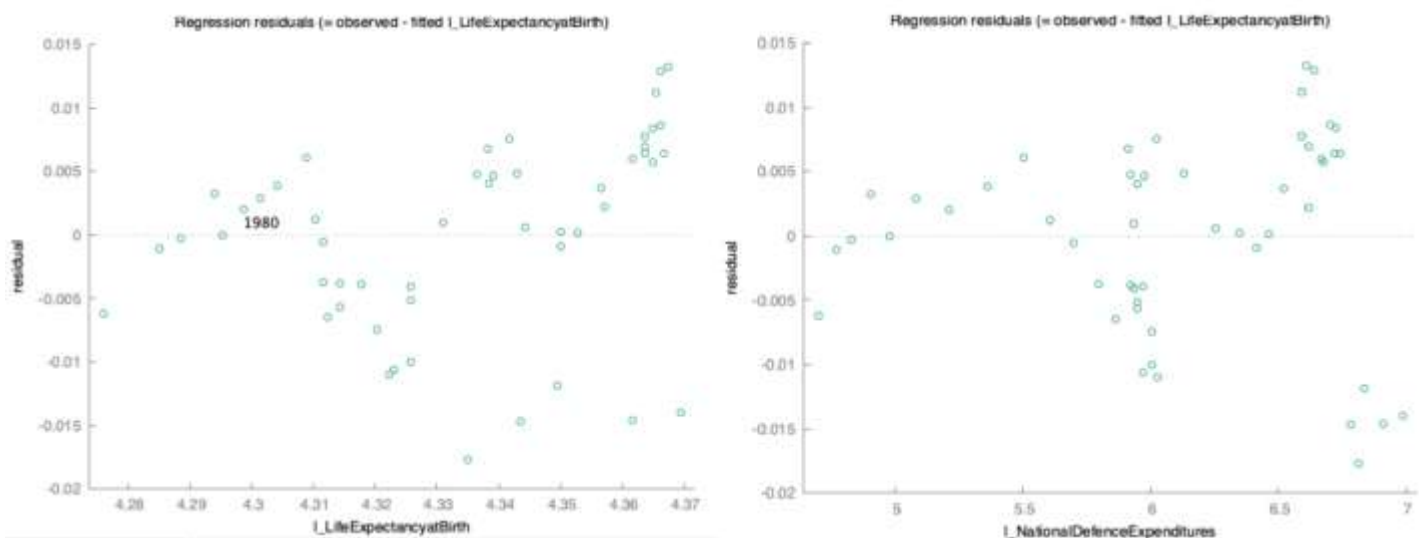
l_NationalDefe~	l_FederalRecei~	PopulationGrow~	GrossFixedCapi~	
1.0000	-0.2988	-0.4711	0.8969	l_NationalDefe~
	1.0000	0.3186	-0.1767	l_FederalRecei~
		1.0000	-0.5975	PopulationGrow~
			1.0000	GrossFixedCapi~

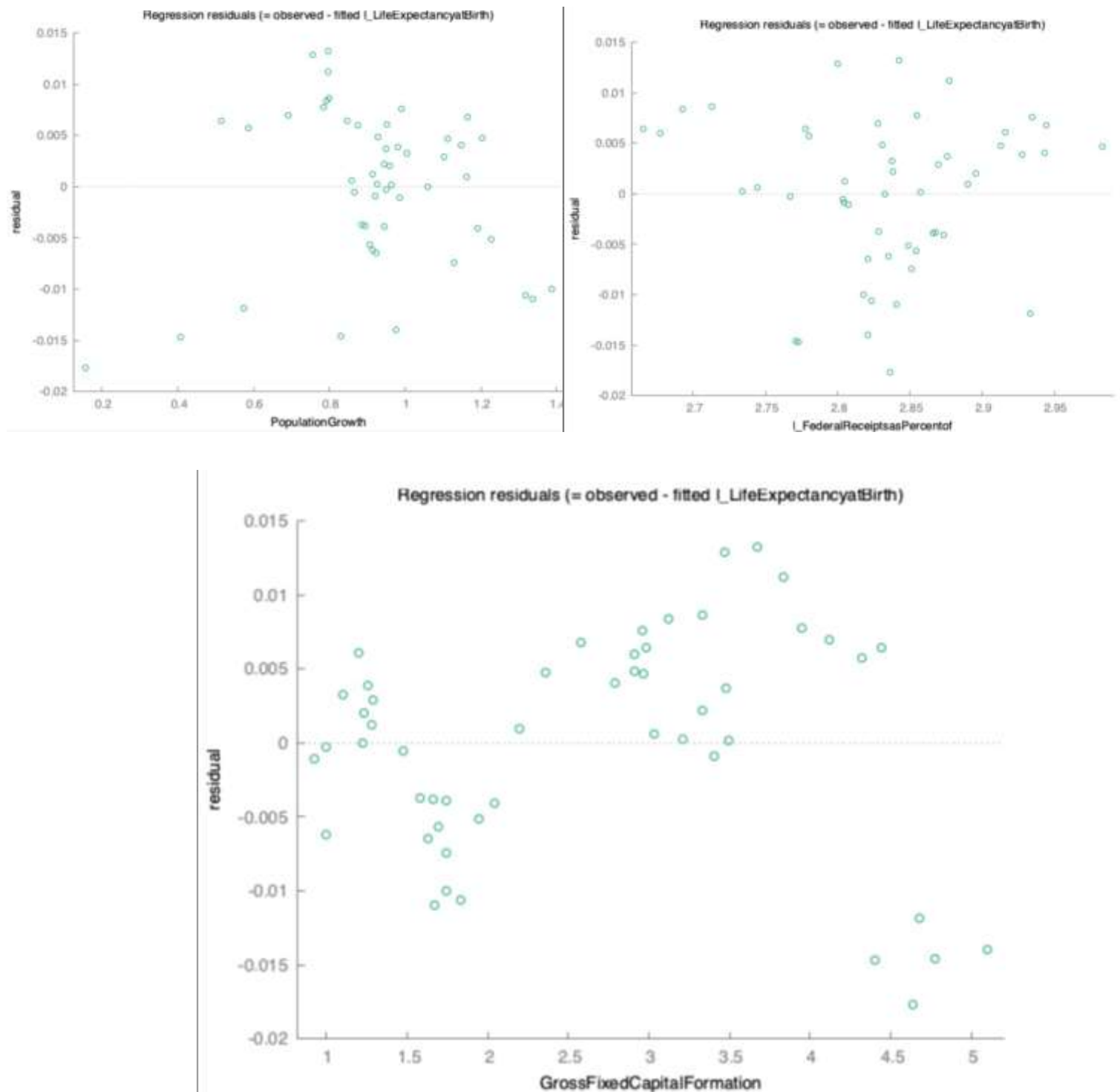
Based on the correlation matrix provided, the calculated correlation coefficients are as follows:-

- Correlation coefficient between Log_National Defence Expenditures and Log_Federal Receipts as Percentage of GDP is -0.2988 — Weak Negative Correlation.
- Correlation coefficient between Log_National Defence Expenditures and Population Growth is -0.4711 — Moderate Negative Correlation.
- Correlation coefficient between Log_National Defence Expenditures and Gross Fixed Capital is 0.8969 — Strong Positive Correlation.
- Correlation coefficient between Log_Federal Receipts as Percentage of GDP and Population Growth is 0.3186 — Weak Positive Correlation.
- Correlation coefficient between Log_Federal Receipts as Percentage of GDP and Gross Fixed Capital is -0.1767 — Very Weak Negative.
- Correlation coefficient between Population Growth and Gross Fixed Capital is -0.5975 — Moderate Negative Correlation.

HeatMap of the Correlation Matrix:-**Residual Analysis:-**

A residual analysis is done to check the model's fit to the data. A residual is a difference between the actual value and the predicted value of the dependent variable. By analysing the residuals, we can verify if the model fits the data well and identify any pattern related to outliers in the data. As we know, there is no pattern for the residuals and thus we can check it through the residual plots.



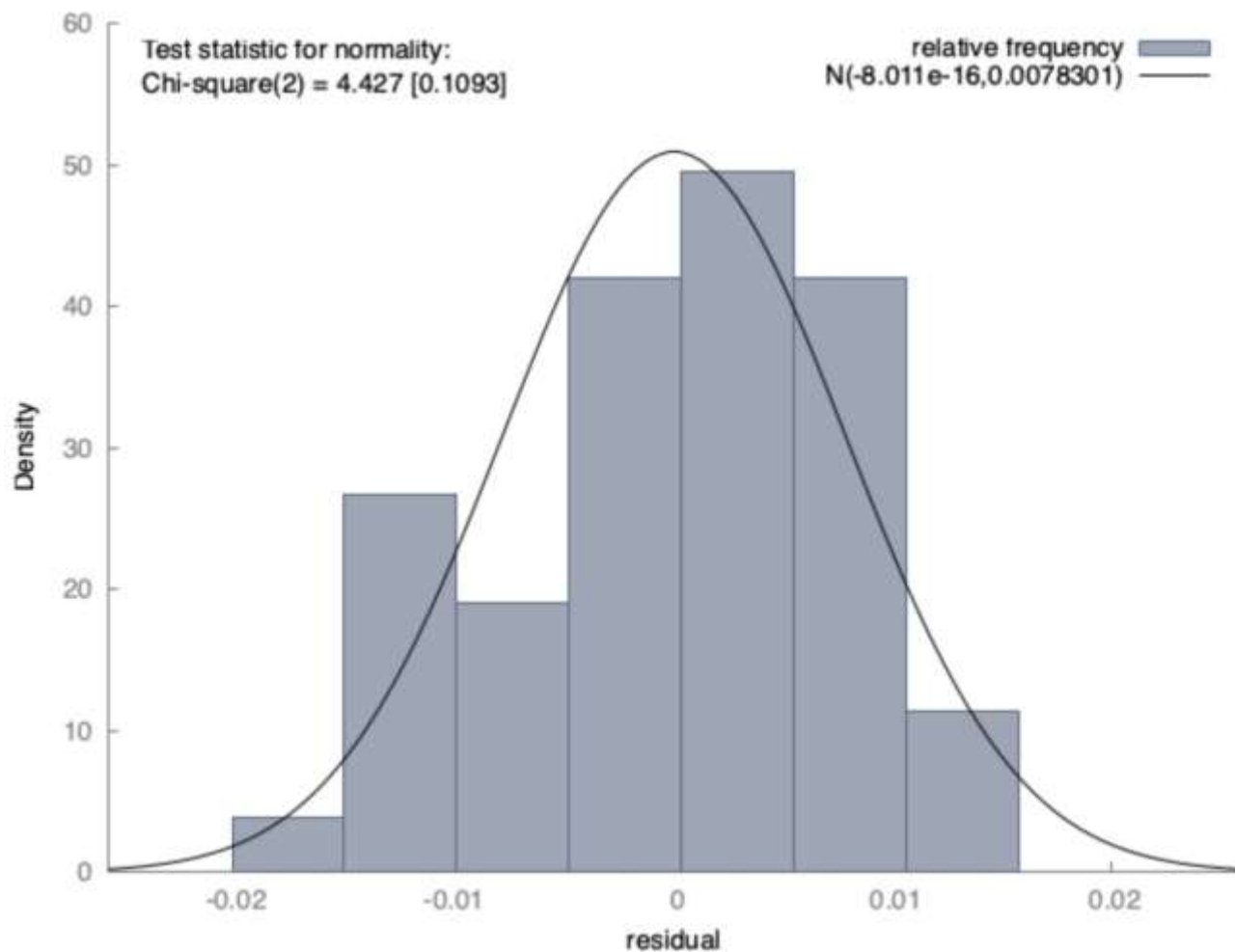


Upon looking at the graphs, it can be clearly stated that the residuals do not exhibit a fixed pattern or do not follow any kind of trend. This proves the fact that errors or residuals have no pattern.

Normality of Residuals:-

H0: Residuals follow a normal distribution

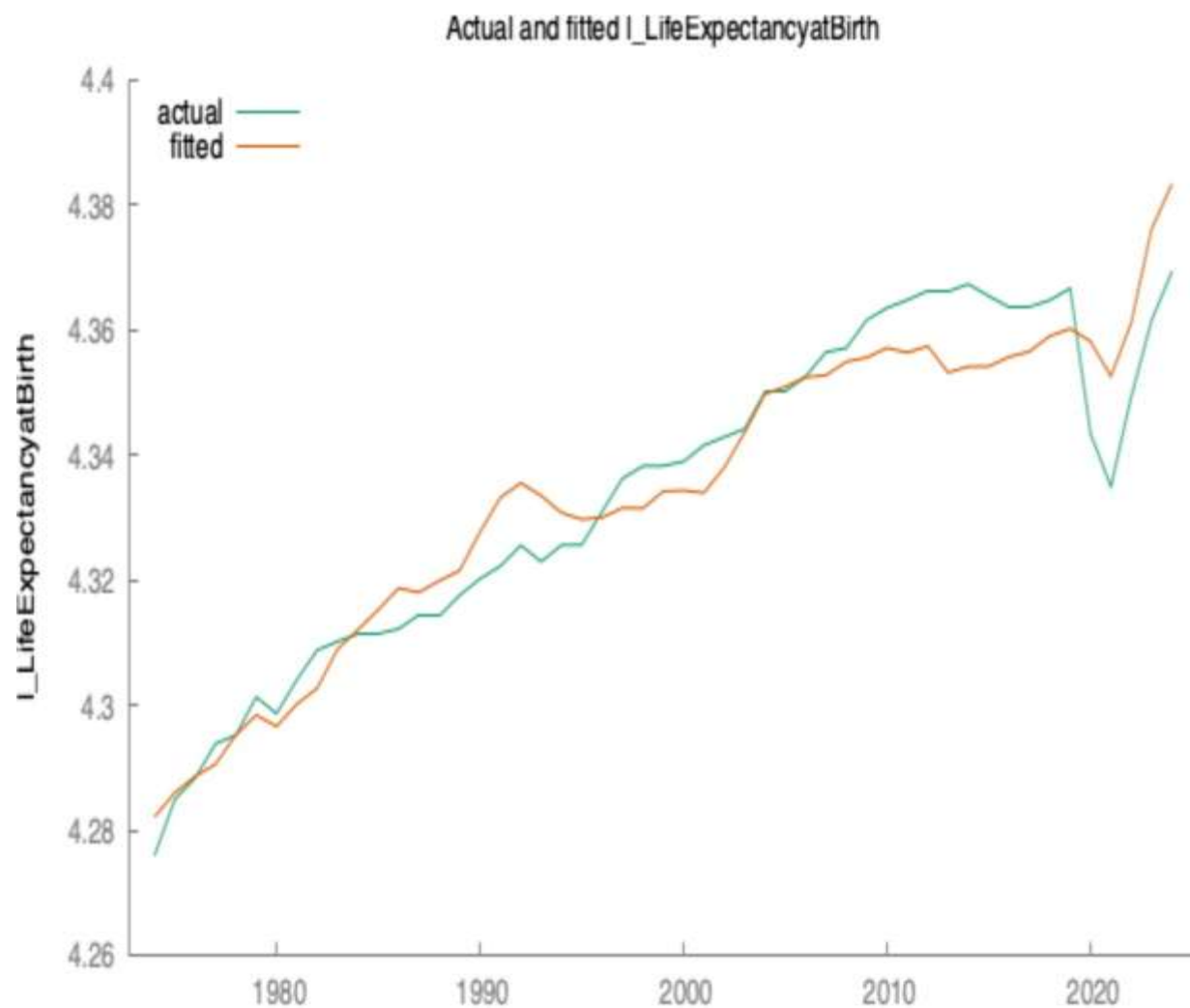
H1: Residuals do not follow a normal distribution



The curve for the test of normality, thus shows that the residuals do follow a normal distribution. This hypothesis test is conducted with the help of chi-square test in order to know the normality of the residuals. Test-statistic: Chi-square(2) = 4.427 & p-value: 0.1093.

Interpretation:-

The p-value is greater than the test statistic. Thus, we fail to reject the null hypothesis, which in turn means the residuals follow a normal distribution.

Fitted Vs Actual

In regression analysis, the actual values are the observed outcomes of the dependent variable while the fitted values are the predictions made by the regression model based on a given set of independent variables. Assessing the disparity between these two values serves as a means to gauge the model's accuracy. A well-fitting model typically yields actual and fitted values that closely align, with small and random residuals. Conversely, a poorly fitting model results in larger discrepancies between actual and fitted values, accompanied by discernible patterns in the residuals, indicating the model's failure to accurately capture the interrelationships among variables. In this specific model, the proximity between actual and fitted values suggests a robust correlation, indicating a strong alignment between the model's predictions and observed outcomes.

Heteroskedasticity - White's Test:-

H_0 : Heteroskedasticity not present

H_1 : Heteroskedasticity is present

```

White's test for heteroskedasticity
OLS, using observations 1974-2024 (T = 51)
Dependent variable: uhat^2

      coefficient    std. error    t-ratio    p-value
-----
const                -0.00633200    0.0227457    -0.2784    0.7823
l_NationalDefenc~    -0.000935882    0.00273247    -0.3425    0.7340
l_FederalReceipt~    0.00492869    0.0130529     0.3776    0.7080
PopulationGrowth      0.00232276    0.00370312     0.6272    0.5345
GrossFixedCapita~    0.000281724    0.00158490     0.1778    0.8599
sq_l_NationalDef~    9.69124e-05    0.000151264    0.6407    0.5258
X2_X3                 8.58117e-05    0.000721297    0.1190    0.9060
X2_X4                -0.000281059    0.000311980    -0.9009    0.3736
X2_X5                -2.99773e-05    0.000172434    -0.1738    0.8630
sq_l_FederalRece~    -0.000719681    0.00186306    -0.3863    0.7016
X3_X4                -0.000801745    0.00100100    -0.8009    0.4284
X3_X5                -0.000151779    0.000389391    -0.3898    0.6990
sq_PopulationGro~    0.000622810    0.000197291     3.157    0.0032 ***
X4_X5                 0.000204978    0.000136210     1.505    0.1411
sq_GrossFixedCap~    2.08883e-05    4.28193e-05     0.4878    0.6286

Unadjusted R-squared = 0.744828

Test statistic: TR^2 = 37.986229,
with p-value = P(Chi-square(14) > 37.986229) = 0.000522

```

Interpretation: The p-value is very small, therefore we have enough evidence to reject the null hypothesis. Therefore, heteroskedasticity is present in the model.

Multicollinearity:-

```

Variance Inflation Factors
Minimum possible value = 1.0
Values > 10.0 may indicate a collinearity problem

l_NationalDefenceExpenditures    6.257
l_FederalReceiptsasPercentof    1.316
PopulationGrowth                 1.839
GrossFixedCapitalFormation       7.334

VIF(j) = 1/(1 - R(j)^2), where R(j) is the multiple correlation coefficient
between variable j and the other independent variables

Belsley-Kuh-Welsch collinearity diagnostics:

variance proportions

lambda    cond    const l_Nation~ l_Federa~ Populati~ GrossFix~
4.797     1.000    0.000    0.000    0.000    0.001    0.001
0.183     5.120    0.000    0.000    0.000    0.050    0.081
0.018     16.508    0.003    0.004    0.004    0.842    0.169
0.002     52.360    0.005    0.635    0.059    0.003    0.485
0.000     163.528    0.992    0.361    0.938    0.104    0.264

lambda = eigenvalues of inverse covariance matrix (smallest is 0.000179403)
cond = condition index
note: variance proportions columns sum to 1.0

According to BKW, cond >= 30 indicates "strong" near linear dependence,
and cond between 10 and 30 "moderately strong". Parameter estimates whose
variance is mostly associated with problematic cond values may themselves
be considered problematic.

Count of condition indices >= 30: 2
Variance proportions >= 0.5 associated with cond >= 30:

const l_Nation~ l_Federa~ GrossFix~
0.997    0.996    0.996    0.749

Count of condition indices >= 10: 3
Variance proportions >= 0.5 associated with cond >= 10:

const l_Nation~ l_Federa~ Populati~ GrossFix~
1.000    1.000    1.000    0.948    0.918

```

Interpretation: All the variables have Variance Inflation Factors less than 10 and hence, there is no multicollinearity among the independent variables in the model. It does not raise any concern.

Autocorrelation:-

Autocorrelation is a representation of the degree of similarity between a given time series and a lagged version of itself over successive time intervals. As our data is measured annually, the lagged intervals will be 1. Two tests will be conducted for autocorrelation.

Breusch-Godfrey Test:-

H_0 : no autocorrelation H_A : not H_0

Breusch-Godfrey test for first-order autocorrelation

OLS, using observations 1974-2024 (T = 51)

Dependent variable: uhat

	coefficient	std. error	t-ratio	p-value
const	-0.0289420	0.0324502	-0.8919	0.3772
l_NationalDefenc~	0.000635577	0.00234901	0.2706	0.7880
l_FederalReceipt~	0.00713595	0.00965613	0.7390	0.4637
PopulationGrowth	0.00523409	0.00349282	1.499	0.1410
GrossFixedCapita~	-9.44996e-05	0.00130163	-0.07260	0.9424
uhat_1	0.907619	0.0812862	11.17	1.47e-14 ***

Unadjusted R-squared = 0.734784

Test statistic: LMF = 124.673282,
with p-value = $P(F(1,45) > 124.673) = 1.47e-14$

Alternative statistic: $TR^2 = 37.474005$,
with p-value = $P(\text{Chi-square}(1) > 37.474) = 9.26e-10$

Ljung-Box $Q' = 35.4314$,
with p-value = $P(\text{Chi-square}(1) > 35.4314) = 2.64e-09$

Interpretation: The p-value is very small, therefore we have enough evidence to reject the null hypothesis. Therefore, autocorrelation is present in the model.

Durbin-Watson Test:-

H_0 : no autocorrelation H_A : not H_0

Durbin-Watson statistic = 0.297712

H_1 : positive autocorrelation

p-value = $9.15878e-13$

H_1 : negative autocorrelation

p-value = 1

Interpretation: The Durbin-Watson statistic for this model is 0.2977 which is substantially lower than the ideal value of 2.0. Because the statistic is close to zero and the associated p-value ($p < 0.05$) is highly significant, we reject the null hypothesis of no autocorrelation. We conclude that there is strong evidence of positive first-order autocorrelation in the residuals meaning the error terms are not independent over time.

Chow Test:-

The Chow Test is used to test whether the structural breaks are statistically significant or not.

H_0 : no structural break

H_A : not H_0

Structural Break in Year 2001 The year 2001 is introduced as a potential structural break point in the model to account for the September 11 terrorist attacks, which marked a major geopolitical and economic turning point in the United States. The event led to a significant shift in national priorities, particularly with respect to defence expenditure, national security policies, and government spending patterns. These changes likely influenced broader macroeconomic conditions, including investment decisions and fiscal allocations, which may in turn affect human capital development proxied by life expectancy.

Augmented regression for Chow test
 OLS, using observations 1974–2024 (T = 51)
 Dependent variable: l_LifeExpectancyatBirth

	coefficient	std. error	t-ratio	p-value	
const	4.09258	0.0979975	41.76	3.17e-35	***
l_NationalDefenc~	0.0181317	0.00398720	4.547	4.74e-05	***
l_FederalReceipt~	0.0279833	0.0321621	0.8701	0.3893	
PopulationGrowth	0.0155358	0.00878585	1.768	0.0845	*
GrossFixedCapita~	0.0135687	0.00450113	3.015	0.0044	***
splitdum	0.0384238	0.144234	0.2664	0.7913	
sd_l_NationalDef~	0.0173564	0.0105034	1.652	0.1061	
sd_l_FederalRece~	-0.0355472	0.0395686	-0.8984	0.3742	
sd_PopulationGro~	0.0109256	0.0114422	0.9549	0.3452	
sd_GrossFixedCap~	-0.0155971	0.00583611	-2.673	0.0108	**
Mean dependent var	4.334114	S.D. dependent var	0.025926		
Sum squared resid	0.001358	S.E. of regression	0.005755		
R-squared	0.959588	Adjusted R-squared	0.950717		
F(9, 41)	108.1717	P-value(F)	1.14e-25		
Log-likelihood	196.2379	Akaike criterion	-372.4758		
Schwarz criterion	-353.1575	Hannan-Quinn	-365.0937		
rho	0.683898	Durbin-Watson	0.578344		

Chow test for structural break at observation 2001
 $F(5, 41) = 8.82825$ with p-value 0.0000

Chow test for structural break at observation 2001 –
 Null hypothesis: no structural break
 Test statistic: $F(5, 41) = 8.82825$
 with p-value = $P(F(5, 41) > 8.82825) = 9.47418e-06$

Interpretation: The p-value of the test is less than 0.05 i.e. 9.47418e-06, which makes the 2001 September 11 terrorist attacks a statistically significant structural break i.e. 2001.

Structural Break in Year 2008:-

The year 2008 is introduced as a potential structural break point in the model to account for the Global Financial Crisis, which marked one of the most severe economic downturns in modern US history. The crisis led to a collapse in financial markets, a sharp contraction in credit availability, rising unemployment, and significant disruptions in investment, fiscal balances, and overall economic stability. Given these widespread macroeconomic changes, it is plausible that the relationships between the explanatory variables and life expectancy (as a proxy for human capital development) may have experienced a structural shift post-2008. Therefore, a Chow test is employed to examine whether the regression coefficients remain stable before and after the crisis period.

Augmented regression for Chow test
 OLS, using observations 1974–2024 (T = 51)
 Dependent variable: l_LifeExpectancyatBirth

	coefficient	std. error	t-ratio	p-value	
const	4.14782	0.0383899	108.0	5.58e-52	***
l_NationalDefenc~	0.0172520	0.00252116	6.843	2.75e-08	***
l_FederalReceipt~	0.0101016	0.0127278	0.7937	0.4320	
PopulationGrowth	0.0129967	0.00502941	2.584	0.0134	**
GrossFixedCapita~	0.0157600	0.00156958	10.04	1.30e-12	***
splitdum	0.755185	0.143837	5.250	5.00e-06	***
sd_l_NationalDef~	-0.0786612	0.0157458	-4.996	1.14e-05	***
sd_l_FederalRece~	-0.0850016	0.0249883	-3.402	0.0015	***
sd_PopulationGro~	0.0282886	0.00740713	3.819	0.0004	***
sd_GrossFixedCap~	-0.00308312	0.00374089	-0.8242	0.4146	
Mean dependent var	4.334114	S.D. dependent var	0.025926		
Sum squared resid	0.000619	S.E. of regression	0.003887		
R-squared	0.981569	Adjusted R-squared	0.977523		
F(9, 41)	242.6143	P-value(F)	1.26e-32		
Log-likelihood	216.2581	Akaike criterion	-412.5161		
Schwarz criterion	-393.1979	Hannan-Quinn	-405.1340		
rho	0.234276	Durbin-Watson	1.394408		

Chow test for structural break at observation 2008
 $F(5, 41) = 29.1368$ with p-value 0.0000

Chow test for structural break at observation 2008 –
 Null hypothesis: no structural break
 Test statistic: $F(5, 41) = 29.1368$
 with p-value = $P(F(5, 41) > 29.1368) = 1.71324e-12$

Interpretation: The p-value of the test is less than 0.05 i.e. 1.71324e-12, which makes the 2008 Global Financial Crisis a statistically significant structural break i.e. 2008.

Structural Break in Year 2020:-

The year 2020 marks a potential structural break in the United States due to the outbreak of the COVID-19 pandemic, which caused an unprecedented health and economic shock. The pandemic led to a sharp decline in life expectancy, significant disruptions in economic activity, and major changes in fiscal policy, healthcare expenditure, and labour market conditions. Given these large-scale and sudden shifts, 2020 is a suitable break point to examine whether the relationships between macroeconomic variables and life expectancy changed significantly in the post-pandemic period.

Augmented regression for Chow test

OLS, using observations 1974–2024 (T = 51)

Dependent variable: l_LifeExpectancyatBirth

	coefficient	std. error	t-ratio	p-value	
const	4.20810	0.0372593	112.9	9.12e-53	***
l_NationalDefenc~	0.0219245	0.00263117	8.333	2.33e-10	***
l_FederalReceipt~	-0.0187793	0.0114205	-1.644	0.1078	
PopulationGrowth	0.0120844	0.00485226	2.490	0.0169	**
GrossFixedCapita~	0.0141576	0.00158888	8.910	3.87e-11	***
splitdum	1.06355	8.89474	0.1196	0.9054	
sd_l_NationalDef~	-0.172366	1.42334	-0.1211	0.9042	
sd_l_FederalRece~	-0.0255437	0.286941	-0.08902	0.9295	
sd_PopulationGro~	0.0359506	0.108023	0.3328	0.7410	
sd_GrossFixedCap~	0.0303695	0.343648	0.08837	0.9300	
Mean dependent var	4.334114	S.D. dependent var	0.025926		
Sum squared resid	0.000774	S.E. of regression	0.004345		
R-squared	0.976964	Adjusted R-squared	0.971907		
F(9, 41)	193.1988	P-value(F)	1.20e-30		
Log-likelihood	210.5703	Akaike criterion	-401.1406		
Schwarz criterion	-381.8223	Hannan-Quinn	-393.7585		
rho	0.726559	Durbin-Watson	0.482872		

Chow test for structural break at observation 2020

F(5, 41) = 21.6722 with p-value 0.0000

Chow test for structural break at observation 2020 –

Null hypothesis: no structural break

Test statistic: F(5, 41) = 21.6722

with p-value = P(F(5, 41) > 21.6722) = 1.4964e-10

Interpretation: The p-value of the test is less than 0.05 i.e. 1.4964e-10, which makes the COVID-19 pandemic a statistically significant structural break i.e. 2020

Reset Specification Test:-

The RESET Specification Test is used to test whether the model needs a new functional form or not and if it suffers from any omitted variables or not. The null hypothesis indicates that the functional form being used is adequate and there are no omitted variables.

H0: Specification is adequate

HA: not H0

Auxiliary regression for RESET specification test

OLS, using observations 1974–2024 (T = 51)

Dependent variable: $\ln_LifeExpectancyatBirth$

	coefficient	std. error	t-ratio	p-value	
const	76.8191	44.8825	1.712	0.0939	*
$\ln_NationalDefence$	0.908810	0.546256	1.664	0.1031	
$\ln_FederalReceipts$	-1.23381	0.742292	-1.662	0.1034	
PopulationGrowth	0.935419	0.562406	1.663	0.1032	
GrossFixedCapita	0.367409	0.220954	1.663	0.1033	
$\hat{y}^2$	-0.00250266	0.00154731	-1.617	0.1128	

Null hypothesis: specification is adequate

Test statistic: $F = 2.616080$,

with p-value = $P(F(1,45) > 2.61608) = 0.113$

RESET test for specification (squares only) –

Null hypothesis: specification is adequate

Test statistic: $F(1, 45) = 2.61608$

with p-value = $P(F(1, 45) > 2.61608) = 0.112775$

Interpretation: The p-value of the test is more than 0.05 i.e. 0.113. Thus, we fail to reject the null hypothesis, meaning, the functional form used is correct and our model does not suffer from any omitted variables.

Lenier Restrictions Test:-

The Linear Restrictions Test is used to examine specific hypotheses about the relationships between regression coefficients. Unlike the overall F-test, which checks whether all explanatory variables jointly influence the dependent variable, this test allows us to impose and evaluate particular restrictions based on economic reasoning. It helps determine whether certain variables have equal effects, whether their combined impact follows a theoretical expectation, or whether a specific variable can be excluded from the model. The test is conducted using the F-statistic framework, and the results provide deeper insights into the structure and validity of the estimated regression model. To further examine specific relationships between the explanatory variables, linear restrictions were tested using the F-test in Gretl.

To compare the impact of defence expenditure and gross fixed capital formation:-

- $H_0: \beta_2 = \beta_5$
- $H_A: \beta_2 \neq \beta_5$

Restriction:

$$b[\text{_NationalDefenceExpenditures}] - b[\text{GrossFixedCapitalFormation}] = 0$$

Test statistic: $F(1, 46) = 4.99345$, with p-value = 0.0303428

Restricted estimates:

	coefficient	std. error	t-ratio	p-value	
const	4.31152	0.0505333	85.32	3.42e-53	***
_NationalDefenceExpenditures	0.0153739	0.000792314	19.40	4.48e-24	***
_FederalReceiptsasPercentof	-0.0496795	0.0177498	-2.799	0.0074	***
PopulationGrowth	0.0315515	0.00638966	4.938	1.04e-05	***
GrossFixedCapitalFormation	0.0153739	0.000792314	19.40	4.48e-24	***

Standard error of the regression = 0.00815598

Interpretation: An F-test was performed to test the equality of the coefficients for National Defence Expenditures and Gross Fixed Capital Formation. With an F-statistic of 4.99 and a p-value of 0.03, we reject the null hypothesis of equality at the 5% level. This indicates that these two factors do not have the same marginal effect on the dependent variable

To examine fiscal trade-offs:-

- $H_0: \beta_2 + \beta_5 = 0$
- $H_A: \beta_2 + \beta_5 \neq 0$

Restriction:

$$b[\text{_NationalDefenceExpenditures}] + b[\text{_FederalReceiptsasPercentof}] = 0$$

Test statistic: $F(1, 46) = 0.159$, with p-value = 0.691924

Restricted estimates:

	coefficient	std. error	t-ratio	p-value	
const	4.20038	0.0102754	408.8	4.12e-85	***
_NationalDefenceExpenditures	0.0263311	0.00367540	7.164	4.61e-09	***
_FederalReceiptsasPercentof	-0.0263311	0.00367540	-7.164	4.61e-09	***
PopulationGrowth	0.0248204	0.00609244	4.074	0.0002	***
GrossFixedCapitalFormation	0.00954248	0.00212819	4.484	4.70e-05	***

Standard error of the regression = 0.00775974

Interpretation: To test whether the combined impact of National Defence Expenditures and Federal Receipts is net zero, a linear restriction test was conducted. The resulting F-statistic (0.159) with a p-value of 0.69 is well above the 5% significance level. Therefore, we fail to reject the null hypothesis. This suggests that the data does not provide sufficient evidence against the imposed restriction, implying that the assumption of a net-zero combined effect cannot be rejected.

Conclusion:-

In this Econometric Study, several key insights emerged regarding the factors influencing the Life Expectancy at Birth (Total for the United States; no. of years) (Proxy for Human Capital Development) in the USA. The study took a Time Series approach, focusing on the Annual data from 1974 to 2024 to examine and dissect the relationship between the Life Expectancy at Birth (Proxy for Human Capital Development) and four independent variables - National Defence Consumption Expenditures and Gross Investment (Billions of Dollars), (2) Government Total

Revenue (Percent of Gross Domestic Product), (3) Population Growth Rate (Percent Change at Annual Rate), (4) Gross Fixed Capital Formation (trillions of Dollars).

The Regression is as follows:-

$\text{Log_Life Expectancy at Birth} = \beta_1 + \beta_2 (\text{Log_National Defence Expenditures}) - \beta_3 (\text{Log_Federal Receipts as Percentage of GDP}) + \beta_4 (\text{Population Growth}) + \beta_5 (\text{Gross Fixed Capital Formation}) + U_i$
 $Y_i = 4.22481 + 0.0253078 X_{2i} - 0.0335601 X_{3i} + 0.0258288 X_{4i} + 0.0100527 X_{5i} + U_i$

The analysis revealed several significant findings. Log National Defence Expenditures and Gross Fixed Capital Formation exhibited a strong positive correlation with Life Expectancy at Birth, indicating that higher government spending capacity and capital investment are associated with improved life expectancy. On the other hand, Population Growth showed a negative correlation with Life Expectancy, suggesting that higher population growth may put pressure on resources and reduce overall health outcomes. Log Federal Receipts as a Percentage of GDP also displayed a weak negative correlation with Life Expectancy, although the relationship is limited.

While the positive association of defence expenditure with life expectancy may seem unexpected, it likely reflects overall economic development rather than a direct causal effect. The model's constant term is statistically significant indicating that the baseline level of Life Expectancy is well captured even in the absence of explanatory variables. Furthermore, the overall specification of the model appears appropriate as supported by diagnostic testing such as the RESET test which suggests that the chosen functional form is adequate and that there is no strong evidence of omitted variable bias. This implies that the variables included in the model are sufficient to explain variations in Life Expectancy. The model's high R-squared value of 0.916079 indicates that the independent variables explain approximately 91.6079% of the variation in Life Expectancy at Birth, highlighting the model's strong explanatory power. Furthermore, the F-statistic of 125.5343 and its associated p-value of 3.92e-24 confirm the overall significance of the model. I conducted various tests for the regression model. Firstly, I examined the Normality of Residuals, which indicated that the residuals were distributed normally. Given that my study follows a Time Series approach, heteroskedasticity and autocorrelation is expected to occur. However, my model did not show any sign of multicollinearity, which was confirmed through the Variance Inflation Factor (VIF) test.

Additionally, I conducted three Chow tests with the structural breaks identified as 2001 (September attacks), 2008 (the Global Financial Crisis) and 2020 (Covid-19). All of these structural breaks were found to be statistically significant. Life expectancy is influenced by a wide range of factors that are not always feasible to fully capture or predict. However, this study focuses on key macroeconomic variables that significantly shape human capital development in the United States. In particular, the analysis highlights the relationship between defence expenditure and life expectancy as a proxy for human capital development. The findings suggest that higher defence expenditure is positively associated with life expectancy which may reflect broader economic strength, technological advancement and institutional capacity that indirectly support public health systems and living standards. At the same time, this relationship is not necessarily direct as defence spending may involve opportunity costs by diverting resources away from healthcare and social sectors.

This becomes especially relevant in developing countries where limited resources mean that higher defence expenditure may negatively impact human capital development. In contrast, in developed countries like the United States, the relationship tends to be positive, as higher defence spending often coexists with strong public investment in health, education and infrastructure. These factors not only influence current health outcomes but also shape long-term human capital formation through improvements in innovation, institutional efficiency, and economic stability. Overall the study provides valuable insights into how defence spending interacts with human capital development highlighting the importance of balanced policy decisions to ensure sustained improvements in population health and overall economic well-being.

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