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Reparameterization of vector error correction model from auto-regressive distributed lag to analyze the effects of macroeconomic shocks on youth employment in Kenya

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Abstract
This study analyzes the effects of reparameterization of autoregressive distributed lag (ARDL) to vector error correction model (VECM) through cointegration of time series. It further verifies the effects of macroeconomic shocks on youth unemployment in Kenya using VECM. First, the unit root test has been done on youth unemployment (YUN), gross domestic product (GDP), external debt (ED), foreign direct investment (FDI), private investment (PI), youth literacy level (LR), and youth population (POP) to verify stationarity. The Johansen Cointegration Test has been employed and revealed three long run relationships which can be interpreted as a *GDP effect*, External *Debt effect* and *Foreign Direct Investment effect* relations. A structural VECM has been described through restrictions derived from the Cointegration Analysis. Based on the results of the Impulse-Response Function analysis and variance decomposition analysis of the Structural VECM, it is concluded that GDP, literacy level, population, Private Investment, External and FDI shocks have significant effects on Kenyan youth unemployment in the long run. Based on the results of the Impulse-Response Function and variance decomposition analyses of the Structural VECM, it is concluded that GDP, literacy level, population, and FDI shocks have significant effects on Kenyan youth unemployment in the long run. Whereas population, external debt, private investment, and GDP have positive effects, foreign direct investment and literacy rate have negative effects on youth unemployment in the long run. The results provide a statistical basis for assessing and prioritising investment policies and initiatives to maximise youth employment and attain the demographic dividend.

Keywords: structural error correction model, cointegration

1. Introduction

The demographic dividend, defined as the opportunity to achieve rapid socio-economic development resulting from decline in fertility levels and targeted investments in intensive employment sectors, has been deemed a solution to many problems being experienced by African countries. The African Union adopted a common position on the Post 2015 Development Agenda that resulted in the incorporating demographic dividend in the 2030 Agenda for Sustainable Development. In this way, the African Union formulated the theme "Harnessing the Demographic Dividend through investments in Youth" for the year 2017.

The Kenya constitution defines youth as persons between the ages of 18 and 34. In Kenya, the youth constitute 35% of the population. The youth in Kenya are experiencing much higher unemployment rates 67% compared to the rest of population at 34%.

The Kenyan labour market is one that is characterized by inadequate employment opportunities against a large and growing population of unemployed young people. It is dual in nature, presenting a small formal sector alongside a large informal sector. Over 30% of those on wage employment are casuals. Youth with primary education are in formal employment 4%, informal employment 54%, students 14% and unemployed 28%.

Those with secondary education in: formal employment 12%; informal employment 40%; students 26%; and unemployed 22%. While those with tertiary education are in: formal employment 31%;

informal employment 9%; unemployed 8% while 52% are students.
Based on the (Census, 2009) [10] and statistics from Ministry of Education, Science and Technology (MoEST), (Sessional Paper No.14, 2012 on Reforming Education and Training Sectors in Kenya), almost 1.5 million children attain the age of 6 years but only 1.3 million enroll in class one. There are 10.5 million children of primary school age, 6-13 years, and only 10 million are attending school. On the other hand, there are 4.5 million secondary school ages (14-17 years) out of which only 2 million are actually in school. Further, there are 5 million youth aged 18-23 out of which only 0.5 million are in tertiary level of education. In total, 1.2 million youth enter labour market without formal training or skills; and at age 24 only 11% have formal training. As such, education is a key determining factor in youth unemployment in Kenya.

2. Literature Review

In the considered literature, the major factor of youth unemployment is GDP. In his seminal paper, (Okun, 1962) defines a coefficient that gives the rate of change of real GDP for a unit in the unemployment rate. According to Okun's Law, an increase in the economic growth rate by 3%, beyond the normal rate, is expected to reduce the unemployment rate by 1%. In this case, GDP growth must be equal to its potential growth so as to keep the unemployment rate constant. To reduce unemployment, the rate of GDP growth must be above the growth rate of potential output.
The study by (Muhammad *et al*, 2013) [12] outlines external factors as macroeconomic policies and institutional changes related to fiscal and monetary policies and market. That study worked on determinants of unemployment by considering GDP, inflation, population, and FDI. The results reveal that youth unemployment has negative relationship with inflation, GDP, FDI. However, population growth and youth unemployment rate have positive relationship.
On mathematical models (Hassler and Wolters, 2010) considered cointegration analysis within an ARDL structure and the review of cointegration tests based on error correction (EC) regression paying particular attention to linear time series without detrending. In order to obtain valid results, variables are tested for stationarity and cointegration before analysis to avoid spurious regressions. Also, (Engle and Granger, 1987; Johansen, 1991; Phillip, 1991; Phillip and Hansen, 1990, Dickey and Fuller 1978 and 1981) [8, 9, 18, 17, 4] provide tests for unit roots.
The reparameterization of ARDL model to conform to VECM yielded equivalent results (Pesaran and Shin, 1998) under exogeneity condition without detrending. The study sought to compare the of results when variables are analyzed and estimated using VECM. The results obtained from the model are subjected to f-type test statistics as suggested by (Banerjee *et al*, l 1998) and (Boswijk, 1994) respectively.
Based on the studies reviewed, the most frequently used variables of youth unemployment are population, GDP, FDI, and PI. In this paper, Education described as literacy rate (LR) is included as one of the key determinants. All studies reviewed in youth unemployment have not considered education in a mathematical model.

3. Data and Methodology

To conduct estimation procedure of VECM to determine the response of youth unemployment to unit shocks of microeconomic variables, annual data covering between 1979 and 2015 is used. The data of FDI, GDP, ED, PI, YUN, LR and POP obtained from World Bank and Kenya National Bureau of Statistics (KNBS) are taken through logarithm transformation to enable interpretation in percentages and reduce outlier effect.
The functional form:

$$YUN = f\,(GDP, POP, FDI, PI, ED, LR) \qquad (1)$$

3.1 Error Correction Model (VECM)

According to (Banerjee *et al* 1998) the structure of VECM is presented as:

$$\nabla y_t = \gamma + \sum_{i=1}^{p} \beta_1 \Delta y_{t-i} + \Omega ECM_{t-1} + \epsilon_t \qquad (2)$$

Where, ΩECM is the error correction component in the structure;
Ω measures the speed of correction of deviation from equilibrium;
y_t Denotes a vector of the dependent variables in the model;
γ Vector of constants;
β Vector of parameters containing short-run information;
p Is the maximum lag?
ϵ_t Is the vector of white noise?
In VECM we are going to incorporate all the considered factors in the model:

$$\Delta lnYUN_t = \gamma + \sum_{i=1}^{p} \beta_1 \Delta lnYUN_{t-i} + \sum_{i=1}^{p} \beta_2 \Delta lnGDP_{t-i} + \sum_{i=1}^{p} \beta_3 \Delta lnPOP_{t-i} + \sum_{i=1}^{p} \beta_4 \Delta lnFDI_{t-i} + \sum_{i=1}^{p} \beta_5 \nabla lnED_{t-i} + \sum_{i=1}^{p} \beta_6\, \Delta lnPI_{t-i} + \sum_{i=1}^{p} \beta_7 \Delta lnLR_{t-i} + \Omega ECM_{t-i} + \epsilon_t \qquad (3)$$

Where,

β_i, i=1, 2, 3, 4, 5, 6, 7 are the short run dynamic coefficients,

When the variables of a VECM are not integrated, we use a vector autoregressive (VAR) model.

3.2 Reparameterization of ARDL to VECM

The conditions for the Reparameterization of ARDL to VECM is that the variables must be stationary, that is **I(0)** or **I(1)** and their linear combination must be I(0) (Engle and Granger 1987) [8]. Where this was not the case, the variables are differenced and cointegration test is run again.

ARDL (1, 1)

$$y_t = \delta + \theta_1 y_{t-1} + \delta_0 x_t + \delta_1 x_{t-1} + e_t \quad (4)$$

Assumption:y and x are cointegrated;
At equilibrium $y_t = y_{t-1}, x_t = x_{t-1}$ and $e_t = 0$
Collecting like terms y and$x$,

$$y_t - \theta_1 y_{t-1} = \delta + \delta_0 x_t + \delta_1 x_{t-1}$$

$$y_t(1 - \theta_1) = \delta + \delta_0 x_{t-1} + \delta_1 x_{t-1}$$

$$y_t = \frac{\delta}{(1-\theta_1)} + \frac{\delta_0 + \delta_1}{(1-\theta_1)} x_t$$

This represents the function: $y_t = \beta_1 + \beta_2 x_t$

Where, $\beta_1 = \frac{\delta}{(1-\theta_1)}, \beta_2 = \frac{\delta_0+\delta_1}{(1-\theta_1)}$ (5)

This is a long-run relationship.
We now manipulate **(4)** to derive ECM

$$y_t - y_{t-1} = \delta + (\theta_1 - 1)y_{t-1} + \delta_0 x_t + \delta_1 x_{t-1} + v_t$$

Add$-\delta_0 x_{t-1} + \delta_0 x_{t-1}$

$$\Delta y_t = \delta + (\theta_1 - 1)y_{t-1} + \delta_0 \Delta x_t + (\delta_0 + \delta_1)x_{t-1} + v_t \quad (6)$$

Multiply (**6**) by $\frac{(\theta_1-1)}{(\theta_1-1)}$ and manipulate (4)

$$\Delta y_t = (\theta_1 - 1)\left[\frac{\delta}{(\theta_1-1)} + y_{t-1} + \left(\frac{\delta_0+\delta_1}{\delta_0-\delta_1}\right)x_{t-1}\right] + \delta_0 \Delta x_t + v_t \quad (7)$$

Reorganizing the equation using the definition of β_1 and $\beta_2$we obtain

$\Delta y_t = \alpha(y_{t-1} - \beta_1 - \beta_2 x_{t-1}) + \delta_0 \Delta x_t + v_t$ is the ΩECM (8)

Where,

$\alpha = 1 - \theta_1$, (7) is the error correction that embeds the cointegration relationship. And,

- $y_\downarrow(t-1) - \beta_\downarrow 1 - \beta_\downarrow 2 x_\downarrow(t-1) + \delta_\downarrow 0 y_\downarrow$Shows deviation from its long run value of$\beta_1 + \beta_2 x_{t-1}$, that is error in the previous period.
- If error term is positive such that $y_{t-1} > \beta_1 - \beta_2 x_{t-1}$,$y_t$falls
- If error term is negative such that $y_{t-1} < \beta_1 - \beta_2 x_{t-1}$, $y_t$rises
- $(\theta_1 - 1)$ Is the correction of $\Delta y_t$to the error

Since VECM and ARDL have different assumptions but are cited by Hassler and Wolters (2010) to be identical and equivalent upon reparameterization and detrending, the study holds that two models are not numerically identical without detrending, although there is reversion of error to maintain equilibrium.

4. Empirical Analysis

Choosing Lag Length

The study conducts lag selection as indicated in the in *table 1* below. The stationarity of the variables is established at lag order 3. The data VAR is applied to the variables to determine the most appropriate lag, and results presented were in table below. The study chooses FPE suggesting 3 lags.

Table1: Lag selection criteria

Lag	AIC	HQ	SC	FPE
1	-3.633133e+01	-3.553215e+01	-3.364367e+01	1.893163e-16
2	-3.837335e+01	-3.687489e+01	-3.333399e+01	5.824986e-17
3	NaN	NaN	NaN	-1.300749e-47 *

Unit Root Test

Stationary test

The stationarity test is conducted to avoid spurious regression. The Augmented Dickey-Fuller unit root Test is used to verify stationarity status of the variables. The study checks whether the variables contained unit roots, appropriate for cointegration. Also, when the variables are not of the same stationary process, we could still perform cointegration test to construct VECM model. The results are presented in Table 3.

Table 2: stationary tests of variables

Variable	p-value	Tau	1st diff Tau		Lag Order
			P-value	Tau	
YUN	0.99	3.0023	0.01	-4.9328	3
GDP	0.04211	-3.6641	NA	NA	3
ED	0.02464	-3.9058	NA	NA	3
FDI	0.01	-5.7999	NA	NA	3
PI	0.6188	-1.8831	0.01	-5.573	3
LR	0.6146	-1.894	0.01	-5.0686	3
POP	0.2925	-2.7199	0.01	-5.0035	3

Based on p-values, the results find that either I (0) or I (1**)** stationary. These results allow the study to construct cointegration analysis of VECM**.**

Time plot

The time plots for all variables in level are generated complementing stationarity test as indicated in the figures below

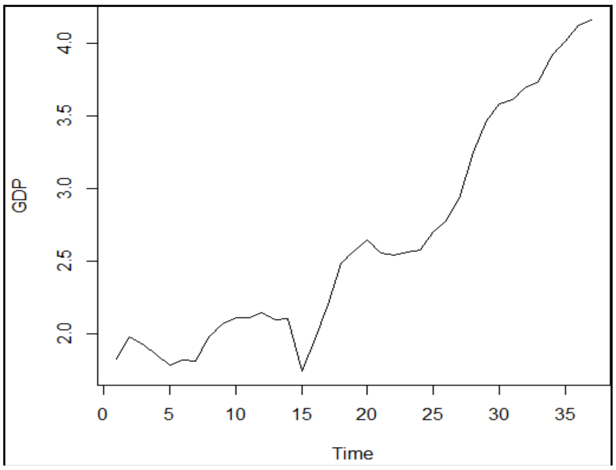

Fig 1: Time plot of GDP

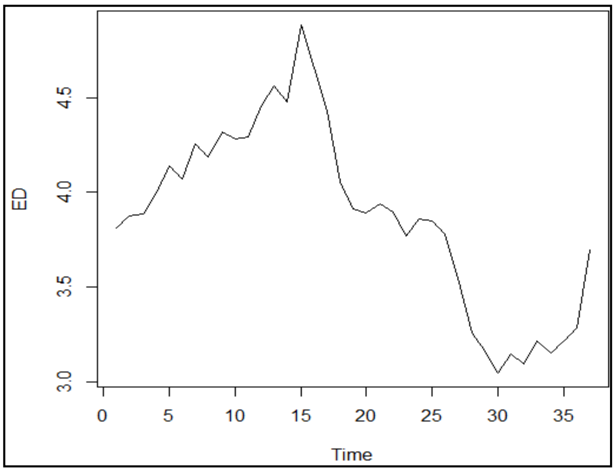

Fig 2: Time plot of External Debt(ED)

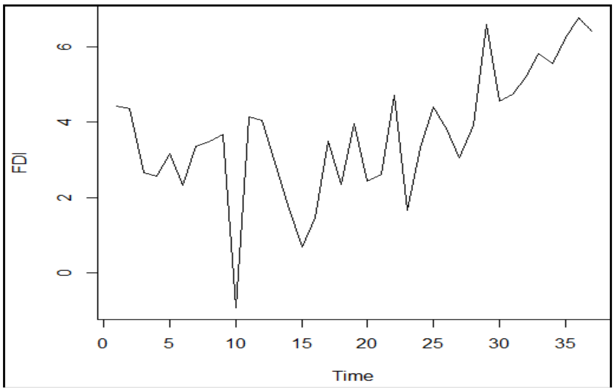

Fig 3: Time plot of FDI

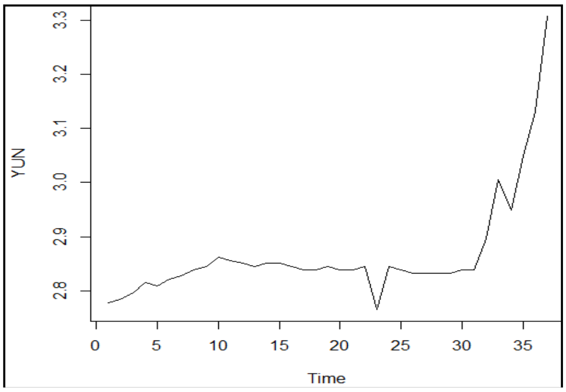

Fig 4: Youth Unemployment (YUN)

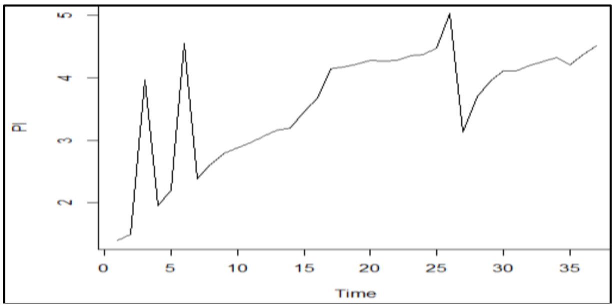

Fig 5: Time plot of Private Investment (PI)

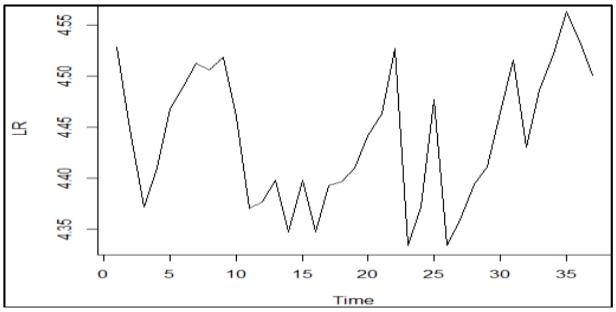

Fig 6: Time plot of Literacy Rate (LR)

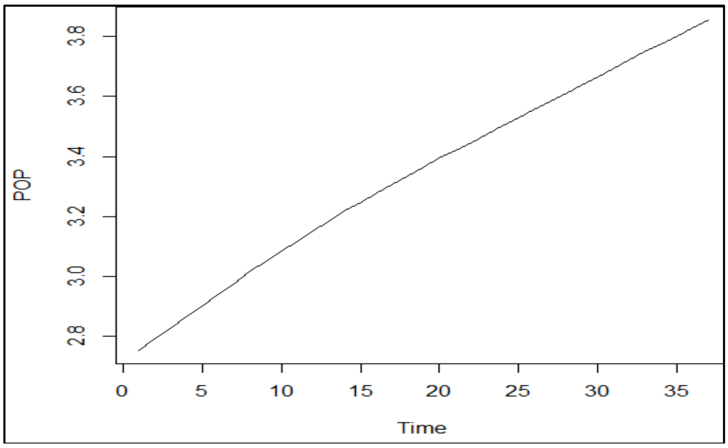

Fig 7: Time plot of Population (POP)

4.1 Cointegration test

The study conducts both Phillips-Ouliaris (PO) test and Johansen cointegration test. The PO test verified the cointegration relations between two variables at a time whereas the Johansen test verifies collectively the cointegration relations between all variables.

Phillips-Ouliaris Test

The Phillips-Ouliaris cointegration test of the variables is conducted to ascertain the order of cointegration between two variables in turns.

Table 3: Philip-Ouliaris Cointegration result of paired variables

R-Codes	Variables	P-Value	Po-demeaned	Differential Order
po.test(diff(log(cbind(YUN,GDP))))	YUN and GDP	0.02140	-24.8909	1
po.test(diff(log(cbind(YUN,ED))))	YUN and ED	0.01	-34.185	1
po.test(diff(log(cbind(YUN,FDI))))	YUN and FDI	0.01	-30.4839	1
po.test(diff(log(cbind(YUN,PI))))	YUN and PI	0.01	-31.1498	1
po.test(diff(log(cbind(YUN,LR))))	YUN and LR	0.01	-29.2731	1
po.test(diff(log(cbind(YUN,POP))))	YUN and POP	0.01	-33.1063	1
po.test(diff(log(cbind(GDP,ED))))	GDP and ED	0.04044	-21.7589	1
po.test(diff(log(cbind(GDP,PI))))	GDP and PI	0.02022	-25.2477	1
po.test(log(cbind(GDP,LR))	GDP and LR	0.02079	-25.0744	1
po.test(diff(log(cbind(GDP,POP))	GDP and POP	0.01094	-28.0382	1
po.test(diff(log(cbind(ED,PI))))	ED and PI	0.01273	-27.5002	1
po.test(diff(log(cbind(ED,LR))))	ED and LR	0.01832	-25.8183	1
po.test(diff(log(cbind(ED,POP))))	ED and POP	0.01	-30.7157	1
po.test(diff(log(cbind(PI,LR))))	PI and LR	0.01	-51.4342	1
po.test(log(cbind(PI,POP)))	PI and POP	0.01	-35.1818	0
po.test(diff(log(cbind(LR,POP))))	LR and POP	0.01	-42.1315,	1
Po.test(log(cbind(GDP,FDI)))	GDP and FDI	0.0446	-21.2072	0
Po.test(log(cbind(ED,FDI)))	ED and FDI	0.05377	-20.1868	0
Po.test(log(cbind(FDI,PI)))	FDI and PI	0.04558	-21.0765	0
Po.test(log(cbind(FDI,LR)))	FDI and LR	0.0344	-22.5618	0
Po.test(log(cbind(FDI,POP)))	FDI and POP	0.01542	-26.6911	0

Explanation

The test reveals that out of 21 relations, 6 are I(0) while 15 are I(1). The Phillip-Ouliaris does not conduct cointegration test of more than two variables. It does not identify coefficients of cointegrating vectors and equations. Johansen test does these.

4.2 Johansen Cointegration Rank Test

The cointegration rank test has the ability to test more than two variables. In Table 4 below, six variables are tested at 95% significance level. The test type is maximal eigenvalue statistic without linear trend and constant.

Table 4: Values of test statistic and critical values of test:

R	Test Stats	10%	5%	1%
r<=6	5.37	7.52	9.24	12.97
r<=5	10.07	13.75	15.67	20.20
r<=4	15.58	19.77	22.00	26.81
r<=3	17.17	25.56	28.14	33.24
r<=2	40.13	31.66	34.40	39.79
r<=1	57.15	37.45	40.30	46.82
r<=0	66.89	43.25	46.45	51.91

Explanation

H0:r<=3, the critical value is less than the test statistics at 95%, we fail to reject null hypothesis and concluded that there were 3 cointegration relationships. i.e. 28.14>17.17. The study is allowed to estimate VECM with r=3.

4.2 Identification of Cointegration Relationship

The eigenvalues are normalized to the first column. The maximum eigenvalue(s) correspond to the column with a cointegration relationship. These are the eigenvalues:

8.601594e-01, 8.137679e-01, 6.928169e-01, 3.964401e-01, 3.675151e-01, 2.562996e-01, 1.461890e-01, 9.150666e-17

The largest eigen values correspond to GDP, ED, and FDI respectively. Johansen Test recommends that the largest eigen values correspond to columns with cointegrating vectors. However, the columns of the variables (as cointegrating relations) are tested for stationarity using ADF test. These are the Cointegrating relations tested for stationarity: The columns in bold are the cointegrating vectors.

Table 5: Columns of cointegration relationships

Variable	GDP	ED	FDI	YUN	PI	LR	POP	CONST
GDP	1.000000	1.0000	1.0	1.00	1.0000	1.0000	1.00000	1.00000
ED	-0.68979268	-0.7225719	0.2363211	2.3730471	0.21836910	0.79938274	0.2874472	0.68483738
FDI	-0.8050538	-0.3684427	-0.0130395	0.3261325	-0.06307162	0.02078336	-0.1283847	-0.01666502
YUN	1.68667026	8.0728399	-1.0932464	-31.3622929	0.37462436	-2.37548733	-3.0544291	-5.49401829
PI	-0.03626714	1.404787	0.3033717	-1.2633971	-0.39335741	0.16457778	0.4907323	0.05221453
LR	-1.11845144	-8.3423590	-2.2610056	-18.5692818	0.72578376	0.22781790	2.8297209	1.68879285
POP	-2.20928252	2.3409439	-3.0604127	8.4011665	-1.30575355	-1.14352444	-2.1788867	-0.12415709
CONST	13.40430269	-13.5878323	20.5798943	118.3169565	-0.96791357	2.71781603	-2.8024775	2.15392386

Identified Three Cointegrating equations

$GDP = 1GDP - 0.68979268ED - 0.80505386FDI + 1.68667026YUN - 0.03626714PI - 1.11845144LR - 2.20928252POP + 13.40430269$ **(9)**

This equation is found to be stationary using Augmented Dickey-Fuller test with p-value= 0.02089.

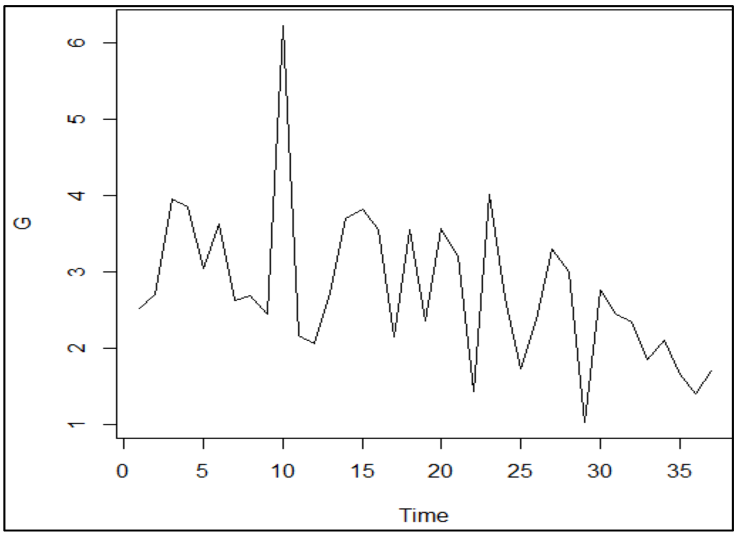

Fig 8: Time plot of Cointegrating Relation GDP

$$FDI = 1GDP + 0.2363211ED - 0.0130395FDI - 1.0932464YUN + 0.3033717PI - 2.2610056LR - 3.0604127POP + 20.579843 \quad (10)$$

The equation is found to be stationary with a p-value of 0.01

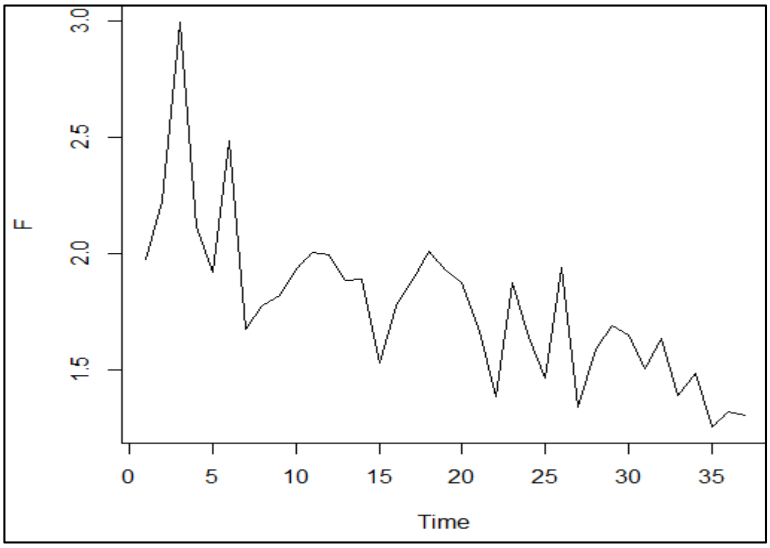

Fig 9: Time plot of cointegrating relation FDI

$$ED = 1GDP - 0.7225719ED - 0.3684427FDI + 8.0728399YUN + 1.4047877PI - 8.342359LR + 2.3409439 - 13.5878323 \quad (11)$$

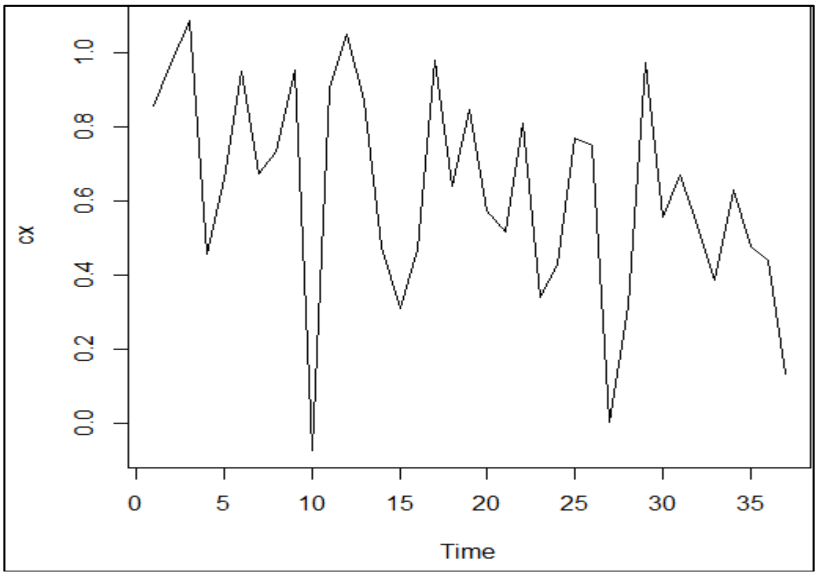

Fig 10: Time plot of cointegrating relations ED

The ADF stationarity test results in the table below show that only cointegrating relation corresponding to GPD, FDI, and ED are stationary with p-values of 0.0209, 0.0476 and 0.01 respectively, thus forming a Cointegrating vectors.
The study tested the cointegrating relation columns for stationarity and presented the results in the table below.

Table 6: Results for cointegrating relations test

Cointegrating Relations Column	Eigen Value(Lambda)	P-value
GDP	8.601594e-01	0.0209
ED	8.137679e-01	0.0467
FDI	6.928169e-01	0.01

5. Estimation of VECM

The VECM equations are estimated under the restrictions in Table 7.
The Results of Johansen Test in table 5 reveals three cointegration vectors (r=3) described as "GDP Effect" and "FDI Effect" and "External Debt Effect". Consequently, the cointegrating vectors have to be identified for the economic interpretation of YUN, GDP, ED, FDI, POP, PI and LR variables in the long run.

From the Johansen cointegration discussed earlier, we estimate the VECM to obtain the three equations in form with error correction terms which adjust the system to the equilibrium.
The restricted equations are presented as follows:

$GDPEffect = 1.0GDP_t + 17.71YUN_t + 3.15PI_t - 8.56LR_t + 12.46\mathrm{POP_t} + ECT$ **(12)**

$FDI\ Effect = 1.0ED_t - 8.88YUN_t - 5.43PI_t + 14.74\mathrm{LR_t} - 23.44\mathrm{POP_t} + ECT$ **(13)**

$ED\ Effect = 1.0FDI_t + 16.75YUN_t + 10.44PI_t - 7.41LR_t + 12.27POP_t + ECT$ **(14)**

Table 7: Restrictions imposed on the structural VECM

VECM	GDP	ED	FDI
VECM1	1	0	0
VECM2	0	1	0
VECM3	0	0	1

The error correction terms (ECT) in the restricted equation∏s ∏ (12), (13), and (14) above are represented as

$\alpha\beta' = \prod$ **(15)**

Where α andβ, are coefficient matrix
∏ is the error correction term (ECT) matrix with each variable coefficient.

The matrices are:

$$\alpha = \begin{bmatrix} -0.081618248 \\ 0.505343993 \\ 3.923971897 \\ 0.182982408 \\ 0.182982408 \\ 0.222520093 \\ 0.002655281 \end{bmatrix}$$

$$\beta = \begin{bmatrix} 1.00000000 \\ -0.09335818 \\ -0.10318207 \end{bmatrix}, B' = [1.00000000 \quad 0.09335818 \quad -0.1031820]$$

$$PI(\prod) = \begin{bmatrix} -0.081618248 & 0.0076197315 & 0.0084215401 \\ 0.505343993 & -0.0471779975 & -0.0521424410 \\ 3.923971897 & -0.3663348906 & -0.4048835563 \\ 0.182982408 & -0.0170829053 & -0.0188805042 \\ 1.021564156 & -0.0953713745 & -0.1054071077 \\ 0.222520093 & -0.0207740718 & -0.0229600846 \\ 0.002655281 & -0.0002478923 & -0.0002739774 \end{bmatrix}$$

Unrestricted Lagged VECM equations

a. $GDPEffect = 0.68478311_{0.1423} - 0.081618248_{0.0278} + 1.041681964_{0.026932}GDP_{t-1} + 0.397612298_{0.00193}ED_{t-1} - 0.0255150492_{0.00867459}FDI_{t-1} + 0.9278922307_{0.045612}YUN_{t-1} + 0.005592738_{0.004908}PI_{t-1} - 0.149172387_{0.03625}LR_{t-1} - 31.8398511_{15.3447}POP_{t-1}$
b. $ED\ Effect = -3.18319209_{106} + 0.50534399_{0.25} - 1.184821983_{0.39}GDP_{t-1} - 0.436486222\ _{0.17}ED_{t-1} + 0.0617421278_{0.02}FDI_{t-1} - 2.458858892_{0.19}YUN_{t-1} + 0.063671436\ _{0.03}PI_{t-1} + 0.253072107\ _{0.08}LR_{t-1} + 53.4281154_{35.62}POP_{t-1}$
c. $FDI\ Effect = 22.32580046_{7.44} + 3.923971897\ _{1.31} - 2.498460158_{0.832}GDP_{t-1} - 3.055893269_{1.02}ED_{t-1} - 0.5656133375_{0.188}FDI_{t-1} - 12.045049342_{8.03}YUN_{t-1} - 0.318886184_{0.21}PI_{t-1} - 2.609287260_{0.87}LR_{t-1} - 11.58130717\ _{7.72}POP_{t-1}$

Equations of second lag

a. $GDP\ Effect = -0.06385096_{0.0213}GDP_{t-2}0.224104318_{0.064}ED_{t-2} - 0.0265371095\ _{0.00665}FDI_{t-2} + 0.87400097\ _{0.583}YUN_{t-2} + 0.0352681753_{0.0186}PI_{t-2} - 0.13053551_{0.0522}LR_{t-2} + 3.150141\ _{1.75}POP_{t-2}$
b. $ED\ Effect = -0.60590768_{0.22}GDP_{t-2} - 0.099116362_{0.33}ED_{t-2} + 0.0414003710\ _{0.014}FDI_{t-2} - 2.41348040_{1.609}YUN_{t-2} - 0.0696685665\ _{0.0279}PI_{t-2} + 0.23082382_{0.0769}LR_{t-2} + 29.359769\ _{7.34}POP_{t-2}$
c. $FDI\ Effect = 1.00925248_{0.3342}GDP_{t-2} - 2.565540917_{0.855}ED_{t-2} - 0.7770933637_{0.31}FDI_{t-2} + 16.26597627\ _{7.394}YUN_{t-2} + 0.7382019274_{0.295}PI_{t-2} - 3.31568913\mathrm{I}_{0.947}LR_{t-2} + 191.920192_{38.384}POP_{t-2}$

Equations of third lag

a. $GDP\ Effectd = -0.64496693\ _{0.21}GDP_{t-3} - -0.292881979_{0.12}ED_{t-3} - 0.0092672922\ _{0.0038}FDI_{t-3} + 0.69493831_{0.28}YUN_{t-3} + 0.0325996781_{0.02}PI_{t-3} + 0.519181892_{0.26}LR_{t-3} + 9.4242655_{3.49}POP_{t-3}$

b. $ED\ Effect = 0.29177615\ _{0.07}GDP_{t-3} + 0.124253977_{0.02}ED_{t-3} + 0.0178582429_{0.0017}FDI_{t-3} - -2.95338510_{1.181}YUN_{t-3} - 0.0315248454\ _{0.01212}PI_{t-3} - 0.261408639\ _{0.07468}LR_{t-3} + 8.9361943_{3.7234}POP_{t-3}$

c. $FDI\ Effects = -17.61866858_{4.4046}GDP_{t-3} - 12.511462711_{4.03595}ED_{t-3} - 0.2764977772_{0.5529}FDI_{t-3} - 10.53903805_{8.54055}YUN_{t-3} + 0.7370746046_{0.3704}PI_{t-3} - 4.0597385661_{1.6239}LR_{t-3} + 4.53959332_{2.4375}POP_{t-3}$

Variance Decomposition

Figure 11 illustrates the propositions of the movement of the dependent variable due to its "own" shocks in relation to shocks to other variables. The variance decomposition determines how much of t-step-ahead forecast error variance of any variable is explained by innovations to each unit of shock to YUN_t at $t = 0$. Figure 11 illustrates the propositions of movement of the variables "own" shock. For a unit exposure of shock to YUN, a lag of 3 years is experienced followed by a response of steady increase for 10 years. The exposure of one unit shock of YUN leads to 2 years lag of no movement and exponential increase for 10 years in GDP, ED, FDI and YUN. Also, exposure of one unit shock to YUN leads to 1 year lag of no movement and 10 year sharp decline in LR and PI.

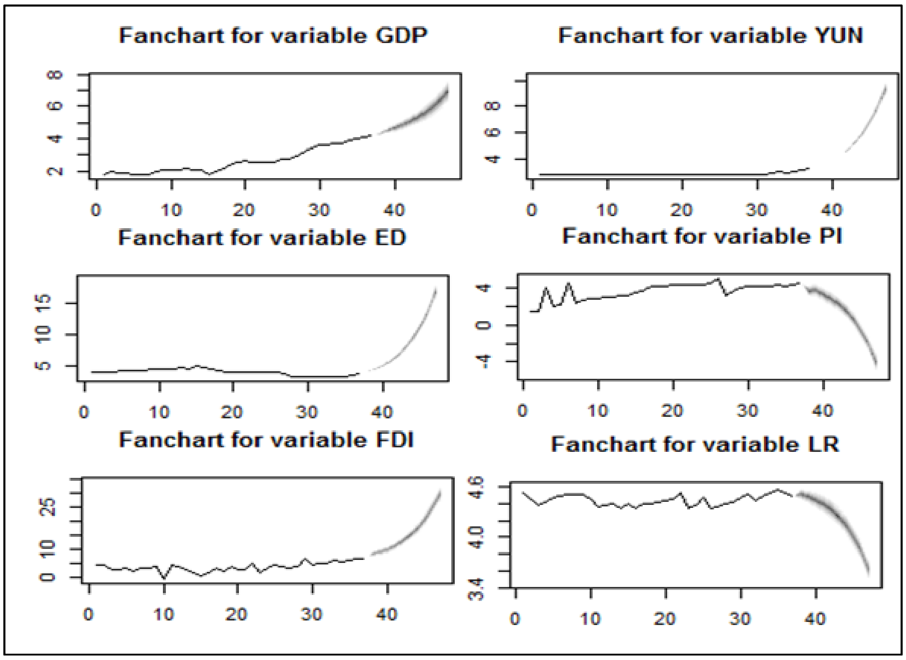

Fig 11: Variance Decomposition of variables

Impulse Response Function (IRF)

The Impulse-Response Analysis of the VECM used determines long run effects on variables when a shock of one unit is applied to each variable. The IRF in this case traces the responsiveness of youth unemployment in the VECM to shocks for other variables. A unit shock is applied to the error and the effect to the VECM system is noted.

It is possible to plot IRF of YUN to all other variables. The YUN response to all other variables makes it possible to interpret long run relation among youth unemployment and other variables as illustrated below.

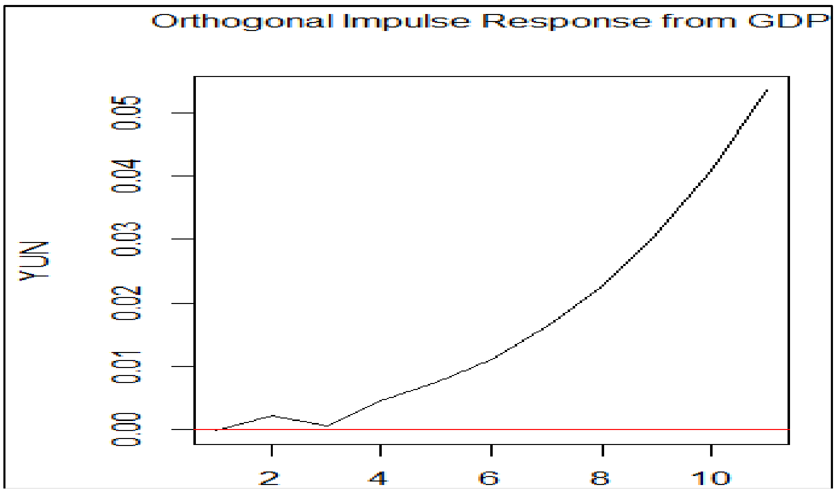

Fig 12: Impulse response of youth unemployment to GDP shock

The youth unemployment's response to GDP shock is displayed in Figure 12. In the short run, GDP shock has a negative effect on youth unemployment stretching out to the third period. In the long run, GDP shock causes an increase in youth unemployment. The equilibrium adjustment to the shock takes longer than 10 years.

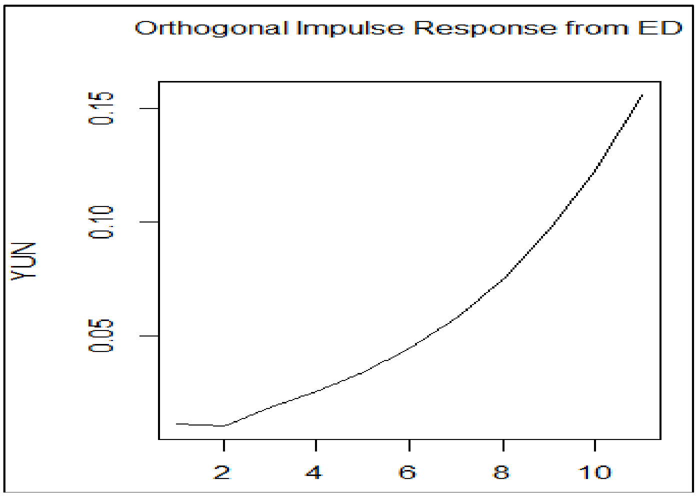

Fig 13: Impulse response for youth employment to a unit shock of external debt.

Figure 13 illustrates the effect of ED shock on youth unemployment. In the short run, a slightly negative effect up to the second period and increasing youth unemployment past the tenth period is observed. This result indicates that ED shock has long run effect on youth unemployment.

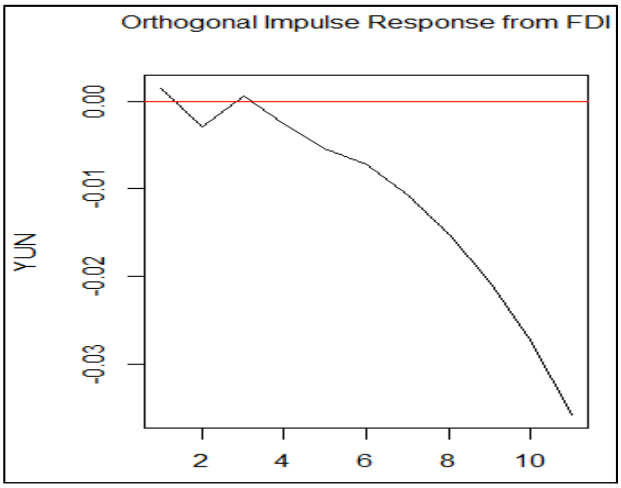

Fig 14: Short run and long run effect to youth employment to a unit shock to foreign direct investment (FDI).

Figure 14 depicts the effect of FDI shock on youth unemployment. There is a short run negative effect on youth unemployment to fourth period, and a further long run decreasing negative effect to the eleventh period. This result indicates that FDI shock has the long run effect.

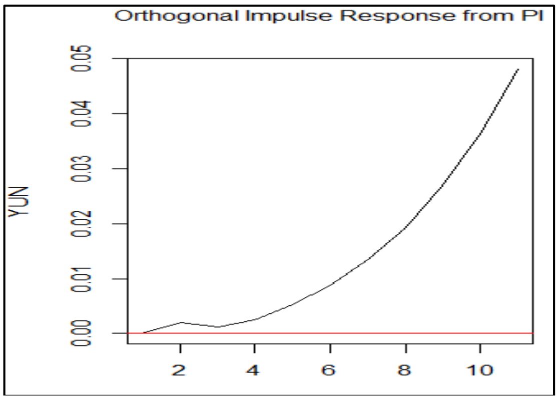

Fig 15: Short run and long run effect to youth employment to a unit shock to private investment (PI).

Figure 15 illustrates the effect of PI shock on youth unemployment. The negative effect of PI shock shows a short run decrease to the fourth period. Then follows a long run increasing effect of PI up to the 11year. The decrease is stationary in short run.

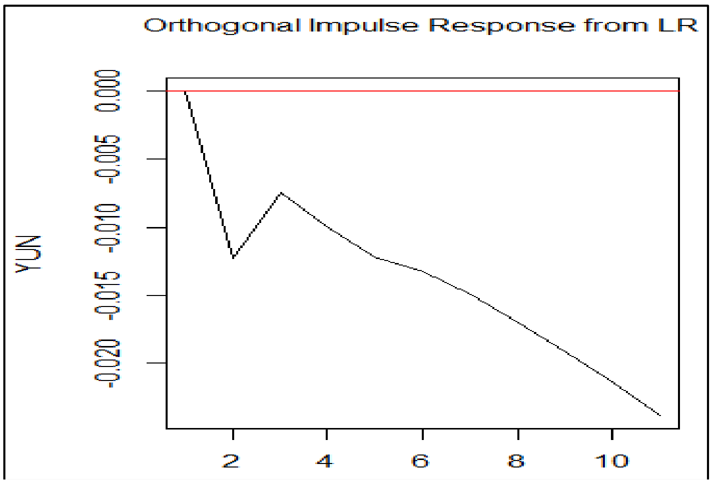

Fig 16: Short run and long run effect to youth employment to a unit shock to youth literacy levelt (LR).

In figure 16, it is observed that after the third period, the negative effect of LR shock on youth unemployment reduced significantly. This result shows that Literacy Rate is a very important factor in reducing youth unemployment in the long run.

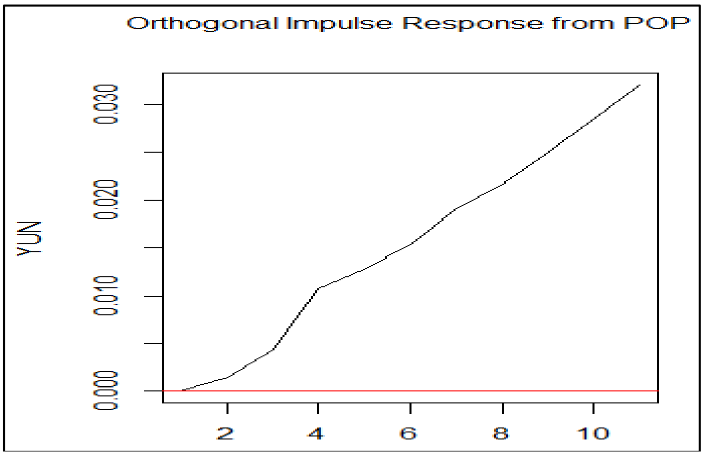

Fig 17: Short run and long run effect to youth employment to a unit shock to youth population (POP).

Figure 16 illustrates the effect of the population shock on youth unemployment. The population shock has a positive effect on youth unemployment in the long run. The adjustment to equilibrium takes 4 years. It can be deduced that the population shock has long run effect.

6. Discussion

In this paper, we analyze youth unemployment dynamics in Kenya. The study focuses on establishing the long run effects of macroeconomic shocks on youth unemployment. In this case, youth unemployment rate, gross domestic product, external debt, private investment, literacy rate, foreign direct investment, and youth population variables for the period between 1979 and 2015 have been used. A VECM model has been estimated. First, the results of the Augmented Dickey Fuller unit root tests used in the study has revealed that GDP, ED, and FDI are I(0), that is, stationary in level. However, YUN, PI, LR, and POP are **I(1)**, i.e. stationary after first difference. Then the Johansen cointegration analysis has been employed. The results of trace and maximum eigen value cointegration tests have revealed the existence of three cointegrating vectors. The three cointegration vectors have shown three long run relationships which can be interpreted as GDP Effect, External Debt Effect, and Foreign Direct Investment Effect. In addition, the Structural VECM Model has been constructed by means of restrictions in the long run impact matrix by analyzing the results of the Cointegration Analysis.

Based on the results of the Impulse-Response Function analysis and variance decomposition analysis of the structural VECM, it is concluded that GDP, literacy level, population, and FDI shocks have significant effects on Kenyan youth unemployment in the long run. Whereas population, external debt, private investment, and GDP have positive effects, foreign direct investment and literacy rate have negative effects on youth unemployment in the long run. Notably, GDP has a negative effect only in the short run. Up to the second period, the negative effect of Literacy Rate shock on youth unemployment reduced significantly. At this period, the negative effect has tended to increase slightly, and reduced steadily afterwards in the long run. This result shows that Literacy Rate is an important factor in reducing youth unemployment. The population shock has a positive effect on youth unemployment in the long run. Consequently, this positive effect explains the direction of relation between population and youth unemployment. It can be deduced that the population shock has contributed to the increase in youth unemployment for the immediate short run and extensive long run period. Results for all variables indicate that adjustment(s) to equilibrium take approximately 3 years.

7. Conclusion

Increase in population increases youth unemployment in the short run and long run. To achieve benefits of Demographic Dividend, population policies have to target reduction in population to cause reduction in dependency ratio. In this way, the national development benefits when a large working population is supporting a smaller dependent population. Also, a second driver of the Demographic Dividend is creation of a productive employment for the youth constituting working population to contribute to the economy through education, technology and innovations to pay for better healthcare, quality education, and food security.

The unmitigated rise in Kenyan youth unemployment can be explained that Kenyan economy is unable to create new sustainable job opportunities. This situation is caused by other investment initiative characterized by less innovation, negligible labour productivity resulting in jobless growth. Therefore, policies aimed at creating an effective, innovative and labor-intensive investments should be implemented to curb youth unemployment and achieve demographic dividends. The suggested policies should support sufficient and effective growth as well as economic stability to address challenges related to unemployment. The VECM is most suitable for multivariate studies because it isolates cointegrating vectors that select parameters of interest. In this paper VECM has identified gross domestic product effect, foreign direct invest effect, and external debt effect.

8. References

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Appendix II: Macroeconomics Data

Year	GDP	ED	FDI	YUN	PI	LR	POP
1979	6.23	45.3	1.35	16.1	0.113047	92.6	15.66
1980	7.27	48.1	1.09	16.2	0.178052	85.5	16.27
1981	6.85	48.6	0.21	16.4	0.15706	79.2	16.9
1982	6.43	54.5	0.2	16.7	0.140596	82.3	17.56
1983	5.98	62.7	0.4	16.6	0.125115	87.2	18.24
1984	6.19	58.6	0.19	16.8	0.122659	89.1	18.94
1985	6.14	70.6	0.47	16.9	0.155369	91.2	19.66
1986	7.24	65.8	0.46	17.1	0.157582	90.6	20.39
1987	7.97	75.2	0.49	17.2	0.193607	91.7	21.14
1988	8.36	72.3	0.005	17.5	0.212636	86.5	21.9
1989	8.28	73.3	0.75	17.4	0.205652	79.1	22.67
1990	8.57	86	0.67	17.3	2.075833	79.6	23.45
1991	8.15	95.8	0.23	17.2	0.170954	81.3	24.24

1992	8.21	87.8	0.08	17.3	0.139101	77.3	25.04
1993	5.75	131.9	2.53	17.3	0.101291	81.3	25.84
1994	7.15	105	0.1	17.2	0.137911	77.3	26.63
1995	9.05	83.8	0.47	17.1	0.197389	80.9	27.42
1996	12.05	57.6	0.91	17.1	0.180734	81.2	28.19
1997	13.12	49.9	0.47	17.2	0.198585	82.3	28.94
1998	14.09	48.9	0.19	17.1	0.235254	84.9	29.7
1999	12.9	51.3	0.4	17.1	0.200165	86.8	30.48
2000	12.71	49.2	0.87	17.2	0.221007	92.5	31.29
2001	12.99	43.4	0.04	17.1	0.244021	76.3	32.13
2002	13.15	47.5	0.21	17.2	0.199056	79.2	33
2003	14.9	47	0.55	17.1	0.245644	88	33.91
2004	16.1	43.8	0.29	17	0.275031	76.3	34.83
2005	18.74	34.7	0.11	17	0.31692	78.2	35.79
2006	25.83	26	2	17	0.40389	81	36.76
2007	31.96	23.7	2.28	17	0.518351	82.4	37.75
2008	35.9	21.1	0.28	17.1	0.610939	86.9	38.77
2009	37.02	23.3	0.32	17.1	0.613535	91.5	39.82
2010	40	22.1	0.45	18.1	0.6675	84	40.91
2011	41.95	25	0.33	20.2	0.74532	88.8	42.03
2012	50.33	23.4	0.32	19.1	0.765232	92	43.18
2013	53.4	25	1.8	21.1	0.667897	95.9	44.35
2014	61.395S	26.7	2.35	22.9	0.743235	93.2	49.3
2015	63.398	40.2	2.1	27.3	0.912553	90.1	50