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Has Knowledge Improved Economic Growth? Evidence from Nigeria and South Africa

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Abstract

This study examines whether knowledge causes economic growth in Africa's two leading economies: Nigeria and South Africa. Using the Vector Autoregressive and Vector Error Correction approach, the findings show cointegration among the variables. The speed of convergence of the variables to their long-term mean values is relatively higher for South Africa than for Nigeria. In the short run, it is observed that knowledge unidirectionally Granger causes growth for Nigeria, whereas bidirectional causality is observed for South Africa. The higher correlation between knowledge and growth in South Africa reflects the success of greater investment in education. Nigeria must increase investment in education and modern infrastructure to converge to South Africa's growth trajectory. Moreover, for Nigeria, (i) knowledge unidirectionally Granger cause growth, (ii) evidence of bidirectional causality flow is apparent between trade, the economic incentive and growth and (iii) health unidirectionally Granger cause knowledge. As for South Africa: (i) there is bidirectional causality between knowledge, trade openness and growth, whereas investment and economic incentive, unidirectionally Granger causes growth, (ii) investment, trade openness and health unidirectionally Granger cause knowledge and (iii) economic incentive unidirectionally Granger cause trade openness. In conclusion, this paper argues that a transformed education system can provide the knowledge base essential for promoting and sustaining economic growth.

1. Introduction

There is no consensus among economists on whether knowledge accumulation significantly increases productivity and promotes economic growth[1]. Critics argue that it may in fact lead to problems such as overqualification (Kaur & Singh, 2016; Molla & Cuthbert, 2018), overproduction (Britz et al., 2006; Odunsi, 2018), and lack of skill development (Okafor, 2010; Janoski et al., 2014).

In the developing world, however, the blame for low productivity and growth may lie, not with knowledge accumulation, but with the inadequate financing of education and essential infrastructure. Evidence from Africa shows that despite knowledge accumulation, economic growth is not quantitative enough to accommodate the needs of the corresponding rising population (Asongu et al, 2019, 2020; Asongu & Odhiambo, 2019, 2020a). This study aims to determine whether knowledge Granger causes growth in the two leading African economies—Nigeria and South Africa in order to provide policy insights on how sustainable growth can be promoted, *inter alia*, by means of the knowledge economy.

Beginning with Becker (1992, 1994) and Mankiw, Romer, and Weil (MRW) (1994), who recognized knowledge as crucial for increasing output and promoting economic growth, empirical literature on the role of the knowledge economy (KE) has continued to accumulate. Becker (1976, 1993, 2007) developed and tested an economic framework that explains the role of knowledge in growth. Subsequently, MRW (1994) examined whether knowledge accumulation is responsible for international variations in standards of living; they discovered that, for the countries investigated, knowledge plays a critical role in economic growth. While the evidence in favour of the KE is relatively mixed; it is generally accepted that knowledge is created through technological innovation, with a long-run prospect of economic growth (Asongu & Andres, 2020).

Recent studies by Becker (2007), the World Bank (2007), Asongu and Odhiambo (2019), and Nyarko (2013), provide new findings that warrant a re-examination. In particular, several studies (Anyanwu, 2012; Nyarko, 2013; Asongu. & Odhiambo, 2020b; Tchamyou et al., 2019a) have provided consistent insights into the relevance of the KE for African growth.

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[1] Growth and economic growth are used interchangeably throughout the study.

However, most of them focus on specific regions and do not provide information on the trickle-down effects of KE, which could have helped in a comparative analysis of different countries. To bridge these gaps in the existing literature, this study presents comparative evidence on the KE in the two of Africa's largest economies, Nigeria and South Africa. Hence, this research departs from the extant literature on the subject by engaging a comparative study of the two largest economies in the continent of Africa.

There are three major reasons behind undertaking this analysis. First, the education sector is currently experiencing a huge transformation, ranging from a shift in the classroom approach to a digitalized economy, which has paved the way for re-examining the role of knowledge in these countries. The large investment required to improve research and training in educational institutions necessitate an inquiry into whether investment in KE will translate into growth. Second, most studies investigating causality have different mechanisms through which KE may lead to convergence, and revalidating the argument requires knowing which approach applies to Nigeria and South Africa. For example, there has been an increase in knowledge accumulation in Nigeria, but the investment does not reflect in its growth trend as has been consistently recorded (Joseph-Raji et al., 2018).

Conversely, South Africa has invested heavily in KE, but growth has been prolonged (Odunsi, 1996). Consequently, examining the linkages between KE and growth will resolve the growth dilemma in these African countries and help policy makers redesign the intervention programs needed to reposition their economies for growth. Hence, it is worthwhile to assess how the different experiences of Nigeria and South Africa in terms of investment in knowledge infrastructure and growth prospects withstand empirical scrutiny. Third, the notable transition in the KE has reshaped competition in knowledge accumulation. Hence, it is imperative and timely for policy makers to be informed on how the transition towards knowledge-based economies is shaping growth trajectories.

In the light of the above insights, the present study extends the empirical literature on the KE and makes the following contributions: (a) It explores whether the KE causes growth in Nigeria and South Africa, (b) By controlling for confounders, the study make inference on the causation links among the factors, and (c) using the Granger causality methodology, it helps decouple the short-and long-run dynamics among the factors to determine the rapid components and their convergence back to their long-term mean values. The findings indicate

a long-run relationship in the KE determinant, in both datasets pertaining to Nigeria and South Africa. However, the rate of convergence of the variables for South Africa is relatively higher than that of Nigeria.

The rest of the study is structured as follows. Section 2 discusses the extant literature on the KE in Africa. Section 3 elaborates upon the data and methodology used. Section 4 presents the empirical results, and section 5 concludes with policy recommendations.

2. Literature Review

For decades, research seeking to determine whether the KE matters for economic growth have accumulated important findings and insights on human capital development, but major findings on the subject are still inconsistent and controversial. Nyarko (2013) examined the role of knowledge and economy structure in sustaining high economic growth in Sub-Saharan Africa (SSA). Nyarko's model on structural change, based on that of Hausmann et al. (2007), reported that the KE is critical for promoting growth across the different sectors, which subsequently improves productivity within SSA.

The work of Asongu and Andres (2020) work on the trajectory of the knowledge economy applied the four components of the KE index from the World Bank: economic incentives, innovation, education, and information infrastructure. The authors conclude that SSA and the Middle East and North African (MENA) countries have a low level of KE and suggested economic integration in these countries to promote knowledge spillovers in order to enable them to catch up with their more technically – advanced counterparts. Comparing the African countries with South Korea, Asongu and Tchamyou (2020) investigated the role of the KE, focusing on human capital, knowledge creation, knowledge diffusion, institutions, and economic incentives using sigma convergence for the period 1996–2010 and reported that the KE diagnosis provides a robust explanation among the countries investigated.

Asongu (2017) presents fresh South Korean lessons to Africa by assessing the knowledge economy gaps using 53 peripheral Africa countries decomposed into different features on wealth, legal origins, regional proximity, oil exporting, political instability and landlockedness. The scholar also exploits the four KE components which include education, innovation, information and communication technology (ICT) and economic incentives and

reported that contemporary KE lessons from South Korea are as relevant as historic lessons to contemporary African nations.

In contrast, Ejemeyovwi and Osabuohien (2018) examined the relevance of KE, focusing on mobile technology and growth in West Africa for 1996–2012, using the generalized method of moments (GMM). They reported that human capital weakens innovation, which affects growth. Oluwatobi et al. (2020) examined the interaction between knowledge economic and economic growth in 32 SSA countries for the period 1996 to 2012, using the System GMM and reported that institutions and human capital in SSA mitigate effect of innovation on economic growth among the African countries examined.

Mohamed (2016) assessed the impact of the KE on long-term economic growth in the Egyptian economy for the period 1980–2014, using Granger causality to test the four components of the KE (i.e., human capital, innovation, economic growth, and institutional regime); the results indicate a causal relationship between the KE and economic growth. Voyvoda and Yeldan (2015) investigated and assessed the interactions between knowledge-driven growth, acquisition of human capital, and role of strategy in public policy for Turkey's economy and reported that the government expenditure on education and other capital investments have a direct link with growth in Turkey. Similarly, Edvinsson and Soderberg (2011) investigated the dynamics of the knowledge economy before the industrial revolution in Sweden and Western Europe and reported the price of essential goods as an important driver of the KE.

Given the diversity of evidence, it becomes clear that more information is required to validate the role of knowledge accumulation in the African economy. There is a dearth of empirical literature investigating the KE at country level; studies based on cross-sectional data provide inconsistent and conflicting results. Therefore, the main aim of the present study is to establish whether the KE matters for growth.

Research Question
Based on the above review of empirical studies and the proposed contribution of the present study to the extant literature discussed in the introduction, the research question for the present study is as follows:

Does knowledge Granger cause economic growth in Nigeria and South Africa?

This research question will provide valuable insights on the need to strengthen the knowledge economy and policy in two of Africa's largest economies, Nigeria and South Africa.

3. Data and Methodology

This section presents the data and the research method. It provides information on the empirical model used and the statistical procedure implemented.

Data

This study examines whether knowledge Granger causes growth in Nigeria and South Africa for the period 1987–2019. The annual data sourced from the Central Bank of Nigeria (CBN) and the South African Reserve Bank (SARB) is used. The variables and measures used as well as their descriptions are stated below. Growth: it is measured by using gross domestic product (GDP) growth (annual %). It reflects the productivity level of the economy and is suitable for international comparison (Asongu & Nwachukwu, 2017).

Knowledge: it is captured as the investment in education. It is measured by the total government expenditure on education (current, capital, and transfers) (% of GDP). It is useful for comparing the investment in knowledge across countries (Tchamyou, 2020). Investment: it is measured by gross capital formation (current US$). It includes all the fixed assets of the economy, including schools, hospitals, and plants and machinery (Asongu et al., 2019, 2020).

Economic incentives: it is measured using the domestic credit provided by the financial sector (% of GDP), including gross credit to various sectors (Tchamyou, 2017; Shobande & Enemona, 2021). Health: it is measured as life expectancy at birth (total years). Life expectancy indicates the number of years a newborn infant would live if the mortality pattern remained the same throughout his/her life (Sira et al., 2020; Ogbeifun & Shobande, 2021; Pasara et al., 2020; Becker, 2007, Ram, 2007). Trade openness: it is the sum of exports and imports of goods and services measured as a share of gross domestic product GDP) (Amavilah, 2009; Asongu et al., 2017, 2018; Asongu & Andre, 2020; Asongu & Nwachukukwu, 2017; Asongu & Tchamyou, 2015; Ogbeifun & Shobande, 2021).

Methodology

The Model

Following the endogenous growth model, the relationship between KE and growth is specified in the Cobb Douglas function as:

$$Y_{i,t} = K_{i,t}{}^{\alpha}(A_{i,t}(L_{i,t}))^{\beta} \quad 0 < \alpha < 1. \tag{1}$$

Where Y is output growth, K is capital, L is labour, and A is efficiency or total factor productivity. $\alpha \; and \; \beta$ are the elasticities of the factor inputs which are assumed to exhibit constant elasticity of substitution (CES) (i.e., $\alpha + \beta = 1$), i is the index of country and t is time.

Following the Becker (2007) and MRW (1994) assumption that labour should be replaced with the human capital component to reflect the state of knowledge and education, we respecified the equation (1) as:

$$Y_t = K_t{}^{\alpha}(A_t(H_t))^{\beta} \tag{2}$$

Where H is substituted human capital (education and health), whereas the linearised form equation (2) is respecified as:

$$\log Y_t = \log A_t + \alpha \log K_t + \beta \log H_t + \upsilon_t \tag{3}$$

The linearised include the error term or shock proxy as υ, and replace the elasticity with ϕ for uniformity and other controls covariate by aligning with components of KE index provided by World Bank. Thus, the model is respecified as:

$$\log Y_t = \phi_0 + \phi_1 \log K_t + \phi_2 \log HE_t + \phi_3 \log KE_t + \phi_4 \log EI_t + \phi_5 \log TR_t + \upsilon_t \tag{4}$$

Where ϕ_0 is a constant parameter and ϕ_{1-5} are not only intercepts but also the elasticities of each associated variable, K is a physical capital proxy with investment, HE is health, KE is education, EI is an economic incentive (monetary policy), and TR is trade openness.

Time Series Modelling

Motivations

This study is framed in a time series approach for the implementation of Granger causality. Specifically, the time series used to follow the VAR/ VEC Granger causality. Three reasons motivate the VAR/VEC Granger causality. First, it provides a yardstick for treating all the variables endogenously (Wang et al., 2020; Benk & Gillman, 2020' Gahysels et al., 2020; Kin et al., 2020). Second, it helps to decompose the factors into short and long-run perspectives, providing information on their dynamic interaction (Mazzarisi et al., 2020; Shao et al., 2020; Wimmer et al., 2020). Third, it provides an avenue to assess the variable's convergence speed to equilibrium and the associated mechanism (Zhao et al., 2020; Liu et al., 2020; Massa & Rosellon, 2020).

Short-run VAR/VEC Granger Causality Model

As stated earlier, the study is framed in VAR/VEC Granger causality and must fulfil two key assumptions before it can be implemented. First, the variables must be stationary at their first differences; second, there must be evidence of cointegration among the variables. Similarly, after cointegration has been determined, it is important to uncover the link between the series' long and short-run properties determined by the error correction term (ect). Consequently, the core relationship between short run, long run and error correction component is summarised, model from equation (4) and presented as follows in equation 5 - 10.

$$
\log Y_{i,t} = \phi_{10} + \sum_{k=1}^{p} \phi_{11ik} \log Y_{i,t-k} + \sum_{k=1}^{p} \phi_{12ik} \log K_{i,t-k} + \sum_{k=1}^{p} \phi_{13ik} \log HE_{i,t-k}
$$
$$
+ \sum_{k=1}^{p} \phi_{14ik} \log KE_{i,t-k} + \sum_{k=1}^{p} \phi_{15ik} \log EI_{i,t-k} + \sum_{k=1}^{p} \phi_{16ik} \log TR_{i,t-k}
$$
$$
+ \alpha_{1i} ECM_{it-1} + \mu_{1i,t} \quad (5)
$$

$$
\log K_{i,t} = \phi_{20} + \sum_{k=1}^{p} \phi_{21ik} \log K_{i,t-k} + \sum_{k=1}^{p} \phi_{22ik} \log Y_{i,t-k} + \sum_{k=1}^{p} \phi_{23ik} \log HE_{i,t-k}
$$
$$
+ \sum_{k=1}^{p} \phi_{24ik} \log KE_{i,t-k} + \sum_{k=1}^{p} \phi_{25ik} \log EI_{i,t-k} + \sum_{k=1}^{p} \phi_{26ik} \log TR_{i,t-k}
$$
$$
+ \alpha_{2i} ECM_{it-1} + \mu_{2i,t} \quad (6)
$$

$$\log HE_{i,t} = \phi_{30} + \sum_{k=1}^{p} \phi_{31ik} \log HE_{i,t-k} + \sum_{k=1}^{p} \phi_{32ik} \log K_{i,t-k} + \sum_{k=1}^{p} \phi_{33ik} \log Y_{i,t-k}$$

$$+ \sum_{k=1}^{p} \phi_{34ik} \log KE_{i,t-k} + \sum_{k=1}^{p} \phi_{35ik} \log EI_{i,t-k} + \sum_{k=1}^{p} \phi_{36ik} \log TR_{i,t-k}$$

$$+ \alpha_{3i} ECM_{it-1} + \mu_{3i,t} \quad (7)$$

$$\log KE_{i,t} = \phi_{40} + \sum_{k=1}^{p} \phi_{41ik} \log KE_{i,t-k} + \sum_{k=1}^{p} \phi_{42ik} \log K_{i,t-k} + \sum_{k=1}^{p} \phi_{43ik} \log HE_{i,t-k}$$

$$+ \sum_{k=1}^{p} \phi_{44ik} \log Y_{i,t-k} + \sum_{k=1}^{p} \phi_{45ik} \log EI_{i,t-k} + \sum_{k=1}^{p} \phi_{46ik} \log TR_{i,t-k}$$

$$+ \alpha_{4i} ECM_{it-1} + \mu_{4i,t} \quad (8)$$

$$\log EI_{i,t} = \phi_{50} + \sum_{k=1}^{p} \phi_{51ik} \log EI_{i,t-k} + \sum_{k=1}^{p} \phi_{52ik} \log K_{i,t-k} + \sum_{k=1}^{p} \phi_{53ik} \log HE_{i,t-k}$$

$$+ \sum_{k=1}^{p} \phi_{54ik} \log KE_{i,t-k} + \sum_{k=1}^{p} \phi_{55ik} \log Y_{i,t-k} + \sum_{k=1}^{p} \phi_{56ik} \log TR_{i,t-k}$$

$$+ \alpha_{5i} ECM_{it-1} + \mu_{5i,t} \quad (9)$$

$$\log TR_{i,t} = \phi_{60} + \sum_{k=1}^{p} \phi_{61ik} \log TR_{i,t-k} + \sum_{k=1}^{p} \phi_{62ik} \log K_{i,t-k} + \sum_{k=1}^{p} \phi_{63ik} \log HE_{i,t-k}$$

$$+ \sum_{k=1}^{p} \phi_{64ik} \log KE_{i,t-k} + \sum_{k=1}^{p} \phi_{65ik} \log EI_{i,t-k} + \sum_{k=1}^{p} \phi_{66ik} \log Y_{i,t-k}$$

$$+ \alpha_{6i} ECM_{it-1} + \mu_{6i,t} \quad (10)$$

In equation 5-10, $\phi_{10}, \phi_{20}, \phi_{30}, \phi_{40}, \phi_{50}, \phi_{60}$ are taken as constants associated with an individual model for each variable; $\phi_{11-16}, \phi_{21-26}, \phi_{31-36}, \phi_{41-46}, \phi_{51-56}, \phi_{61-66}$ are parameters and elasticities for each model associated with endogenous factors; p represents the lag lengths and its decay with decreasing k; and ECM_{it} is the speed of convergence of

the variables to the long term means and α is the elasticity or velocity of each of the equations.

4. Empirical Results

In this section, we estimate whether knowledge cause growth in Nigeria and South Africa using the VAR/VEC Granger causality approach and discuss the corresponding of results, before comparing the attendant results with previous studies.

Preliminary Checks

Here, we examined the descriptive statistics and correlation matrix of the series used in the study. The goal is to have information on the series' prior behaviour, which is deemed important before undertaking any robust analysis. The summary statistics are presented in Table 1, while the correlation matrix is reported in Table 2.

"Table 1 here"

According to Nigeria's descriptive statistics, the mean value and standard deviation of the GDP growth rate are about 4.5 (3.8). Consistently for the other variables: knowledge (KE) 1.4 (0.25); health (HE), 48.7 (2.4); investment (K), 4.1 (2.6); economic incentive (EI), 196.1 (34.8) and trade openness (TR) 36 (9.3). For South Africa, the GDP growth rate and the corresponding standard deviation stood at 2.2 (1.94), and consistently for some other variables: knowledge (KE) is 3.1 (1.07) and health (HE) 59.4 (13.7).

Correlation Matrix

The goal of this section is to check the correlation matrix of the variable used. The correlation provides information on the kind and nature of the association among the variables. The report of the correlation matrix is reported in Table 1.

"Table 2 here"

Unit root test– Ng Perron Test

This section aims to conduct unit roots tests on the series used for the analysis. It is important to have information on the stochastic properties of the variables used. Also, overlooking this

check may lead to spurious regression, if the variable is non-stationary. Similarly, information about the mean, variance and autocovariance of each lag is essential for policy purpose. Simultaneously, the precise unit test conducted to follow the Ng and Perron (2001) Modified statistic procedure. Three reasons motivate our use of Ng Perron unit root test. First, it provides an avenue for checking our series' long trend cycle by decomposition of time. Second, Ng and Perron test stresses the importance of long-run variance in series behaviour and help choose appropriate lag lengths that conform to the series' good size and power properties (Philip, 1987; Perron & Ng, 1996). The Ng and Perron primary properties summarised in M_t and decomposed into three tests: MZ_α, MZ_t and MSB, statistically expressed in equation (11-12):

$$MZ_\alpha = \left[\left(T^{-1} y^2{}_T - s^2{}_{AR} \right) \left(2T^{-2} \sum_{t=1}^{T} y^2{}_{t-1} \right)^{-1} \right], \quad (11)$$

$$MSB = \left| \left(T^{-1} \left. \Sigma_{t=1}^{T} y^2{}_{t-1} \middle/ s^2{}_{AR} \right) \right| \quad (12)$$

The MZ_α, MZ_t and MSB are assumed to be an autoregressively estimate of the spectral density at frequency zero (see Ng and Perron, 2001; Perron 1996). The M test for $p = 0$ and 1 are taken from the least squares obtained. The results of the Ng-Perron unit root test conducted are reported in Table 3.

"Table 3 here"

According to the Ng – Perron unit root test results for Nigeria and South Africa, the variable was not stationary at level. To circumvent this shortcoming and ensure stationarity of the series, we used the trend stationary and differencing stationary series. After the transformation process, the series was then stationary. Thus, we conclude that the variables' stationarity was induced by differencing and is integrated at order one.

VAR Lag Selection Criteria

In this section, select our optimal lag length using the Akaike information criteria (AIC), Hannan-Quinn information (HQ), and Bayesian information criterion (BIC). The corresponding results are reported in Table 4. According to the optimal lag selection results, most of the statistical criteria admitted that lag 2 is the optimal lag length for the variables in Nigeria and South Africa.

"Table 4 here"

Johansen Cointegration Test

The goal of this section is to test for cointegration among the variables used for the analysis. Specifically, the Johansen (1991) cointegration test was implemented. The approach assesses whether there is evidence of a linear combination among the candidate variables employed. To conduct the cointegration test, we have used the lag values in the proceeding section to test for cointegration, and the results are reported in Table 5. For Nigeria, the results indicate four cointegrated equations, whereas for South Africa five cointegrated equations are apparent. Based on the suggested cointegration result from the T-value of the trace statistics, we conclude that the variables can revert to their long-run mean.

"Table 5 here"

VAR/VEC Granger Causality Tests

The Granger causality proposed and developed by Granger (1969) is used in this analysis. Two reasons satisfied the implementation of the method. First, Ng – Perron tests confirmed that the dataset is stationary. Second, the Johansen cointegration test also confirmed that the variables are cointegrated. The specific Granger causality used is framed in VAR/VEC Granger causality or Block exogeneity Wald tests. The approach enables us to uncover the short run, long run and the speed of the convergence of the variables to their long term mean values, summarised in Table 6.

"Table 6 here"

Four main findings can be deduced for Nigeria. (a) there is evidence of short - and long-run relationships among the variables, (b) the error correction term (ect) showing the speed of convergence of the variables to their long-run mean values is negative and statistically

significant, but relatively slow, (c) knowledge (KE) unidirectionally Granger cause growth (GDP), (d) evidence of bidirectional causality flow was observed between trade, the economic incentive (EI) and growth (GDP), (e) health (HE) unidirectionally Granger cause knowledge.

Consistently, five findings can be deduced for South Africa, (a) there was evidence of cointegration among the factors, (b) the velocity of the variables to their equilibrium position was relatively high, (c) observed bidirectional causality between knowledge (KE) trade openness (TR) and growth (GDP) was apparent; whereas investment (K), the economic incentive (EI), unidirectionally Granger causes growth, (d) investment and trade openness (TR), heath (HE) unidirectionally Granger cause knowledge, (e) economic incentive unidirectionally Granger cause trade openness (TR).

Now we compare Nigeria's results with those of South Africa in order to reveal the lesson on the relationship between knowledge and growth. First, evidence shows a unidirectional causality flow from knowledge to growth in Nigeria, whereas bidirectional causality was observed for South Africa. Second, the speed of convergence of the variables to their long-term mean was slow in Nigeria compared to South Africa. Third, both variables in the two countries have short- and long-run properties.

The finding has some policy implications for Nigeria. First, there is unidirectional causality observed in Nigeria, indicating that knowledge can indeed help to promote growth. Yet, the country recorded consistent negative growth for two decades (Joseph-Raji et al., 2018). It would appear that poor investment in key infrastructure may have contributed to the abysmal growth performance observed. Second, evidence on the bidirectional relation between health and knowledge is an indication that the Nigerian economy cannot survive without proper investment in health and knowledge. This is because it is most likely healthy people that seek education and contribute to economic growth. Third, the existence of a long-run potential relationship between knowledge and growth in Nigeria indicates that if an investment is channelled to the educational sector, the country can meet up with its counterpart in the growth trajectory. However, the speed of convergence calls for concern as it would appear to be relatively slow. The velocity raises critical questions on policy response, as this may give

rise to prolonged economic growth, which can be attributed to delay in convergence of the variables to their long-term mean.

The implication of the finding on the relationship between knowledge and growth in South Africa is explained from three standpoints. First, the bidirectional causality observed shows that notable growth in South Africa, whereas reports show that reforms are needed as educational inequality is prominent (Ferreira & Gignoux, 2014). However, recent report has shown that education inequality is prominent. Of course, the economic intuition that investing in knowledge can promote growth has actually reflected that more intervention programs are needed to improve the contribution of knowledge as the country's growth trajectory has been slow in the past two decades.

Second, the channel through which knowledge affects South Africa's growth has been identified as investment, trade openness, and economic incentive. There is overwhelming evidence that trade openness and the financial sector's robustness have contributed to the growth recorded (see, Odhiambo, 2004; Odhiambo & Nyasha, 2020; Tchamyou *et al*., 2019b). Third, the evidence on the unidirectional causality between health and education indicates that investment in the health sector is important for preserving its future human resources in the country. Fourth, one plausible explanation for the higher speed of convergence in South Africa compared to Nigeria is the disparity in quality of education between the countries. Therefore, policy makers should prioritise education investment in order to foster long term growth.

5. Conclusion and future research directions

Knowledge is generally referred to as the engine that drives growth. Although recent evidence has indicated that knowledge may be a source of problems, such as overqualification and overproduction, scholars have argued that the structure of the economy, and not knowledge accumulation, is the primary constraint (Britz et al., 2006, Okafor, 2010; Janoski et al., 2014).In this study, we have explored whether knowledge Granger causes growth in the two leading African economies. Our study has contributed to the existing empirical literature on the knowledge economy in the following ways.

First, the methodological approach has been framed using VAR/VEC Granger causality. This approach enabled the examination of the dynamic relationships among the factors that decouple the short-and long-run components, and the error correction term, that reflects the rapid adjustment of the variables to their equilibrium position. Second, our findings confirmed that a long-run relationship exists among the variables, but the speed of adjustment was relatively higher for South Africa than for Nigeria. Similarly, it was observed that knowledge unidirectionally Granger causes growth for Nigeria, whereas evidence of bidirectional Granger causality was observed for South Africa.

The findings of this study have several implications for sampled countries. For Nigeria, there is evidence that knowledge can help the country in catching-up with its targeted growth trajectory. However, intervention programs, such as education financing and investment in modern infrastructure must necessarily bridge the existing gaps in growth. Similarly, the observed bidirectional causality for South Africa is evidence that investment in education has a feedback effect on growth. However, more knowledge financing is required to promote efficiency and speed-up the increase in productivity. Finally, it is not enough to increase the population's access to learning opportunities without also focusing on the skill development required to sustain economic growth, which justifies this study's position. A plausible explanation for the higher speed of convergence in South Africa compared to Nigeria is the disparity in quality of education between the countries. Therefore, policy makers should prioritise education investment in order to foster long term growth.

Another major implication of this study is that the economic structures should be tailored to be consistent with the education system such that knowledge produced and human resources resulting from these educational systems are put in good use for economic growth and structural transformation. Accordingly, such consistency is in accordance with the structure-system theory within the remit of the educational system depending on the structure of the economy for economic growth imperatives and vice-versa. Such inter-dependences between economic growth and knowledge as have been established in this study are nonetheless contingent on time-dynamic elements (i.e. short run versus long run) as well as on the involvement of other factors or variables in the modelling exercise. These theoretical and practical contingencies emphasize the importance of not adopting blanket policies, but conditioning such policies on the discussed specificities.

The findings in this study obviously leave room for future research, especially as it pertains to assessing how the established findings withstand empirical scrutiny in other

African countries. Accordingly, engaging country-specific studies as has been done in this study is worthwhile for more targeted and/or country-specific implications. Moreover, considering other panel and country-specific empirical strategies to assess the validity of these findings is a worthwhile future research endeavour. While investment in education is used to capture knowledge, other proxies for knowledge should be considered in future research in the light of some contemporary studies (Galindo & Mendez, 2014; Kose et al., 2020).

Table 1
Summary Statistics

	Nigeria		South Africa		
Variables	Mean	Std. Dev.	Mean	Std. Dev.	Obs.
GDP	4.5	3.8	2.2	1.94	33
KE	1.4	0.25	3.1	1.07	33
HE	48.7	2.4	59.4	13.7	33
K	4.1	2.6	5.1	2.3	33
EI	196.1	34.8	152.5	32.86	33
TR	36	9.3	53.15	3.73	33

Notes.*GDP, growth; KE, knowledge; HE, health; K, gross capital formation (investment); EI, the economic incentive (monetary policy); TR, trade openness.*

Table 2
Correlation Matrix

			Nigeria			
	GDP	*KE*	*HE*	*K*	*EI*	*TR*
GDP	1					
KE	0.06	1				
HE	0.05	0.15	1			
K	0.19	0.09	0.7	1		
EI	0.12	0.33	0.8	0.72	1	
TR	0.24	0.18	0.17	0.01	0.13	1
			South Africa			
	GDP	*KE*	*HE*	*K*	*EI*	*TR*
GDP	1					
KE	0.2	1				
HE	0.5	0.18	1			
K	0.1	0.6	0.11	1		
EI	0.25	0.7	0.46	0.68	1	
TR	0.27	0.6	0.30	0.68	0.77	1

Notes.*GDP, growth; KE, knowledge; HE, health; K, gross capital formation (investment); EI, the economic incentive (monetary policy); TR, trade openness.*

Table 3.

Ng-Perron Modified Unit Root Test

Variables	Nigeria		South Africa	
	MZ_α	ΔMZ_α	MZ_α	ΔMZ_α
	1(0)	1(1)	1(0)	1(1)
GDP	-5.5	-12.4**	-5.2	15.1**
KE	-5.3	-9.3**	-3.8	-15.4**
HE	-5.4	-8.9**	0.05	-6.7**
K	-4.1	-6.1**	-4.5	8.15**
EI	-0.56	-12.03**	-0.8	14.2**
TR	4.3	-14.7**	4.02	15.3**
Critical value	1%	-13.8000		
	5%	-8.10000		
	10%	-5.70000		

Notes. *GDP, growth; KE, knowledge; HE, health; K, gross capital formation (investment); EI, economic incentive (monetary policy); TR, trade openness. *** (**) denotes the rejection of null hypothesis at 1% (5%) significant level. Δ Symbolises that the variable is in first difference.*

Table 4.
VAR Lag Selection Criteria

			Nigeria			
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1169.715	NA	3.53e+25	75.85257	76.13012	75.94304
1	-990.7220	277.1501	3.64e+21	66.62723	68.57005*	67.26054
2	-930.7919	69.59634*	1.03e+21*	65.08335*	68.69144	66.25950*
			South Africa			
Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1212.254	NA	5.49e+26	78.59704	78.87459	78.68751
1	-1035.800	273.2193	6.68e+22	69.53548	71.47830	70.16879
2	-936.3273	115.5167*	1.48e+21*	65.44047*	69.04857*	66.61662*

Notes. *Indicates the lag order selected. LR: sequentially modified LR test statistic (each test is at the 5% level), FPE: Final prediction error, HQ: Hannan-Quinn information criterion, AIC: Akaike and SC: Schwarz information criterion.*

Table 5.

Johansen Cointegration (Trace test) for Nigeria and South Africa

Nigeria

Hypothesised No of CE	Eigenvalue	Trace Statistics	Critical Value 5%	Prob**
None *	0.890935	200.1884	95.75366	0.0000
At most 1 *	0.798658	133.7141	69.81889	0.0000
At most 2 *	0.697960	85.63154	47.85613	0.0000
At most 3 *	0.604302	49.71570	29.79707	0.0001
At most 4 *	0.499814	21.90260	15.49471	0.0047

South Africa

Hypothesised No of CE	Eigenvalue	Trace Statistics	Critical Value 5%	Prob**
None *	0.981392	243.1644	95.75366	0.0000
At most 1 *	0.839417	123.6394	69.81889	0.0000
At most 2 *	0.612209	68.77107	47.85613	0.0002
At most 3 *	0.522969	40.35240	29.79707	0.0021
At most 4 *	0.366240	18.14718	15.49471	0.0195
At most 5 *	0.138276	4.464618	3.841466	0.0346

*denotes rejection of the hypothesis at the 0.05 level. ** Mackinnon-Hang-Michalis (1999) values*

Table 6.

VAR/VEC Granger Causality/Block Exogeneity Wald Tests

Independent Variable	The Direction of Causality for Nigeria Dependent variable						Long run
	ΔGDP_t	ΔKE_t	ΔHE_t	ΔK_t	ΔEI_t	ΔTR_t	$VECT_{t-i}$
ΔGDP_{t-i}	-	0.92 [0.17]	1.99 [0.61]	0.85 [0.18]	8.33** [0.03]	5.6** [0.00]	-0.03* (0.0)
ΔKE_{t-i}	3.6** [0.00]	-	18.0** [0.00]	2.9 [0.62]	1.01 [0.51]	3.7 [0.27]	-0.5** (0.1)
ΔHE_{t-i}	6.0** [0.00]	5.90** [0.00]	-	2.7 [0.24]	1.90 [0.22]	28.1** [0.00]	0.018** (0.00)
ΔK_{t-i}	8.3** [0.00]	0.16 [0.26]	13.8** [0.00]	-	4.20 [0.30]	0.3 [0.19]	0.001* (0.0)
ΔEI_{t-i}	6.7** [0.00]	10.1** [0.00]	6.0** [0.00]	6.6** [0.00]	-	0.75 [0.33]	5.4 (0.7)
ΔTR_{t-i}	21.6*** [0.00]	6.4** [0.00]	0.87 [0.17]	9.2** [0.00]	1.37 [0.25]	-	2.49** (0.2)

Independent Variable	The Direction of Causality for South Africa Dependent variable						Long run
	ΔGDP_t	ΔKE_t	ΔHE_t	ΔK_t	ΔEI_t	ΔTR_t	$VECT_{t-1}$
ΔGDP_{-i}	-	7.8** [0.00]	0.27 [0.27]	0.43 [0.33]	1.27 [0.45]	7.14** [0.00]	-0.10** (0.0)
ΔKE_{t-i}	4.63** [0.00]	-	3.0 [0.45]	4.1** [0.00]	2.06 [0.19]	1.87 [0.50]	-0.04** (0.01)
ΔHE_{t-i}	0.94 [0.42]	12.0** [0.00]	-	8.5** [0.00]	7.61** [0.00]	0.59 [0.58]	0.002** (0.00)
ΔK_{t-i}	29.4** [0.00]	5.68** [0.00]	3.63** [0.00]	-	3.46 [0.69]	0.12 [0.18]	-0.05** (0.00)
ΔEI_{t-i}	15.9*** [0.00]	3.66 [0.28]	2.26 [0.19]	0.31 [0.91]	-	19.36** [0.00]	-0.20 (0.2)
ΔTR_{t-i}	5.02** [0.00]	6.62** [0.00]	2.94 [0.66]	0.76 [0.17]	1.39 [0.52]	-	-0.28 (0.2)

Notes. GDP, growth; KE, knowledge; HE, health; K, gross capital formation (investment); EI, the economic incentive (monetary policy); TR, trade openness. *** (**) denotes the rejection of null hypothesis at 1% (5%) significant level.

Data Availability Statement

The data that support the findings of this study are available on request from the corresponding author.

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