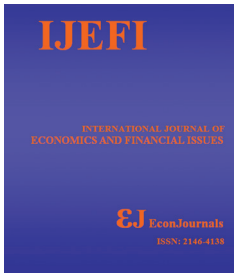

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Human Capital, Institutions and Innovation in Sub-Saharan Africa

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ABSTRACT

This study examined the impact of human capital and institutions on innovation in Sub-Saharan Africa (SSA) and clearly highlighted the relevance of the human factor in determining innovation outcomes in the Sub-Saharan African region. Using the system generalized method of moments, coupled with some descriptive analyses, it was found out that human capital, as well as an enabling institutional environment, affects innovation outcomes in SSA. On the contrary, innovation outcomes in the region did not benefit from foreign investment. The study, therefore, recommends that human capital capacity be cultivated and given the enabling environment to contribute to innovation outcomes. This is expected to attract innovation-centred investments into the region.

Keywords: Human Capital, Institutions, Innovation, Sub-Saharan Africa
JEL Classifications: I25, O15, O31, O32, O43, O55

1. INTRODUCTION

The quality of human capital has been adjudged a crucial determinant of innovation in countries world over. In turn, innovation significantly impacts on the varying levels of growth and development (Romer, 1990; Romer, 1994; Tebaldi and Elmslie, 2013). Developed countries, which are at the frontier of technological advancement and innovation are characterized by a highly skilled labour force, which drive their production and innovation processes. On the other hand, countries with low human development indices usually lag behind in development and capacity to innovate due to human and physical capital deficits. Brain drain which connotes the movement of highly skilled labour and professionals from developing to developed countries also contributes to Africa's human capital deficits. However, it is theoretical propositions as well as empirical indications posit that latecomer countries have greater chance of achieving higher rates of innovation growth as a result of lower effective costs of education, which enable them catch up (Ang et al., 2011).

Notably, African countries have been experiencing the highest levels of growth in the history of their development path (The Economist, 2013). However, this rapid growth rate is not accompanied by structural transformation which entails a significant shift of labour skills from low-productivity agricultural sectors to sectors with higher productivity potentials. Much of Africa's growth is driven by resource booms and windfalls from resource-seeking foreign direct investment. The capital-intensive nature of resource seeking FDI provides meager opportunity for local capacity building, which efficiency-seeking and cost-saving FDI have as advantage. Nevertheless, given the extent globalization and the proliferation of a knowledge economy, Africa could catch up with frontier economies by leapfrogging major channels of technology transfer - trade, investment and knowledge flows. Countries' absorptive capacity, indicated by human capital and innovation capacity, however determine the extent of learning and leapfrogging that may occur.

Sub-Saharan Africa (SSA) has been termed the region with the least innovative output (Oluwatobi et al., 2014). As a latecomer

in development, SSA demonstrates potential for accelerated economic growth and development. However, since innovation is not an end in itself, it cannot drive growth. The human capital component is essential in determining innovation outcomes, since even physical investments tend to accrue to regions with larger stock of human capital hence greater growth (Chi, 2008). Even though, SSA region has 60% of the fastest growing economies in the world, the dismal level of innovation and competiveness leaves much to be desired and raises a cause for concern for development experts. Most of the existing studies on the relationship between human capital and innovation have been based on non-African economies. Related regional studies focused on the human capital, institutions, economic nexus**,** while most others are country-specific studies (Oluwatobi and Ogunrinola, 2011).

Going forward, it is pertinent to investigate the impact of human capital on innovation outcomes in SSA in order to ascertain the possibility of achieving innovation-driven growth in the region. Also, the study by Oyelaran-Oyeyinka and Barclay (2004), which is the closest to this study on SSA, examined human capital and the systems of innovation in the development of Africa. However, we highlight the shortcomings of the study in an attempt to carry on a current and more robust analysis. Firstly, the study by Oyelaran-Oyeyinka and Barclay (2004) did not capture innovation; rather it related human capital variables with growth and development. Secondly, the study adopted simple descriptive statistics and ordinary least squares as estimation techniques; these are incapable of addressing endogeneity and heterogeneity problems associated with cross country studies on the subject. Thirdly, the study spans the period 1960-2000; hence, its findings may no longer be current and useful for drawing meaningful conclusions. In addition to these, most studies on this subject looked at the relationship between human capital and innovation with little attention to institutions, which defines the environment that enables innovation. Besides, most of the studies have been on non-SSA countries (Chi, 2008; Ang et al., 2011; Kato et al., 2015).

This study, thus, fills these gaps by considering institutions in the relationship between human capital and innovation as well as paying attention to SSA in isolation of other regions. This is necessary to capture results that are distinct to the region given its peculiarity. In addition, the study employs the System Generalized Method of Moments (SGMM) estimation technique, which has the capacity to address endogeneity and heterogeneity problems. Next to this introductory section we present a brief overview of existing literature. Section three is a presentation of some stylized facts on human capital, institutions and innovation in SSA as well as in relation to other regions of the world. Section four describes the methodology employed for the study. The results from data analyses and estimations are presented I section five. The paper is concluded in section five with a summary of findings, their implications and policy recommendations.

2. LITERATURE REVIEW

The theoretical background behind the relationship between human capital and innovation has been established by the proponents of endogenous growth theory (Romer, 1990; Aghion and Howitt 1992; Romer, 1994; Aghion and Howitt, 1997). This theory emphasized the predetermination of innovation as against the neoclassical idea that suggested that innovation was exogenous and could not be explained (Solow, 1957). This foundation sets the pace for examining the impact of certain variables, such as human capital and institutions, on innovation. Tebaldi and Elmslie (2008, 2013) developed the baseline model to advance this theory specifically to establish the relationship among human capital, institutions and innovation. Several studies in literature have examined this relationship. However, most of them have been in advanced and emerging economies. Particularly, most of the studies are non-African studies. Some of them are reviewed in this section.

Kato et al. (2015) embarked on a study aimed at investigating how the human capital of founders affect the innovation outcome of their organizations. Their study is based on the premise that the value of human capital determines the level of investments made in R and D for innovation. They discovered that founders with greater human capital positively affects the innovation outcomes of their organization using probit model. They were able to pinpoint that it is the human capital as a result of training and experience that directly affects innovation while human capital as a result of educational background indirectly affects innovation outcomes through investment in R and D.

Some studies have validated that human capital is a major driver of innovation. Mariz-Perez et al. (2012) is one of such studies. Their goal was to find out the impact human capital has on the capacity for innovation since human capital is the potential for vale creation. Thus, they asserted that human capital is relevant for any economy to achieve competitive advantage sustainably. Their argument was based on the fact that human capital manifests knowledge and capacity as main features for developing innovation and commercializing it.

Some other studies distinguished themselves by examining the composition of human capital and investigating which component is responsible for innovation (Chi, 2008; Ang et al., 2011; Zhang and Zhuang, 2011). Their results confirmed that human capital with tertiary education play more significant role in affecting innovation that human capital with primary and secondary education. This suggests that higher levels of human capital are required to improve innovation outcomes. This does not mean that primary education and secondary education are irrelevant in the innovation process; it may, however, be an evidence of low level of development of an economy.

Ang et al. (2011) used a sample of 87 countries over a period of 35 years to find out whether the composition of human capital affects innovation using the SGMM technique. They discovered that a higher intensity of human capital with primary and secondary education translates in imitation while a higher intensity of human capital with tertiary education facilitates innovation. They posited that developing economies characterized by more of human capital with only primary and secondary education, which translates in imitation instead of innovation. Thus, such economies imitate what advanced economies are doing as against generating new

ideas, processes and products. This suggests that the composition of human capital has a direct impact on innovation growth.

Zhang and Zhuang (2011) also examined the impact of human capital composition on innovation; however, unlike Ang et al. (2011), who examined 87 countries, they examined China specifically using difference GMM. They found out that more developed provinces in China have more capacity to absorb human capital with tertiary education unlike less developed provinces that depend on primary and secondary education. This result is a validation of the result of Ang et al. (2011). Their findings suggest that economic growth is enhanced when innovation is enhanced; and innovation is enhanced when human capital is enhanced. Chi (2008) embarked on a similar study on the same scope. However, she used different methodology. Though she used GMM technique for estimation, it was for robustness purposes as the main technique used was two-stage least squares.

There is, therefore, an established relationship between human capital and innovation; but, this relationship is expected to translate in growth and development. Fleisher et al. (2010), therefore, tried to provide evidence from their investigation that variances in regional patterns of growth are as a result of variances in innovation, human capital and foreign investment. Using fixed effect, they discovered that the direct effect of human capital was traceable to innovation activities while its indirect effect was traceable to spillover effects from foreign investments. Their study revealed that the human capital investment not only leads to innovation growth, but also leads to a decline in inequality. This indicates the effect the relationship has on economic development. The findings of Basu and Mehra (2014) buttressed this. They posited that innovation reflects the capacity of human capital and discovered that wage inequality increases as a result of diversification of human capital in terms of skilled and unskilled human capital. Human capital investments will, therefore, improve the innovation capacity of unskilled human capital in order to reduce the level of inequality.

Developing economies can, therefore, address their development challenges by investing in human capital development in order cultivate the innovation capacity required to drive economic development. Teixeira and Fortuna (2010) conducted a study on the Portugese economy to examine this using cointegration technique. They discovered that investing in human capital capacity building activities develops the economy's ability to identify, assimilate and value knowledge developed by more advanced economies. This gives developing economies the opportunity of learning fast to bridge the technology gap, address the challenge of inequality and promote domestic innovation.

These studies, therefore, validate that there is a relationship between human capital and innovation and innovation growth can be achieved by the enhancement of human capital. These have been the expience in advanced, emerging and non-African developing economies. This study therefore seeks to investigate whether similar outcomes are valid in SSA. Though there are related studies in SSA, they examined majorly the relationships between human capital, innovation and economic growth in Africa (Oyelaran-Oyeyinka and Barclay, 2004) while some others were country-specific (Oluwatobi and Ogunrinola, 2011).

3. SOME STYLIZED FACTS

Human capital capacity in SSA has been the lowest when compared with other regions of the world within the time period of this study. Table 1 shows that the region has the least human capital capacity through the period. Europe and Central Asia (ECA) topped the list. This was followed by Latin America and the Caribbean (LAC) after which Middle East and North Africa (MENA) and East Asia and the Pacific (EAP) followed. The trend clearly shows that advanced economies invest substantially in cultivating their human capital capacity. ECA, which topped the list, has experienced an increasing trend in its human capital capacity. SSA also experienced an increasing trend in its human capital capacity though its performance is low compared to the others. Nevertheless, the trend is an indication that the region is experiencing growth in its human capital capacity to contribute to the development process.

Assessing the trend of human capital in SSA, however, is not sufficient; for it is imperative to assess the trend of the enabling factors that allow the optimization of this capacity. Table 2, therefore, presents the trend of institutional quality in SSA in comparison with other regions of the world. Virtually all the regions have been almost on a downward trend in their ability to control corruption except LAC and ECA. Government effectiveness and regulatory quality were also on a downward trend for all the regions except LAC and ECA. SSA performance of institutional quality, thus, have been poor, which is an indication that human capital in the region lacks the enabling institutional environment to contribute to innovation outcomes and the development process.

This conclusion was reinforced by assessing the trend of innovation outcomes in the region in comparison with those of other regions of the world. This is presented in Table 3. It was observed that regions with the largest human capital capacity, as shown in Table 1, had the largest innovation output as shown in Table 3. Moreover, the region with the best performing institutional quality had the largest innovation output. This is a signal of the direct relationships among the variables. SSA, which had the least human capital capacity, has the least innovation output throughout the period of study as shown in Table 3.

Table 1: Human capital with tertiary education: SSA and the World

Region	1996	2001	2006	2007	2008	2009	2010	2011
SSA	3.71	4.63	5.87	6.10	6.43	6.71	7.21	7.56
EAP	11.25	17.24	24.37	25.24	26.08	27.72	29.11	30.11
ECA	38.52	47.23	55.95	56.82	57.50	58.49	60.04	60.32
MENA	17.24	21.09	24.43	25.95	27.91	28.66	30.48	31.34
SA	5.59	8.33	10.13	11.50	13.02	14.17	15.67	15.88
LAC	18.09	24.43	32.42	35.52	38.52	39.60	41.17	42.32

Source: Oluwatobi et al. (2014). SSA: Sub Saharan Africa, EAP: East Asia and the Pacific, ECA: Europe and Central Asia, MENA: Middle East and North Africa, SA: South Asia, LAC: Latin America and the Caribbean

Table 2: Institutions: SSA and the World

Region	Control of corruption				Government effectiveness				Regulatory quality			
	1996	2000	2005	2008	1996	2000	2005	2008	1996	2000	2005	2008
EAP	−0.43	−0.6	−0.53	−0.57	−0.3	−0.48	−0.46	−0.53	−0.35	−0.61	−0.56	−0.69
ECA	−0.7	−0.62	−0.52	−0.48	−0.58	−0.51	−0.37	−0.31	−0.59	−0.49	−0.32	−0.1
LAC	−0.35	−0.18	−0.16	−0.12	−0.34	−0.15	−0.14	−0.1	−0.22	−0.07	−0.07	−0.12
MENA	−0.46	−0.57	−0.55	−0.62	−0.45	−0.63	−0.63	−0.61	−0.64	−0.78	−0.73	−0.63
SSA	−0.63	−0.58	−0.68	−0.62	−0.66	−0.72	−0.78	−0.78	−0.65	−0.64	−0.75	−0.7
World	−0.03	−0.02	−0.02	−0.02	−0.04	−0.01	−0.01	−0.01	−0.05	−0.03	−0.02	−0.01

Source: Oluwatobi et al. (2014), SSA: Sub Saharan Africa, EAP: East Asia and the Pacific, ECA: Europe and Central Asia, MENA: Middle East and North Africa, LAC: Latin America and the Caribbean

Table 3: Innovation: SSA and the World

Region	1996	2001	2006	2007	2008	2009
SSA	3908.6	3860	4615.6	4952.4	5074.4	5080.1
EAP	89930.6	117690	161522.7	169109.4	182046.1	190578.9
ECA	240081.3	255860.3	282648.5	287422.2	291637	290424.4
MENA	9500.4	11452.6	15206.1	16628.2	17920.1	19167
SA	10266.1	11380.8	17784.2	19385.6	20372.6	21432.3
LAC	10503.8	16074	21729.6	23337	24743.1	24032.6

Source: Oluwatobi, Efobi, Olurinola and Alege (2014), SSA: Sub Saharan Africa, EAP: East Asia and the Pacific, ECA: Europe and Central Asia, MENA: Middle East and North Africa, SA: South Asia, LAC: Latin America and the Caribbean

These trends reveal clear patterns that not only show the relationship that exists among human capital, institutions and innovation in SSA but also indicate the performance of the region in comparison to other regions of the world. The result of the low performance of the region in terms of its innovation output, is buttressed by the performance of selected countries in SSA for this study. The global innovation index 2014, presented in Table 4, showed that none of the countries scored up to average.

On the other hand, the global competitiveness report, shows that the SSA region has potentials to improve its innovation performance given its level of competitiveness. Though not among the top ranking most competitive economies, selected countries in SSA are improving the level of competitiveness to catch up with advanced economies. From Table 5, 18 countries out of 32 countries studied, scored above average.

4. METHODOLOGY

The foundation on which this study is conducted is based on the theoretical and empirical model developed by Tebaldi and Elmslie (2008, 2013) consistent with Romer (1990),…. on the interelationship among human capital, institutions, innovation and economic growth. Their model relates human capital and innovation as follows:

$$A=\delta AH_A q[T(A)] \quad (1)$$

Where A is a measure of innovation, H_A is a measure of human capital and q is a measure of institution in relation to institutional quality and technical knowledge. This model, thus, is augmented to suit this study and capture two other variables; namely economic growth and spillovers from foreign investments. It is expected that innovation will be enhanced as the economy grows. It is also expected that spillovers from foreign investments improve innovation. The model for this study is therefore presented as follows:

$$Innovation_{i,t}=AH_{i,t}^{\alpha_2} e^{\alpha_3 ins_{i,t}} Y_{i,t}^{\alpha_4} S_{i,t}^{\alpha_5} \varepsilon_{i,t} \quad (2)$$

Table 4: Global innovation index 2014

Countries	Score (0-100)	Global rank (Out of 143)	SSA rank
Benin	24.21	132	28
Botswana	30.87	92	6
Burkina Faso	28.18	109	14
Burundi	22.43	138	30
Cabo Verde	30.09	97	8
Cameroon	27.52	114	17
Cote d'Ivoire	27.02	116	18
Ethiopia	25.36	126	24
Gambia, The	29.03	104	11
Ghana	30.26	96	7
Guinea	20.25	139	31
Kenya	31.85	85	4
Lesotho	27.01	117	19
Madagascar	25.5	124	23
Malawi	27.61	113	16
Mali	26.18	119	20
Mauritius	40.94	40	1
Mozambique	28.52	107	12
Namibia	28.47	108	13
Niger	24.27	131	27
Nigeria	27.79	110	15
Rwanda	29.31	102	10
Sao tome and principe			
Senegal	30.06	98	9
South Africa	38.25	53	3
Swaziland	25.33	127	25
Tanzania	25.6	123	22
Togo	17.65	142	32
Uganda	31.14	91	5
Zimbabwe	24.31	130	26

Table 5: Global competitiveness index 2014/2015

Countrie	Score (1-7)	Rank 2014/15 (out of 144)	SSA Rank
Benin			
Botswana	4.15	74	4
Burkina Faso	3.21	135	23
Burundi	3.09	139	24
Cabo Verde	3.68	114	10
Cameroon	3.66	116	12
Central African Republic			
Comoros			
Cote d'Ivoire	3.67	115	11
Ethiopia	3.6	118	13
Gambia, The	3.53	125	18
Ghana	3.71	111	8
Guinea	2.79	144	25
Kenya	3.93	90	6
Lesotho	3.73	107	7
Madagascar			
Malawi	3.25	132	21
Mali	3.43	128	20
Mauritius	4.52	39	1
Mozambique	3.24	133	22
Namibia	3.96	88	5
Niger			
Nigeria	3.44	127	19
Rwanda	4.27	62	3
Sao Tome and Principe			
Senegal	3.7	112	9
South Africa	4.35	56	2
Swaziland	3.55	123	16
Tanzania	3.57	121	14
Togo			
Uganda	3.56	122	15
Zimbabwe	3.54	124	17

Source: World Economic Forum (2014), SSA: Sub Saharan Africa

Where A captures technical knowledge, H_{it} measures human capital, Ins_{it} measures institutions, Y_{it} measures economic growth, S_{it} measures knowledge spillovers from foreign investments and ε_{it} represents the stochastic error term. i and t represent the country and time identifiers respectively. The formulation of the model is consistent with theoretical and empirical postulations framed on the logic that human capital cultivation is significant to absorption of knowledge, creation of ideas, enhanced R and D output and innovation growth.

The model presented in equation 2 is re-presented in equation 3 as a linear function for the purpose of estimation. The transformation into a linear function for estimation is done using logarithm.

$$\ln Innovation_{i,t}=\alpha_0+\alpha_1 \ln Innovation_{i,t-1}+\alpha_2 \ln H_{it}+\alpha_3 Ins_{it}+\alpha_4 \ln Y_{it}+\alpha_5 \ln S_{it}+\varphi_{i,t} \quad (3)$$

Where $\alpha_0=\ln A$, $\varphi_{i,t}=\ln\varepsilon_{i,t}$ and $\ln Innovation_{i,t-1}$ is a signification that it is a dynamic panel model.

The SGMM is the estimation technique employed for this study. Some of the reasons responsible for the choice of this technique is that it helps to cater for unobserved heterogeneity and endogeneity biases associated with estimating dynamic panel models. It has proven to be more efficient than instrumental variables estimator in the presence of heteroskedasticity and can exploit stationarity restrictions.

5. RESULTS AND DISCUSSION

The results for this study are presented in Tables 6 and 7. The two tables indicate the relationship between human capital and institutions and innovation in SSA. Human capital, in Table 6, is indicated by secondary school enrolment, thus, capturing human capital with secondary education; while human capital in Table 7 is indicated tertiary school enrolment, hence, capturing human capital with tertiary education. It is pertinent to examine what kind of human capital has the most significant impact in affecting the innovation outcomes of SSA.

The six indicators measuring institutional quality were each used independently. This was pertinent since they were highly correlated with each other from the multicollinearity test as indicated in the correlation matrix in the appendix (See Table A1). The relationship between human capital and innovation was therefore examined in the presence of each of these institutional variables.

The probability values of the Sargan test in each of the six models in Table 6 showed that there is no over-identifying restriction. Hence, the Roodman (2009) concern of too many instruments has been addressed. The Hansen test results as indicated by the probability values, further corroborates this. The AR(1) and AR(2) results for each of the models in the table also indicates that there is no autocorrelation. These results strengthen the validity of the results of this study. Hence, the results are useful for drawing conclusions.

From Table 6, human capital had a significant relationship with innovation in all the models except for where control of corruption was the indicator for institutional quality. Only regulatory quality, political stability and rule of law were statistically significant for all the indicators of institutional quality. From model 1, a change in human capital with secondary education by 1 percent leads to a contemporaneous change in innovation by 0.541%. This is a clear indication of the relevance of human capital in driving innovation in SSA. Regulatory quality had a much more significant impact on innovation in the model compared to human capital. The result showed that a unit change in regulatory quality will translate in a change in innovation by 0.586%.

The result from model 4 validates the human capital has a significant effect on innovation in SSA. Specifically, a change in human capital with secondary education by one percent leads to a change in innovation by 0.514%. This reflects a greater impact of human capital on innovation that political stability. The result shows that innovation outcome is altered by 0.499% as a result of a unit change in political stability. This means that… The result from model 5 corroborates previous results indicating the impact of human capital with secondary education on innovation outcomes in SSA. It showed that a change in human capital with secondary education by 1% translates into a change in innovation by 0.652%. Institutional quality, as indicated by rule of law, was responsible for 62% of the variations in innovation, thus, validating the relevant role institutions have in affecting the amount and quality of innovation in the SSA region.

Table 6: SGMM estimation (human capital measured by secondary school enrolment)

Variables	Dependent variable: Innovation					
	1	2	3	4	5	6
Lag of innovation	0.207	0.172	0.225	0.278	0.300*	0.393
	(0.142)	(0.154)	(0.175)	(0.183)	(0.169)	(0.395)
Human capital (secondary)	−0.541**	−0.178	−0.428*	−0.514***	−0.652**	−0.970*
	(0.239)	(0.201)	(0.224)	(0.194)	(0.255)	(0.510)
Regulatory quality	0.586*					
	(0.355)					
Corruption of control		−0.345				
		(0.263)				
Government effectiveness			0.264			
			(0.220)			
Political stability				0.499**		
				(0.228)		
Rule of law					0.617**	
					(0.274)	
Voice and accountability						1.088
						(0.760)
Economic growth	1.521***	1.540***	1.611***	1.758***	1.708***	1.604***
	(0.186)	(0.192)	(0.234)	(0.270)	(0.232)	(0.357)
FDI spillover	−0.0216	0.0179	−0.0109	−0.0753*	−0.0249	−0.0618
	(0.0308)	(0.0421)	(0.0279)	(0.0395)	(0.0323)	(0.0521)
Year	−0.0151	0.00329	−0.0107	−0.0223	−0.00895	−0.0100
	(0.0172)	(0.0296)	(0.0200)	(0.0177)	(0.0169)	(0.0381)
Constant	−1.161	−36.79	−11.43	7.820	−17.72	−13.98
	(33.58)	(60.12)	(40.32)	(32.50)	(33.89)	(71.50)
Sargan P	0.188	0.133	0.168	0.488	0.469	0.241
Hansen P	0.235	0.212	0.221	0.458	0.404	0.114
AR (1) P	0.045	0.048	0.058	0.045	0.048	0.219
AR (2) P	0.165	0.239	0.132	0.148	0.123	0.217
Observations	253	253	253	253	253	253
Number of year	13	13	13	13	13	13

Source: Computed by Authors using Stata 12.1. Standard errors are in parentheses. ***.**.*Denotes P<0.01, P<0.05 and P<0.1 respectively, SGMM: System Generalized Method of Moments

The result shows that economic growth has a significant relationship with innovation. The variable was statistically significant at 1% level of significance for all the six models. Moreover, the result shows that innovation is highly sensitive to economic growth in SSA as indicated by the coefficients, which reflect that a change in economic growth leads to a more than proportionate change in Innovation in SSA. This means that innovation thrives as the economies in the region grow.

FDI Spillover, measured by net FDI inflows as a percentage of GDP, did not show a statistically significant relationship with innovation except in model 4, which indicates vary little impact of the variable on innovation. This means that the SSA region hardly benefits from knowledge spillovers from foreign investments in the region. This is not farfetched given that most FDI in the region are targeted at extracting available raw materials as well as taking advantage of the large market for their products and services.

These results are clear indications of the significant impact human capital with secondary education has on innovation in SSA. It was, hence, necessary to validate this result by examining the relationship between higher levels of human capital and the effect on innovation. The impact of human capital with tertiary education on innovation outcomes in SSA was therefore examined. The results of the investigation are presented in Table 7.

Human capital with tertiary education was statistically significant for all the six models in the table, thus, indicating that there is a significant relationship between highly skilled human capital and innovation in SSA. This validates the idea that highly-skilled human capital is relevant to innovation outcomes and will enable developing economies improve on their capacity to innovate and catch up with advanced economies. Hence, a 1% change in tertiary human capital will cause a contemporaneous change in innovation.

The coefficient of institutional quality indicated statistical significance for regulatory quality, political stability, rule of law and voice and accountability. A unit change in regulatory quality translate in a change in innovation by 0.506% while a unit change in political stability leads to a change in innovation by 0.406%. The coefficient of rule of law indicates that it is affects changes in innovation by 0.377% as it changes by a unit while a change in voice and accountability by one unit leads to a contemporaneous change in innovation by 0.613%.

The results showing the relationship between economic growth and innovation are consistent with those in Table 6. It was statistically significant at 1% level of significance and the coefficients show that a change in economic growth by 1% leads to more than proportionate changes in innovation, thus, validating that magnanimous impact the variable has on innovation in SSA and

Table 7: SGMM estimation (human capital measured by tertiary school enrolment)

Variables	Dependent variable: Innovation					
	1	2	3	4	5	6
Lag of innovation	−0.0530	−0.0765	−0.0274	−0.0860	−0.0268	0.0869
	(0.0793)	(0.104)	(0.0703)	(0.0751)	(0.0782)	(0.0804)
Human capital (tertiary)	−0.413***	−0.360**	−0.341***	−0.394***	−0.467***	−0.478***
	(0.106)	(0.144)	(0.0929)	(0.105)	(0.0802)	(0.110)
Regulatory quality	0.506*					
	(0.260)					
Corruption of control		0.319				
		(0.284)				
Government effectiveness			0.213			
			(0.192)			
Political stability				0.406***		
				(0.139)		
Rule of law					0.377*	
					(0.203)	
Voice and accountability						0.613***
						(0.177)
Economic growth	1.234***	1.328***	1.340***	1.242***	1.365***	1.481***
	(0.184)	(0.233)	(0.153)	(0.187)	(0.196)	(0.145)
FDI spillover	−0.0383	−0.00809	−0.0293	−0.0180	−0.0397	−0.0580
	(0.0559)	(0.0693)	(0.0553)	(0.0546)	(0.0477)	(0.0485)
Year	0.0809**	0.0575	0.0676**	0.0554**	0.0781**	0.0808
	(0.0411)	(0.0389)	(0.0323)	(0.0279)	(0.0318)	(0.0516)
Constant	−187.4**	−142.0*	−162.5**	−136.3**	−184.4***	−193.4*
	(83.23)	(79.43)	(65.04)	(56.16)	(62.84)	(105.5)
Sargan P	0.444	0.130	0.290	0.228	0.282	0.115
Hansen P	0.248	0.133	0.276	0.311	0.175	0.423
AR (1) P	0.182	0.213	0.283	0.078	0.171	0.140
AR (2) P	0.444	0.232	0.347	0.657	0.505	0.346
Observations	191	191	191	191	191	191
Number of year	13	13	13	13	13	13

Source: Computed by authors using stata 12.1. Standard errors are in parentheses. ***.**.*Denotes P<0.01, P<0.05 and P<0.1 respectively, SGMM: System Generalized Method of Moments

indicating that innovation advances in the region as the economies in the region grow. This indicates the direct relation economic growth has with innovation in SSA.

The results show that FDI spillover did have any significant relationship with innovation in SSA, thus, buttressing the idea that foreign investments in the region are not impactful on innovation in the region.

6. CONCLUSION

This study examined the impact of human capital and institutional quality on innovation in SSA. The study ascertains that human capital capacity at the secondary and tertiary levels are relevant to drive innovation in the region. Moreover, the quality of institutions affects the output of innovation. These results, thus, validate the idea that human capital capacity, coupled with the enabling institutional environment, are requirements to facilitate innovation. The implication for SSA is that it can catch up with advanced economies and close the technology gap by investing in human capital capacity development and providing the enabling institutional environment that facilitates free enterprise and supports innovation. The study, therefore, recommends to policy makers that efforts be made to catch up by cultivating the human capital capacity at the secondary and tertiary levels as well as provide the enabling environment for such capacities to be engaged to enhance innovation outcomes. The human capital capacity generated, coupled with the enabling environment should translate in competent human capital pool that attracts foreign investments that are innovation-centred. Based on the results, this study recommends that part of the enabling environment should be to redefine terms with foreign investors to direct their investments in such a way that SSA benefits from knowledge spillovers that contributes to innovation outcomes in the region.

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APPENDIX

Appendix Table

Table A1: Correlation matrix

Indicators	Control of corruption	Government effectiveness	Political stability	Regulatory quality	Rule of law	Voice and accountability
Control of corruption	1.0000					
Government effectiveness	0.8322	1.0000				
Political stability	0.6925	0.6178	1.0000			
Regulatory quality	0.7548	0.8575	0.5791	1.0000		
Rule of law	0.8526	0.8644	0.7820	0.8244	1.0000	
Voice and accountability	0.7104	0.7409	0.7148	0.7078	0.8097	1.0000