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EDUCATION AND ECONOMIC GROWTH IN SOUTH AFRICA: AN EMPIRICAL INVESTIGATION

Abstract:

This paper examines the dynamic causal relationship between education and economic growth in South Africa using annual time-series data from 1986-2017. The study attempts to answer one critical question: Does education, which is one of the priority sectors in South Africa, drive economic growth? Unlike some of the previous studies, this study uses three proxies to measure the level of education in South Africa, namely: education expenditure, primary school enrolments, and secondary school enrolments. In addition, the study uses two variables, namely: investment and labour, as intermittent variables between the various proxies of education and economic growth – thereby estimating a system of multivariate Granger-causality models. Using the ARDL-bounds testing approach, the study finds that the causal relationship between education and economic growth is dependent on the variable used to measure the level of education. In addition, the causality tends to change over time. When education expenditure is used as a proxy, a unidirectional causal flow from economic growth to education is found to prevail both in the short run and in the long run. When primary school enrolment is used as a proxy, a unidirectional causal flow from economic growth to education is also found to prevail, but only in the short run. However, when secondary school enrolment is used as a proxy, education is found to Granger-cause economic both in the short run and in the long run, but economic growth is also found to Granger-cause education in the short run. Overall, the study finds the causal flow from economic growth to education to supersede the causal flow from education to economic growth. Policy implications are discussed.

1. Introduction

Education is one of the key sectors in South Africa in which the government has significantly invested. According to the South African Constitution, all South Africans have a right to basic education, and the Bill of Rights requires the government to progressively make education available and accessible through reasonable measures (Government of South Africa, 2018a). Improvements in basic education and expansion

of technical and vocational education have always been prioritised by the government since the 1990s. Since the end of apartheid in 1994, the government of South Africa has made efforts to restructure the education system in order to redress the inequalities of the pre-1994 era. The South African Schools Act (1996) promotes access to education, promotes quality and democratic governance in the schooling system, and makes schooling compulsory for children aged 7 to 15. It also ensures that all learners have access to quality education without discrimination (see Government of South Africa, 2018b).

Since the adoption of the National Development Plan (NDP), the Department of Education has taken a number of initiatives to improve the quality of education in South Africa. These include: i) improved infrastructure and learning materials to support effective education; ii) improved quality teaching and learning through teacher development programmes; iii) improved access to quality early childhood development; iv) improved human resource development and management of schools; v) interventions in the education sector in order to support quality education and improve the performance of the basic education sector; and vi) implementation of various policy documents in order to ensure effective learning oversight (Government of South Africa, 2015).

As the most industrialised and technologically advanced economy in Africa, South Africa relies heavily on the education sector for its human capital and knowledge production. The sector is therefore considered as the source of scarce skills which are currently needed by the country in various facets of the economy. Moreover, given the sophisticated nature of the South African labour market when compared with some

other African economies, the demand for skilled labour currently outstrips the supply. The important role of education in the South African economy can be supported by the budget that has been allocated to the sector over the years. For example, the total expenditure on education increased by R80 billion over a five-year period, from R169 billion in 2009/10 to R249 billion in 2013/14. During the same period, the spending on primary school education increased from R60 billion to R79 billion, secondary school education increased from R50 billion to R71 billion, and tertiary education increased from R38 billion to R60 billion (see Statistics South Africa, 2015).

Theoretically, education plays a critical role in economic development in general and economic growth in particular. According to some of the previous studies, the role of education as a possible source of output growth emerged as far back as in the mid-1950s as a result of the failure by the traditional development models to fully explain the total increase in economic output during a given growth period (Carnoy, 1977). This was mainly because the inputs used in the traditional development models at that time were only defined in terms of homogenous labour and capital.[1] As a result, the early works on the relationship between education and economic development focussed mainly on establishing education as one of the key inputs into the growth process in the form of increasing the productivity of labour (Carnoy, 1977). One of the studies that first popularised the role of education on economic growth was based on the work done by Denison (1967). The author argued that there is a tremendous importance of education on economic growth of a nation (see also Mallik *et al*., 2016). More recently, investment in education has been found to be the primary source of improved human resources, which is likely to lead to an increase in economic development through skilled labour force (Mallick *et al.,* 2016). The endogenous growth models have also emphasised the role of human capital as one of the key factors of economic growth. Previous studies have also found that higher investment in education is also likely to enhance labour productivity, and leads to an increase in economic growth (see Mankiw *et al*., 1992). Moreover, human capital, which is dependent on education, has also been

[1] See, Carnoy (1977, pp. 428).

found to be one of the key drivers of economic growth (Lucas, 1988; Romer, 1990). Education has also been found to facilitate the transmission and diffusion of knowledge and technologies, which, in turn, promotes economic growth (Nelson and Phelps, 1966). Some of the studies that have found a positive impact of education on economic growth include studies like Barro (1991), Mankiw *et al*. (1992), Barro and Lee (1993), Agiomirgianakis *et al*. (2002), Gylfason and Zoega (2003), Musila and Belassi (2004), Self and Grabowski (2004), Blankenau *et al*. (2007), and Seetanah (2009), among others.

Although a number of studies have been conducted to examine the role of education in a number of countries in recent years,[2] very few studies have been conducted to examine the causal relationship between education and economic growth in sub-Saharan African countries. The majority of the previous studies on this subject have largely focussed on Asia and Latin America. Studies that could give policy makers some insights on the nature of the causal relationship between these two economic indicators in sub-Saharan Africa are difficult to come by. Even where such studies have been conducted, the findings on the causal relationship between education and economic growth have been either conflicting or at best inconclusive.

The current study, therefore, aims to examine the dynamic causal relationship between education and economic growth in South Africa – using annual time-series data. Unlike some of the previous studies, the current study uses three proxies to measure the level of education in South Africa, namely: education expenditure, primary school enrolments, and secondary school enrolments. In addition, the study uses two variables, namely: investment and labour as intermittent variables between the various proxies of education and economic growth – thereby leading to a multivariate Granger-causality model. In order to address the methodological weaknesses of some of the previous studies, the current study uses the Autoregressive Distributed Lags (ARDL) bounds testing approach and the ECM-based Granger causality model to examine this linkage.

[2] See, for example, Tchamyou et al. (2019), Asongu et al. (2019), Asongu and Odhiambo (2019a, b), Asongu and Tchamyou (2019), Abdullah et al. (2015) and Asiedu et al. (2014), amongst others.

To our knowledge, this may be the first study of its kind to examine this linkage in South Africa on this scale using modern time-series econometric techniques. The study, which is closest to this paper in the case of South Africa, is based on the work done by Malangeni and Phiri (2017). However, unlike Malangeni and Phiri (2017) who focused on the impact of education on economic growth, the current paper focuses on the intertemporal causal relationships between the various proxies of education and economic growth in South Africa within a multivariate setting.

The rest of the paper is organised as follows: section 2 provides an overview of the literature review, while section 3 presents the methodology, empirical analysis and the discussion of the results. Section 4 concludes the study.

2. Literature Review- An Overview

A plethora of empirical studies have been conducted on the relationship between education and economic growth in both developed and developing countries. While the majority of these studies focused on the impact of education on economic growth, there are a few studies that focussed on the causal relationship between education and economic growth. These studies can be broadly divided into three groups. The first group argues that there is a unidirectional causal flow from education to economic growth, since a highly educated work force increases economic growth. The second theory, however, maintains that it is economic growth that Granger-causes education at all levels – because higher economic growth leads to a greater investment in education. The third view is a middle-ground view, which states that both economic growth and education Granger-cause each other.

Studies whose findings are consistent with the education-led growth hypothesis include studies like De Meulemeester and Rochat (1995), Chuang (2000), Asterioua and Agiomirgianakis (2001), Self and Grabowski (2003), Self and Grabowski (2004), Jaoul (2004), Sari and Soytas (2006), Beskaya *et al*. (2010), Katircioğlu (2010), Danacica (2011), Pegkas and Tsamadias (2014), Sari and Soytas (2006), Aka and Dumont (2008), Mallick and Dash (2015), Oancea *et al*. (2017), Marquez-Ramos and Mourelle (2019), among others. De Meulemeester and Rochat (1995), for example, while examining the

causal link between higher education and economic development in six developed countries, found the existence of a significant causality from higher education to economic development in four countries – Japan, the United Kingdom, France and Sweden. Chuang (2000), while examining the causal relationship between higher education attainment ratio, exports and economic growth in Taiwan during the period 1952–95, found that there is a unidirectional causality running from higher education to real GDP. Asterioua and Agiomirgianakis (2001), while examining the relationship between human capital and economic development in Greece during the period 1960–1994, found that causality runs through all the educational variables used in the study to economic growth, with the exception of higher education where there exists a reverse causality. Self and Grabowski (2003) examined the relationship between education and economic growth in Japan for both the pre- and post-war period using the VECM-based Granger causality test. Their study shows that secondary and tertiary education have a causal impact on growth in the post-war period, with the evidence strongly supporting the multiple channels via which tertiary education influenced the post-war Japanese economy. In a separate study, Self and Grabowski (2004) examined the relationship between education and economic growth in India for the period 1966–1996. Their study found that female education at all levels has the potential for generating economic growth. Jaoul, M. (2004), while comparing the causal relationship between higher education and economic growth in France and Germany before the Second World War, found that higher education leads to economic growth in the case of France. Sari and Soytas (2006), while examining the relationship between income and education in Turkey during the period between 1937 and 1996, found that school enrolments are important in explaining economic growth. Specifically, the study found, among other things, that there is a unidirectional causality from primary and secondary enrolments to GDP. The study concludes that investing in primary and secondary education to increase income levels may be a viable policy tool in Turkey. Aka and Dumont (2008), while examining the relationship between health, education and economic growth in the USA during the period 1929-1997, found that there is a causality running from education to economic growth in the USA, but not the reverse. Beskaya *et al*. (2010), in looking at the relationship between education and economic growth in Turkey, found a short-run unidirectional causal flow from education to economic growth. Katircioğlu (2010), in examining the relationship between international tourism, higher education growth and real income growth in the Turkish Republic of Northern Cyprus found that

higher education-led growth hypothesis predominates in North Cyprus. Danacica (2011), when investigating the causality between school education and economic growth on Romania during the period 1985-2009, found that there is a unidirectional causality from school education to gross domestic product per capita. Pegkas and Tsamadias (2014), while examining the relationship between higher education and economic growth in Greece, found that there is unidirectional long-run and short-run Granger causality running from higher education to economic growth. Mallick and Dash (2015), in examining the casual relationship between expenditure on education and economic growth over the period 1951 to 2012, found that unidirectional causality runs from expenditure on education to economic growth in India. Oancea *et al*. (2017), while comparing the relationship between higher education and economic growth in the Czech Republic and Romania, using data series for the period 1980-2013, found that higher education Granger-causes economic growth for both countries. More recently, Marquez-Ramos and Mourelle (2019) examined the relationship between education and economic growth in Spain during the period 1971-2013. Their study found that both secondary and tertiary education matter for economic growth.

Despite the overwhelming support for the education-led growth hypothesis, there are some studies that maintain that it is economic growth that Granger-causes education. These include studies such as Jaoul (2004), Francis and Iyare (2006), Narayan and Smyth (2006), Chaudhary *et al*. (2009), Dahal (2010), Danacica et al. (2010), Yun and Yusoff (2015), Mallick *et al*. (2016), amongst others. Jaoul (2004), while examining the causality between higher education and economic growth in France and Germany before the Second World War, found that economic growth increases the number of students in Germany. The study concludes that Germany does not seem to obey the dominant theory whereby education is the cause of growth. The author argues that this finding is consistent with the idea that education is a growth-driven accompanying investment. Francis and Iyare (2006), while examining the relationship between education and development in the Caribbean, found evidence of a unidirectional causality running from income to education for Barbados and Trinidad and Tobago. Narayan and Smyth (2006) examined the relationship between higher education, real income and real investment in China over the period 1952–1999. The study found that in the short run there is unidirectional Granger-causality running from real income to enrolments in higher education. Chaudhary *et al*. (2009), while analysing the role of

higher education in economic growth for Pakistan between 1972 and 2005, found that there is a unidirectional causality running from economic growth to higher education. Dahal (2010), in examining the causal relationship between higher educational enrolment, school teachers, and GDP in Nepal, found that there is a causal flow running from real gross domestic product to enrolment in higher education. Danacica *et al*. (2010) examined the causal relationship between higher education and economic growth in Romania. Using annual time series data from 1980 to 2008, the authors found that there is a unidirectional causal flow from economic growth to higher education in Romania. Yun and Yusoff (2015), while empirically examining the relationship between education expenditure and health care expenditure towards economic growth in Malaysia during the period 1980-2012, found that there is unidirectional Granger-causality running from GDP to the public education expenditure in Malaysia. While examining the dynamic relationship between expenditure on education and economic growth in selected 14 major Asian countries during the period 1973 to 2012, Mallick *et al*. (2016) found that there is a unidirectional Granger causality running from economic growth to expenditure on education both in the short run and in the long run.

In between the education-led growth and growth-led education hypotheses, there are some studies that argue that both education and economic growth Granger-cause each other. In other words, these studies argue that there is bidirectional causality between economic education and economic growth. Studies that have findings consistent with this view include In and Doucouliagos (1997), Francis and Iyare (2006), Narayan and Smyth (2006), Islam *et al*. (2007), Al-Yousif (2008), Beskaya *et al*. (2010), Afzal *et al*. (2011), Rashid (2014), Kyophilavong (2018), and Liao *et al*. (2019), amongst others. In and Doucouliagos (1997) examine the causal relationship between private sector output and human capital formation using annual data for the United States from 1949 to 1984. The authors used a number of proxies to measure human capital, including amongst others, enrolments in Grades 1–8, enrolments in high school and enrolments in college. The study found that there is bi-directional Granger-causality in most cases. Francis and Iyare (2006), while examining the relationship between education and development in the three Caribbean countries during the period 1964 to 1998, found that there is bidirectional causality between education and economic growth in Jamaica in the short run. Narayan and Smyth (2006), while examining the relationship between higher education, real income and real investment in China over the period 1952–1999,

found that in the short run there is bidirectional Granger-causality between real income and tertiary education graduates in China. Islam *et al.* (2007) examined the causal relationship between education and economic growth in Bangladesh. Using annual time series data from 1976 to 2003, the study found bidirectional causality between education and economic growth in Bangladesh. Al-Yousif (2008) examines the nature and direction of the relationship between education expenditure as a proxy for human capital and economic growth in the six GCC economies. Using time-series data for the period 1977-2004, the study found strong support in favour of bidirectional causality between education expenditure and economic growth. Beskaya *et al*. (2010), while looking at the relationship between education and economic growth in Turkey during the period 1923-2007, found that there is a long-run bidirectional relationship between education and economic growth in Turkey. Afzal *et al*. (2011) explored the causal relationship between education and economic growth in Pakistan using time series data from 1970/71 to 2008/09. Using the Autoregressive Distributed Lag (ARDL) Model of Cointegration and the Augmented Granger Causality Approach, the authors found feedback causality between education and economic growth. Kesikoğlu and Öztürk (2013), while examining the relationship between education and health expenditures that are accepted as an indicator of human capital and economic growth in 20 OECD countries during the period 1999 – 2008, found that there is a bi-directional causal relationship between education expenses and economic growth in the studied countries. Rashid (2014) examined the relationship between education and economic growth in Pakistan during the period 1972-2012. The author found that there is a feedback relationship between the two variables. Kyophilavong (2018), in examining the relationship between education and economic growth in Lao during the period 1984 to 2013, found evidence of a feedback causality between education and economic growth at all levels. The study recommends that more investment should be channelled towards the education sector in order to foster economic growth. Liao *et al*. (2019), while examining the relationship between educational investment and sustainable economic growth in Guangdong, China, using the panel data of 21 cities from 2000 to 2016, also found the existence of the feedback causality between education and sustainable economic growth.

Although the majority of the previous studies argue that there is a causal relationship between economic growth and education at least in one direction, there are a few studies

that argue in favour of a neutral relationship between education and economic growth. In other words, these studies argue that there is no formidable relationship between education and economic growth, and that the perceived relationship between these two variables could merely be mechanical in nature. De Meulemeester and Rochat (1995), for example, while examining the causality between higher education and economic development in six developed countries, failed to find any causal link between education and economic development in Italy and Australia during the period 1885–1986 and 1906–1986, respectively. The authors conclude that the relationship between education and economic development is not mechanistic as pointed out by some social scientists. Ray *et al*. (2011), while assessing the causal relationship between education expenditure and economic growth during the period 1961/62 to 2009/10, found that education expenditure does not Granger-cause economic growth and economic growth does not Granger-cause education.

Apart from the aforementioned studies, there are other studies that, although they did not examine the causality between education and economic growth, found weak or no impact of education on economic growth. These include studies like Nketiah-Amponsah (2009), Benhabib and Spiegel (1994), and Pritchett (2001), amongst others. Nketiah-Amponsah (2009), while examining the relationship between public spending and economic growth in Ghana during the period 1970–2004, found that expenditure on education has no significant impact on economic growth in the short run. Benhabib and Spiegel (1994) also found that human capital, which is accumulated by education, has an insignificant direct effect on per capita growth rates; however, it may have a positive indirect effect through technological progress. Pritchett (2001) also found no conclusive association between increases in human capital attributable to the rising educational attainment of the labor force and the rate of growth of output per worker. The author attributed this finding to institutional governance or the miss-match between the demand and supply of skilled labor or low education quality.

3. Methodology and Empirical Analysis

3.1 ARDL-Bounds Testing Approach

In this study, three models have been used to examine the relationships between education (EDU), economic growth (y) and the two intermittent variables, namely investment (INV) and labour (LAB). These models are based on the three proxies that have been used to measure education (EDU) in South Africa. They are defined as follow:

i) Model 1 – Total education expenditure (EDExp), investment (INV), labour (LAB) and economic growth (y);

ii) Model 2 – Primary school enrolment (PRI), investment (INV), labour (LAB) and economic growth (y); and

iii) Model 3 – Secondary school enrolment (SEC), investment (INV), labour (LAB) and economic growth (y).

The ARDL representation (formulation) based on Pesaran and Pesaran (1997) and Pesaran *et al.* (2001) for these models can be summarised as follows (see Narayan and Smith, 2006; Odhiambo and Ntenga, 2016):

$$\Delta lny_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta lny_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta lnEDU_{t-i} + \sum_{i=0}^{n} \alpha_{3i} \Delta lnINV_{t-i} + \sum_{i=0}^{n} \alpha_{4i} lnLAB_{t-i} + \alpha_5 lny_{t-1} + \alpha_6 lnEDU_{t-1} + \alpha_7 lnINV_{t-1} + \alpha_8 lnLAB_{t-1} + \mu_{1t} \dots\dots\dots (1)$$

$$\Delta lnEDU_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lnEDU_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta lny_{t-i} + \sum_{i=0}^{n} \beta_{3i} \Delta lnINV_{t-i} + \sum_{i=0}^{n} \beta_{4i} lnLAB_{t-i} + \beta_5 lnEDU_{t-1} + \beta_6 lny_{t-1} + \beta_7 lnINV_{t-1} + \beta_8 lnLAB_{t-1} + \mu_{2t} \dots\dots\dots (2)$$

$$\Delta lnINV_t = \delta_0 + \sum_{i=1}^{n} \delta_{1i} \Delta lnINV_{t-i} + \sum_{i=0}^{n} \delta_{2i} \Delta lny_{t-i} + \sum_{i=0}^{n} \delta_{3i} \Delta lnEDU_{t-i} + \sum_{i=0}^{n} \delta_{4i} lnLAB_{t-i} + \delta_5 lnINV_{t-1} + \delta_6 lny_{t-1} + \delta_7 lnEDU_{t-1} + \delta_8 lnLAB_{t-1} + \mu_{3t} \dots\dots\dots (3)$$

$$\Delta lnLAB_t = \theta_0 + \sum_{i=1}^{n} \theta_{1i} \Delta lnLAB_{t-i} + \sum_{i=0}^{n} \theta_{2i} \Delta lny_{t-i} + \sum_{i=0}^{n} \theta_{3i} \Delta lnEDU_{t-i} + \sum_{i=0}^{n} \theta_{4i} lnINV_{t-i} + \theta_5 lnLAB_{t-1} + \theta_6 lny_{t-1} + \theta_7 lnEDU_{t-1} + \theta_8 lnINV_{t-1} + \mu_{4t} \dots\dots\dots (4)$$

where:

y = Economic growth (real GDP per capita)

EDU = Education proxy – i.e. total education expenditure (EDExp) for Model 1, primary enrolment (PRI) for Model 2 and secondary enrolment (SEC) for Model 3.

INV = Gross fixed capital formation – a proxy for investment

LAB = Labour force participation – a proxy for labour

$\alpha_0, \beta_0, \delta_0, \theta_0$ = Respective constants

$\alpha_1 - \alpha_8$, $\beta_1 - \beta_8$, $\delta_1 - \delta_8$, $\theta_1 - \theta_8$ = Respective coefficients

Δ = Difference operator

n = Lag length

t = Time period

μ_{it} = White-noise error terms

ln = Log linear transformation.

3.2 ECM-Based Granger Causality Model

Following Narayan and Smyth (2008) and Odhiambo (2015; 2016), the following system of ECM-based multivariate Granger-causality equations can be used to examine the relationship between economic growth, the two intermittent variables (investment and labour) and the three proxies of education (EDU):

$$\Delta lny_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta lny_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta lnEDU_{t-i} + \sum_{i=1}^{n} \alpha_{3i} \Delta lnINV_{t-i} + \sum_{i=1}^{n} \alpha_{4i} lnLAB_{t-i} + \Omega_1 ECM_{t-1} + \mu_{1t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

$$\Delta lnEDU_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta lnEDU_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta lny_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta lnINV_{t-i} + \sum_{i=1}^{n} \beta_{4i} lnLAB_{t-i} + \Omega_2 ECM_{t-1} + \mu_{3t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

$$\Delta lnINV_t = \delta_0 + \sum_{i=1}^{n} \delta_{1i} \Delta lnINV_{t-i} + \sum_{i=1}^{n} \delta_{2i} \Delta lny_{t-i} + \sum_{i=1}^{n} \delta_{3i} \Delta lnEDU_{t-i} + \sum_{i=1}^{n} \delta_{4i} lnLAB_{t-i} + \Omega_3 ECM_{t-1} + \mu_{3t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7)$$

$$\Delta lnLAB_t = \theta_0 + \sum_{i=1}^{n} \theta_{1i} \Delta lnLAB_{t-i} + \sum_{i=1}^{n} \theta_{2i} \Delta lny_{t-i} + \sum_{i=1}^{n} \theta_{3i} \Delta lnEDU_{t-i} + \sum_{i=1}^{n} \theta_{4i} lnINV_{t-i} + \Omega_4 ECM_{t-1} + \mu_{3t} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (8)$$

Where:

ECM = Error correction term;

$a_0, \beta_0, \delta_0, \theta_0$ = respective constants;

$\Omega_1 - \Omega_4$ = respective coefficients for the error-correction terms

Δ = difference operator;

n = lag length; and

μ_{it} = mutually uncorrelated white noise residuals.

From equations (5) – (8), the short-run causality will be tested using the corresponding F-statistics in each equation, while the long-run causality will be tested by the coefficient of the corresponding ECM term. It is, however, worth mentioning that even though the ECM term has been included in all the equations, only the equations that are found to be cointegrated will be estimated with the ECM term.

Sources of Data

The study used annual time-series data from 1986 to 2017. Although the bulk of the data were obtained from World Bank's World Development Indicators (2018), other local databases were used to supplement the World Bank data.

3.3 Empirical Analysis

3.3.1 Unit Root Tests

Although the ARDL bounds testing approach does not require all variables to be integrated of the same order, it is important to ensure that the variables are not integrated of order 2 or higher – because the critical values proposed by Pesaran *et al.* (2001) assumes that the variables are either integrated of order zero [I(0)] or order one [I(1)]. Consequently, the study used ADF, Phillips-Perron (PP) and Dickey-Fuller – GLS to test for the stationarity of the variables included in the causality equations. The results of the unit root tests in levels and in first difference are reported in Table 1.

Table 1: Stationarity Tests of all Variables

Panel 1: ADF

Variable	**Stationarity of all Variables in Levels**		**Stationarity of all Variables in First Difference**	
	Without Trend	With Trend	Without Trend	With Trend
ln y	-0.646033	-1.621104	-2.965376**	-2.623785
ln EDExp	-1.427810	-2.953620	-3.594565**	-3.785549**
ln PRI	-1.098480	-1.851535	-3.847018***	-3.764416**

ln SEC	-2.492368	-2.553559	-5.400265***	-5.570696***
ln INV	-0.855786	-3.005013	-3.035657**	-2.844253
ln LAB	1.169648	-1.436372	-5.617886***	-5.810144***

Panel 2: Phillips-Perron (PP)

Variable	**Stationarity of all Variables in Levels**		**Stationarity of all Variables in First Difference**	
	Without Trend	With Trend	Without Trend	With Trend
ln y	-1.022121	-3.102156	-3.001828**	-3.671186**
ln EDExp	-1.413744	-3.174023	-4.036863***	-3.999282**
ln PRI	-1.168231	-2.092252	-3.862682***	-3.780394**
ln SEC	-2.391811	-2.644142	-5.870644***	-5.835734***
ln INV	-1.029732	-3.090610	-9.898519***	-9.777861***
ln LAB	1.321146	-1.968665	-5.613095***	-8.482995***

Panel 3: Dickey-Fuller – GLS

Variable	**Stationarity of all Variables in Levels**		**Stationarity of all Variables in First Difference**	
	Without Trend	With Trend	Without Trend	With Trend
ln y	-0.965769	-2.261278	-3.001828**	-3.671186**
ln EDExp	0.290473	-2.134707	-4.036863***	-3.999282**
ln PRI	-0.862248	-1.726396	-3.862682***	-3.780394**
ln SEC	-0.787973	-2.076963	-5.870644***	-5.835734***
ln INV	-0.787057	-2.727333	-9.898519***	-9.777861***
ln LAB	-1.490657	-2.209613	-5.613095***	-8.482995***

Note: ** and *** denotes stationarity at 5% and 1% significance levels, respectively.

The above results show that all variables included in this study are integrated of order one [I(1)], and not of order two (2) or higher. This implies that the ARDL-bounds testing approach as proposed by Pesaran and Pesaran (1997) and Pesaran et al. (2001) can be used.

3.3.2 Cointegration results

Having confirmed that all the variables included in the causality test are not integrated of order two or higher, the next step is to test for the existence of a cointegration relationship among the variables included in Models (1)-(3). The results of the ARDL bounds test are reported in Table 2.

Table 2: Bounds F-test for Co-integration

Dependent Variable	Function	F-statistic
Model 1: Economic Growth, Education Expenditure, Investment and Labour lny, ln EDExp, lnINV, lnLAB		
ln y	ln y (ln EDExp, ln INV, ln LAB)	1.923356
ln EDExp	ln EDExp (ln y, ln INV, ln LAB)	4.428855**
ln INV	ln INV (ln y, ln EDExp, ln LAB)	6.473940***
ln LAB	ln LAB (ln y, ln EDExp, ln INV)	6.877327***
Model 2: Economic Growth, Primary School Enrolments, Investment and Labour lny, lnPRI, lnINV, lnLAB		
ln y	ln y (ln PRI, lnINV, ln LAB)	4.123420**
ln PRI	ln PRI (ln y, lnINV, ln LAB)	1.333756
ln INV	ln INV (ln y, ln PRI, ln LAB)	5.334462**
ln LAB	ln LAB (ln y, lnPRI, lnINV)	2.039207
Model 3: Economic Growth, Secondary School Enrolments, Investment and Labour lny, lnSEC, lnINV, lnLAB		
ln y	ln y (ln SEC, lnINV, ln LAB)	6.176905***
ln SEC	ln SEC (ln y, lnINV, ln LAB)	2.725416
ln INV	ln INV (ln y, ln SEC, ln LAB)	5.013608***
ln LAB	ln LAB (ln y, ln SEC, lnINV)	5.386851***

Asymptotic Critical Values						
	1 %		**5%**		**10%**	
	I(0)	**I(1)**	**I(0)**	**I(1)**	**I(0)**	**I(1)**
Pesaran et al (2001), p. 300, Table CI(ii) Case II	3.65	4.66	2.79	3.67	2.37	3.20

Note: ** and *** denote statistical significance at the 5% and 1% levels, respectively

The results reported in Table 2 show that there is a cointegration relationship among the variables include in ln EDExp, ln INV and ln LAB equations in the case of model 1; ln y and ln INV equations in the case of Model 2; and ln y, ln Inv and ln LAB equations in the case of Model 3. This has been confirmed by the F-statistics, which have been found to be significant in the corresponding equations.

3.3.3 *Causality Results*

The results of the short-run and long-run causality are report in Table 3.

Table 3: Granger-Causality Results

Note: *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively

Dependent variable	**F-statistics [probability]**				***ECT*$_{t-1}$ [t-statistics]**
Model 1: Economic Growth, Education Expenditure, Investment and Labour DIny, DInEDExp, DInINV, DInLAB					
	ΔIny_t	$\Delta In\ EDExp_t$	$\Delta In\ INV_t$	$\Delta In\ LABt$	
ΔIny_t	-	1.470 [0.251]	3.70* [0.081]	0.371049 [0.5548]	-
$\Delta In\ EDExp_t$	4.387416* [0.0695]	-	0.168577 [0.6922]	0.950753 [0.3412]	-0.327*** [-5.031]
$\Delta In\ INV_t$	10.45091*** [0.0038]	1.931581 [0.1863]	-	5.535608** [0.0280]	-0.525631 [-6.391]***
$\Delta In\ LABt$	4.687121** [0.041]	2.635336 [0.1181]	3.493012* [0.0756]	-	-0.302313** [-3.203250]
Model 2: Economic Growth, Primary School Enrolments, Investment and Labour DIny, DInPRI DInINV, DInLAB					
	ΔIny_t	$\Delta In\ PRI_t$	$\Delta In\ INV_t$	$\Delta In\ LABt$	
ΔIny_t	-	1.575746 [0.2220]	13.64616*** [0.0013]	9.859*** [0.0046]	-0.112 [-5.938]***
$\Delta In\ PRI_t$	3.728523* [0.0659]	-	1.986546 [0.1721]	4.642682** [0.0478]	-
$\Delta In\ INV_t$	7.380747*** [0.0200]	11.94399*** [0.0024]	-	6.817969** [0.0156]	-0.146*** [-4.572418]
$\Delta In\ LABt$	16.98815*** [0.0004]	1.098923 [0.3059]	4.723479** [0.0419]	-	-
Model 3: Economic Growth, Secondary School Enrolments, Investment and Labour DIny, Din SEC, DInINV, DInLAB					
	ΔIny_t	$\Delta In\ SEC_t$	$\Delta In\ INV_t$	$\Delta In\ LABt$	
ΔIny_t	-	5.492644** [0.0356]	6.271452** [0.0264]	6.002888** [0.0343]	-0.544*** [-6.176688]
$\Delta In\ SEC_t$	5.839573** [0.0240]	-	4.833873** [0.0398]	0.545805 [0.4686]	-
$\Delta In\ INV_t$	14.15679*** [0.0012]	0.763208 [0.3932]	-	14.32648*** [0.0012]	-0.360*** [-5.508677]
$\Delta In\ LABt$	5.606556** [0.0287]	4.838571** [0.0404]	5.764487** [0.0281]	-	-0.749*** -5.686330

The results reported in Table 3 show that when education expenditure is used as proxy, a unidirectional causal flow from economic growth to education is found to prevail both

in the short run and in the long run. The short-run causal flow is confirmed by the corresponding F-statistic in the education expenditure equation, which is found to be statistically significant. The long-run causal flow, on the other hand, is confirmed by the coefficient of the ECM term in the education equation which has also been found to be negative and statistically significant. When primary school enrolment is used as a proxy, a unidirectional causal flow is also found to prevail from economic growth to education but only in the short run. This is confirmed by the corresponding F-statistic in the education which has been found to be statistically significant. However, when secondary school enrolment is used as proxy, a bidirectional causality between education and economic growth is found to prevail in the short run, while a unidirectional casual flow from education to economic growth is found to dominate in the long run. The short-run bidirectional causality has been confirmed by the corresponding F-statistics in the economic growth and secondary enrolment equations, which have found to be both statistically significant. The long-run unidirectional causal flow from education to economic growth has been confirmed by the coefficient of the error-correction term in the economic growth equation, which has been found to be negative and statistically significant. Although the results show that the magnitude and the directional of causality between education and economic growth depends on the proxy used to measure education, on balance, the results show that the causality from economic growth to education tends to dominate. While the finding is contrary to some previous studies that support education-led growth, it is consistent with some recent studies which support the growth-led education nexus. These include studies, such as Mallick et al. (2016) for the case of 14 major Asian countries, Yun and Yusoff (2015) for the case of Malysia, Danacica *et al*. (2010) for the case of Romania, and Dahal (2010) for the case of Nepal – just to mention a few.

Other results show that the relationships between investment and economic growth, investment and education, labour and economic growth, and labour and education also depend on education proxy used as well as the time frame. When education expenditure is used as proxy for education: i) a bidirectional causality between investment and economic growth is found to prevail in the short run while a unidirectional casual flow from economic growth to investment is found to predominate in the long run; ii) no causal relationship is found to exist between investment and education both in the short run and in the long run; iii) economic growth is found to Granger-cause labour both in the short run and in the long run; and iv) education and labour are found to have no causal relationship in either direction both in the short run and in the long run. When primary school enrolment is used as a proxy: i) a bidirectional causality is found to prevail between investment and economic growth both in the short run and in the long run; ii) a unidirectional causal flow from education to investment is found to prevail both in the short run and in the long ruin; iii) a short-run bidirectional causality between labour and economic growth is found to exist and a long-run unidirectional casual flow from labour to economic growth is found to predominate; and iv) short-run unidirectional casual flow from labour to education is found to exist. Finally, when secondary enrolment is used as proxy: i) a bidirectional causality between investment and economic growth is found to prevail both in the short-run and in the long-run; ii) a unidirectional causal flow from investment to education is found to prevail in the short run; iii) a bidirectional causality between labour and economic growth is found to exist both in the short run and in the long; and iv) education is found to Granger-cause labour both in the short run and in the long run.

4. Conclusion

In this study, we examined the causal relationship between education and economic growth in South Africa using annual time-series data. Since the end of apartheid in 1994, South Africa has made efforts to restructure the education system in order to redress the inequalities of the pre-1994 era. As a result, the total expenditure on education has grown exponentially. This study, therefore, attempts to answer one critical question: Does education, which is one of the priority sectors in South Africa, drive economic growth? Unlike some previous studies, the study used three proxies to measure the level of education in South Africa. These include total education expenditure, primary school enrolments and secondary school enrolments. In order to address the omission-of-variable bias associated with a bivariate analysis, the study used two intermittent variables, namely investment and labour, to examine this linkage. Using the ARDL-bounds testing approach, the study found that the causal relationship between education and economic growth is dependent on the variable used to measure the level of education. In addition, the causality tends to change over time. When education expenditure was used as proxy, a unidirectional causal flow from economic growth to education was found to prevail both in the short run and in the long run. When primary school enrolment was used as a proxy, a unidirectional causal flow from economic growth to education was also found to prevail, but only in the short run. However, when secondary school enrolment was used as proxy, education was found to Granger-cause economic both in the short run and in the long run, but economic growth was also found to Granger-cause education in the short run.

Overall, the study found that the causal flow from economic growth to education tends to predominate in South Africa. The study, therefore, concludes that there is a prima facie casual flow from economic growth to education in South Africa. Although the

findings of this study are contrary to the findings of some previous studies that supported a distinct unidirectional casual flow from education to economic growth, they are consistent with the findings of some recent studies, such as those by Mallick *et al*. (2016), Yun and Yusoff (2015), Danacica *et al*. (2010), and Dahal (2010), among others, which found the causality between education and economic growth to be running from economic growth to education rather than from education to economic growth. These findings are also not surprising given the chronology of the South African educational landscape. Prior to 1994, South Africa's education system was racially differentiated, which left many schools, especially in rural areas, under-capitalised. This system did not only compromise the quality of education, but it also left a huge backlog in public school infrastructure, which the present (post-1994) government has been trying to redress since the end of apartheid. This, therefore, suggests that the causality between education and economic growth in South Africa during the study period is more likely to run from economic growth to education because the investment in education has been largely supported by tax revenue generated from various economic activities within the country. This study, therefore, recommends that government should continue to pursue its current pro-growth policies in order to generate the requisite tax revenue necessary to expand and sustain the on-going investment in the education sector.

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