The impact of GDP, Population and FDI on Life expectancy in Africa

What economic data drives life expectancy in Africa? Is there a link between life expectancy, GDP, Foreign direct investments, the population

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Soutenance de Project Fundamental Economy

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Figure: Would you like to live longer?

Background

"Improved health and life expectancy were not the cause of England's economic success but one of the fruits of its previous political and economic changes."

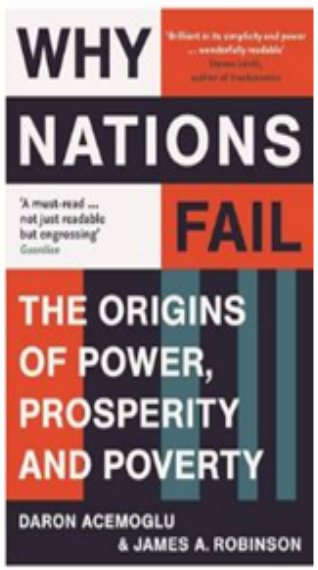


Figure: Daron Acemoglu, Why Nations Fail, the origins of Power, Prosperity and Poverty

Background

"We are living longer, and we need to live better."

Figure: Donna Shalala, *The former US Secretary of Health and Social Services*

Introduction

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).

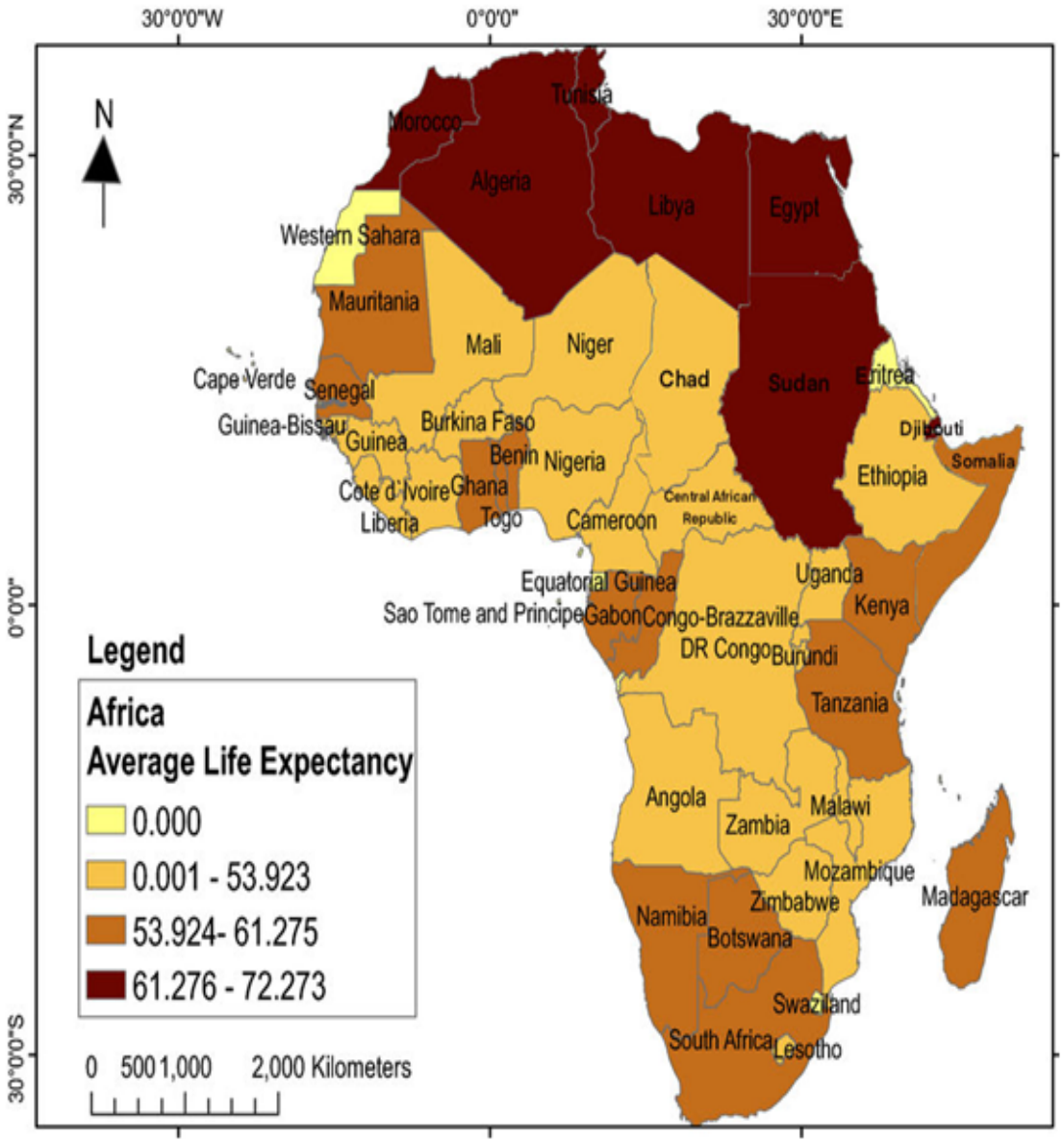
72.6–73.2 years on a world average level and Africa 64.38 years in 2020

Methodology:

- Collecting data.
- Data analysis
- Data pre-processing
- Selection of principle attribute
- Train model(linear regressions)
- Test model
- Implements models on dataset

Regional level comparison

Region	Avg life expectancy
Southern Africa	58.9
Middle Africa	59.9
Western Africa	60.7
Eastern Africa	62.8
Northern Africa	71.8



Questions of interest and Assumptions

Questions of interest:

- Is there a significant link between respectively life expectancy and GDP, population and FDI?
- What are the impacts of GDP on life expectancy?
- What are the impacts of population size on life expectancy? What are the impacts of FDI on life expectancy in Africa?

Initial assumptions

- The higher the GDP of an African country, the higher its life expectancy.
- The lower the population the higher the life expectancy.
- The more FDI an African country receive/has, the higher the life expectancy.

Factors we want to study

Life Expectancy (in years)	GDP (in Million)	Population (in Million)	FDI (in Million)
Life expectancy at birth indicates the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	GDP is often used as a metric for international comparisons as well as a broad measure of economic progress. It is often considered to be the world's most powerful statistical indicator of national development and progress.	A growing population increases the size of the labor force, providing more human capital which is a key component of economic growth.	Foreign direct investment refers to direct investment equity flows in the reporting economy. It is the sum of equity capital, reinvestment of earnings, and other capital.
*Here for both men and women(average value)	*Here GDP is the total value for year 2015		*FDI data do not give a complete picture of international investment in an economy.

Data collection and pre-processing

1. Our project uses data from multiple sources, **GDP** and **Life expectancy** data are from the World Bank Open Data platform and **Population** data is from Worldometers.
2. Change the values except **FDI** into ln, because the FDI in Algeria is negative in 2015.
3. We have no data about Eritrea's GDP in 2015, we deleted it from the database.
4. Sample size n=53 countries in Africa.

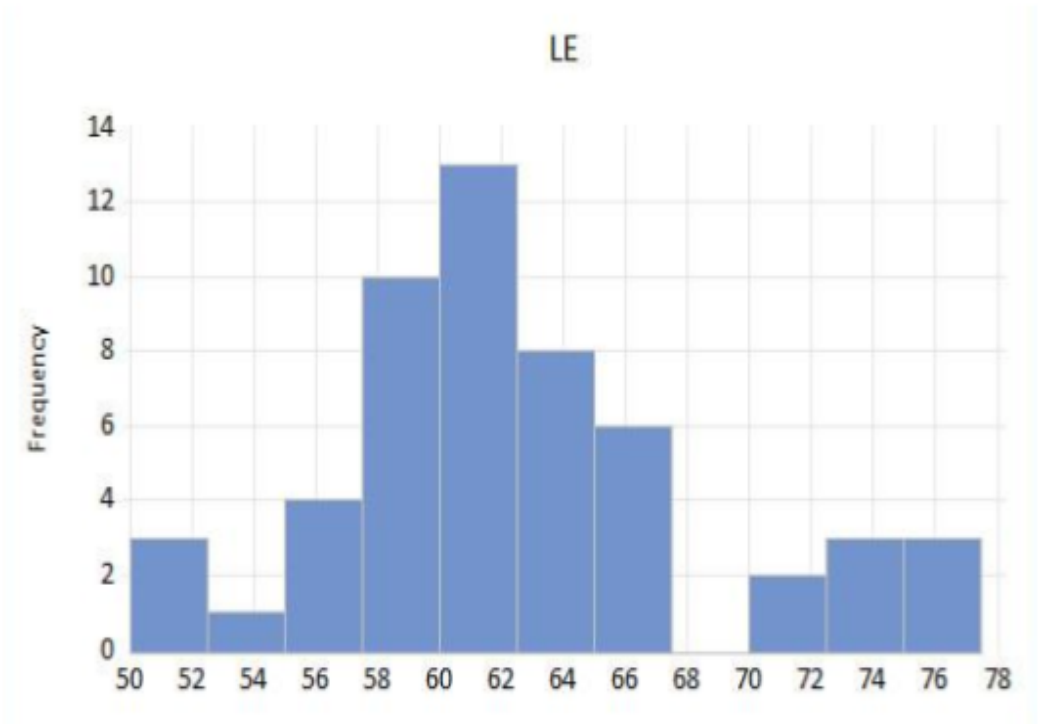
Data: Descriptive statistics

- Life Expectancy **Q1**: 58 years (13 countries below) **Median**: 61 years (26 countries) **Q3**: 62 years (39 countries)

Data	Highest value	Mean value	Lowest value	Medium value
LE	76(Tunisia)	62	51(Lesotho)	61(Uganda)
GDP	493027M (Nigeria)	45303M	259M (Sao Tome & Principe)	12007M (Mauritius)
Population	223M(Nigeria)	23M	0.1M(Seychelles)	14M(Rwanda)
FDI	970521M(Tunisia)	22055M	-537M(Algeria)	328M (Madagascar)

Test : Jarque-Bera F-Test for le

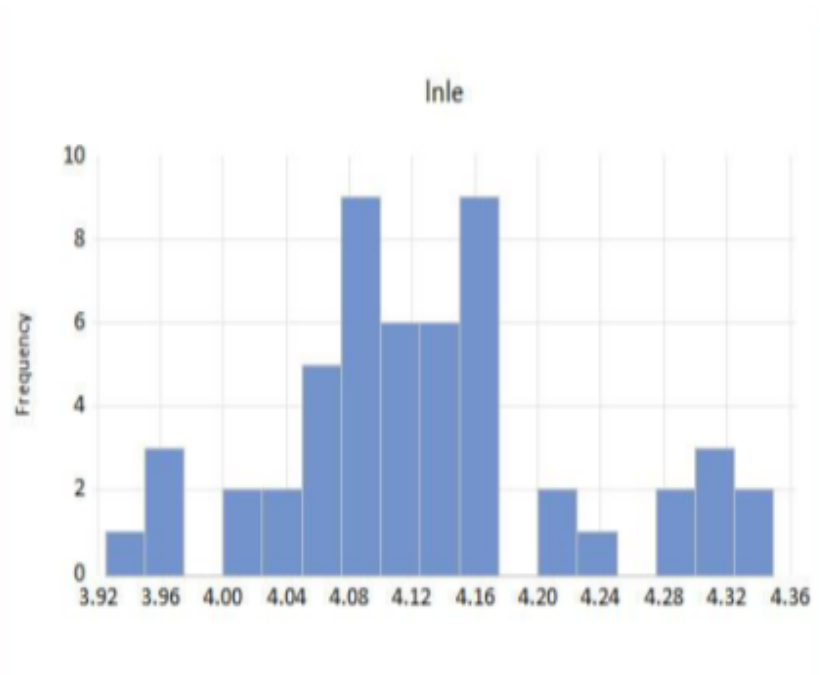
- Skewness is **0.6** and kurtosis is **3.04**, Pvalue is **0.19**, we conclude that LE is **normally distributed**



	LE
Mean	62.28302
Median	61.00000
Maximum	76.00000
Minimum	51.00000
Std. Dev.	6.118627
Skewness	0.606082
Kurtosis	3.047376
Jarque-Bera	3.249753
Probability	0.196936
Sum	3301.000
Sum Sq. Dev.	1946.755
Observations	53

Test : Jarque-Bera F-Test for lnle

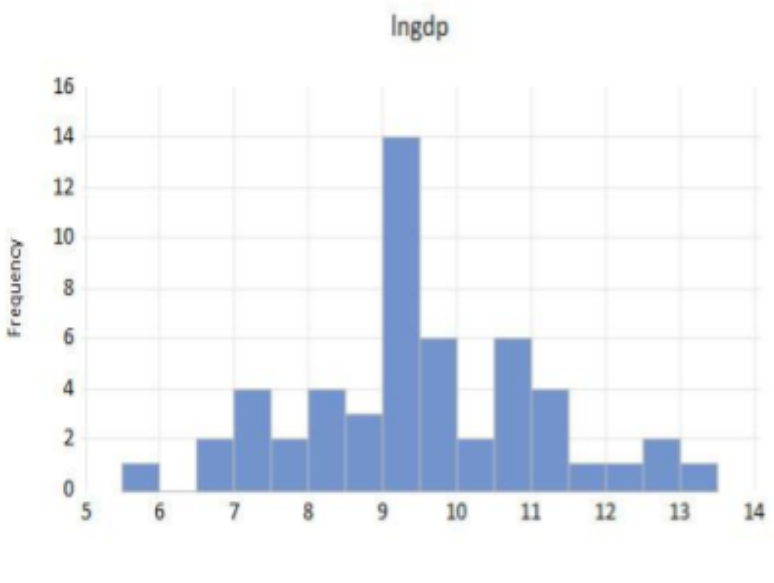
- Skewness is **0.35** and kurtosis is **2.92**, Pvalue is **0.56**, we conclude that lnLE is **normally distributed**



	LNLE
Mean	4.127077
Median	4.110874
Maximum	4.330733
Minimum	3.931826
Std. Dev.	0.096423
Skewness	0.355469
Kurtosis	2.929035
Jarque-Bera	1.127286
Probability	0.569132
Sum	218.7351
Sum Sq. Dev.	0.483461
Observations	53

Test :Jarque-Bera F-Test for lnGDP

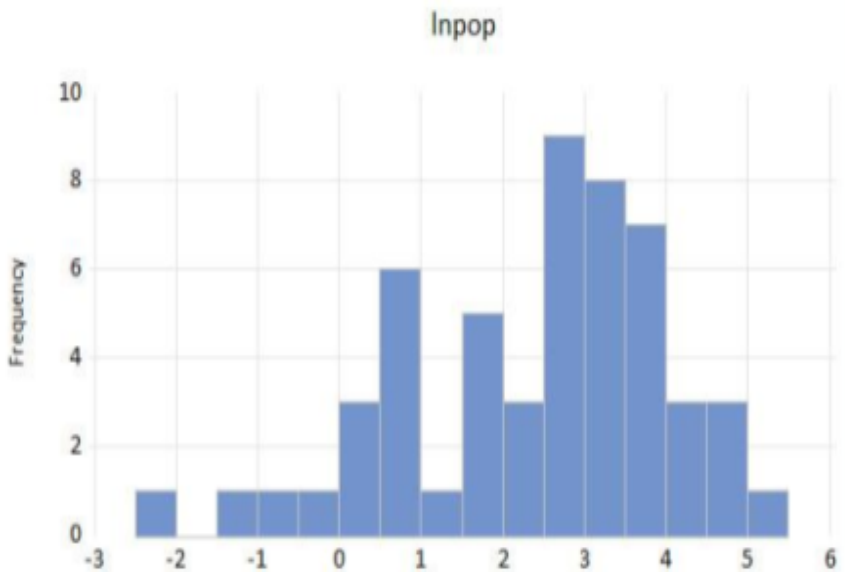
- Skewness is **0.05** and kurtosis is **2.93**, Pvalue is **0.98**, we conclude that lnGDP is **normally distributed**



	LNGDP
Mean	9.517427
Median	9.393269
Maximum	13.10832
Minimum	5.560680
Std. Dev.	1.587449
Skewness	0.050960
Kurtosis	2.933157
Jarque-Bera	0.032807
Probability	0.983730
Sum	504.4236
Sum Sq. Dev.	131.0397
Observations	53

Test : Jarque-Bera F-Test for lnPOP

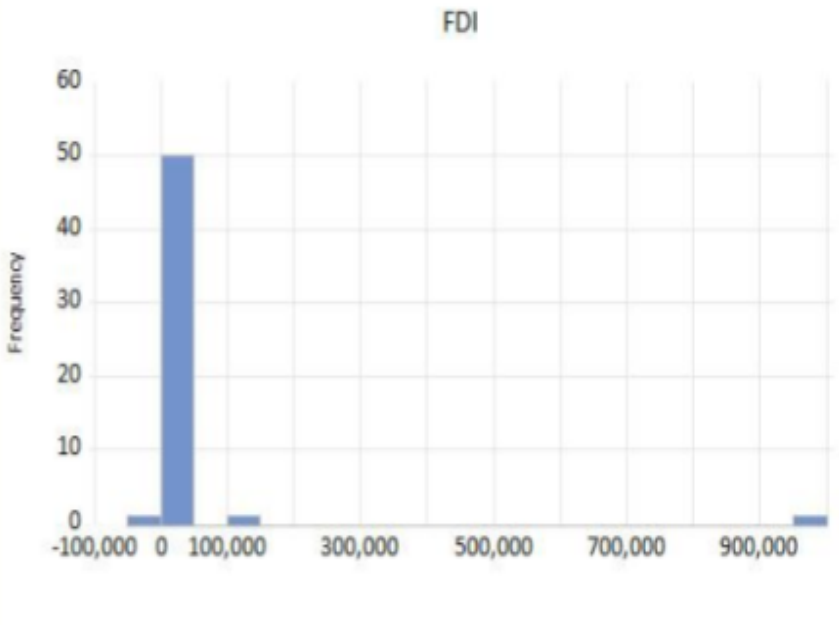
- Skewness is -**0.65** and kurtosis is **3.12**,Pvalue is **0.14**, we conclude that lnPOP is **normally distributed**



	LNPOP
Mean	2.374782
Median	2.652581
Maximum	5.410773
Minimum	-2.228777
Std. Dev.	1.627842
Skewness	-0.659115
Kurtosis	3.122798
Jarque-Bera	3.870791
Probability	0.144367
Sum	125.8634
Sum Sq. Dev.	137.7932
Observations	53

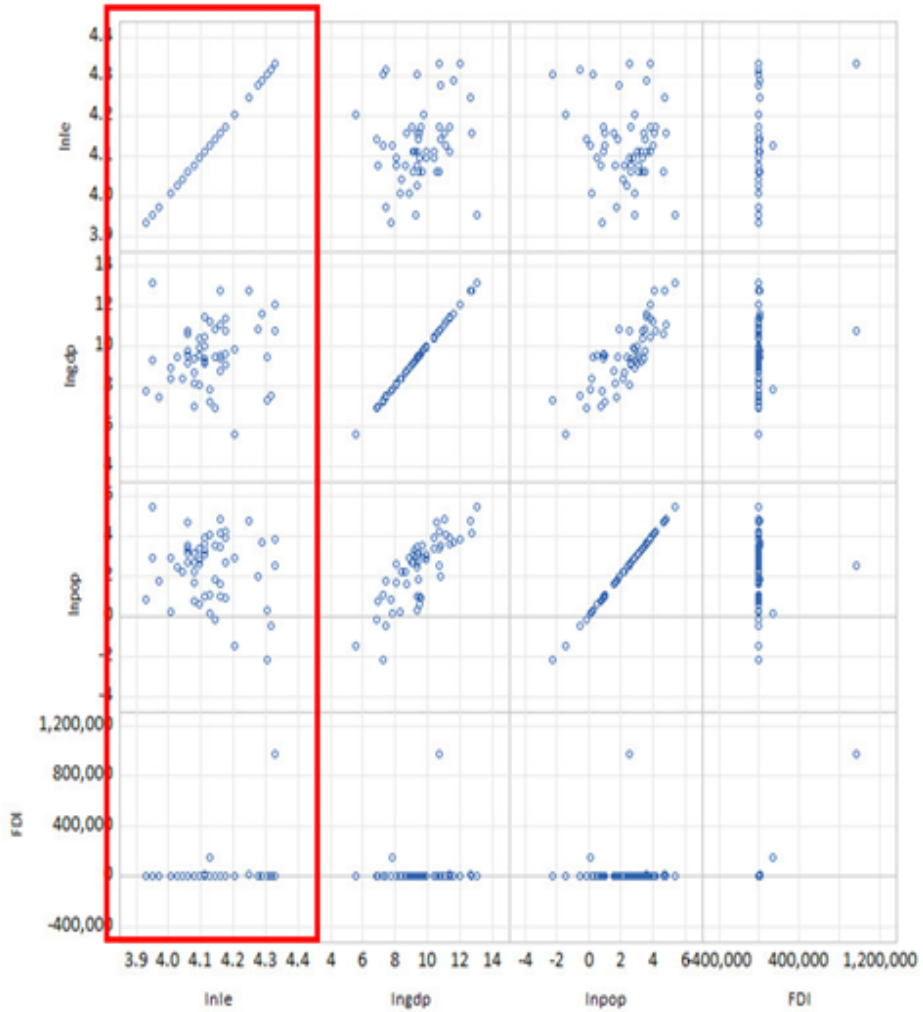
Test : Jarque-Bera F-Test for FDI

- Skewness is **6.8** and kurtosis is **48**,Pvalue is **0**, we conclude that FDI is **not normally distributed**

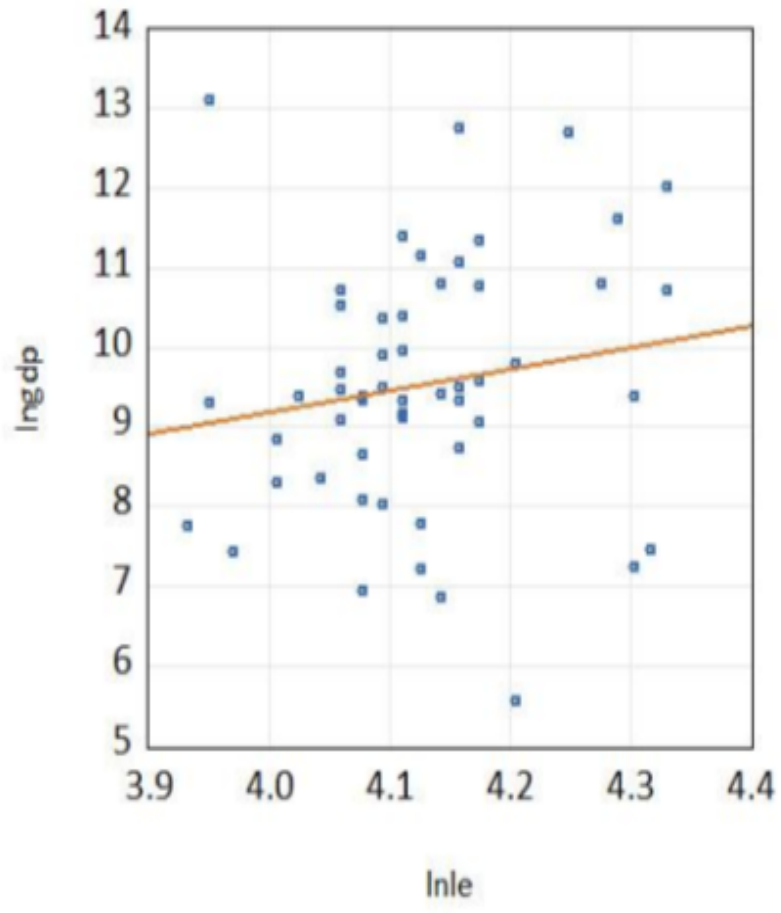


	FDI
Mean	22044.58
Median	328.0593
Maximum	970521.9
Minimum	-537.7929
Std. Dev.	134241.4
Skewness	6.858481
Kurtosis	48.86010
Jarque-Bera	5059.963
Probability	0.000000
Sum	1168362.
Sum Sq. Dev.	9.37E+11
Observations	53

Test :Correlation



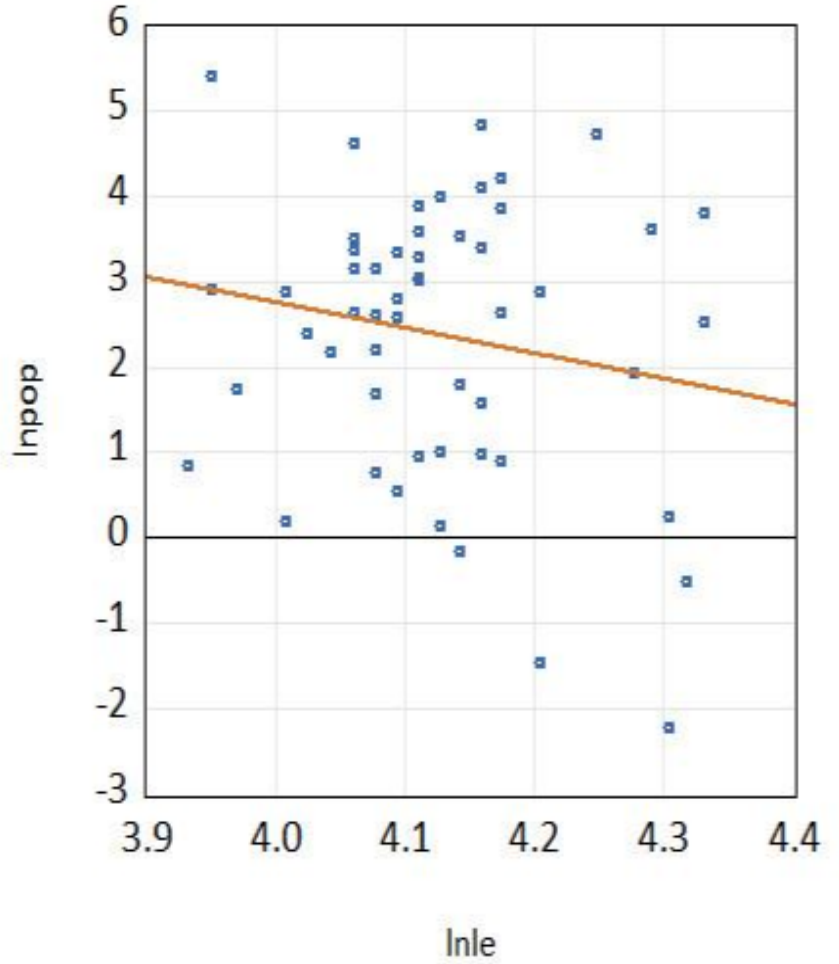
Test :Correlation



Lnle and lngdp

	LNLE	LNGDP
LNLE	1.000000	0.164255
LNGDP	0.164255	1.000000

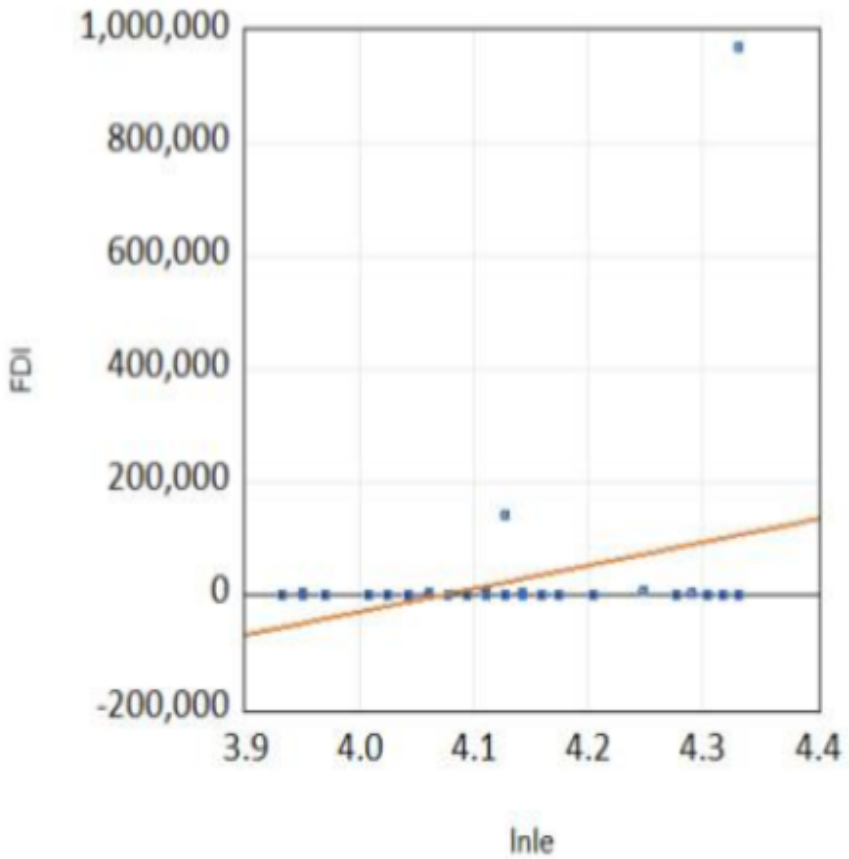
Test :Correlation



lnle and lnpop

	LNLE	LNPOP
LNLE	1.000000	-0.176671
LNPOP	-0.176671	1.000000

Test :Correlation



Lnle and FDI

	LNLE	FDI
LNLE	1.000000	0.294230
FDI	0.294230	1.000000

Test :First Equation

$$\ln(le)_{ijt} = \beta_1 \cdot \ln(GDP)_i + \beta_2 \cdot \ln(POP)_i + \beta_3 \cdot (FDI)_{ij} + C_{ijt}$$

- Note1: **i** stand for the index of country, **j** stand for the index of region in Africa, **t** stand for the country political and democracy situation

Test: First Regression

Dependent Variable: LNLE
Method: Least Squares
Date: 01/12/24 Time: 13:51
Sample: 1 53
Included observations: 53

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.769666	0.093952	40.12344	0.0000
LNGDP	0.049484	0.012048	4.107172	0.0002
LNPOP	-0.049225	0.011701	-4.206916	0.0001
FDI	1.52E-07	8.44E-08	1.803145	0.0775

R-squared	0.342950	Mean dependent var	4.127077
Adjusted R-squared	0.302723	S.D. dependent var	0.096423
S.E. of regression	0.080516	Akaike info criterion	-2.128252
Sum squared resid	0.317658	Schwarz criterion	-1.979551
Log likelihood	60.39868	Hannan-Quinn criter.	-2.071069
F-statistic	8.525270	Durbin-Watson stat	1.781382
Prob(F-statistic)	0.000117		

Test :Second Equation

$$\ln(le)_{ijt} = \beta_1 \cdot \ln(GDP)_i + \beta_2 \cdot \ln(POP)_i + C_{ijt}$$

- Note1: **i** stand for the index of country, **j** stand for the index of region in Africa, **t** stand for the country political and democracy situation

Test: Second Regression

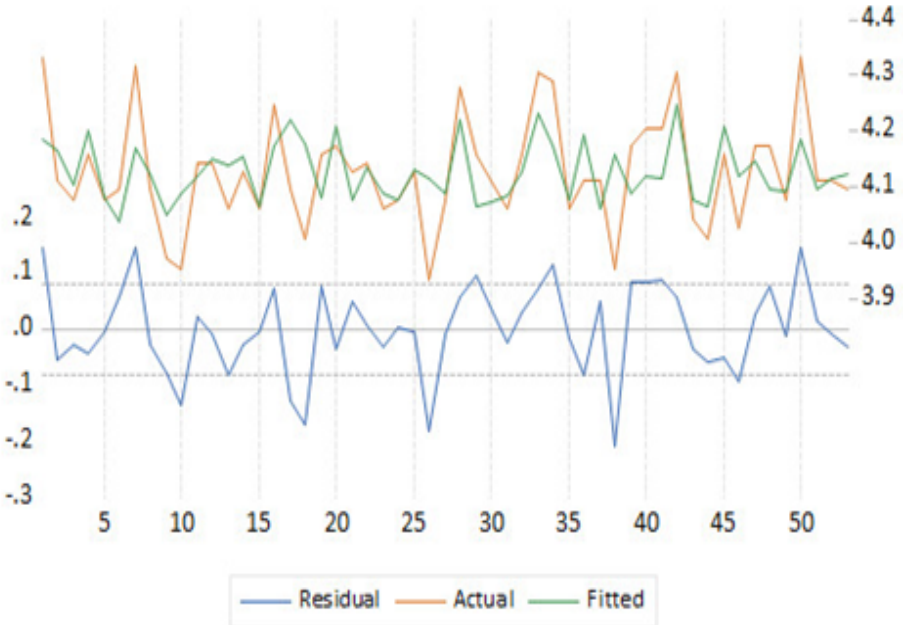
Dependent Variable: LNLE
Method: Least Squares
Date: 01/12/24 Time: 11:30
Sample: 1 53
Included observations: 53

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.745516	0.095063	39.40049	0.0000
LNPOP	-0.052207	0.011842	-4.408769	0.0001
LNGDP	0.053117	0.012143	4.374377	0.0001

R-squared	0.299353	Mean dependent var	4.127077
Adjusted R-squared	0.271327	S.D. dependent var	0.096423
S.E. of regression	0.082309	Akaike info criterion	-2.101743
Sum squared resid	0.338736	Schwarz criterion	-1.990217
Log likelihood	58.69618	Hannan-Quinn criter.	-2.058855
F-statistic	10.68130	Durbin-Watson stat	1.815775
Prob(F-statistic)	0.000137		

$$\ln(le)_{ijt} = 0.053117 \cdot \ln(GDP)_i + (-0.052207) \cdot \ln(POP)_i + 3.745516$$

Test: Residual



Heteroskedasticity Test: White
Null hypothesis: Homoskedasticity

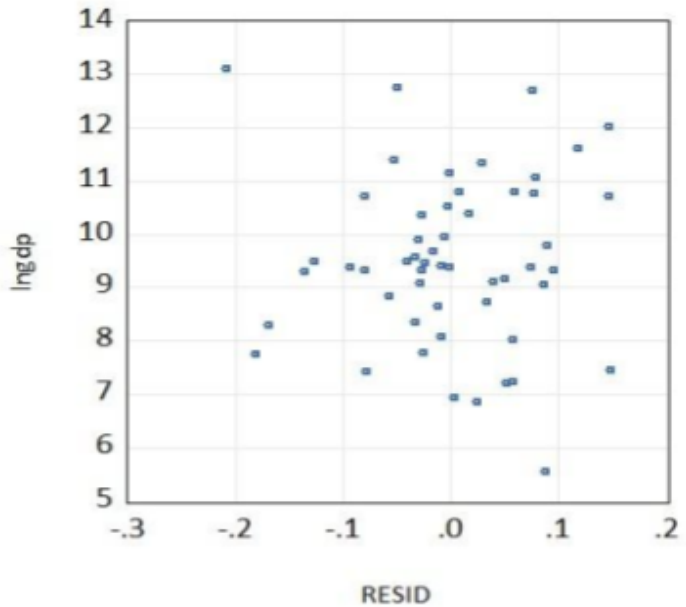
F-statistic	1.711100	Prob. F(5,47)	0.1506
Obs*R-squared	8.161955	Prob. Chi-Square(5)	0.1475
Scaled explained SS	7.582553	Prob. Chi-Square(5)	0.1808

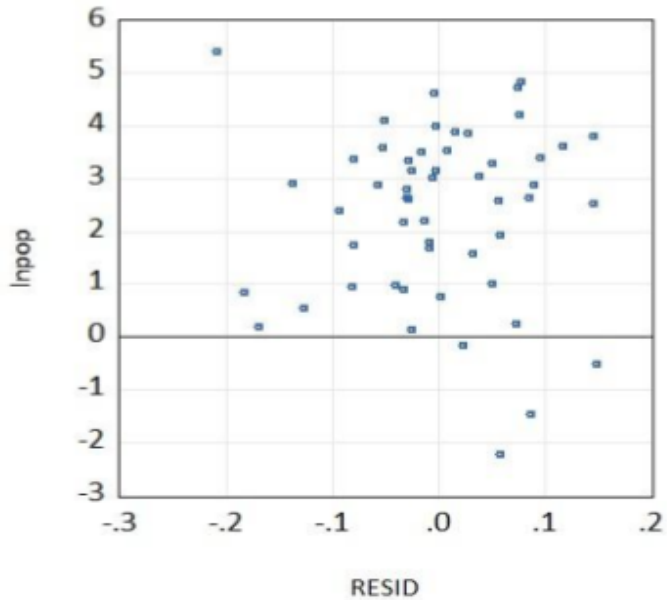
Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/12/24 Time: 15:14
Sample: 1 53
Included observations: 53

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.014377	0.092849	-0.154838	0.8776
LNGDP^2	-0.000496	0.001564	-0.317335	0.7524
LNGDP*LNPOP	0.002186	0.002696	0.810538	0.4217
LNGDP	0.006794	0.024192	0.280836	0.7801
LNPOP^2	-0.000953	0.001296	-0.735442	0.4657
LNPOP	-0.018412	0.020620	-0.892905	0.3765

R-squared	0.153999	Mean dependent var	0.006391
Adjusted R-squared	0.063999	S.D. dependent var	0.009323
S.E. of regression	0.009020	Akaike info criterion	-6.472546
Sum squared resid	0.003824	Schwarz criterion	-6.249494
Log likelihood	177.5225	Hannan-Quinn criter.	-6.386771
F-statistic	1.711100	Durbin-Watson stat	2.065575
Prob(F-statistic)	0.150576		

Test: Residual

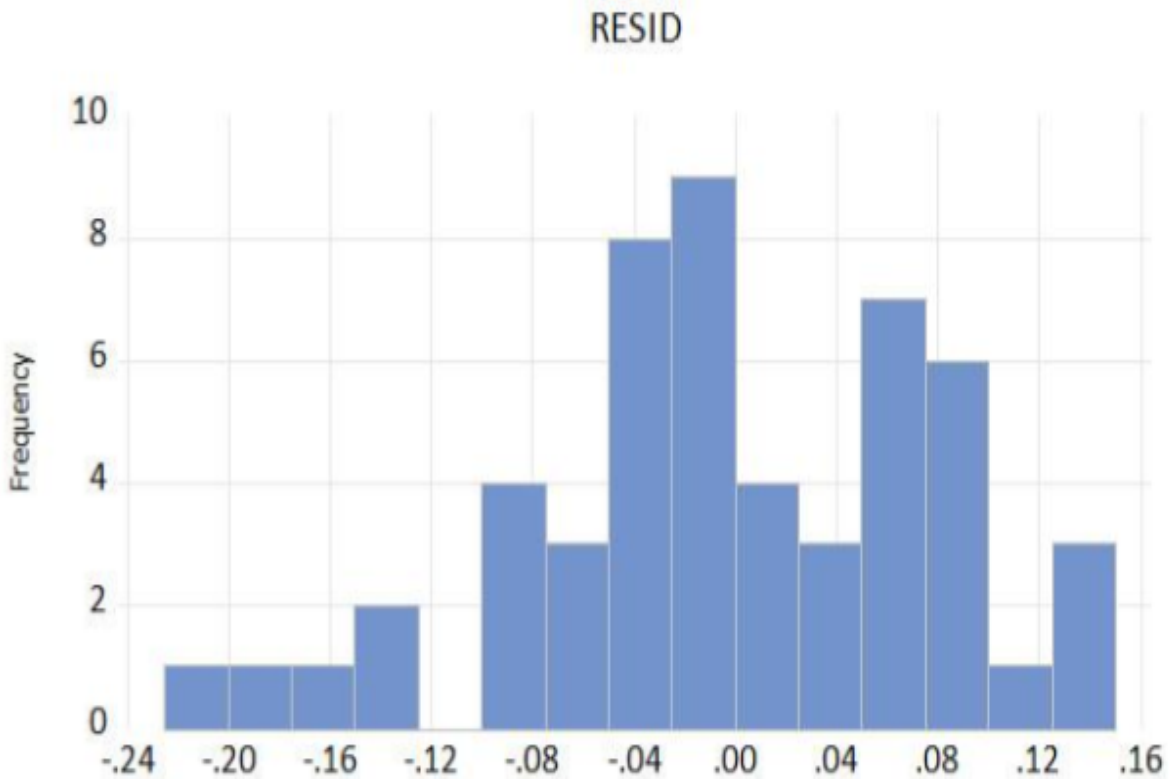




Based on the graph, there is no slope/line, no pattern. The errors/residuals of the regression are independent and constant, the model is linear

Test :Residual

- Skewness is -**0.39** and kurtosis is **3.08**, Pvalue is **0.49**, we conclude that Residual is **normally distributed**



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	RESID
Mean	2.14E-16
Median	-0.003510
Maximum	0.148547
Minimum	-0.208073
Std. Dev.	0.080710
Skewness	-0.397442
Kurtosis	3.087675
Jarque-Bera	1.412287
Probability	0.493544

Conclusions

$$\ln(le)_{ijt} = 0.053117 \cdot \ln(GDP)_i + (-0.052207) \cdot \ln(POP)_i + 3.745516$$

Variables	Unit (without LN)	Expected sign	Sign
LNGDP	$M	+	+
LNPOP	M	-	-
FDI	$M	+	/

Figure: Equation signs compared to assumptions/expectations

Conclusions

Back to Hypothesis

- The **higher** the GDP of an African country, the **higher** its life expectancy, but low impact.
- The **lower** the population the **higher** the life expectancy, but low impact.
- The FDI has **no impact** on the life expectancy in the model.

Robustness of the model: $R^2 = 0.29$

Further conclusions and comments

$$\ln(le)_{ijtr} = \beta_1 \cdot \ln(GDP)_{i(r-k)} + \beta_2 \cdot \ln(POP)_{i(r-m)} + C_{ijtr}$$

- Note1: i stand for the index of country, j stand for the index of region in Africa, t stand for the country political and democracy situation, r stand for the index of years, k stand for the hysteresis number for GDP, m stand for the hysteresis number for Population If k=5, when r=2015, the LE on 2015 depends on the GDP on 2010

Further conclusions and comments

- R-square can be improved by taking into account other variables, not necessarily economical such as health expenditures, diseases...
- From our analysis and model: we can state that governments and policies/ politics may play a key role in life expectancy.
- A different study comparing men and women average life expectancy in Africa, maybe on a larger period, (one decade for instance) could be also interesting to have a more accurate model and concrete solution.

Further conclusions and comments

Figure: Smiley Team, **Life expectancy rises 10 years across Africa**

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