NATURAL RESOURCE RENTS, HUMAN CAPITAL AND INDUSTRIAL DEVELOPMENT IN THE SUB-SAHARAN AFRICAN REGION

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ABSTRACT

This study assesses whether natural resource rents can enhance the positive association between human capital and industrial development using a sample of 14 sub-Saharan African (SSA) countries over the period 1995 to 2015. The dynamic approach was adopted through the use of the system generalized method of moments. The empirical findings reveal that the direct impact of natural resource rents on industrial development is negative and statistically insignificant. The study further confirms an insignificant impact of human capital on industrial development in the presence of natural resource rents. This implies that despite the huge amount of rents realized from natural resources, the industrial sector is yet to benefit substantially from this. In addition, a direct drag of education expenditure (one of the indicators of human capital) on industrial development was observed. Thus, the study recommends that governments in the SSA region need, as a matter of urgency, to efficiently utilize proceeds from the sale of natural resources by massively investing in meaningful human capital development.

JEL classification: I190, I150, L160, O32, O130, Q43

1. Introduction

Abundance of natural resources can play a significant role in the industrial development of a country or region, most especially through the transmission

mechanism of accumulation of highly skilled human capital. The role of industrial advancement in spurring growth and development remains core in developing countries such as Nigeria, which are blessed with abundant human resources. Therefore, it is expected that the excess labour resources in the country could be absorbed through positive desired developments in the industrialization process (Lewis, 1954; Todaro and Smith, 2011). Developing economies with abundant natural resources can enhance their industrial advancement through a well-developed human capital base for sustainable development.

However, if an economy with abundant resources is not able to optimize this opportunity to develop the capacity of its human capital, then, it may continue to experience high unemployment and youth underdevelopment, thus making development a mirage. According to Suslova and Vlochkova (2007), industrial sectors that had high-skilled intensive labour developed disproportionately slowly in countries with higher contribution of natural resource sectors to GDP and low-skilled labour intensity did not differentiate industrial growth between resource rich and resource poor countries. Thus, industrial development goes beyond the endowment of abundant resources; rather it is the ability to use the resources efficiently for the development of the industrial sector.

An empirical study (Ashish and Badge, 2008) on private investment in human capital and industrial development in the Indian software industry showed that engineering baccalaureate capacity influenced software export growth positively due to the skills capacity of private rather than publicly-supported colleges. This implies that the ability of any country or region to develop its human capacity goes a long way in promoting and sustaining industrial development. In the literature, the link between human capital development and natural resource abundance has been explored to some extent. The argument is built on the idea that resource-intensive sectors absorb national savings while creating only a few extremely qualified jobs and this could lead to lower incentive for the society to educate its citizens relative to societies with lower abundant natural resources.

Using several proxies for human capital development such as share of public expenditure on education in GDP, expected years of schooling for females, and gross secondary school enrolment, Gylfason (2001) revealed that there is a significant negative bivariate correlation with the share of natural capital in

national wealth in a cross section of 86 countries. Since the results of bivariate correlation can hardly be used as a basis for profound policy advice, more rigorous empirical analysis of the human capital development explanation for the link between the natural resource richness and economic growth is required.

The elusive nature of industrial development in sub-Saharan Africa (SSA) has generated extended debates among academics and policymakers. In a bid to understand the possible drivers of industrial development, human capital and resources have been identified as key factors in both theoretical and empirical studies. Development of human capital through investment of rents received from the export of natural resources or their final products can be an appropriate medium for spurring industrial development in the region. A region such as sub-Saharan Africa, has many resource endowed countries like Nigeria, Ghana, Sierra-Leone, Angola, among others, but the region is still backward in the area of industrial development. Many challenges in the region have been attributed to poor industrial development; these include poor electricity supply, poor infrastructure development, low human capacity development, mismanagement of resources, armed conflicts, etc. One of the key features of industrial development in the literature is the absorption of a larger number of skilled labour which implies that a country or region with low industrial development is likely to experience a high unemployment rate as is the case in most sub-Saharan countries. Thus, if SSA countries need to develop their industrial sectors, then there is a need for them to invest massively in human capital development.

To shed light on the role of human capital development through the investment of proceeds from the sale of natural resources in SSA region, we attempt to analyse in detail and examine the empirical validity of this human capital-industrial development nexus via natural resource rents. Purposefully, this study seeks to find answers to the following research questions; can human capital spur industrial development in SSA? What role does natural resources play in this human capital-industrial development connection? To what extent can abundant natural resources promote industrial development in SSA?

A panel data of fourteen countries with complete data on all the key variables of interest was deployed in this study. The panel econometric approach was applied. The results show that the region has not taken advantage of natural resource endowment in promoting human capital development on the one hand

and spurring industrial development on the other. These findings have a number of applicable policy implications for policymakers.

2. Review of Literature

Industrialization is generally accepted by policy makers, economic planners, researchers and professionals as one of the most desirable means to achieve objectives such as improving welfare, securing viable employment, increasing consumer and capital goods as well as expanding people's choices generally. Abundant natural resources play a significant role in the industrial development of a country or region: first, it serves as a means of generating revenue for government activities in the economy and second, it promotes accumulation of both human and physical capital through investment.

Some studies have examined the relationship between human capital and industrial development, and natural resources and industrial growth. These studies include Birdsall et al., (1995) Hayami et al. (1998); McMahon (1998); Gylfason et al. (1999); Leamer et al. (1999); Gylfason (2001); Guisan (2005); Sonobe and Otsuka (2006); Suslova and Volchkova (2007); Ashish and Badge (2008) and Lin and Chang (2009). An empirical study by Ashish and Badge (2008) on private investment in human capital and industrial development in the Indian export software industry between 1990 and 2003 shows that engineering baccalaureate capacity influenced the software export growth positively due to the skills capacity of private rather than publicly-supported colleges. This implies that the ability of any country or region to develop its human capacity goes a long way in promoting and sustaining industrial development. Natural resource dependence may reduce people's incentive to accumulate human capital due to high levels of non-wage income or resource-based wages. Using random-effects regression analysis on natural resources and economic growth in 125 countries between 1960 and 1992, empirical evidence shows that school enrolment at all levels is inversely related to natural resource dependence and growth (Gylfason et al., 1999). In an extension to Gylfason et al. (1999), Gylfason (2001) examined the relationship among natural resources, education, and economic development between 1965 and 1998 using seemingly unrelated regression (SUR) and ordinary least squares (OLS) regression for 90 countries. He used several proxies for human capital development such as share of public expenditure on education in GDP, expected years of schooling for females, and

gross secondary school enrolment. The findings show that a nation rich in natural resources systematically under-invests in education as a proportion of national income. Consequently less attention is paid to the accumulation of human capital, which is crowded out by the rich endowment of natural capital.

Natural resource abundance may imbue people with a false sense of financial security and lead governments to lose sight of good and growth-friendly economic management, including human capital development, natural resource management and institutional quality (Sachs and Warner, 1999). Suslova and Volchkova (2007) conducted a study on human capital, industrial growth and resource curse in 42 countries for two different periods (1980-1990 and 1990-2000). Their study employed OLS regression and different measures of resource abundance, namely: share of primary export in GDP and average share of hydrocarbon production in GDP. They explained that the false confidence reposed on the natural resource asset makes governments neglect other economic assets such as human capital. The deteriorative effect of natural resources on the development of the industrial sector is a by-product of the capital accumulation process in a resource-abundant open economy that slows down the development of marginally high-skilled labour force compared to resource poor economies. One of the channels that the literature addresses is the link between human capital development and natural resource abundance (Leamer et al., 1999; Gylfason 2001). The argument is based on the idea that resource intensive sectors absorb national savings while creating only a few eminently qualified jobs which leads to lower incentive of the society to educate its citizens, compared to societies with less abundant natural resources.

Guisan (2005) examined the state of human capital, population growth and industrial development in Mexico and Turkey in relation to other OECD countries between 1964 and 2004, adopting the OLS regression. He observed that in comparison with other OECD countries, both countries could have experienced a higher increase in real GDP per inhabitant if they hade higher levels of average education per inhabitant. It is important to remark that improvements in education will have positive effects to increase industrial and non-industrial real-valued added per inhabitant. In the same vein, Lin (2013) conducted a 9-year longitudinal analysis on the effects of R&D sources, diversity of human capital, innovation infrastructure and academic knowledge on industrial performance in Taiwan between 2002 and 2010 using fixed effect

OLS regression and ANOVA. Three striking outcomes were deduced from the study. First, there was an inverse U-shaped relationship between R&D sources and industrial performance. Second, industrial performance is related to diversity of human capital in a curvilinear (i.e. inverted U-shaped) relationship. Third, innovative infrastructure negatively moderates the effect of diversity of R&D human capital on industrial performance while academic knowledge also negatively moderates the effect of diversity of R&D human capital industrial performance.

Industrial development in developing countries is imperative to reduce poverty and to attain sustainable economic growth (Lin and Chang, 2009; Hayami et al., 1998). This is because, the agriculture sector, which is the major employment provider in many developing countries, alone cannot create enough employment opportunities for a growing labour force. Birdsall et al. (1995) and McMahon (1998) empirically demonstrated that rapid industrial and economic development in East Asian countries that contributed to the successful eradication of poverty is attributed to investment in general education in the 1960s. Using a more direct and rigorous approach, Sonobe and Otsuka (2006) empirically demonstrated that the fundamental determinants of the successful industrial development in East Asian countries is the general education level of the entrepreneurs. It is found that the level of education of the entrepreneurs critically determines their product upgrading efforts, and, thus, the performance and growth of enterprises.

Olayemi (2012) examined the nexus between human capital investment and industrial productivity in Nigeria between 1978 and 2008 employing the co-integration and error correction mechanism (ECM). His result revealed that government expenditure on education has a long-run positive relationship with industrial productivity while government expenditure on health has an inverse long-run relationship with industrial productivity. Adejumo et al. (2013) examined the role of human capital in industrial development in Nigeria from 1980 to 2010. In their ordinary least squares regression, they found that human capital has a direct relationship with the industrial value-added, but in terms of output generated industrially, effect of human capital is low in Nigeria. Irfan et al. (2012) examined the effect of human capital on economic development in Pakistan between 1972 and 2009. They employed autoregressive distributed lags

(ARDL) and found that there is a two-way relationship between human capital and economic development in Pakistan during the periods under consideration.

Jaiyeoba (2015) examined the impact of human capital on economic growth in Nigeria from 1982 to 2011. He used the ordinary least squares method and the result revealed that there is a long-run relationship between government expenditure on education and health and economic growth. Badri et al. (2016) studied the impact of human development on industrial value added in developing countries between 2006 and 2012 using the panel data method. Their results show that human developmen has a direct impact on industrial value added. Fakoya (2014) studied the impact of productive resources and industrial value added on economic growth between 2004 and 2012 in fifteen selected Africa countries. He used the panel data model and the results show that production and industrial value added have a direct relationship with economic growth in the countries under study. Akpan and Chuku (2014), in their study of natural resources, human capital and economic development in Nigeria between 1970and 2008 using seemingly unrelated regression (SUR), found that natural resource abundance has adverse effects on institutional quality, crowds out human capital and affects economic growth negatively.

From the empirical review above, there is a need for more empirical investigation into the issue of human capital and industrial development in Africa, particularly a region like sub-Saharan Africa which is endowed with natural resources which can promote industrial development. The literature indicates that to facilitate meaningful industrial development in this region, the role of human capital is extremely important. This study clearly identified this gap in the literature and this was explored extensively in the study.

3. Data and Trend Analysis

Data for all the interested variables are secondary data sourced from the World Development Indicators (WDI) of the World Bank. The key variables of interest are: industrial development, natural resource rent and government expenditure on human capital development indicators (education and health). Further, industrial development has remained one of the key prerequisites and drivers of economic development. A productive labour force (with adequate skills and knowledge) is also critical to industrial development because of the large human resources required. Thus, the growth of industry, value added (INDGRW) is

used as proxy for industrial development to capture the growth of value added in mining, manufacturing, construction, electricity, water, and gas. Natural resource rent is proxied by total natural resource rent (TNRR). According to the World Bank, natural resources are in four categories: oil, natural gas, forest and mineral. The aggregate of these categories yields the total natural resource rent, which is measured as a proportion of GDP. In addition, the government expenditure (EDUC) variable is captured by current operating expenditures in education, including wages and salaries and excluding capital investments in buildings and equipment as a percentage of GDP. On the other hand, expenditure on health (HEXP) is captured by per capita public health expenditure, which covers the provision of health services (preventive and curative), family planning activities, nutrition activities, and emergency aid designated for health, but does not include provision of water and sanitation as a percentage of GDP. Physical capital and labour force (GFCF and LFPR respectively) are captured by gross fixed capital formation as a percentage of GDP and labour participation rate respectively. The control variables are: inflation (INFL), to capture macroeconomic fluctuations in the economy (see Khan and Senhadji, 2000); trade openness (OPN), to capture the level of domestic economic openness and country receptiveness to foreign businesses (see Law and Habibullah, 2009); and foreign direct investment (FDI), expected to account for the net inflow of foreign investment which may improve or retard growth depending on the sector experiencing the net inflows (Alfaro et al., 2001; Iwasaki and Suganuma, 2015). A panel dataset of 14 countries[1] in SSA covering the period 1995 to 2015 is used.

The average industry, value added in the fourteen selected sub-Saharan African (SSA) countries are depicted in figure 1. The countries are partitioned into two categories to include countries whose industrial value added is below 5% (countries in red bars), and between 5% - 15% (countries in yellow bars). The average industrial growth in South Africa, Cameroon, Congo, Nigeria, Kenya, Senegal, Malawi and Madagascar falls in the first category of below 5%, indicating Nigeria as a country with one of the lowest average industrial growth compared with other SSA countries. Burkina Faso, Mali, Tanzania, Uganda and Sudan falls below 10% but above 5% while Mozambique is above 10% but

[1] Burkina Faso, Cameroon, Congo Democratic Republic, Kenya, Madagascar, Malawi, Mali, Mozambique, Nigeria, Senegal, South Africa, Sudan, Tanzania, Uganda.

below 15%. Though, the countries in the region have been experiencing industrial backwardness for a long time compared to the developed countries, there seems to be significant improvement in industrial activities in some countries like Uganda, Sudan and Mozambique. The largest economy, Nigeria, recorded on average, less than 5% growth in its industrial value added growth. In addition, out of the fourteen countries, more than half recorded growth below 5%. This shows that in general, SSA countries still have a long way to go in the area of industrialization.

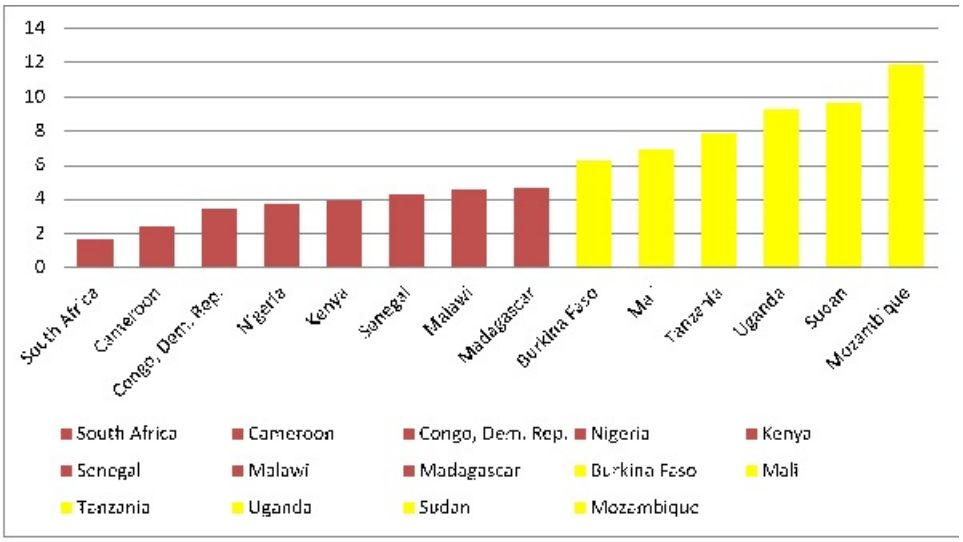

Figure 1. Industry, Value Added (annual % growth).
Source: Plotted by the authors

The average growth of industry, value added for seven regions is shown in figure 2. It can be observed that the growth in the sub-Saharan African (SSA) countries is slightly above that of the North American, the European and the Latin America countries. However, other regions such as the Middle East North African countries, Arab and East Asia have higher average growth of industry, value added as compared with SSA countries. This appears to suggest that the industrial sector in the SSA countries is still not as well developed as expected and its contribution to the economy is low compared to the Arab countries and the East Asia countries. The growth in North America and Europe may be low because these regions are already at the steady state. Furthermore, what they

require to maintain and sustain their growth is not much when compared to the SSA region where there is still a need for pragmatic industrial revolution. It is clear that the SSA region needs remarkable growth in its industry, value added, compared to North America and Europe, for any meaningful industrial development to take place.

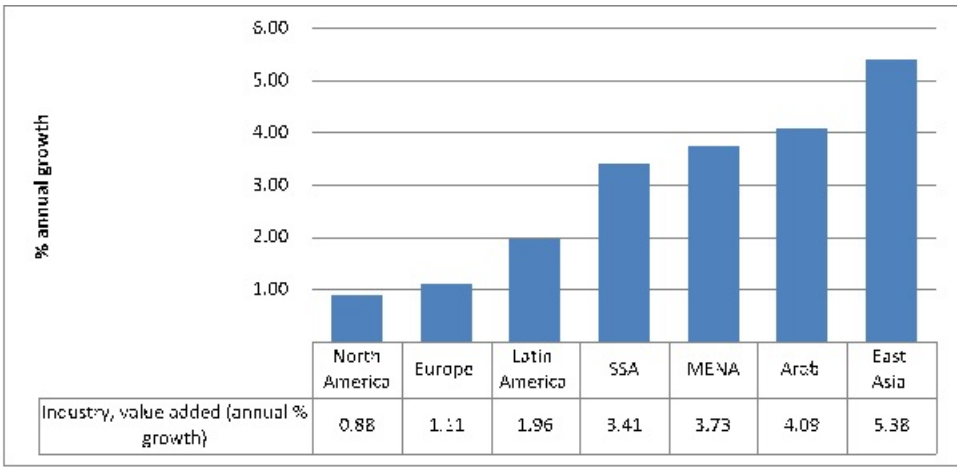

Figure 2. Average Industry, Value Added (2001 - 2015).
Source: Plotted by the authors.

Further, figure 3 shows the average total natural resource rent as a percentage of GDP in the seven regions. The natural resources rent in the SSA region is above those of North America, Europe, East Asia and Latin America while the Middle East and North Africa (MENA) and Arab regions are slightly higher than the SSA region. This shows that out of the seven regions, SSA is the third most endowed region in the world in terms of natural resource abundance. The natural resources include crude oil, gas, tin, coal, gold, rubber, diamond, etc. Thus, governments in SSA countries generate a lot revenue from their sales at the international market. With such natural resource endowment, it would be expected that SSA will record meaningful and sustainable industrial development compared to regions like North America, Europe, East Asia and Latin America, but this is not the case. Interestingly, regions like MENA and Arab have started experiencing meaningful development because they are utilizing their resources efficiently.

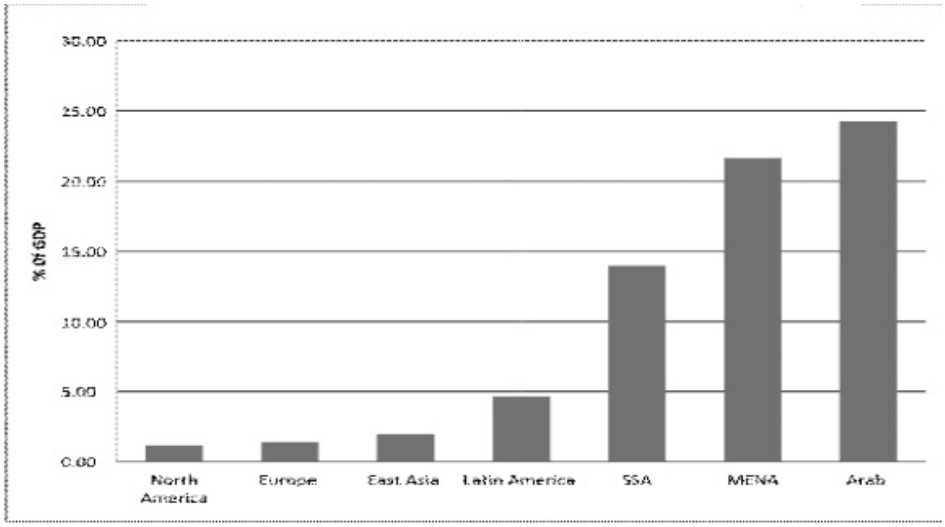

Figure 3. Average Total Natural Resources Rents (1995-2015).
Source: Plotted by the Authors

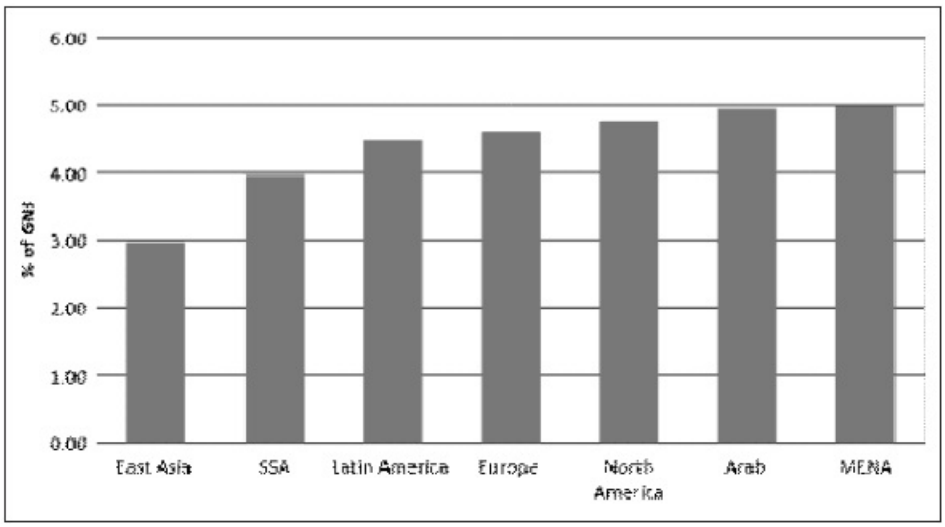

Figure 4. Average Education Expenditure (1995-2015).
Source: Plotted by the authors.

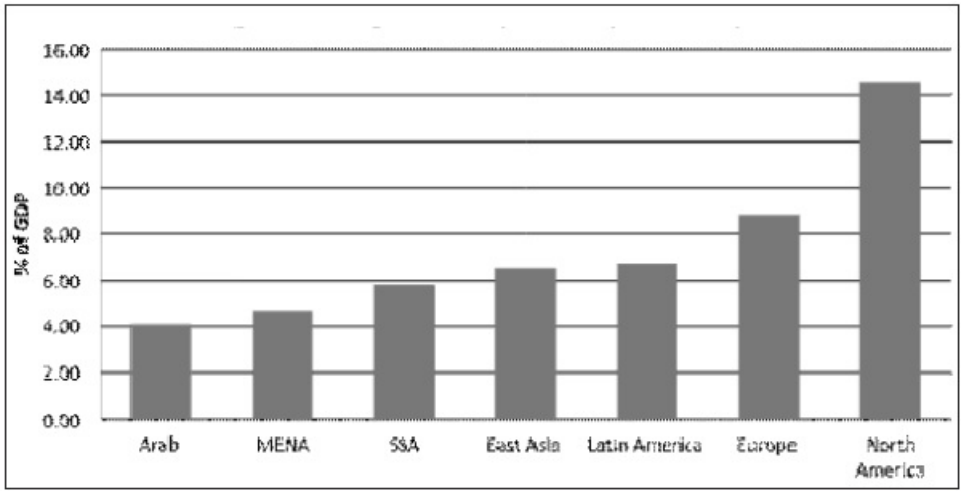

Figure 5. Average Health Expenditure (1995-2015).
Source: Plotted by the authors.

4. Methodological Framework and Model Specification

4.1 Theoretical framework

Many theoretical and empirical studies have examined extensively the importance of human capital for development of resource-rich economies (Gylfason, 2001; Stijns, 2001; Bravo-Ortega and de Gregorio, 2005). Leamer et al. (1999) examined the role of human capital as the most important factor which the accumulation will allow a resource-abundant country to overcome the problems of underdevelopment while low accumulation of human capital will hinder industrial diversification. They argued that resource-intense sectors absorb national savings while creating only a few eminently qualified jobs which leads to lower incentive for the society to educate its citizens relative to societies with lower abundant resources. In addition, the insufficient investment in human capital development in resource-rich countries hinders them from attaining higher and sustainable growth.

Exploring the theoretical proposition of Leamer et al. further from the traditional trade framework where countries are modelled as Heckscher-Ohlin small open economies, product mix and returns to factors of particular countries are usually determined by its factor endowment. Therefore, cone of diversification refers to the product mix and the factor returns that remain constant within some range of factor endowments while the country accumulates

the physical capital stock and switches from one cone of diversification to another given its corresponding changes in product mix for a number of years. Leamer et al. (1999) highlighted three productive factors, namely: labour associated with human capital, physical capital and natural resources, and the relative endowments of these factors determine the path of evolution of the economy.

Furthermore, the principle of comparative advantage in a world of free trade, principle of comparative advantage explains that countries with abundant natural resources choose to produce a relatively natural-resource-rich mix of tradable goods. The speed of capital accumulation along the development path depends on the relative return to capital which determines the time the countries switch from one cone of diversification to another (i.e. from a lower capital-intensive mix to a higher capital-intensive mix). A cone of diversification with a fixed product mix makes changes in factor supply have no effect on factor prices and returns. Thus, the moment of switch from one cone to another is accompanied by a decline in the price of capital due to its easier availability.

Hypothetically, the development paths of resource-rich countries suggest that underdeveloped countries should develop labour-intensive extractive industries. The initial capital accumulation leads to more capital-intensive extraction that is accompanied by a decline in wages of primitive labour since capital accumulation is structured to economize on the labour input. The more capital accumulation the country achieves, the more new ways of capital-intensive utilization of natural resources develop resource-based manufacturing. This implies that the resource-rich country with substantial capital accumulation should produce sophisticated and capital intensive products such as chemicals and machinery.

However, the challenge that comes with the evolutionary path which can prevent further development in a country at some point is that the new more capital-intensive technologies require more skilled labour. On the contrary, the explanation above suggests that the availability of natural resources makes the sufficient accumulation of skills and human capital very unlikely as the return to labour decreases as physical capital accumulation in the economy increases. This is not applicable in countries with insignificant amount of resources where capital accumulation makes labour and corresponding human capital more critical factors of production. Consequently, the development of skills can

prevent the country from changing into new more advanced product mixes and retain the country in the past cone of diversification.

In this context, linkages among human capital development, resource abundance and industrial development can be summarized as follows. The existence of natural resources in a country can cause a decline in the return to labour which in turn affects human capital as physical capital stock accumulation increases. This leads to underdevelopment of new more sophisticated industries as there is low-skilled labour. Thus, the resource-rich country faces a trap of skilled labour underdevelopment.

This model explains that actual industrial development across countries can vary in the sense that those industrial sectors with technologies that are more intensive in sophisticated human capital will be at a disadvantage in economies rich in natural resources. It further predicts that despite enough average skilled workers in the resource-rich economy, it is insufficient marginal high skills that prevent the successful development of new industries. In this context, this study focuses on the transmission mechanism among human capital development, total natural resource rents and industrial development in the sub-Saharan Africa region.

4.2 Model specification

Given the theoretical linkage among the three key variables, this study adopts and modifies the Leamer et al. (1999) framework to empirically examine the contribution of natural resource rent and human capital to industrial development vis-à-vis natural resource rents through human capital development on industrial development in SSA. To achieve our objective, we examine the following: (i) the direct impact of human capital on industrial development without natural resource rents; (ii) the direct impact of total natural resource rents on industrial development without human capital; (iii) the direct impact of human capital as well as total natural resource rents on thevindustrial development process; and (iv) if total natural resource rents have a significant role to play in augmenting human capital investment to enhance industrial development. In this context, the baseline equation models are presented as follows:

$$INDGRW_{it} = \alpha_0 + \beta_0 INDGRW_{it\text{-}1} + \beta_1 LAB_{it} + \beta_2 CAP_{it} + \beta_3 HUM_{it} + \beta_4 TNRR_{it} + X'\delta + \varepsilon_{it} \quad (1)$$

where i =1,…, N and t = 1,…,T

$$\varepsilon_{it} = \mu_i + \pi_{it} \tag{2}$$

where $\varepsilon_i \sim IID\ (0,\sigma_\mu^2)\ and\ v_{it} \sim IID\ (0,\sigma_v^2)$ (3)

The component μ_i represents the country-specific fixed effects which are time invariant and μ_{it} represents the country-specific shocks and varies over time. The country-specific shocks are heteroscedastic and correlated within individuals over time but not among them.

As proposed by Arellano and Bond (1991), the first-differenced operation is applied in order to remove individual time-invariant effect μ_i, which is the source of inconsistency due to the correlation between $INDGW_{it}$ and μ_i. Thus, the first-differenced equation form is:

$$\Delta INDGRW_{it} = \alpha_0 + \beta_0 \Delta INDGRW_{it\text{-}1} + \beta_1 \Delta LAB_{it} + \beta_2 \Delta CAP_{it} + \beta_3 \Delta HUM_{it} + \beta_4 \Delta TNRR_{it} + \Delta X'\delta + \varepsilon_{it} \tag{4}$$

where Δ denotes the first-differenced operator.

The OLS estimation will not br efficient for the first-differenced equation and the estimation obtained by OLS will be upward biased and inconsistent because of the correlation between $\Delta INDGRW_{it\text{-}1}$ and μ_i. To circumvent this problem, Arellano and Bond (1991) proposed to use the lagged dependent variable, in level equation as an instrument and then estimated the model by the generalized method of moments (GMM) technique. This method is usually termed the first-differenced GMM estimator.

Furthermore, Bound et al. (1995) introduced the weakness of instrumental variable in the first-differenced GMM estimator because of the non-stationarity of the instruments. Thus, Blundell and Bond (1998) employed the system GMM estimator developed by Arellano and Bover (1995) to deal with weak instruments by introducing the different forms of the lagged dependent variable into the matrix of instrumental variables. Their simulation results show that the system GMM estimator's efficiency is increased when the lagged dependent variable coefficient is near to 1. Thus, the two-step system GMM estimator is applied in this study. Finally, the system GMM estimator is appropriate for "small T, large N" panels and if T is large, dynamic panel bias becomes

insignificant, and a more straightforward fixed-effects estimator will be fitting. Meanwhile, the number of instruments in system GMM tends to explode with T. If N is small, the cluster-robust standard errors and the Arellano-Bond test for autocorrelation may be unreliable (see Roodman, 2009).

In this regard, the extension of the model specification to account for the interaction between human capital and natural resource rents is presented in Equation (5):

$$\Delta INDGRW_{it} = \alpha_0 + \beta_0 \Delta INDGRW_{it\text{-}1} + \beta_1 \Delta LAB_{it} + \beta_2 \Delta CAP_{it} + \beta_3 \Delta HUM_{it} + \beta_4 \Delta TNRR_{it} + \beta_5 (\Delta HUM_{it} * \Delta TNRR_{it}) + \Delta X'\delta + \varepsilon_{it} \quad (5)$$

5. Empirical Results and Discussion

The descriptive statistics of series utilized in the study are presented in table 1. The table shows that *INDGROW* has an average value of 5.7 with minimum and maximum values of -20.7and 49.3 respectively. This implies that on the average, industrial growth in terms of value added in SSA is still very low given the poor industrial development in the region. The average values of *EDUC* and *HEXP* are 3.1 and 5.5 respectively, which imply that the level of total income invested in education and health to foster human capital development is significantly low in SSA countries as depicted in table 1. These results show the similar direction between *INDGROW* and the human capital development indicators (i.e. *EDUC* and *HEXP*). The *TNRR* has the average value of 12.4 with minimum and maximum values of 0.1 and 47.1 respectively. Among the series, *EDUC* and *HEXP* have the least standard deviation since the level of investment in human capital development in this region has not witnessed the significant and desired changes.

Table 1. Descriptive Statistics

Variables	Obs	Mean	Std. Dev	Min	Max
INDGROW	294	5.720	7.439	-20.7	49.3
EDUC	279	3.190	1.524	0.85	6.9
HEXP	280	5.503	1.931	1.446	12.056
GFCF	293	18.662	6.389	2.1	42.520
INFL	292	17.991	59.642	-3.099	541.909
OPN	293	53.956	16.190	14.772	114.376
TNRR	280	12.407	10.054	0.103	47.122

Variables	Obs	Mean	Std. Dev	Min	Max
FDI	294	3.095	4.688	-1.53	41.8
GOVT	294	88.663	7.188	60.9	114
LAB	294	72.160	12.696	50.6	89.6

Source: Authors' computation.

Note that all the series are in percent.

To answer the research questions earlier stated in the introductory part of this paper, the empirical results from system GMM estimation are presented in table 2. This study utilizes a step-wise method by first examining the impact of human capital development on industrial development in the natural resource rents. Model 1 examines the impact of human capital development on industrial development in the SSA region. We further examine a similar idea in model 2 which includes total natural resource rents and other control variables. A similar procedure is adopted in model 3 where both human capital indicators and total natural resource rents were introduced while model 4 accounts for the inclusion of interactive terms. The results show that the initial level of industrial development has a significant role to play in the determination of the present level of industrial development in the economy as indicated by the lagged dependent coefficients ranging between 0.13 and 0.17. They are statistically insignificant though positive. This clearly gives a true picture of the development of the industrial sector in SSA, thus appearing that the level of industrial development was poor in the past, which does not significantly improve the current level of industrial development in the region. Interestingly, the coefficients of the initial level of industrial development started declining as human capital and natural resource rents were jointly introduced into model 3 without interaction. They further declined in model 4 suggesting that discovery of natural resources by countries in SSA has not propelled the desired industrial development.

Further, the coefficients of physical capital are positive and statistically insignificant across the models. A critical look at models 2-4 shows a continuous fall in industrial development in SSA. This further supports the intense debate that sub-Saharan Africa is a net creditor to the rest of the world (see Ndikumana and Boyce, 2011 and Oyinlola and Adedeji, 2017). The results reveal inconsequential coefficients of physical capital that are statistically insignificant, which clearly shows that the existing stock of capital necessary to propel

significant and sustainable industrial development is not sufficient to drive the required investment that will absorb a large proportion of the labour force in the productive industrial sector (such as mining, manufacturing, etc.). A similar situation is observed in the pattern of coefficients of labour whereby the result shows trivial coefficients that are statistically insignificant across the model. This is not too surprising as industrial sector (i.e. the large employer) performance is poor, thus more labour cannot be engaged in the production process.

The coefficients of trade openness, which capture the country's receptiveness to foreign businesses, are negative in models 1and 2 but positive in models 3 and 4. However, the coefficients are statistically insignificant, which suggests that the number of people in the region who could benefit from productive activities in the industrial sector is limited due to technological challenges and poor international market accessibility. Furthermore, government consumption is largely negative and statistically significant in most of the models. The coefficients are also small which suggests that the SSA region comprises more of consuming countries than investing countries. Thus, fiscal policy through government expenditure retards industrial development in the region because most countries in the region have a larger proportion of their revenue allocated to recurrent rather than to capital expenditure that will spur necessary industrial development. Also, the coefficients of FDI are positive and statistically insignificant in all the models. Economically, the result gives an insight into the poor foreign investment inflows into the industrial sector in sub-Saharan Africa. The plausible reason is the inflow of investment to the capital-intensive sector that requires small number of labour. For example, in Nigeria, most foreign investment goes to the oil and gas sector because of the huge benefits, but the sector is highly capital intensive.

Table 2. System GMM Regressions

	1	2	3	4
C	1.4230	6.4640	10.0984	12.9292
	(7.9988)	(10.4354)	(12.0538)	(13.4959)
INDGRW(-1)	0.1458	0.1677	0.1337	0.1327
	(0.1186)	(0.1241)	(0.1174)	()0.1198
GFCF	0.1293	0.0435	0.0343	0.0342
	(0.0983)	(0.1185)	(0.1143)	(0.1153)
LAB	0.0234	0.0386	0.0294	0.0153
	(0.0471)	(0.0545)	(0.0431)	(0.0481)

	1	2	3	4
EDUC	-0.6874*		-1.3063**	-1.1370*
	(0.3891)		(0.5822)	(0.6161)
HEXP	0.1532		0.2549	0.2914
	(0.2441)		(0.2180)	(0.1993)
OPN	-0.0443	-0.0430	0.0071	0.0114
	(0.0470)	(0.0472)	(0.0512)	(0.0501)
FDI	0.0597	0.0945	0.0767	0.0749
	(0.1011)	(0.1064)	(0.1175)	(0.1161)
GOVT	0.0346	-0.0297	-0.0399	-0.0706
	(0.0818)	(0.0961)	(0.1095)	(0.1245)
TNRR		-0.0438	-0.1713*	0.0574
		(0.0685)	(0.0996)	(0.7921)
TNRREDU				-1.47e-11
				(1.61e-11)
TNRRHELTH				-0.0253
				(0.0917)
AR(1)	-2.51**	-2.57***	-2.55**	-2.57***
AR(2)	1.48	1.44	1.48	1.50
Sargan test	191.16	185.15	191.77	191.37
Observation	264	265	264	264
Number of group	14	14	14	14

Source: Author's computation. Values in parenthesis are standard error, while ***, ** and * shows the level of statistical significance at 1, 5 and 10 per cent correspondingly.

The succeeding discussions focus on the direct impact of human capital and natural resource rents on industrial development in sub-Saharan Africa. Starting with human capital measured by EDUC and HEXP, the results generally show positive and negative impacts of health and education expenditure respectively on industrial development. The coefficients are statistically significant and insignificant for education and health expenditure respectively. These results show that human capital development via spending on education and health have not aided the attainment of the required industrial development. Consequently, education expenditure serves as a direct drag on industrial development in SSA contrary to theoretical expectation. It further suggests that labour is not adequately equipped with the necessary skills through significant investment in the key areas of health and education, such infrastructural development, quality research, etc. This evidence shows that meaningful industrial development can be achieved only when governments in sub-Saharan African countries take proactive steps by investing heavily in human capital development as one of the key drivers of industrial development.

The second part of the discussion focuses on the interaction terms in model 4. The essence is to examine if industrial development can be better achieved through the allocation of a significant part of the proceeds from the sale of natural resources to human capital. The negative and insignificant coefficients of the interaction terms in the model are not too surprising. This is in line with the argument in the literature as to whether the discovery of abundant natural resources is a curse or a blessing. The evidence from the empirical results show a trivial and indirect drag of natural resources on the industrial development in the region. This further corroborates the claim that if the sub-Saharan Africa region needs meaningful industrial development then it must invest a larger proportion of its natural resource proceeds on the development of human capacity through significant infrastructural development, and encouragement of quality research with proper implementation of research outcomes where and when necessary.

This study examined the validity of the statistical inferences of the estimated coefficients in models 1-4 through the diagnostic tests of the overall model specification. The Sargan tests statistics for over-identification restriction and instrument validity indicate that they cannot be rejected at 5% level of significance. Also, the z-statistic for the Arellano-Bond AR(2) test for second-order autocorrelation in the residuals reveals that there is no second-order autocorrelation with just the non-inclusion of more lags of the dependent variables as regressors. The level of significance of AR(1) suggests the rejection of the null hypothesis of no first-order autocorrelation.

6. Conclusion

This study specially investigated the role of natural resource rents on the human capital-industrial development nexus in 14 sub-Saharan African countries between 1995 and 2015. We were empirically motivated by the passionate idea that significant investment in human capital should spur the desired level of industrial development and also, that natural resource proceeds could boost its overall impact on industrial development.

The findings from our estimated model reveal that the initial level of industrial development was negatively affected by the presence of natural resource rents in SSA. Further, the empirically results indicate that human capital does not propel industrial development as education expenditure has a

direct drag effect. This suggests that significant industrial development cannot be recorded in the absence of human capital development. The results also show that natural resource rents do play a desired role in enhancing human capital development which is indicative of poor industrial development in the SSA region.

The policy relevance of this study suggests that in an attempt to boost industrial sector development, it is important for governments in the SSA region to efficiently utilize the proceeds from the sale of natural resources by massively investing in human capital development. This can be done through acquisition of knowledge and skills at different areas by the majority of the population thereby making them contribute substantially to the development of the industrial sector in the region. In addition, governments could invest in the establishment of many technical schools, as well as skills acquisition and entrepreneurship centres for their teeming population. On the healthcare system, governments can boost investment in primary and secondary healthcare services by allocating huge amounts of resources and promoting monitoring exercises for significant human capital development. Thus, policymakers need to re-design the existing policies and frameworks on education and the healthcare system to improve the capacity of the workforce through the acquisition of skills and knowledge if they really want to see industrial revolution in SSA region, otherwise, the desired industrial development will continue to be a mirage.

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