CAN AFRICA'S YOUNG DRIVE INNOVATION? INVESTIGATING THE EFFECT OF ENTREPRENEURIAL INNOVATION ON ECONOMIC GROWTH IN AFRICA[1]

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Abstract

Innovation shocks are known to have strong and significant effect on growth particularly when such shocks are attributable to technology changes. Literacy rates in Africa appear to have significantly improved compared to those of the 1970s (World Bank literacy rate statistics 2013). There also appears to be significant use of high level technology in information access across Africa despite poor infrastructure and in many instances impediments to technology, use attributable to high cost of access to telecommunication infrastructure and devices. Growth for Africa has also been mostly attributable to exports in commodities and a gradual development of local markets. This study investigates the effect of Africa's growing demographic composition on growth and innovation. Quantile regression technique is utilized in the analysis of the results, specifically the Qreg2 Wrapper by Parente and Silva (2013) allowing us to derive covariance matrix estimators that are valid when there is heteroskedasticity and intra-cluster correlation. Results show that Africa's young and their innovative capacity have strong implications for growth.

Keywords: *Quantitative Economics, Entrepreneurship, Innovation and Demographic Composition*

1.0. Background of The Study

In this section some background statements are made on the subject under study. What exactly are the ramifications of -improved innovation trends- for –growth- in –Africa-? To what extent is Africa's current -demographic composition- improving growth in many -sub Saharan African- (SSA) countries? Innovation can be defined as the employment of new ideas and ways of doing old tasks. Innovation can have strong implicative effects for growth in many African countries that are still largely developing and have not yet achieved a significant level of industrial growth. Few studies have tried to study in a quantitative manner the implicative effects of a vibrant, young and innovative population for growth in Africa. Trends already depict that above 41 percent of the total population of sub Saharan Africa are between the ages of 0 to 24 (World Bank Statistics 2013). Therefore Africa has quite a significant young population that can inject some energy into nation building. Many among this young category are also beginning to engage in innovative and entrepreneurial activities therefore a clear understanding of how this vibrant segment of the population can affect growth could offer significant insight into their contribution to the current growth trend across the continent.

There exist various channels through which a thriving, healthy and young segment of the African populace can affect growth. For instance many young people in Africa are more likely to have a secondary and tertiary school education unlike their parents thereby improving labour quality across the continent. There is also the tendency for the literate young to take advantage of recent technologies utilizing telecommunication networks and the internet to sharpen their skills increasing learning and the flow of knowledge among the highly literate segment of the African population. There is also the energy associated with youths: they are more likely to work longer hours and engage in rigorous brainstorming and energy sapping activities that are likely to lead to firm start-ups and new product generation. However there is no significant result to show that innovation has significantly increased in Africa compared to the results obtained in other parts of the world.

There is evidence that a low amount of patents turn out from Africa compared to those from other regions of the world, with South Africa alone accounting for over 73 percent of all total patents on the continents (World Bank Statistics 2013), with a significant decline in number of patents noticeable from 1990 with the end of the apartheid regime in South Africa. There are also significant indications that industrialization is also eluding Africa. Africa still remains the industrial raw material power house for the global economy with only a little share of World industrial activity taking place on the continent. It is highly unlikely that Africa will catch up with the rest of the World without a clear path to industrialization.

1.1. Scope and Objectives of the Study

In this sub section the scope and objective of the study is presented. This study investigates the effect of innovation and Africa's young population on economic growth on the continent with special emphasis on sub Saharan Africa (SSA). The method of estimation used is the quantile estimation technique, this is based on the premise that the sample median will converge that to that of the population. It is valid in the presence of heterscedasticity and it allows for the utilization of other measure of dispersion other than the mean (in this case the median). Data for 54 years (1960 to 2013) were utilized but many years of data are missing in the observation.

The specific objectives of the study include:

a) To determine if Africa's current demographic composition comprising of over 41% of the population between the ages of 0 to 24 has a positive significant effect on growth?

b) To determine if the level innovation as provided for, by available investment in telecommunication technologies that is known to improve knowledge sharing and drive skill has any significant effect on economic growth in Africa?

c) And finally to examine the nature of and state of this innovation in helping this young and very literate segment of the population to promote growth.

The rest of the study is divided into the data sources and empirical analysis, discussion of results and conclusion.

2.0. Data Sources and Empirical Analysis

In this section the data sources and the empirical foundations of the study is discussed. In study the relationship between innovation, Africa's young population and growth is examined, different intuitive arguments are considered. They include the evidence from past studies that have utilized different methodologies and estimation techniques on eco-

nomic growth as well as other empirical papers that have investigated the effect different economic variables and their causal implicative effects on economic growth. They include the study by Aghion P. and Howitt P. (2004) who studied the effect of quality innovation with growth enhancing capabilities on economic growth, OjeagaP., Odejimi D., George O. and Azuh D. (2014) who argue that innovative and modern utilization of renewable energy production plants can drive economic growth using panel data and generalized method of moment estimation technique, Ojeaga P., Odejimi D. O., Okhiku J. and Ojeaga D. (2013) who study the effect of commercial lending on growth utilization time series data and non-parametric estimation techniques (with special emphasis on quantile regression by Silva et al 2013) finding strong relationship between lending and economic growth which is negative for Nigeria etc.

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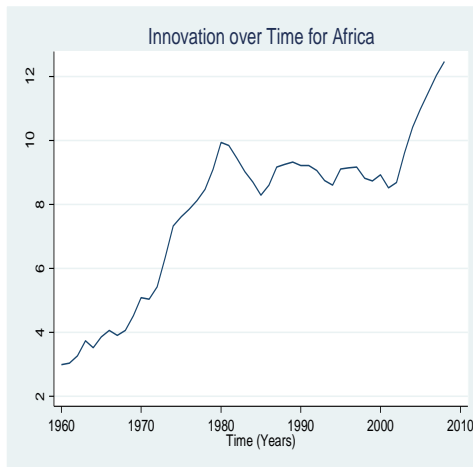
**Fig. 1**   **Fig. 2**

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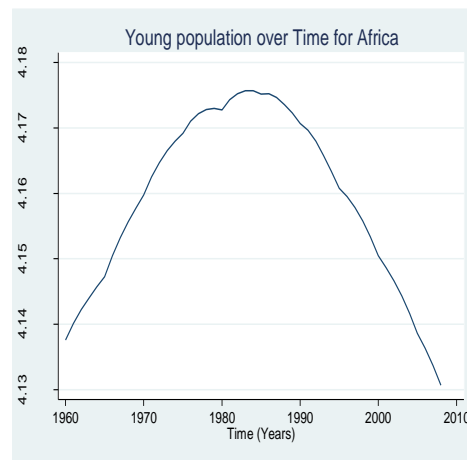
Note: Fig. 1 and 2 depicts innovation young population between 0-24 years of age over time in Africa. It reveals that innovation is on the increase with increased wave of knowledge and information sharing unfortunately the African business environment remains risky.

Other studies Ojeaga P., Odejimi D. and Ikpefan O. (2014) have also used quantile regression and time series data to study the relationship between deposit and fraud finding strong relationship between the two variables. The study, by Ojeaga P. (2014), also finds that foreign inflow also affects exporting capabilities utilizing panel data. Trends show that innovation is increasing as the use of knowledge sharing devices appears to be on the increase even though the nature and depth of the use are still quite questionable (see Fig. 1). This is attributable to improved living conditions and the influx of telecommunication gadgets from China of low and cheap quality etc. However fewer children utilize these facilities compared to children in other regions of the world. There also exist poor learning environment and poor access to credit in Africa for young people to implement their ideas. The share of young population between 0-24 years of age in sub Saharan Africa is around 41 percent of the total population meaning that 4 out 10 Africans are between the ages of 0 to 24. The share of young workable people that can drive growth can therefore be said to be high which can have strong implicative effects on growth if properly channeled (see Fig. 2).

Fig.3

Fig.4

Growth Rate over Time for Africa

Gross Capital Formation over Time for Africa
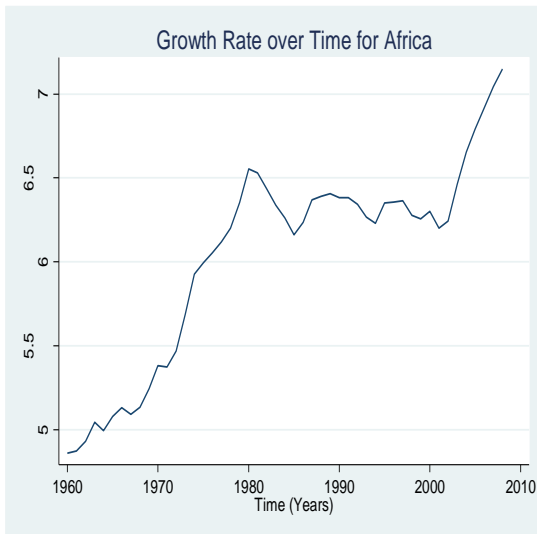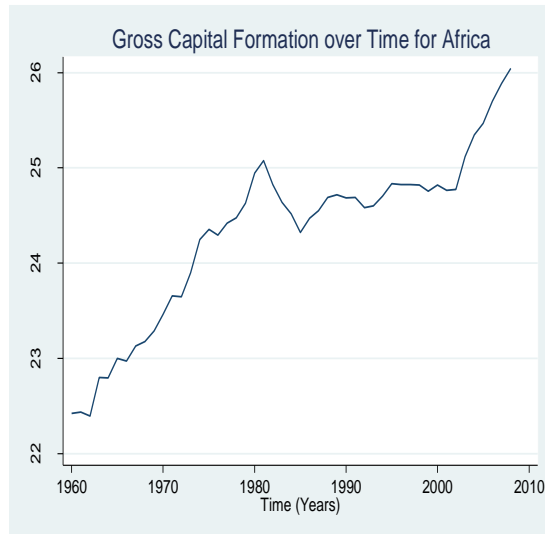
Note: Fig.3 and 4 depict that growth has increased for Africa so also is gross capital formation. The growth of over 7% remains unsustainable as most African countries are raw material exporting countries and have not managed to promote significant industrialization. Gross capital formation stands at about 26 billion dollars as at 2009, which is still low compared to those of other regions of the world.

There appears to have been significant economic growth on the continent. With growth surpassing 7 percent by 2008 even amidst a severe global interconnected financial crisis, depicting once again the disconnection of the African financial system from those of the developed north (see fig. 3). Gross capital formation for sub Saharan Africa also surpassed 25 billion dollars for the first time in 2004 (World Bank Statistics 2013 see fig. 4) depicting increase access to capital for firms in the private sector..

All data for the study are obtained from the data market of Iceland, which in turn archives data from the World Bank and United Nation data. Data for 54 years (1960 to 2013) were utilized but many years of data are missing in the observation. The growth variable is GDP growth rate which is GDP per capita. GDP is gross domestic product and is defined as the total goods and services produces in Africa over time, in this case yearly data is utilized. Other explanatory variables utilized include innovation which is measured as fixed and mobile phone use as a percentage of the young population, gross capital formation in constant United states dollars which measure the total available flow of capital in banks and in the private sector of the African economy, the percentage illiterate population as a percentage of the total population in Africa.

The model estimated is the endogenous growth model which accounts for human capital, labour quality, and capital and assumes that technology is fixed. Therefore growth can be expressed as

Growth f (Tech, Human Capital, Capital)

The model is extended to include unskilled labour in this case illiterate population as a percentage of total population, therefore allowing us to express three different model specifications below as

$$Growth_t = \alpha_0 + \alpha_1 Inn_t + \alpha_2 X_t + u_t \qquad (1)$$

Where growth is a function of innovation (innv.) and a set of other explanatory variables which will include gross capital formation and illiteracy level. The year variable is also

included to control for annual variation in innovation levels and other variables not included in the model specification.

$$Growth_t = \alpha_0 + \alpha_1 Ypop_t + \alpha_2 X_t + u_t \qquad (2)$$

In the second model specification in equation 2 growth is a function of youth population, gross capital formation and illiteracy level. The year variable is also included to control for annual variation in innovation levels and other variables not included in the model specification.

$$Growth_t = \alpha_0 + \alpha_1 Inn * Ypop_t + \alpha_2 X_t + u_t \qquad (3)$$

In the third model specification in equation 3 growth is a function of an interactive variable in this case innovation* youth population, this is necessary to understand the extent to which youth can utilize innovation in Africa. The extent of which will be the level to which they actually innovate and will be a function of the level of education, access to technical facilities, the rate of flow of knowledge in the Africa region and its link to the global community while not neglecting country specific innovation policy, in conjunction with other variables such as gross capital formation and illiteracy level. The year variable is also included to control for annual variation in innovation levels and other variables not included in the model specification. (It should be noted that X_t represents other explanatory variables which include gross capital formation, illiterate population and the year variable for all three model specifications).

The method of estimation utilized as stated earlier is the quantile regression which estimates the median as a measure of central tendency. It is a non-parametric estimation technique therefore the assumption of Gaussian normality and choice of functional form do not significantly limit the choice of the estimation technique. It also produces heteroscedastic robust standard errors especially with the quantile regression 2 (qreg 2) handle implementable in Stata 11 see Silva et al 2013.

2.1 Results

In this sub section the results of the study is presented systematically. The results of the regression of innovation and growth are shown in table 1 using the quantile regression 2 handle in Stata 11. The R-Squared depicts that the model fits the data well with an R-Squared of 0.99. The objective function is .00044761 depicting the convergence to the sample median is achieved. The results below depicts that innovation (lnshphoneuse) with P-Value 0.000 has strong significant effect on economic growth in Africa using the measure of access to fixed and mobile phone lines. Gross capital formation (lngcf) and illiterate population as a percentage of youth population (lnyillpopafc) both had no significant effect on economic growth for Africa.

Table 1. Regression of Innovation on Growth Rate for Africa

Median regression					
R-squared = .99996802					
Number of obs = 24					
Objective function = .00044761					
Heteroskedasticity robust standard errors					
lngdppercap | Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnshphoneuse |1.001509	.0078429	127.70	0.000	.9850934	1.017924
lngcf |-.0052024	.0067375	-0.77	0.450	-.0193041	.0088993

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lnyillpopafc |-.0327627 .0697839  -0.47  0.644  -.1788221   .1132966
Year Effect |-.0016873 .0004983  -3.39  0.003  -.0027303  -.0006442
      _cons |7.790102 .6285926  12.39  0.000   6.474443   9.105762
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Machado-Santos Silva test for heteroskedasticity
Ho: Constant variance
Variables: Fitted values of lngdppercap and its squares
chi2(2)   =   6.486
Prob > chi2 =   0.039

Note: The above results shows the regression of innovation gross capital formation and illiterate youth population as a percentage of total youth population on economic growth for sub Saharan Africa. It was found that innovation has positive significant effect on economic growth in sub Saharan Africa.

The result of the regression of youth population, on economic growth is also depicted in the regression table of Table- 2. The results depict that the youth population has no significant effect on growth. In this case gross capital formation has strong positive effect on growth with (P-value 0.000). The R- Squared is reasonably high and the objective function (with value of .01234785) in this case depicts convergence of data used.

Table 2. Regression of Young Population on Growth Rate for Africa

Median regression						
R-squared = .98157682						
Number of obs = 24						
Objective function = .01234785						
Heteroskedasticity robust standard errors						
lngdppercap |	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
lnafrica |	-2.197519	5.610783	-0.39	0.700	-13.94102	9.545985
lngcf |	.8033851	.043785	18.35	0.000	.7117421	.895028
lnyillpopafc |	-1.103577	1.209525	-0.91	0.373	-3.635143	1.427989
Year Effect|	-.0162338	.0100541	-1.61	0.123	-.0372772	.0048096
_cons |	32.61901	41.74685	0.78	0.444	-54.75814	119.9962
Machado-Santos Silva test for heteroskedasticity						
Ho: Constant variance						
Variables: Fitted values of lngdppercap and its squares						
chi2(2) = 1.611						
Prob > chi2 = 0.047						

Note: The above results shows the regression of youth population gross capital formation and illiterate youth population as a percentage of total youth population on economic growth for sub Saharan Africa. It was found that gross capital formation has positive significant effect on economic growth in sub Saharan Africa (see p-value of 0.000).

The results of the regression of the interactive variable (youth population* innovation) on economic growth is depicted in Table-3. The use of the interactive variable allows us to gauge the level of youth engagement of innovative technology to drive growth and enterprise build up in Africa. It was found that the interactive variable (lnshphone~ca) has positive significant effect on economic growth in Africa.

Table 3. Regression of the Interaction (Young Population * Innovation) on Growth Rate For Africa

Median regression						
R-squared	= .9999771					
Number of obs	= 24					
Objective function	= .0005057					
Heteroskedasticity robust standard errors						
lngdppercap |	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
lnshphone~ca |	.2442787	.0020727	117.86	0.000	.2399551	.2486022
lngcf |	-.0118693	.0070382	-1.69	0.107	-.0265508	.0028122
lnyillpopafc |	-.1076503	.0323649	-3.33	0.003	-.1751622	-.0401384
_cons |	4.871293	.0664857	73.27	0.000	4.732606	5.00998
Machado-Santos Silva test for heteroskedasticity						
Ho: Constant variance						
Variables: Fitted values of lngdppercap and its squares						
chi2(2) = 1.326						
Prob > chi2 = 0.515						

Note: The above results shows the regression of the interactive variable (innovation*youth population) gross capital formation and illiterate youth population as a percentage of total youth population on economic growth for sub Saharan Africa. It was found that gross capital formation has positive significant effect on economic growth in sub Saharan Africa (see p-value of 0.000).

**Table 4.** Vector Auto-regression of innovation gross capital formation and youth population

Vector auto regression						
Sample: 1962 - 2008		No. of obs =	47			
Log likelihood = 675.7256		AIC	= -27.22236			
FPE = 1.80e-17		HQIC	= -26.68909			
Det(Sigma_ml) = 3.82e-18		SBIC	= -25.80523			
Equation	Parms	RMSE	R-sq	chi2	P>chi2	
Gross Capital Formation	9	.098443	0.9884	4018.344	0.0000	
phone use as a % Pop	9	.318865	0.9851	3115.524	0.0000	
Young Population	9	.00059	0.9983	28211.58	0.0000	
GDP per Capital	9	.076567	0.9853	3142.87	0.0000	

Note: The above results shows the vector auto regression results

Shocks transmitted from innovation to growth is also examined using the Vector Auto regression model in the case the error is assume to follow an AR (1) process and that variance accounts for transmitted shocks from the set of interdependent variables to one another. The results are shown above in Table-4. It was found that innovation shocks to economic growth (GDP) were positive and that such shocks where significantly affecting growth (GDP) in Africa. The impulse response function depicts that such shocks lasted up to the eight periods showing that innovation was likely a more sustainable way of driving growth in many African countries. Although positive shocks were noticeable from gross capital formation to growth the effect were not as significant as that of innovation (see the third row of Fig. 5 of impulse response function among variables). Fund the Stata 11 results tables in the appendix.

Fig. 5. Impulse Response among Variables

Graphs by irfname, impulse variable, and response variable
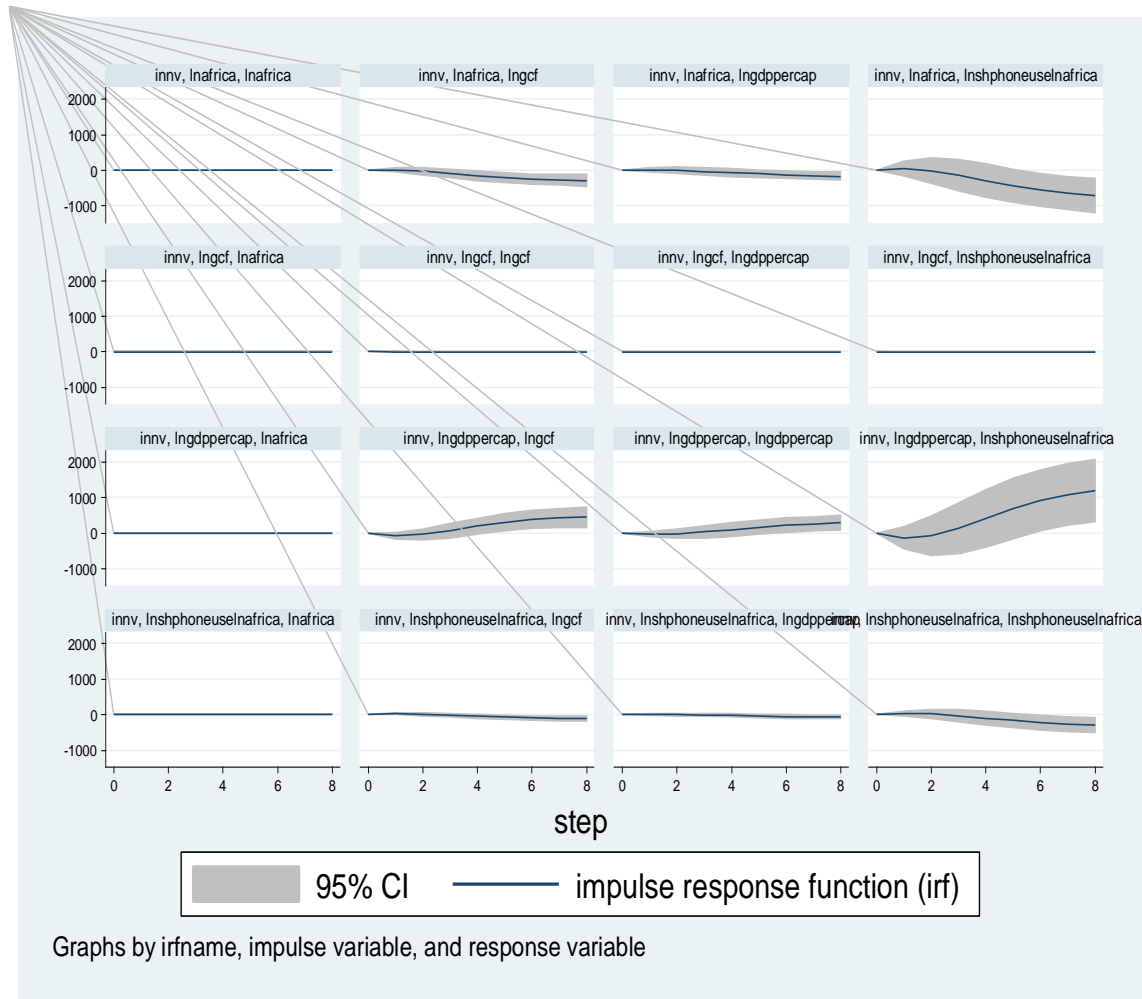
Note: The above figure shows the impulse response function among variable using the Vector Auto Regressive (VAR) model. The results interpreted here are those of the third column. It depicts that gross capital formation extend positive shocks to economic growth, this is noticeable between the second to eighth periods see graph on row 3 column 2. There are also noticeable shocks from entrepreneurship to economic growth also noticeable from the secon to eighth periods see row three column 4.

3.0. Discussion of Results

In this section the results of the study are discussed in detail. Interestingly, the results show that Africa's current demographic composition has no significant effect on growth. Depicting that it was rather a burden because they are mainly unproductive given the hostile environment which is often a limitation to the extent to which they could be productive. Infrastructure remains a strong driver for growth particularly telecommunication infrastructure which helps improve knowledge sharing and connect people with ideas to likely venture capitalists enabling them to access funds for either new start-ups or bringing such ideas onboard existing firms. There is also suggestive evidence from the results that an innovative young population could be a strong advantage to countries on the continent since the interactive variable (young population * Innovation) had strong positive influences on economic growth. Making platforms for knowledge sharing more accessible and affordable is likely to contribute significantly to growth in many African countries.

Innovation shocks across the continent were found to be positively contributing to growth, in countries. This depicted that improving knowledge flow is likely to have meaning

effects on economic growth on the continent. It was also found that capital access were also transmitting positive shocks to growth, however the increment to growth were not as noticeable as those from innovation. These shocks in general were found to last up to 6 periods respectively with the shocks starting from the second and lasting to the 8 periods respectively for innovation and gross capital formation respectively (see fig. 4 in the results presentation section).

The share of illiterate population in the African workforce had no significant effect on economic growth. This was likely to be true since most people in this segment of the population where likely to be engaged in subsistence farming and petty trade with little consequence for GDP increases. The implication of the above results are that innovation and gross capital formation had strong positive effect on economic growth, therefore strengthening knowledge flow and increasing the flow of capital to the real sector of the African economy could had strong positive effects for growth.

4.0. Conclusion and Recommendation

In this section we conclude and make useful recommendations. In the study, the implicative effects of Africa's young population and innovation, on economic growth, were investigated. The question that the study tries to answer include to what extent does Africa's current youth demographic composition influence growth across the continent and the second question was to what extent does the innovation influence economic growth on the continent. Finally it was also necessary to ask if, youths were substantially driving economic growth utilizing innovative skills across the continent allowing for a clear understanding of how the current young and vibrant population can drive growth due to the obvious advantages that the current generation of Africa's youth have over the predecessors. Which include that they are more literate, have more access to knowledge sharing devices such as telecommunication services etc.

It was found that Africa's young population had no effect on economic growth on the continent. It was also found that innovation had positive significant effect on economic growth in Africa. Finally it was found that utilizing innovative skills which improve knowledge sharing was likely to make Africa take advantage of its young population composition to drive growth. The vector auto regression results also provided an understanding of the nature of innovation and capital flow shocks transmitted to growth in Africa. It was found that innovation and capital flows transmit shocks lasting up to six periods and that it takes at least two periods for government policy regarding innovation and capital flow improvements to take effect in many African countries. This depicts that policies designed by government to improve innovation and knowledge access as well as increase capital flow to the private sector of the African economy are not likely to yield meaningful results for growth until after two periods.

A policy to drive and increase the flow of knowledge among the young vibrant population through training, skill acquisition and knowledge sharing is therefore recommended for many African economies wishing to take advantage of their current demographic composition. It is also recommended that ease of access to capital should be encouraged in order to facilitate start-ups and link potential ideas that can lead to increase in patents would also have reaching implicative effects for many African economies. Patents are likely to increase if the business environment is made more friendly through infrastructure devel-

opment particularly telecommunication infrastructure, which can increase knowledge flow. The future remains bright if only innovative policies and sound monetary policies to drive invention and innovation, leading to patents are developed and sustained in Africa.

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8. * * * **World Bank Statistics**, 2013

Appendix

Appendix I. Regression of Youth Population (0-24) on Economic Growth without the Year Effect Controls

VARIABLES	(1) GDPPERCAP	(2) GDPPERCAP	(3) GDPPERCAP	(4) GDPPERCAP
Young Population (0-24)	4.980 (3.213)			
Gross Capital	0.822*** (0.0461)	0.832*** (0.0699)	0.813*** (0.0868)	0.806*** (0.0510)
Illiterate Population/Total Population SSA	-1.566 (0.941)	-1.700 (1.140)	-2.440** (0.974)	-1.789* (0.892)
Young pop SSA ex South Africa &Nigeria		10.13 (9.906)		
Young pop SSA ex South Africa			5.603 (10.83)	
Young pop SSA Developing				6.289 (5.539)
Constant	-28.16 (17.90)	-49.61 (47.70)	-26.98 (51.09)	-32.36 (27.64)
Observations	24	24	24	24
R-squared	0.978	0.975	0.973	0.975

Note: Standard errors in parentheses*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Appendix II. Regression of Youth Population across SSA with Year Effect Control

VARIABLES	(1) GDPPERCAP	(2) GDPPERCAP	(3) GDPPERCAP	(4) GDPPERCAP
Youth Population Africa	-2.198			
	(5.611)			
Gross Capital	0.803***	0.786***	0.777***	0.804***
	(0.0438)	(0.0445)	(0.0454)	(0.0435)
Illiterate Population/Total Pop	-1.104	-1.072	-1.082	-1.109
	(1.210)	(1.127)	(1.096)	(1.225)
Year Effect	No	Yes	Yes	Yes
	(0.0101)	(0.00555)	(0.00571)	(0.00742)
SSA Pop exc. SA & Nigeria		-4.401		
		(6.023)		
SSA Pop exc. SA			-3.854	
			(4.977)	
Pop exc. SA Developing only				-2.285
				(5.756)
Constant	32.62	38.67	33.59	29.40
	(41.75)	(30.03)	(23.49)	(33.37)
Observations	24	24	24	24
R-squared	0.982	0.980	0.981	0.981

Note: Standard errors in parentheses*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Appendix III Regression of Innovation (Fixed and Mobile Phone Access as a % of total Youth population) on Growth in Africa.

VARIABLES	(1) GDPPERCAP	(2) GDPPERCAP	(3) GDPPERCAP	(4) GDPPERCAP	(5) GDPPERCAP
Innovation all of Africa (Phone Use)	1.032***				
	(0.0121)				
Gross Capital Formation	-0.0331***	-0.0119	-0.0223**	-0.0234*	-0.0218**
	(0.0102)	(0.00704)	(0.0105)	(0.0114)	(0.0104)
Illiterate population	-0.205***	-0.108***	-0.185***	-0.183***	-0.147***
	(0.0512)	(0.0324)	(0.0449)	(0.0481)	(0.0443)
Innovation all of SSA (Phone Use)		0.244***			
		(0.00207)			
Innovation all of SSAEX. S.A. &Nig.			0.245***		
			(0.00308)		
Innovation all of SSAEX. S.A.				0.245***	
				(0.00334)	
Innovation all of SSA Dev.					0.245***
					(0.00304)
Constant	5.773***	4.871***	5.433***	5.450***	5.264***
	(0.118)	(0.0665)	(0.103)	(0.116)	(0.104)
Observations	24	24	24	24	24
R-squared	0.97	0.97	0.98	0.97	0.98

Note: Standard errors in parentheses*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Appendix IV. Regression of Innovation on Economic Growth Including the Year Effect Control

VARIABLES	(1) GDPPERCAP	(2) GDPPERCAP	(3) GDPPERCAP	(4) GDPPERCAP	(5) GDPPERCAP
Innovation All of Africa	1.002***				
	(0.00784)				
Gross Capital Formation	-0.0052	0.00461	-0.00233	-0.00229	-0.00202
	(0.00674)	(0.00439)	(0.00279)	(0.00234)	(0.00325)
Illiterate Population	-0.0328	-0.0281	-0.0912***	-0.0748***	-0.0434
	(0.0698)	(0.0199)	(0.0239)	(0.0203)	(0.0279)
Year Effect	Yes	Yes	Yes	Yes	Yes
Innovation all of SSA		0.240***			
		(0.00124)			
Innovation all of SSA EX. S.A. & Nig.			0.239***		
			(0.000811)		
Innovation all of SSA EX. S.A.				0.240***	
				(0.000686)	
Innovation all of SSA Develop-ing					0.240***
					(0.000947)
Constant	7.790***	5.848***	6.512***	6.770***	6.538***
	(0.629)	(0.184)	(0.173)	(0.144)	(0.202)
Observations	24	24	24	24	24
R-squared	0.97	0.97	0.98	0.97	0.98

Note: Standard errors in parentheses*** $p<0.01$, ** $p<0.05$, * $p<0.1$