Long Run Relationship between Education and Economic Growth in Nigeria: Evidence from the Johansen's Cointegration Approach

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Abstracts

This paper investigates the long run relationship between education and economic growth in Nigeria between 1970 and 2003 through the application of Johansen Cointegration technique and Vector Error Correction Methodology. It examines two different channels through which human capital can affect long run economic growth in Nigeria. The first channel is when human capital is a direct input in the production function and the second channel is when the human capital affects the technology parameter. The Johansen Cointegration result establishes a long run relationship between education and economic growth. A well educated labour force appears to significantly influence economic growth both as a factor in the production function and through total factor productivity.

I. Introduction

The Nigerian economy could be said to have enjoyed some form of macroeconomic stability in the recent period as the rate of economic growth averaged 2.01 percent within the last two decades. However, as a result of rapid population growth rate, per capita growth has remained negative and it averaged -0.852. (World Development Indicator, 2004) With its large reserves of human and natural resources, Nigeria has the potential to build a prosperous economy, reduce poverty significantly, and provide the health, education, and infrastructure services that its population needs. Nevertheless, despite the country's relative oil wealth, poverty is widespread (oil revenue is only about .50c per capita), and Nigeria's basic social indicators place it among the twenty poorest countries in the world. (World Bank, 2004) Poverty, which has no geographical boundary, is seen in all part of the country, rural and urban areas inclusive. Although the incidence of poverty is much higher in the rural areas than in the urban centers, the urban slum-dwellers form one of the more deprived groups in Nigeria. The poor are those who are unable to obtain an adequate income,

find a stable job, own property or maintain healthy living conditions. They also lack an adequate level of education and cannot satisfy their basic health needs. As such the poor are often illiterate, in poor health and have a short life span. (Amaghionyeodiwe and Osinubi, 2004)

The attempt by Nigeria to shift the focus of the economy from the oil industry to other economic activities has been unsuccessful, largely due to corruption, low investment, and a largely unskilled labor force. The education that most Nigerians receive is not very good. Children attend primary schools which last for six years, but the education they receive there is not sufficient. The pupils to teachers ratio there was 37 to 1 and the youth literacy rate was 13% for males and 20% for females up to the late 1990s. Unfortunately, in 2002, 33% of the relevant age group attended secondary school and only 4% attended tertiary schools. The low number of students in tertiary school can be easily explained in that spending per student in tertiary schools is 529.8% of the GNP. Furthermore, public spending on education was only 0.9% of the GNP in 2002. (World Bank, 2004)

However, it is still very important for Nigeria to increase the growth rate in other sectors of the economy. A good way of generating economic growth is through educational development. The basic importance of education is to enable individuals with knowledge and the ability to apply that knowledge. Education is therefore commonly regarded as the most direct avenue to rescue a substantial number of people out of poverty since there is likely to be more employment opportunities and higher wages for skilled workers. Furthermore, education can enable children's attitudes and assists them to grow up with social values that are more beneficial to the nation and themselves.

The theoretical basis of education on economic growth is rooted in the endogenous growth theory. Endogenous growth economists believe that improvements in productivity can be linked to a faster pace of innovation and extra investment in human capital. Endogenous growth theorists argue the need for government and private sector institutions and markets which nurture innovation, and provide incentives for individuals to be inventive. There is also a central role for knowledge as a

determinant of economic growth. Endogenous growth theory predicts positive externalities and spill-over effects from development of a high valued-added knowledge economy which is able to develop and maintain a competitive advantage in growth industries in the global economy.

While there is rather strong theoretical basis for a key role of human capital in economic growth (Romer 1986, 1989,1990, Lucas 1988, Quah and Rauch ,1990, Grossman and Helpman 1991, Rivera-Batiz and Romer 1991), the empirical evidence is associated with contentious issues such as measurement of human capital and the structural form of the model in the regression analysis. While the Mincerian wage equation of the microeconomic analysis established a positive contribution of education to individual earnings, economic growth regression at the aggregate level has not been able to establish a straightforward positive effect of human capital on output growth. Recent empirical studies provide mixed assessments on the magnitude of social returns to human capital. In addition, most of the evidences in the human capital growth regression analysis are cross-country regression analysis of developing countries and OECD countries. Many of the empirical analysis are yet to be done for individual countries. There is no study yet to empirically assess the direct effect of education on economic growth in Nigeria to the best of our knowledge. The findings from this study should have a strong implication on education policy in Nigeria.

The contribution of this paper is to fill these gaps using a multivariate Johansen cointegration technique. Expectedly, the sequence of the paper is clear. Section one focus on introduction. Thereafter, relevant literatures are reviewed in section two. Section three focuses on the methodology and the specification of the various equations. These are followed by the discussion of the estimation technique and data sources in section four. Empirical findings are discussed in section five. The study is rounded up with concluding summary in section five.

II. Review of Related Studies

Education at all levels contributes to economic growth through imparting general attitudes and discipline and specific skills necessary for a variety of workplaces. It contributes to economic growth by improving health, reducing fertility and possibly by contributing to political stability. The major importance of the educational system to any labour market would depend majorly in its ability to produce a literate, disciplined, flexible labour force via high quality education. Consequently, with economic development new technology is applied to production, which results in an increase in the demand for workers and better education. The pioneer work in this regard is the work of Lucas (1988) which revealed that the growth rate of human capital, which is also dependent on the amount of time, allocated by individuals to acquire skills. Rebelo (1991) later extended the model by introducing physical capital as an additional input in the human capital accumulation function. However, the model of endogenous growth by Romer (1990) assumes that the creation of new ideas is a direct function of human capital, which manifests in the form of knowledge. As a result investment in human capital led to growth in physical capital which in turn leads to economic growth. Other studies that supported the human capital accumulation as a source of economic growth include (Barro and Lee, 1993; Romer, 1991; Benhabib and Spiegel, 1994). Some studies have examined different ways through human capital can affect economic growth.

In a recent development, Gupta and Chakraborty (2004) develop an endogenous growth model of a dual economy where human capital accumulation is the source of economic growth. They argued that the duality between the rich individual exists in the mechanism of human capital accumulation. Rich individuals allocate labour time not only for their own production and knowledge accumulation but also train the poor individuals. In a different dimension, Bratti et al (2004) estimated a model of economic growth and human capital accumulation based on a sample of countries at a different stage

of development. Their result revealed that the increase in the primary and secondary level of education contributes to an increase in productivity. They posit that human capital accumulation rates are affected by demographic variables. For example, they established that an increase in life expectancy at birth brings about an increase in secondary and tertiary education while a decrease in the juvenile dependence rate negatively affects secondary education. Finally, they added that geographic variables have a considerable importance in the human capital accumulation process. Nevertheless, studies differed on the impact of human capital on productivity growth.

As a source of productivity, Haouas and Yagoubi (2005) examined openness and human capital as sources of productivity growth for MENA countries. Controlling for fixed effects as well as endogeneity in the model, they found that while human capital significantly influence growth , it has no underlying effect on productivity growth. Park (2004) empirically investigates the growth implication of dispersion of population distribution in terms of educational attainment levels. Based on a pooled 5-year interval time-series data set of 94 developed and developing countries between 1960 and 1965, the study finds that the dispersion index as well as average index of human capital positively influences productivity growth. They conclude that education policy that creates more dispersion in the human capital will promote growth. Similarly, but in a slightly different manner, Loening (2002) investigates the impact of human capital on economic growth in Guatemala through the application of an error correction methodology. He examined two different channels by which human capital is expected to influence growth. The result from his study revealed that a better-educated labour force appears to have a positive and significant impact on economic growth both via factor accumulation as well as on the evolution of total factor productivity. This study therefore examines whether the human capital can act as a source of productivity growth and whether there is long run relationship between the level of schooling and economic growth for Nigeria.

III. The Model

Following Loening (2002) we first consider human capital as an independent factor of production. This is presented in Cobb-Douglas production function with constant returns to scale as:

$$Y = A.\ K^{\gamma}.\ H^{\theta}.\ L^{(1-\gamma-\theta)} \ldots \quad (1)$$

Where Y is defined as output: A is the total factor productivity; K is physical capital, H is human capital and L is labour. The logarithmic conversion of equation (1) above yields the structural form of the production function as:

$$Ln\ y_t = Ln\ A + \gamma.Ln\ k_t + \theta.Ln\ h_t + u_t \ldots \quad (2)$$

Where y = Y/L = output per worker

k = K/L= capital per worker

h = H/L= average human capital

In its error correction form equation (2) can be represented as:

$$\Delta Ln\ y_t = \beta_0 + \beta_1 \Delta Ln\ k_t + \beta_2.\ \Delta Ln\ h_t \ldots \beta_3.\ (Ln\ y_{t-1}\ \gamma.Ln\ k_{t-1} + \theta.Ln\ h_{t-1} - Ln\ A) + u_t \ldots (3)$$

The final structural form of the model in the vector error correction form is given as:

$$\Delta Ln\ y_t = Ln\ A + \beta_1.\Delta Ln\ k_t + \beta_2.\ \Delta Ln\ h_t \ldots \beta_3.\ Ln\ y_{t-1} + \beta_4.Ln\ k_{t-1} + \beta_5.Ln\ h_{t-1} + \beta_6.Dummy_t + u_t \ldots (4)$$

The coefficient β_3 represents the measure of the speed of adjustment through which the system moves towards its equilibrium on the average. Dummy variable is included in the model to account for the number of strikes that cause disruptions to the educational sector in the Nigerian educational sector. In the second model, human capital is taken to affect the technology parameter directly rather than as a factor of production. The Cobb-Douglas production function with constant returns to scale is given as:

$$Y = A.\ K^{\alpha}.\ L^{(1-\alpha)} \ldots \quad (5)$$

Expressed as a logarithmic expression after standardizing by labour units, equations (5) becomes:

$$\text{Ln } Y = \text{Ln } A + \alpha.\text{Ln } K \ldots \quad (6)$$

The vector error-correction model combines the long-run aspect of the model and the short-run adjustment mechanism in the form:

$$\Delta\text{Ln } y_t = \beta_1.\Delta\text{Ln } k_t + \beta_2.\ (\text{Ln } y_{t-1} - \alpha.\text{Ln } k_{t-1} - \text{Ln } A) + u_t \ldots \quad (7)$$

Total factor productivity in this model is taken to be a function of exogenous variables, such as level of human capital, government expenditure and foreign inputs. The argument is that an educated labour force performs a major role in the determination of productivity level instead of entering the production function as a factor. The expenditure on education is assumed to influence the level of human capital which is expected to cause improvements in total factor productivity. In addition, higher level of human capital speeds up the adoption of foreign technology that is expected to balance the knowledge gap between the developed and the developing countries. (Nelson and Phelps, 1966; Lee; 1995; Benhabib and Spiegel, 1994; Loening, 2002) Consequently, we take the technology parameter in the second model as a non-constant which is then allowed to be dynamic with time. The technology parameter is presented as:

$$\text{Ln } A = b + \beta_4.\text{Lnh}_t + \beta_5\ .\text{IMPGCF}_t + \beta_6.\text{GEXEDU}_t + \beta_7.\text{Dummy}_t \ldots \quad (8)$$

Where b is the exogenous technological progress, h is the level of human capital proxy by average years of schooling; IMPGCFt is the ratio of total imports to gross capital formation and GEXEDU as government expenditure on education. We expect human capital, the measure of foreign inputs and government expenditure on education to have positive effect on total factor productivity. The dummy variable is defined as the number of general strikes, which is expected to have a negative impact on productivity performance and output growth. Substituting equation (8) into (7) gives the vector error correction model as:

$$\Delta\text{Ln } y_t = b + \beta_1.\Delta\text{Ln } k_t + \beta_2.\text{Ln } y_{t-1} + \beta_3.\text{Ln } k_{t-1} + \beta_4.\text{Ln } h_t + \beta_5\ .\text{IMPGCF}_t + \beta_6.\text{GEXEDU}_t + \beta_7.\text{Dummy}_t$$

$+ u_t$ … (9)

We therefore assume that the level of human capital instead of the growth rates perform a basic role in the determination of the growth of output per worker in the second model whereby human capital affects the productivity parameter than the first model whereby the human capital enters as a production function factor.

IV. Estimation Technique and Sources of Data

We first perform unit root test on the time series macro-variables in our sample. This is because most macroeconomic time-series have unit roots and that regressing non-stationary series on each other is bound to yield spurious regression results. Also, the determination of whether a variable exhibits a unit root is to know if the variables exhibit certain characteristics such as mean reversion characteristics and finite variance, transitory shocks with the autocorrelations dying out with the increase in the number of lags under the alternative hypothesis of stationarity. Thus, we first test the nature of the time series to determine whether they are stationary or non stationary and also their order of integration. The order of integration should assist us in determining the subsequent long-run relationship among the variables. The Phillip-Perron unit root test is adopted for this purpose.

Thereafter, we test for cointegration among the series. Cointegration indicates the presence of a linear combination of non-stationary variables that are stationary. In a case where cointegration does not exist, it means the linear combination is not stationary and the variable does not have a mean to which it returns. The presence of cointegration however implies that a stationary long-run relationship among the series is present. The procedure adopted in this study is a representation of the approach of analyzing multivariate cointegrated systems developed and expanded by Johansen and Juselius (1990, 1992, and 1994) Unlike the Engle Granger static procedure, the Johansen Vector Autoregressive

(VAR) procedure allows the simultaneous evaluation of multiple relationships and imposes no prior restrictions on the cointegration space. The Johansen cointegration approach tests for the cointegration rank for a VAR process, estimates the TRACE and LMAX stats, the eigen values, and the eigenvectors. It computes the long-run equilibrium coefficients, the adjustment coefficients, the covariance matrix of the errors, and the R-squares for each of the equations in the VECM. In addition, it also tests for linear restriction on the long-run equilibrium coefficients. Thus, the approach consists of a full information maximum likelihood estimation (FI|ML) of a system characterized by *r* cointegrating vectors. If for instance, we assume qt such that t=1…T, whereby *(px1)* denotes a vector of random variables and follows a *p-dimensional* Vector Autoregressive (VAR) model with Gaussian errors (whereby *p* is the number of jointly endogenous variables). We can write the conditional model which is conditional on the observations Z_{-k+1}, ---,z_0 which are fixed as:

$$q_t = B_1 q_{t-1} + \ldots + B_k q_{t-k} + \mu + \psi C_t + \varepsilon_t \ \ldots \qquad (10)$$

where $B_1, B_2, \ldots, B_k$ are *p* by *p* matrices, μ is the vector of constants and C_t is a vector of nonstochastic variables such as a dummy variable. If there exists cointegration between the variables in qt, the model can be written in error correction form as ;

$$\Delta qt = \Gamma_1 \Delta q_{t-1} + \ldots + \Gamma_{t-1} \Delta q_{t-k-+1} + \Pi\, q_{t-k} + \mu + \psi C_t + \varepsilon_t. \quad t=1,\ldots, T. \qquad \ldots (11)$$

Where $\Gamma_i = -(I-A_1 \ldots -A_i)$, for i=1… k-1; and $\Pi = -(I-A_1-\ldots-A_k)$

The model in equation (11) is the vector error correction model for the cointegrated series. In this case, the short-run dynamics of the variables in the system are represented by the series in differences and the long-run relationships by the variables in levels. A shock to the i-th variable not only directly affects the i-th variable but is also transmitted to all of the other endogenous variables through the dynamic (lag) structure of the VAR. An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. The

accumulated response is the accumulated sum of the impulse responses. It can be interpreted as the response to step impulse where the same shock occurs in every period from the first. If the estimated ARMA model is stationary, the impulse responses will asymptote to zero, while the accumulated responses will asymptote to its long-run value.

If the innovations are contemporaneously uncorrelated, interpretation of the impulse response is straightforward. Innovations, however, are usually correlated, and may be viewed as having a common component that cannot be associated with a specific variable. While impulse response functions trace the effects of a shock to one endogenous variable on to the other variables in the VAR, variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR.

Data for the study were sourced from the World Bank World Development Indicators (WDI, 2004), Central Bank of Nigeria Statistical Bulletin and Annual Report and Statement of Account, Easterly and Sewadeh (2000) among other sources. A full description of the source for each variable is presented in the appendix.

V. Empirical Analysis

Table 1 below presents the stationarity test of the time series used in the empirical analysis.

Table 1: Stationarity of the Time Series

Variables	Phillips-Peron Statistics	Probability	Order of Integration
PRY	-3.495	0.056**	I(1)
LNPRY	-3.787	0.030*	I(1)
SEC	-3.934	0.022*	I(1)
LNSEC	-3.769	0.031*	I(1)
TER	-3.586	0.047v	I(1)
LNTER	-4.862	0.002*	I(1)
GEXPEDU	-4.292	0.009*	I(1)

LNGEXPEDU	-9.753	0.001*	I(1)
IMPGCF	-4.153	0.013*	I(1)
GDPPW	-3.897	0.023*	I(1)
LNGDPPW	-3.564	0.049*	I(1)
KAPW	-2.548	0.304*	I(1)
GRKAPW	-7.806	0.001*	I(1)
SCHOLNG	-6.053	0.001*	I(1)
LNKAPW	-9.041	0.001*	I(1)

* Stationary at the 5 per cent level.
** Stationary at the 10 per cent level.

Table 2: Johansen Cointegration Test between Education and LNGDP per Worker

		LNPRY	**LNSEC**	**LNTER**	**SCHOLNG**
H_0	H_a	Trace Statistics	Trace Statistics	Trace Statistics	Trace Statistics
r = 0	r ≥ 1	16.222*	8.034	25.966*	3.474*
r =1	r ≥ 2	7.488**	1.997	1.440	0.504

** Trace test statistics indicate 2 cointegrating equation (s) at the 5 per cent level assuming two lag in the test equation.
*Trace test statistics indicate one cointegrating equation at the 5 per cent level assuming two lags in the test equation.

Table 3: Johansen Cointegration Test for the model of Human Capital as Factor Input in the Production Function.

Series: LNKAPW STRIKE GRKAPW SCHOLNG LNGDPPW
Lag interval (In first Differences)

H_0	H_a	Trace Statistics
r = 0	r ≥ 1	84.271
r =1	r ≥ 2	51.403**

** Trace test statistics indicate 2 cointegrating equation (s) at the 5 per cent level assuming two lag in the test equation.

Table 4: Johansen Cointegration Test for the Model of Human Capital Affecting the Technology Parametr.
Series: LNKAPW STRIKE GRKAPW SCHOLNG LNGDPPW LNGEXPEDU IMPGCF
Lag interval (In first Differences)

H_0	H_a	Trace Statistics
r = 0	r ≥ 1	193.423
r =1	r ≥ 2	105.202
r =2	r ≥ 3	58.184***

*** Trace test statistics indicate 2 cointegrating equation (s) at the 5 per cent level assuming two lag in the test equation.

Table 5: VECM Estimates of the Production Function for Nigeria
Dependent Variable is percentage change in output per worker

Variable	Human Capital as Factor Input	Human Capital Affecting the Technology Parameter
CointEq	-0.0261 (1.965)	-0.039 (2.680)
D(STRIKE(-1))	-0.013 (2.104)	-0.007 (1.696)
D(STRIKE(-2))	0.026 (2.522)	-0.029 (3.290)
D(GRKAPW(-1))	0.005 (0.358)	
D(GRKAPW(-2))	0.003 (2.530)	
D(SCHOLNG(-1))	0.036 (2.341)	0.049 (2.359)
D(SCHOLNG(-2))	-1.237 (2.020)	0.054 (2.498)
D(LNKAPW(-1))	-0.511 (1.820)	0.171 (2.630)
D(LNKAPW(-2))	1.633 (2.509)	0.336 (1.470)
D(LNGDPPW(-1))	0.645 (3.118)	0.667 (2.534)
D(LNGDPPW(-2))	0.289 (2.373)	0.161 (2.737)
D(LNGEXPEDU(-1))		0.029 (2.417)
D(LNGEXPEDU(-1))		0.055 (3.417)
D(IMPGCF(-1))		0.012 (1.965)
D(IMPGCF(-2))		0.014 (2.181)
Constant	0.025 (0.017)	0.342 (1.291)
R-Squared	0.614	0.719
Adj. R.Squared	0.390	0.504
S.E. Equation	0.038	0.034
F-Statistics	2.749	3.36
Log Likelihood	64.65	69.59

* Absolute values of t-statistics in parenthesis.

Table 6: Johansen Cointegrating Vector for Human Capital as factor Input
Normalized Cointegrating Coefficients: 1 Cointegrating Equation

LNGDPPW	LNKAPW	SCHOLNG	STRIKE	GRKAPW	CONSTANT
1.0000	0.1390 (1.047)	0.860 (0.268)	-1.118 (0.203)	0.212 (0.238) 3.877	

Log Likelihood 92.174

Table 7: Johansen Cointegrating Vector for Human Capital affecting the technology parameter
Normalized Cointegrating Coefficients: 1 Cointegrating Equation

LNGDPPW	LNKAPW	SCHOLNG	STRIKE	LNGEXPEDU	IMPGCF	CONSTANT
1.0000	0.483 (1.030)	0.135 (0.008)	-0.063 (0.005)	0.242 (0.008)	0.007 (0.002)	-2.248

Log Likelihood 150.17

The stationarity test result presented in Table 1 revealed that all the variables are non stationary. They are all of order one from the Phillip Perron test statistics. Also, the result of the Johansen cointegration test between school enrolment and output per worker indicate that there exists long run relationship between education and output per worker for Nigeria. The long run relationship is more pronounced for enrolments at the primary school level, the tertiary school level and average years of schooling. Similarly the cointegration test for the model of human capital as a factor input in the production function provide evidence of long run relationship among the series in the model. In specific terms, the trace test statistics indicate 2 cointegrating equation at the 5 per cent level among the series in the model. In addition, the cointegration test for the model in which the human capital affects the technology parameter revealed a long run relationship among the series in the model. The statistics indicate 3 cointegrating equation (s) at both the 5 per cent and the 1 per cent level respectively.

Since there is existence of long-run relationship among the series, we can then go ahead to estimate the VECM for both models. The VECM result of the model of human capital as a direct input in the production function presented in column 2 of Table 5 revealed that the human capital variable measured by the average years of schooling is positive and significantly influence output per worker.

Disruptions to the educational sector captured by the number of general strikes in a year also appear to have a negative impact on the output per worker. Other significant coefficients in the VECM are those for the dependent variables (at lags 1 and 2 at the 95 per cent level of significance) and also capital per worker (at lags 2 at the 5 per cent level of significance). The growth rate of capital per worker is however insignificant in the model. The VECM estimates of the first model thus indicates that the impact and lagged effect of an increase in human capital, less disruptions to the educational sector in terms of strike and an increase in capital per worker would lead to an improvement of the output per worker. The speed of adjustment coefficient is significant in the model as well. This implies that the rate at which the rate of variation of output per worker at time t, the dependent variable in the VECM system, adjusts to the single long-run cointegrating relationship is different from zero. In other words, the equation of output per worker contains information about the long run relationship since the cointegrating vector does enter into this equation. From the cointegrating vector estimates, a short run output per worker is corrected to a speed of 3 per cent per annum.

In the second model, the level of human capital measured by average years of schooling is consistently significant and established that human capital has a positive effect on productivity growth in Nigeria. In addition, the result revealed that the amount of government expenditure on education significantly influence output per worker growth while foreign inputs is also a very important determinant of productivity growth through the adaptation of foreign technology. Our result is in agreement with that of Loening (2002) who conducted a similar research for Guatemala. Disruptions and instability in the economy as proxy by number of strikes results in inefficient use of factor inputs and output per worker. The speed of adjustment coefficient is however higher in this model with a speed of 4 per cent per annum. The normalized cointegrating coefficients in Table 6 and 7 represent the long run relationship between output per worker and the independent series in the two different

models. From Table 6, the estimated long run effect of a 1 per cent increase of the average years of schooling on output per worker while keeping the other variable constant is approximately 0.86 per cent while the long run elasticity of capital is 0.139 per cent. The long run elasticity of human capital in the model where human capital affects the technology parameter is 0.135 while that of capital is 0.483 per cent. In addition, the growth rate of capital per worker, import as a percentage of investment, and government expenditure on education has positive long run effects on output per worker while disruptions to the educational sector have a negative long run relationship with output growth.

Table 7: Decomposition of Variance (Percentage of forecast variance explained by innovations)

Variance Decomposition of Output per Worker

Period	Output/Worker	Capital/Worker	Avg. Years of Sch.
1	100.00	0.00	0.00
2	97.33	0.18	2.48
3	97.86	0.49	1.63
4	97.79	1.82	1.37
5	94.00	4.22	1.77
6	91.03	6.77	2.19
7	89.09	8.52	2.38
8	88.28	9.29	2.41
9	88.13	9.43	2.42
10	88.18	9.32	2.49

Variance Decomposition of Capital per Worker

Period	Output/Worker	Capital/Worker	Avg. Years of Sch.
1	16.23	83.76	0.00
2	23.34	68.28	8.35
3	35.06	53.87	11.05
4	43.31	45.61	11.05
5	47.80	42.31	9.87
6	49.53	41.84	8.61
7	49.88	42.51	7.59
8	49.96	43.20	6.82
9	50.31	43.41	6.26
10	51.01	43.15	5.82

Variance Decomposition of Average Years of Schooling

Period	Output/Worker	Capital/Worker	Avg. Years of Sch.
1	3.40	1.15	95.36
2	17.04	0.74	82.20
3	20.01	3.19	76.79
4	18.58	11.73	69.68
5	15.95	23.13	60.90
6	13.94	31.88	54.17
7	13.35	36.69	49.95
8	14.34	38.75	46.89
9	18.02	40.43	41.54
10	16.18	40.66	44.15

The variance decomposition results are summarised in Table 7 over a 10-year period. Consistent with the findings from the cointegration results, the variance decomposition analysis revealed that human capital and output per worker are the most exogenous variables. A high proportion of their shocks are explained by their own innovations. At the end of 10 years, the forecast error variance for human capital and output per worker explained by their own innovations are 44.54 per cent and 88.18 per cent respectively, while the forecast error variance for capital per workers explained by its own innovations is 43.15 per cent. An alternative way through which we can obtain information with regards to the relationships among the variables included in the variance decomposition analysis is through generalized impulse response functions. Graphs 1 to 3 in the appendix present the impulse response functions. Graph 1 plots the response of output per worker to shocks in capital per worker, output per worker and human capital. A shock in human capital has an initially positive effect on output per worker and then has a negative effect after the third year. A shock to capital per worker has a positive effect initially increasing but start to decrease after the 6^{th} year. The response of capital per worker to shocks in human capital output per worker and capital per worker is plotted in graph 2. As in graph 1, shocks to output per worker have the largest effect on capital per worker and followed by human capital. This is consistent with the results of the variance decomposition earlier discussed.

Graph 3 plots the response of human capital to shocks in output per worker, capital per worker and human capital. Most of the variance in human capital is explained by shocks to output per worker.

VI. Concluding Summary

This paper investigates the long run relationship between education and growth in Nigeria through the application of the Johansen cointegration technique and the vector error correction methodology. The results of the cointegrating technique suggest that there is long run relationship between enrolments in primary and tertiary level as well the average years of schooling with output per worker. The study was also able to establish long run relations among the other series in the model.

Two channels through which human capital can affect growth were analysed. Although, it may be difficult to separate the two different channels from each other, the result revealed that a well-educated labour force possessed a positive and significant impact on economic growth through factor accumulation and on the evolution of total factor productivity. A good performance of an economy in terms of per capita growth may therefore be attributed to a well-developed human capital base. A major policy implication of our result is that concerted effort should be made by policy makers to increase the level of human capital in Nigeria. Our study therefore supports the human capital as a source of economic growth hypothesis.

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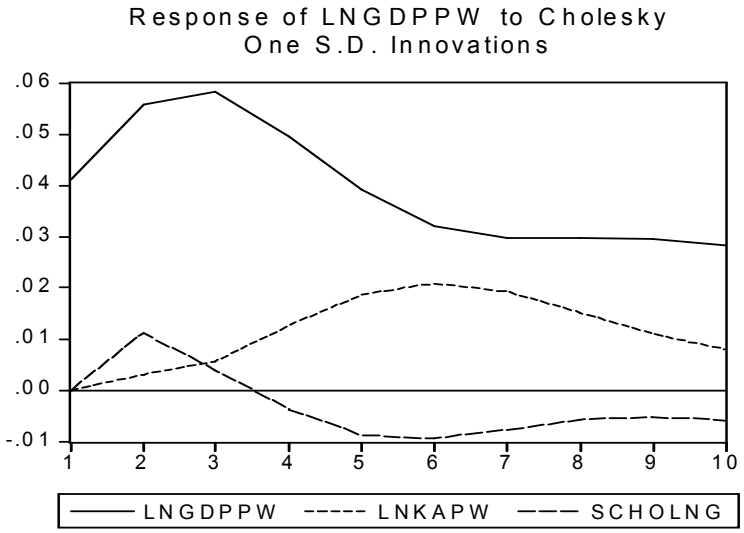
Appendix 1

Description of the Data Sources

Variable		Source
Gross Domestic Product (GDP)	GDP	World Bank World Development Indicator (2004)
Gross fixed capital formation	GCF	World Bank World Development Indicator (2004)
Imports of goods and services	IMP	World Bank World Development Indicator (2004)
Average years of schooling	SCHOLNG	http://www.dwyerecon.com/pdf http://www.dwyerecon.com/pdf/readme.txt

Primary, Secondary and Tertiary gross enrolments ratios	PRY,SEC, TER	Data for 1970 -1996 was obtained from Easterly and Sewadeh (2000) while data for 1996-2003 was obtained from Central Bank of Nigeria (CBN) Annual Report and Statement of Account (Various Issues)
Output per worker	GDPPW	Data for 1970-1992 was obtained from Easterly and Sewadeh while data for 1993 -2003 was obtained from http://www.dwyerecon.com/pdf http://www.dwyerecon.com/pdf/readme.txt
Labour force	L	World Bank World Development Indicator (2004)
General strikes	STRIKE	Easterly and Sewadeh (2000)
Capital per Worker	KAPW	Data for 1970-1992 was obtained from Easterly and Sewadeh while data for 1993 -2003 was obtained from http://www.dwyerecon.com/pdf http://www.dwyerecon.com/pdf/readme.txt
Government Expenditure on Education	GEXPEDU	Data for 1970-1976 was obtained from Central Bank of Nigeria Annual Report and Statement of Account (Various Issues) while data for 1977 to 2002 was obtained from Central Bank of Nigeria Statistical Bulletin 2002. This was updated by CBN Annual Report and Statement of Account 2003.

Appendix 2


Response of LNGDPPW to Cholesky
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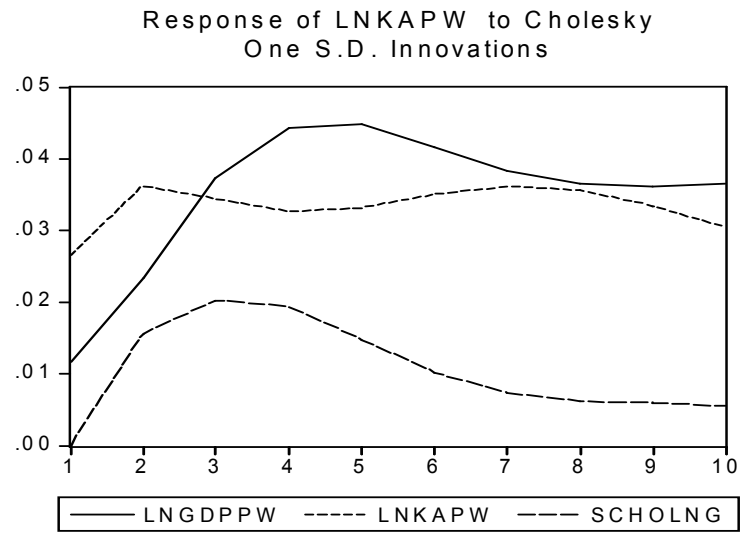
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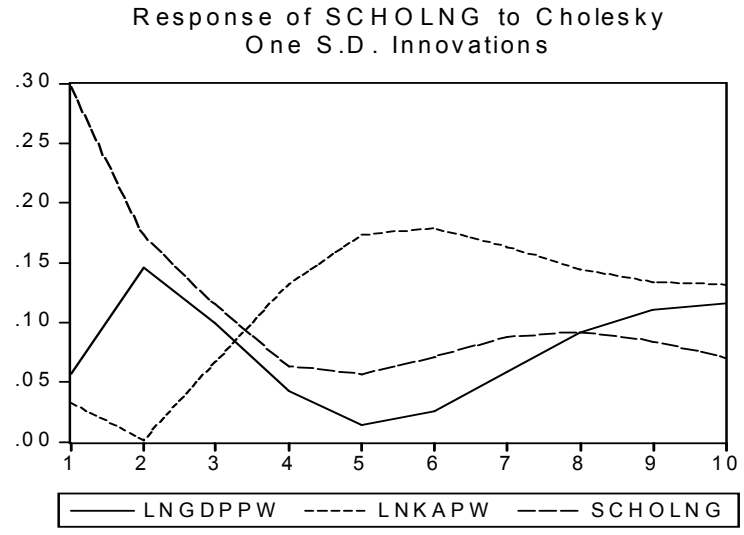
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