# Educational levels and economic growth in Nigeria: Evidence from ARDL and Toda-Yamamoto causality approaches

**Kenneth O. Ahamba, Hycenth O.R. Ogwuru, Jude Ozor, Cletus Offor Onwuka, Blessing N. Udenta, Glory Chibuzo Agu, Sunday Amalunweze Okwor and Chima Nwabugo Durueke**[*]

**Abstract:** The declining gap between education and economic growth in Nigeria needs urgent policy attention. This paper therefore examines educational levels-economic growth nexus in Nigeria by applying autoregressive distributed lag and Toda-Yamamoto causality test to time series data spanning 1981 to 2020. Augmented Dicky-Fuller, Phillips-Perron and Zivot-Andrews unit root tests indicate a mixture of I(0) and I(1) stationarity properties of data. Bounds test reveals cointegration between primary, secondary and tertiary education indices, and real gross domestic product (RGDP). Findings indicate positive impact of primary, secondary and tertiary education indices and education policy dummy (NEP) on RGDP with the tertiary education index being significant. Toda-Yamamoto causality test reveals that secondary and tertiary education indices and NEP cause RGDP without a feedback effect. Diagnostic tests justify reliability of the parameter estimates. Hence, the study recommends for educational reform in line with the actual needs of the global economy, increased educational funding and strict implementation, monitoring and periodic evaluation of education policies in Nigeria.

**Keywords:** educational levels, economic growth, ARDL, Toda-Yamamoto causality, Nigeria

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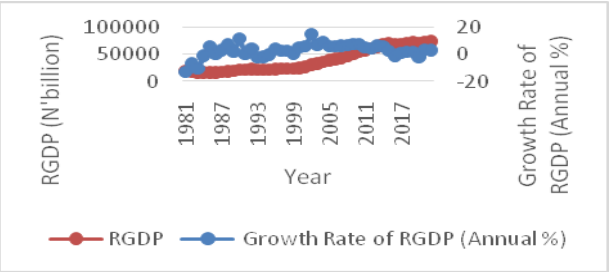
## Introduction

Human capital especially education is pivotal to long-term economic growth (Alfoul 2024); and earlier studies of Schultz (1961), Becker (1964), Mincer (1984), Romer (1986) and Lucas (1988) highlighted the importance of human capital in promoting innovation and driving inclusive and sustainable economic growth. The transformative capacity of education in fostering innovation and enhancing productivity has been widely recognised in both empirical and theoretical literature. Three channels through which education affects economic growth have been identified as increasing the collective ability of the labour force to complete existing tasks faster, facilitating the transfer of knowledge about new information, products and technologies created by others, and increasing creativity which spurs a country's ability to invent new products, and technologies (Ziberi et al. 2022; Grant 2017; World Economic Forum 2016; Barro and Lee 2013).

The first motivation behind this study is the poor performance of the Nigerian economy in terms of real gross domestic product (RGDP) and its growth rate despite the large number of graduates and abundant natural resources. Mulhearn and Vane (1999) note that a stable and satisfactory rate of economic growth is one of the four main objectives of macroeconomic policy in every country. But over the years, the value of RGDP of Nigeria has been low, though with rising and falling trends; and the actual growth rate of RGDP has fallen below the targeted growth rate on most occasions as depicted by Figure 1. This suggests that Nigeria's economic growth may be below its potential which necessitates urgent policy intervention in order to improve RGDP of Nigeria.

Figure 1. Trends of RGDP and RGDP growth rate (annual %) in Nigeria (1981-2020)
Source: CBN Statistical Bulletin (2023) and World Development Indicators, WDI (2023)



The second motivation behind this study is empirical gap. Studies like Dragoescu (2015) for Romania, Dudzevičiūtė and Šimelytė (2018) for 17 selected European Union countries, Singh, Sieng and Saukani (2018) for Malaysia and Adeniyi, Ajayi and Adedeji (2020) for 8 West African countries have examined education-growth nexus. On the whole, these studies established that the number of students enrolled into primary, secondary and higher education institutions, percentage of the population who have successfully completed tertiary education, average years of schooling and rate of return on education made significant positive impact on economic growth except Adeniyi et al. (2020) that found negative impact in a few countries.

Marquez-Ramos and Mourelle (2019) investigated education-growth nexus in Spain using STR model and time series data spanning 1971-2013. Findings at country level indicate nonlinearites in the nexus between secondary and tertiary education levels with a positive effect on GDP growth but different patterns emerge for various regions. Odhiambo (2021) studied the causal relationship between education and economic growth in South Africa using ECM-based Granger causality and time series data covering the period of 1986-2017. Findings reveal a unidirectional causality from RGDP per capita to total education expenditure and primary school enrolment; and a bidirectional causality between secondary school enrolment and RGDP per capita in the short run; and a unidirectional causal flow from secondary school enrolment to real GDP per capita in the long run. In view of the findings, the study concluded that the causal relationship between education and economic growth in South Africa depends on the variable used to proxy education; and that causality tends to change over time. Maneejuk and Yamaka (2021) examined both linear and nonlinear impacts of education on the economic growth in ASEAN-5 countries. Findings of the linear model for all five countries reveal that average annual government education expenditure per student in the tertiary level, secondary and tertiary education enrolment rates impacted positively on GDP of all the countries whereas that of nonlinear model indicate that most of the education indicators are significant and positive. Applying instrumental variable two-stage least squares to time series data spanning 1997-2020, Ziberi et al. (2022) explored the link between education and economic growth in North Macedonia. Findings reveal that public expenditures on education significantly increased GDP growth rate when tertiary education enrolment is used as instrumental variables. Alfoul et al. (2024)

investigated the effect of education on economic growth using panel ARDL model and data from 18 sub-Saharan African countries spanning 2000-2020. Findings indicate that education proxy by secondary school enrolment made an insignificant negative impact on economic growth proxy by GDP growth rate in the long-run and a significant negative impact in the short-run.

In Nigeria, Ayara (2002) who used standard growth-accounting model found that education proxy by secondary and tertiary school enrolments impacted negatively and insignificantly on GDP. Yusuf (2014), and Emediegwu and Ighodaro (2016) employed vector error correction model. Yusuf (2014) found that capital and recurrent expenditures on education and post-primary school enrolment made significant positive impact on GDP per capita. Emediegwu and Ighodaro (2016) found that budget allocation to education and primary education enrolment exerted significant positive impact on RGDP growth rate while that of post-primary education enrolment is insignificantly negative. Ayeni and Omobude (2018), and Onwunali et al. (2024) utilized ARDL technique while Jelilov et al. (2016), Aigbedion et al. (2017), and Ogunleye et al. (2017) employed OLS multiple regression. All of them found a positive relationship between GDP and education except Jelilov et al. (2016) and Ogunleye et al. (2017) that found an insignificant negative impact of primary school enrolment on RGDP and Aigbedion et al. (2017) who established a significant negative impact of education expenditure on RGDP. Omojimite (2010) and Omodero and Nwangwa (2020) used Granger causality technique. While Omojimite (2010) found a causal relationship between total and recurrent public expenditure on education and GDP; Omodero and Nwangwa (2020) found no causality. These studies focused on the impact of school enrolment, education expenditure and budget allocation to education on GDP but neglected the impact of other vital education indicators like educational attainments and changes in national education policy on RGDP. In order to fill these gaps and also capture the impact of each level of education on RGDP, the study built a primary education index, a secondary education index and a tertiary education index which contain access to education and educational attainment at each level of education respectively. The study also constructed a dummy variable to capture the impact of changes in national education policy on RGDP. This study simultaneously estimated the impact of education

levels on RGDP and investigated their direction of causality using autoregressive distributed lag approach and the Toda-Yamamoto causality test unlike previous studies. Specifically, the study investigated: 1. the impact of primary education index, secondary education index, tertiary education index and changes in national education policy on real gross domestic product in Nigeria; and 2. the direction of causality between primary education index, secondary education index, tertiary education index, changes in national education policy and real gross domestic product in Nigeria from 1981 to 2020.

The remainder of this paper is structured into section 2 materials and methods, section 3 results and discussions, and section 4 conclusion, policy implications and recommendations.

## Materials and methods

*Theoretical framework*

The theoretical framework of this study is anchored on the endogenous growth theory. The theory maintains that the overall output of an economy at time t (Yt) is a function of total physical capital (Kt), total human capital (Ht) and total labour force (Lt). It assumes that the production function is of the form of a standard Cobb-Douglas function stated as:

$$Y_t = AK_t^{\phi} L_t^{\varphi} H_t^{\gamma} \quad (1)$$

where $Y_t$ is output or RGDP; $K_t$ is physical capital; L is the number of workers employed; $H_t$ is total human capital; A is the technology parameter; t is the observation subscript denoting time; whereas $\phi$, $\varphi$, and $\gamma$ denote parameters to be estimated.

Human capital, $H_t = EA_t L_t$ (2)

where $EA_t$ is the average educational attainments per worker.

Substituting Eq. (2) into Eq. (1) gives:

$$Y_t = AK_t^{\phi} L_t^{\varphi} (EA_t L_t)^{\gamma} \quad (3)$$

$$Y_t = AK_t^{\phi} L_t^{\varphi} L_t^{\gamma} EA_t^{\gamma} \quad (4)$$

$$Y_t = AK_t^{\phi} L_t^{\varpi} EA_t^{\gamma} \quad (5)$$

where $\varpi = \varphi + \gamma$; hence, $L_t^{\varphi} - L_t^{\gamma} = L_t^{\varpi}$

Taking natural logarithms, a linear transformation of equation gives:

$$\ln Y_t = \ln A + \phi \ln K_t + \varphi \ln L_t + \gamma \ln EA_t + \varepsilon_t \quad (6)$$

where ln = variables in their natural logarithm, εt is the white noise

error term. Eq. (6) is the basic model which enables this study to relate economic growth proxy by real gross domestic product (RGDP) to the different education variables. The extended model in Eq. (7) contains additional control variables which capture the peculiarities of the Nigerian economy.

*Model specification and data*

Following the endogenous growth model with slight modification, a linear model that captures objective one is specified in Eq.7 as:

$$\ln RGDP_t = \varphi_0 + \varphi_1 PEIND_t + \varphi_2 SEIND_t + \varphi_3 TEIND_t + \varphi_4 NEP_t + \varphi_5 EPC_t + \varphi_6 \ln GFCF_t + \varphi_7 PGRt + \varepsilon_t \quad (7)$$

where lnRGDP = the natural logarithm of real gross domestic product; PEIND = primary education index built with primary school enrolment and completion rates and years of schooling; SEIND = secondary education index built with secondary school enrolment and completion rates and years of schooling; TEIND = tertiary education index built with tertiary school enrolment rate and years of schooling; NEP = changes in national education policy, measured by a dummy variable of zero or one for the absence or presence of change in the national education policy in Nigeria respectively; EPC = electric power consumption in Nigeria, a proxy for technology; lnGFCF = natural logarithm of gross fixed capital formation, a proxy for physical capital, PGR = population growth rate, a proxy for labour force, $\varepsilon_t$ is the white noise error term whereas t is a time subscript; $\varphi_0$ = constant while $\varphi_1, \varphi_2, \ldots \varphi_7$, = coefficients of the variables. Based on theory, all the variables are expected to impact positively on RGDP.

This study employed annual time series data from 1981 to 2020 to investigate the impact of formal educational levels on economic growth in Nigeria. Note that RGDP and GFCF are in log form whereas other variables in rates and percentages were not logged. Table 1 presents the summary of the variables, measurements and sources of the data used in the empirical analysis.

Table 1. Summary of the variables, measurement and data sources
Source: Authors' compilation (2024)

| Variable | Measurement | Sources of data |
|---|---|---|
| Real gross domestic product (RGDP) | GDP at 2010 constant market prices (₦'Billion) | CBN Statistical Bulletin (2023) |
| Primary education index (PEIND) | Primary school enrolment ratio (% gross), primary school completion rate and primary school years of schooling | Researcher's computation using PCA technique and data from National Bureau of Statistics, NBS (2023), and World Development Indicators, WDI (2023) |
| Secondary education index (SEIND) | Secondary school enrolment ratio (% gross), secondary school completion rate and years of schooling | Researcher's computation using PCA technique and data from NBS (2023), UIS (2023), and WDI (2023) |
| Tertiary education index (TEIND) | Tertiary school enrolment ratio (% gross) and tertiary school years of schooling | Researcher's computation using PCA technique and data from NBS (2023), UIS (2023), and WDI (2023) |
| Changes in national education policy (NEP) | Dummy variable constructed by the researcher. 1 for a year with changes in the NEP and 0 for a year without changes in the NEP | Researcher's construct (2024) |
| Electric power consumption (EPC) | Electric power consumption (kwh per capita) | WDI (2023) |
| Gross fixed capital formation (GFCF) | Gross fixed capital formation (₦'Billion) | CBN Statistical Bulletin (2023) |
| Population growth rate (PGR) | Population growth rate (annual %) | WDI (2023) |

*Estimation techniques and procedures*

This study employed the autoregressive distributed lag (ARDL) technique developed by Pesaran, Shin and Smith (2001) in order to achieve objective one and the Toda-Yamamoto causality test developed by Toda and Yamamoto (1995) to achieve objective two. The choice of ARDL is because of its suitability for I(1), I(0), or a mixture of I(1) and I(0) stationary variables (Sulaiman and Abdul-Rahim 2014; Sulaiman, et al. 2015); and a finite data sample size of 30 to 80 observations in which Narayan (2004) developed the set of critical values. Further, ARDL has the capacity to estimate different lags as well as both short-run and long-run coefficients simultaneously (Chindo, Abdulrahim, Waziri, Huong, and Ahmad 2015; Durmaz and Jie 2024). The ARDL framework of Eq. (7) is compactly specified in Eq. (8) to capture short-run and long-run impacts of formal educational levels on RGDP and the error correction term (ECT) as follows:

$$\Delta \ln RGDP_t = \varphi_0 + \varphi_1 \ln RGDP_{t-1} + \varphi_2 PEIND_{t-1} + \varphi_3 SEIND_{t-1} + \varphi_4 TEIND_{t-1} + \varphi_5 NEP_{t-1}$$
$$+\delta_6 EPC_{t-1} + \varphi_7 \ln GFCF_{t-1} + \varphi_8 PGR_{t-1} + \sum_{j=1}^{k} \theta_{1j} \Delta \ln RGDP_{t-j} + \sum_{j=0}^{k} \theta_{2j} \Delta PEIND_{t-j} +$$
$$\sum_{j=0}^{k} \theta_{3j} \Delta SEIND_{t-j} + \sum_{j=0}^{k} \theta_{4j} \Delta TEIND_{t-j} + \sum_{j=0}^{k} \theta_{5j} \Delta NEP_{t-j} + \sum_{j=0}^{k} \theta_{6j} \Delta EPC_{t-j} + \sum_{j=0}^{k} \theta_{7j} \Delta \ln GFCF_{t-j}$$
$$+\sum_{j=0}^{k} \theta_{8j} \Delta PGR_{t-j} + \sum_{j=0}^{k} \theta_{9j} \Delta ECT_{t-j} \quad (8)$$

where the variables are as defined above, $\ln RGDP_{t-1}$ = lagged value of natural logarithm of RGDP, $\varphi_0$ = constant whereas $\varphi_1, \varphi_2, ..., \varphi_8$ = long-run coefficients, $\theta_1, \theta_2, ..., \theta_9$ = short-run coefficients, $\Delta$ = difference operator, k = optimal lag length, and ECT = error correction term.

To test for the exitence of cointegration between RGDP and the independent variables, the ARDL bound test approach to co-integration test incorporating the NEP as dummy is used and the hypothesis is specified as:

$H_0 := \phi_1 = \phi_2 = \phi_3 = \phi_4 = \phi_5 = \phi_6 = \phi_7 = \phi_8 = 0$ (no cointegration).

$H_1 := \neq \phi_1 \neq \phi_2 \neq \phi_3 \neq \phi \neq_4 \neq \phi_5 \neq \phi_6 \neq \phi_7 \neq \phi_8 \neq 0$ (cointegration exists).

The test is conducted by testing the null hypothesis ($H_0$) against the alternative ($H_1$) using the F test which employs asymptotic critical value bounds which depend on whether the variables are I(0), I(1), or

mixed. The two sets of critical values generated are I(0) and I(1) known as the lower bound, and the upper bound respectively. The decision rule is to reject $H_0$ if the computed F statistic value is greater than the upper bound at 5% significance level and conclude that cointegration exists; but if the computed F statistic value is less than the lower bound, the null hypothesis of no cointegration is accepted. However, the test becomes inconclusive if the computed F-statistic falls between the lower and upper critical bounds. The existence of cointegration necessitates the estimation of both short-run and long-run coefficients as in this study.

The Toda-Yamamoto causality test proposed by Toda and Yamamoto (1995) and employed in Wolde-Rufael (2009) and Salahuddin and Gow (2019) was utilised to actualise objective two which is to investigate the direction of causality between RGDP and education variables. Shahbaz et al. (2013) notes that a better understanding towards policy implications of empirical findings is enhanced by tracing causal link among the variables. When variables are integrated of mixed order, the traditional Granger causality test (Granger 1969) becomes inappropriate (Salahuddin and Gow 2019). To obviate some of these anomalies, Toda and Yamamoto (1995, subsequently T-Y) based on augmented VAR modelling introduced a Wald test statistic that asymptotically has a Chi-Square ($\chi 2$) distribution irrespective of the order of integration and/or cointegration features of the variables. T-Y procedure is novel as pre-testing for cointegrating features is not required, hence, the potential bias associated with unit roots and cointegration tests is avoided, thus it can be applied irrespective of whether the variables are of I(0), I(1), I(2) or of a mixture of I(0), I(1), and I(2) (Rambaldi and Doran 1996; Zapata and Rambaldi 1997; Clark and Mirza 2006). Clark and Mirza (2006) note that pre-tests for unit roots and cointegration could suffer from size distortions which could lead to the use of inaccurate model for causality test. This study conducts the T-Y causality test because the variables in this study are of a mixture of I(0) and I(1). The key advantage of T-Y test is that it is not sensitive to the order of integration. T-Y utilized a modified Wald test (MWald) to restrict the parameters of the VAR (k) where k denotes the lag length aimed at artificially augmenting the correct order k by the maximal order of integration denoted dmax. Pittis (1999) opines that when this is done, a $(K+dmax)^{th}$ order of VAR is estimated and the coefficients of the last

lagged dmax vectors are ignored. The mathematical details of the test are not provided here to save space (please refer to Toda and Yamamoto, 1995 for such details). Employing the seemingly unrelated regression (SURE) framework, the T-Y causality test could be estimated using a VAR (4) model specified as follows:

$$\begin{bmatrix} \ln RGDP_t \\ PEIND_t \\ SEIND_t \\ TEIND_t \end{bmatrix} = C_0 + C_1 \sum_{i=1}^{4} \begin{bmatrix} \ln RGDP_{t-1} \\ PEIND_{t-1} \\ SEIND_{t-1} \\ TEIND_{t-1} \end{bmatrix} + C_2 \sum_{i=0}^{4} \begin{bmatrix} \ln RGDP_{t-2} \\ PEIND_{t-2} \\ SEIND_{t-2} \\ TEIND_{t-2} \end{bmatrix} + C_3 \sum_{i=0}^{4} \begin{bmatrix} \ln RGDP_{t-3} \\ PEIND_{t-3} \\ SEIND_{t-3} \\ TEIND_{t-3} \end{bmatrix} + C_4 \sum_{i=0}^{4} \begin{bmatrix} \ln RGDP_{t-4} \\ PEIND_{t-4} \\ SEIND_{t-4} \\ TEIND_{t-4} \end{bmatrix} + \begin{bmatrix} \mu_t^{\ln RGDP} \\ \mu_t^{PEIND} \\ \mu_t^{SEIND} \\ \mu_t^{TEIND} \end{bmatrix} \quad (9)$$

In Eq. (9) C1,…C4 are four 4 by 4 matrices of coefficients with C0 being the identity matrix, μts are the white noise error term with zero mean and constant variance. We test the educational levels (PEIND, SEIND, TEIND) do not Granger cause lnRGDP. The null hypothesis is stated as: $H_0 : C_{ij} = 0$ versus $H_1 : C_{ij} \neq 0$ where $C_{ij}$ are the coefficients of the variables.

## Results and discussions

*Descriptive statistics*

Descriptive statistics is employed to reveal the behaviour of the variables of the model. Table 2 presents the summary of descriptive statistics. The proximity between the mean and median and the small values of the standard deviations of PEIND, SEIND, TEIND, NEP, and PGR indicate that their data cluster around their sample means which implies that they are not grossly affected by their extreme values. The large distance between the mean and median and the large values of the standard deviations of RGDP, EPC and GFCF is evidence that their data are highly dispersed from their sample means implying that they are grossly affected by their extreme values. All the variables are positively skewed except SEIND which exhibits a negative skewness. RGDP, SEIND, TEIND, EPC and PGR with kurtosis values less than 3 are platykurtic; PEIND with kurtosis value of 3 is mesokurtic whereas NEP and GFCF with kurtosis values greater than 3 are leptokurtic. RGDP, PEIND, SEIND, TEIND, EPC and PGR are normally distributed following their Jarque-Bera probability values that are greater than 0.05 while NEP and GFCF are not normally

distributed following their Jarque-Bera probability values that are less than 0.05.

*Correlation matrix*

Correlation matrix was conducted in order to determine the degree of association among the variables. Table 3 presents the correlation matrix. The correlation matrix in Table 3 reveals that all the independent variables are positively correlated with RGDP except PEIND and SEIND that are negatively correlated with RGDP. From the correlation coefficients, it can be inferred that there is no multicollinearity among the variables as none of the pairs of regressors has a coefficient greater than 0.61. Gujarati and Porter (2009) asserted that multicollinearity exists if the correlation coefficient between any pair of regressors exceeds 0.80.

Table 2. Summary of descriptive statistics

| Variables | Mean | Median | Maximum | Minimum | Std. Dev. |
|---|---|---|---|---|---|
| RGDP | 37243.45 | 26182.87 | 72094.09 | 16211.49 | 20015.68 |
| PEIND | 0.415586 | 0.369535 | 1.000000 | 0.000000 | 0.245076 |
| SEIND | 0.575539 | 0.547694 | 1.000000 | 0.000000 | 0.265914 |
| TEIND | 0.412448 | 0.497147 | 1.000000 | 0.000000 | 0.369562 |
| NEP | 0.125000 | 0.000000 | 1.000000 | 0.000000 | 0.334932 |
| EPC | 105.8325 | 98.96437 | 154.1723 | 51.08055 | 27.61001 |
| GFCF | 8598.236 | 8206.830 | 15789.67 | 5668.870 | 1987.939 |
| PGR | 2.580769 | 2.582495 | 2.709830 | 2.488792 | 0.066333 |

Table 2. Summary of descriptive statistics (cont'd)
Source: Authors' computation (2024)

| Variables | Jarque-Bera | Jarque-Bera Prob. | Sum Sq. Dev. | Observations |
|---|---|---|---|---|
| RGDP | 5.089529 | 0.078492 | 1.56E+10 | 40 |
| PEIND | 4.699574 | 0.095389 | 2.342425 | 40 |
| SEIND | 0.889919 | 0.640850 | 2.757701 | 40 |
| TEIND | 4.567088 | 0.101922 | 5.326468 | 40 |
| NEP | 50.74830 | 0.000000 | 4.375000 | 40 |
| EPC | 2.484213 | 0.288775 | 29730.18 | 40 |
| GFCF | 24.30300 | 0.000005 | 1.54E+08 | 40 |
| PGR | 2.652550 | 0.265464 | 0.171603 | 40 |

Table 3. Correlation matrix

| Correlation | RGDP | PEIND | SEIND | TEIND |
|---|---|---|---|---|
| RGDP | 1.000000 | | | |
| PEIND | -0.342065 | 1.000000 | | |
| SEIND | -0.223998 | -0.391511 | 1.000000 | |
| TEIND | 0.645187 | -0.229742 | -0.311776 | 1.000000 |
| NEP | 0.006954 | 0.103444 | -0.280148 | 0.033311 |
| EPC | 0.648472 | -0.337904 | -0.331376 | 0.553771 |
| GFCF | 0.400035 | 0.241225 | -0.282528 | 0.340984 |
| PGR | 0.495338 | -0.084055 | -0.606995 | 0.435255 |

Table 3. Correlation matrix (cont'd)
Source: Authors' computation (2024)

| Correlation | NEP | EPC | GFCF | PGR |
|---|---|---|---|---|
| NEP | 1.000000 | | | |
| EPC | -0.004530 | 1.000000 | | |
| GFCF | 0.226472 | 0.153077 | 1.000000 | |
| PGR | 0.191637 | 0.537555 | 0.360816 | 1.000000 |

**Unit root tests**

Unit root test was conducted to determine the stationarity property of data utilised in the empirical analysis. Table 4 presents the augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) unit root tests while Table 5 presents the Zivot-Andrew's unit root test with a single structural break. The test was implemented with intercept and the maximum lag length of 9 was auto-selected on SIC basis for ADF test and Newey–West Bandwidth employing the Bartlett–Kernel procedure for PP test.

Table 4. Results of ADF and PP unit root tests of stationarity

| | ADF Test | | |
|---|---|---|---|
| Variables | t- statistic I(0) | t- statistic I(1) | Result |
| RGDP | -1.041159 | -3.783083* | I(1) |
| PEIND | -2.005030 | -5.742917* | I(1) |
| SEIND | -1.946392 | -5.145058* | I(1) |
| TEIND | -0.432778 | -6.105773* | I(1) |
| NEP | -7.555210* | -3.937994* | I(0) |
| EPC | -2.174719 | -7.478639* | I(1) |
| GFCF | -2.404291 | -5.103451* | I(1) |
| PGR | -5.125087* | -3.058851** | I(0) |

Table 4. Results of ADF and PP unit root tests of stationarity (cont'd)
Source: Authors' computation (2024)

| | PP Test | | |
|---|---|---|---|
| Variables | t- statistic I(0) | t- statistic I(1) | Result |
| RGDP | 0.451047 | -3.783083* | I(1) |
| PEIND | -2.222015 | -5.742611* | I(1) |
| SEIND | -1.946392 | -5.091118* | I(1) |
| TEIND | -0.432778 | -6.105173* | I(1) |
| NEP | -7.574747* | -20.70182* | I(0) |
| EPC | -2.152015 | -7.604205* | I(1) |
| GFCF | -3.610453** | -5.613544* | I(0) |
| PGR | -2.403062 | -4.363696* | I(1) |

Note: ***, **, * implies rejection of the null hypothesis at 10%, 5%, or 1% significance level

Table 4 which shows the ADF and PP results of the unit root test indicates that most of the variables are stationary at first difference, I(1) while few of the variables are stationary at levels, I(0). The result of Zivot-Andrews unit root test with structural break presented in Table 5 shows that the break point (mid-point) years are at 2004, 1998, 2004, 2013, 1998, 2004, 2001 and 2011 for RGDP, PEIND, SEIND, TEIND, NEP, EPC, GFCF and PGR respectively. These years are very significant as important policy changes affecting formal education as a major driver of RGDP in Nigeria were made. For example, the national

education policy in 2013 spelt out the prospects of early childhood care development, pre-primary, primary and junior secondary educations.

Table 5: Zivot-Andrews breakpoint unit root test

| | Level form I(0) | | | |
|---|---|---|---|---|
| | t-Statistic | Break Date | Lag | Result |
| RGDP | -2.916131 | 2004 | 4 | Non-stationary |
| PEIND | -5.131726** | 1998 | 4 | I(0) with break |
| SEIND | -6.792704* | 2004 | 4 | I(0) with break |
| TEIND | -3.971896 | 2013 | 4 | Non-stationary |
| NEP | -8.384042* | 1998 | 4 | I(0) with break |
| EPC | -4.460320 | 2004 | 4 | Non-stationary |
| GFCF | -6.387448* | 2001 | 4 | I(0) with break |
| PGR | -4.398053*** | 2011 | 4 | I(0) with break |

Table 5: Zivot-Andrews breakpoint unit root test (cont'd)
Source: Authors' computation (2024)

| | First difference form I(1) | | | |
|---|---|---|---|---|
| | t-Statistic | Break Date | Lag | Result |
| RGDP | -4.988638*** | 2000 | 4 | I(1) with break |
| PEIND | -6.230660* | 2012 | 4 | I(0) with break |
| SEIND | -5.786328* | 2005 | 4 | I(0) with break |
| TEIND | -7.288573* | 1991 | 4 | I(1) with break |
| NEP | -6.290714* | 2008 | 4 | I(0) with break |
| EPC | -8.637637* | 2002 | 4 | I(1) with break |
| GFCF | -5.606443* | 1994 | 4 | I(0) with break |
| PGR | -2.446218* | 2012 | 4 | I(0) with break |

The break locations, i.e. intercept/trend and both are denoted by the midpoint indicating rejection of the null hypothesis at 10% (*); 5% (**) and 1% (***) levels of significance respectively, based on percentage points of the asymptotic distribution critical values in the Zivot and Andrew (1992) Table.

The need and prospect of senior secondary education, technical and vocational education and training and mass and nomadic educations were also spelt out by the 2013 National Policy on Education. The need and prospect of senior secondary education, technical and

vocational education and training and mass and nomadic educations were spelt out by the 2013 national education policy. The Zivot-Andrews break-point unit root results of I(1) and I(0) validates the ADF and PP results.

*Cointegration test*

Having confirmed the stationarity property of the variables, the study conducted cointegration test and the result presented in Table 6 indicates existence of cointegration as the F-statistic value of 9.191170 is greater than 3.28 upper bounds value at 5% significance level. The study therefore concludes that there is a long-run relationship between education variables and RGDP. This necessitates the estimation of both short-run and long-run coefficients of the model.

Table 6. ARDL F-bounds test to cointegration
Source: Authors' computation (2024)

| Test statistic | Value | K |
|---|---|---|
| F-statistic | 9.191170 | 6 |
| Critical Value Bounds | | |
| Significant | I0 Bound | I1 Bound |
| 10% | 1.99 | 2.94 |
| 5% | 2.27 | 3.28 |
| 2.5% | 2.55 | 3.61 |
| 1% | 2.88 | 3.99 |

The results were estimated under ARDL (1,1,0,1,0,0,1) using the Akaike information criterion (AIC) and maximum dependent lag length of one.

From the short-run result presented in the upper part of Table 7, RGDP at lag 1 and PEIND at lag 1 made significant negative impact on RGDP while level PEIND, SEIND, TEIND, TEIND(-1) and NEP made positive impact on RGDP with TEIND(-1) being significant. Specifically, 1% increase in RGDP(-1) and PEIND(-1) reduced RGDP by 0.275102 unit and 0.115736 unit respectively whereas 1% increase in PEIND, SEIND, TEIND, TEIND(-1) and NEP increase RGDP by 0.040971 unit, 0.013456 unit, 0.134351 unit, 0.301690 unit and 0.014364 unit respectively. Interestingly, the control variables of EPC, GFCF, PGR and its lag 1 made positive impact on RGDP with PGR being significant. Precisely, 1% increase in EPC, GFCF, PGR and PGR(-1) promotes RGDP by 0.000869 unit, 0.058672 unit, 1.099777

unit and 0.160256 unit respectively. The coefficient of ECT which measures the speed of adjustment of RGDP towards long-run equilibrium shows that approximately 27.51% disequilibrium was corrected annually to ensure convergence at the long-run.

Table 7: ARDL short-run and long-run estimates (Dependent variable: LNRGDP)
Source: Authors' computation (2024)

| | Short-run | Result | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| LNRGDP(-1) | -0.275102 | 0.077828 | -3.534735 | 0.0015 |
| D(PEIND) | 0.040971 | 0.043550 | 0.940766 | 0.3552 |
| PEIND(-1) | -0.115736 | 0.033260 | -3.479704 | 0.0017 |
| SEIND | 0.013456 | 0.036205 | 0.371670 | 0.7130 |
| D(TEIND) | 0.134351 | 0.073879 | 1.818534 | 0.0801 |
| TEIND(-1) | 0.301690 | 0.076779 | 3.929321 | 0.0005 |
| EPC | 0.000869 | 0.000649 | 1.338804 | 0.1918 |
| LNGFCF | 0.058672 | 0.065801 | 0.891659 | 0.3805 |
| D(PGR) | 1.099777 | 0.336851 | 3.264880 | 0.0030 |
| PGR(-1) | 0.160256 | 0.137210 | 1.167963 | 0.2530 |
| NEP | 0.014364 | 0.017080 | 0.841007 | 0.4077 |
| ECT | -0.275102 | 0.028589 | -9.622501 | 0.0000 |
| | Long-run | Result | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| PEIND | -0.420703 | 0.135144 | -3.112989 | 0.0043 |
| SEIND | 0.048914 | 0.125784 | 0.388877 | 0.7004 |
| TEIND | 1.096647 | 0.142933 | 7.672456 | 0.0000 |
| EPC | 0.003158 | 0.001887 | 1.673083 | 0.1059 |
| LNGFCF | 0.213273 | 0.210183 | 1.014705 | 0.3193 |
| PGR | 0.582534 | 0.501972 | 1.160490 | 0.2560 |
| C | 6.434040 | 2.324961 | 2.767375 | 0.0101 |
| $R^2$ = 0.710919; $R^{-2}$ = 0.676910; F-statistic =1027.153; Prob(F-statistic) = 0.000000); Durbin-Watson stat. = 2.14 | | | | |

About 71.09% variation in RGDP is jointly explained by the independent variables of the model as indicated by R-Squared while F-statistic and its p-value reveals that the overall model is significant. Durbin-Watson statistic of 2.146187 indicates absence of serial correlation which is a desirable quality of an econometric model.

The long-run result in the middle part of Table 7 indicates that PEIND made significant negative impact on RGDP as 1% increase in PEIND reduced RGDP by 0.420703 unit. This finding contradicts theory. A plausible explanation may be that primary education level is not sufficient to equip the human capital with the requisite productive skills required for production and given the high rate of unemployment in Nigeria, the few jobs available are rationed among those with higher qualifications (Ahamba et al. 2020). SEIND, TEIND, EPC, GFCF and PGR impacted positively with TEIND being significant. Numerically,1% increase in SEIND, TEIND, EPC, GFCF and PGR increased RGDP by 0.048914 unit, 1.096647unit, 0.003158 unit, 0.213273 unit and 0.582534 unit respectively. Sadly, the NEP has no long-run impact on RGDP. This implies that the impact of the changes in national education policy is not sustainable. This necessitates an urgent need for further revision of the NEP.

*Toda-Yamamoto causality test result*

Result of Toda-Yamamoto causality test conducted to determine the direction of causality between educational levels and RGDP is presented in Table 8.

Table 8. Toda-Yamamoto causality (modified WALD) test results
Source: Authors' computation (2024)

| | Chi-Square ($\chi^2$) | Prob. | Conclusion |
|---|---|---|---|
| ΔPEIND→ ΔLNRGDP | 2.064263 | 0.3562 | Do not reject |
| ΔLNRGDP → ΔPEIND | 2.609072 | 0.2713 | Do not reject |
| ΔSEIND → ΔLNRGDP | 17.86809 | 0.0001 | Reject |
| ΔLNRGDP → ΔSEIND | 4.814484 | 0.0901 | Do not reject |
| ΔTEIND → ΔLNRGDP | 9.278873 | 0.0097 | Reject |
| ΔLNRGDP → ΔTEIND | 0.448831 | 0.7990 | Do not reject |
| ΔNEP → ΔLNRGDP | 8.459508 | 0.0146 | Reject |
| ΔLNRGDP → gΔNPE | 0.030710 | 0.9848 | Do not reject |

The T-Y causality test in Table 8 indicates no causality between PEIND and RGDP. Interestingly, SEIND, TEIND and NEP cause RGDP without a feedback effect. This implies that secondary and tertiary education indices as well as national education policy Granger-cause economic growth in Nigeria within the reviewing period because their Chi-square statistics are significant at 5% as indicated by their probability values.

*Diagnostic tests*

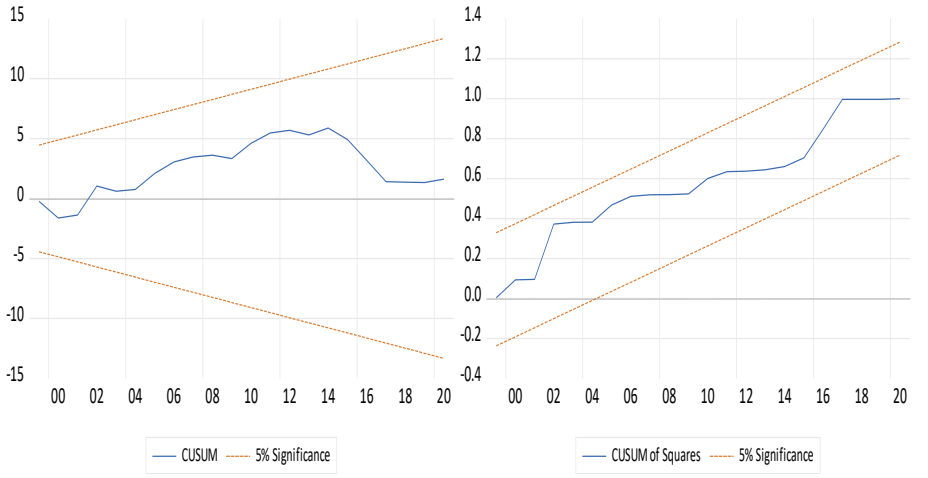
The diagnostic tests are performed to ascertain the reliability of the estimates for forecasting and policy formulation and the results are presented in Table 9.

Table 9: Diagnostic tests
Source: Authors' computation (2024)

| Battery of Tests | Results |
|---|---|
| B-G Serial Lagrange Multiplier (Correlation) | 0.115211(0.8916) |
| B-P-G Heteroskedasticity | 1.307920(0.2729) |
| Ramsy Reset | 1.163728(0.2906) |
| J-B Normality | 0.430684(0.806266) |

From the residual diagnostic tests of model adequacy reported in Table 9, the probability values in parentheses are greater than 0.05 implying absence of serial correlation, heteroskedasticity and specification error; and non-violation of normality assumption, hence the obtained results are reliable. The parameter stability of the estimated function is confirmed by the CUSUM and CUSUM of Squares displayed in Figure 2 as the lines appear within the acceptable region.

Figure 2. CUSUM and CUSUM of squares graphs
Source: Authors' computation using Eviews



This implies that the model of this study is stable within the 5% level of significance. Hence, the estimates are appropriate for prediction and policy formulation.

**Conclusion: Policy implications and recommendations**

This study investigated the nexus between educational levels and economic growth in Nigeria from 1981 to 2020 by applying ARDL and Toda-Yamamoto causality approaches to annual time series data. Results indicate that: primary education index made insignificant positive impact on lnRGDP in the short-run but its impact at lag 1 and in the long-run is significantly negative; secondary and tertiary education indices made positive impact on lnRGDP with the latter being significant in both short-run and long-run; changes in national education policy made insignificant positive impact on lnRGDP. Causality test reveals a unidirectional causality flowing from SEIND, TEIND and NEP to ln RGDP. The study concludes that secondary and tertiary educational levels as well as national education policy are strong drivers of economic growth in Nigeria within the period under review.

In the light of the findings, the study recommends as follows: 1. Educational programmes in Nigeria should be reformed in line with the actual needs of the global economy in terms of skills, knowledge and technology and the country should pay more attention to education quality. 2. Government should increase education funding to improve teaching and learning facilities at all levels of formal education. In fact, government should initiate and implement policies that promote student academic needs – well equipped libraries, laboratories, technology and engineering workshops, provision of active internet facilities and institutional subscription for high impact journals and other online study materials, agricultural demonstration centres and agricultural farms; and students should be exposed to practical entrepreneurial apprenticeship experience while in secondary and tertiary institutions. Further, there is need to motivate the manpower (teaching and non-teaching) staff across all levels of education in Nigeria. Staff development should be taken seriously; adequate remuneration and improved welfare packages should be implemented so as to encourage teachers, lecturers, researchers, curriculum developers and education administrative workers. This will reduce the high incidence of brain drain and attract foreign expatriates into the education sector. 3. Education policies should be strictly implemented,

adequately monitored and evaluated periodically by formal education experts to identify areas of strength and weakness and should be revised accordingly to improve its efficacy.

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