UNIVERSITY OF KWA-ZULU NATAL

The Impact of Education on Economic Growth in South Africa

by

Ntsapokazi Deppa

216071607

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College of Law & Management Studies

Supervisor: Christopher Chikandiwa

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DECLARATION

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DEDICATION

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ABSTRACT

Education is acknowledged as a crucial mechanism of advocating economic growth of developing countries. The theoretical model of education on economic growth originates from the human capital theory which attests that investing in education yields positive externalities such as increased efficiency and productivity, improved technology, better salaries, and innovation and knowledge capacity. This study investigated the impact of all levels of education and its positive externalities such as better salaries, the field of study, and enhanced innovation, research and development, on economic growth in all the nine provinces of South Africa using yearly panel data from 2001 to 2014. The study applied XLSTAT econometrics model to test for stationarity, Johansen co-integration and Vector Error Correction Modelling (VECM) Lagrange Multiplier (LM) and Jacque-Bera tests. The co-integration tests showed that education at all levels, except for matric for most provinces, has a positive effect on economic growth and that the outcome fluctuates across the provinces. For matric and GDP, co-integration was observed for only KwaZulu-Natal and Mpumalanga provinces. Government expenditure towards education, the field of study and innovation, research and development also play a role in the economic growth of South Africa. The results emphasize that the South African government must allocate more funding towards education funding, encourage more innovation, research and development, and focus more on improving the quality of the education system.

Keywords: Economic growth, education, panel data, unit root, stationarity, co-integration.

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LIST OF ACRONYMS AND ABBREVIATIONS

ABET	Adult Basic Education and Training
AIC	Akaike Information Criterion
ADF	Augmented Dickey Fuller
BIC	Corrected Akaike's Information
CHET	Centre for Higher Education Trust
DBE	Department of Basic Education
DF	Dickey Fuller
DHET	Department of Higher Education and Training
DIY	Do- It -Yourself
DOE	Department of Education
FET	Further Education and Training
FPL	Food Poverty Line
GCC	Gulf Cooperation Council
GDP	Gross Domestic Product
HQ	Hannan-Quinn Information Criterion
IC	Information Criteria
ICT	Information and Communications Technology
IRD	Innovation, Research and Development
JIPSA	Joint Initiative for Priority Skills Acquisition
KPSS	Kwiatkowski, Phillips, Schmidt and Shin
LM	Lagrange Multiplier
NSFAS	National Students Funding Aid Schemes
OECD	Organisation for Economic Corporation and Development
OLS	Ordinary Least Squares
PP	Phillips-Perron
R&D	Research and Development
RDP	Reconstruction and Development Plan
RGDP	Real Gross Domestic Product
SA	South Africa
SADF	South African Defence Force
SAMPI	South Africa Multidimensional Poverty Index
SAPS	South African Police Services

SARS	South African Reserve Bank
StatsSA	Statistics South Africa
VAR	Vector Autoregressive
VECM	Vector Error Correction Modelling

CHAPTER ONE
INTRODUCTION

1.1 INTRODUCTION

This chapter provides some background information on the study of education and economic growth in South Africa. It also touches on the main focus and problem statement that this study hopes to resolve. The motivation for the pursuit of the study is highlighted. Research objectives and questions that unveil the study are presented, as well as the expected outcomes and limitations thereof.

Education is extensively acknowledged as a principal mechanism for advocating economic growth. For Africa, where economic growth is crucial if the continent wants to reduce poverty, education is predominantly important (Bloom, Canning & Chan, 2006). Higher education generates larger tax revenue, upsurges savings and investment, and leads to a more entrepreneurial and civic society with more technologically advanced skills and more job creation. It also provides better employment prospects and higher salaries. Several countries have many tools at their disposal to increase productivity, including investments in public infrastructure, human capital development and in technological innovation at public universities and other institutions, and in workers by enhancing the education and training systems (Berger & Fischer, 2013).

1.2 BACKGROUND CONTEXT OF THE STUDY

Economists (Garba, 2002; Ayeni, 2003; Cohen & Soto, 2007; Olaniyan & Okemakinde, 2008; Barro & Lee, 2010) honour education as both a capital and consumer good, because it tenders efficacy and gratification to a customer and also contributes towards development of the human resources essential for economic and societal transformation. The emphasis on education as a capital value is associated with the notion of the human capital theory (Garba, 2002; Ayeni, 2003; Cohen & Soto, 2007; Olaniyan & Okemakinde, 2008; Barro & Lee, 2010), which underscores that the development of skills is an imperative aspect in production activities. Education is broadly recognized as a tool that generates better-quality citizens and aids to uplift the overall standard of living in a society (Garba, 2002; Ayeni, 2003; Cohen & Soto, 2007; Olaniyan & Okemakinde, 2008; Barro & Lee, 2010). The augmented reliance on education as a proxy of transformation in many developing countries, has commanded substantial investments in it. Other theorists advocate for the innovation approach, which correlates education to boosting the growth and capacity of the economy through the development of new ideas and technologies (Olaniyan & Okemakinde, 2008; Earle, 2010; Westmore, 2013; Barro, 2015; Pece, 2015). Also there is a notion of the knowledge transfer approach, which is an extension of the innovation approach, and acknowledges education as a mean of dispersing the innovative knowledge that is needed to apply new ideas, processes and developments, products and technologies (Earle, 2010; Barro, 2015).

The pressure for higher education in numerous developing countries has indisputably been facilitated by communal insight of economic compensation from undertaking such education (Romer, 1986; Lucas, 1988; Rabiei, 2011). There is great confidence on the attitude that intensifying educational prospects and access to such opportunities stimulates economic growth. The economic affluence and effectiveness of the state depends on its physical and human capital stock (Romer, 1986; Lucas, 1988; Rabiei, 2011).

Education and the quality thereof, in South Africa has been topical and has been in the limelight for a vast number of years because of the numerous changes that have been presented in the curriculum, particularly the learner-oriented approach and the outcome-based approach (CDE Round Table, 2011). Some of these changes were motivated with an aim to improve the quality of education for the subsequent drive of growing a knowledgeable nation that can innovate and deliver opportunities for further economic growth (CDE Round, 2011; Denise & Mehmet, 2012). The introduction of some of the policies by the Department of Basic Education (DBE), such as matric pass rates of 35% for different subjects and mathematics literacy is however concerning if government hopes to improve the quality of education. This notion deters the objective of increasing cognitive skills levels which would be fundamental for science and engineering disciplines. The chances of such matriculants furthering their studies towards innovation, research and development are quite scant.

South Africa urgently needs to develop and expand its education sector, both at basic and higher levels. The country has made great strides in offering free basic education, but the quality thereof, is questionable. South Africa needs to foster the culture of learning amongst the nation, ensure easy access to higher education institutions and improve the quality of education institutions. South Africa does not display a considerable sense of urgency as far as the country's crisis in education is concerned (NCHE, 2011). Perhaps the South African government does not fully acknowledge the significant role that education can play in enhancing economic growth of the country. Hence this study attempts to establish the impact of the different levels of education on the economic growth of South Africa. With the scarce literature in the field, particularly in South Africa, this study hopes to contribute more towards closing this limited research availability.

The current study will gather yearly readily available (secondary) time series data for economic growth, and school enrolment as well as attainment for all the various levels of education for the nine provinces of South Africa, from various search engines and websites which will be outlined in the following chapters. Data stationarity tests will be conducted for all the variables and co-integration tests between various levels of education and economic growth will be undertaken. Emanating from the intensive empirical literature review undertaken for the study which is presented in Chapter Three, this current study will focus on the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) unit root tests as main stationarity tests, the Johansen co-integration model, as well as the Vector Error Residual Modelling (VECM) diagnostic frameworks to assess the reliability of the econometrics models utilised.

1.3 MOTIVATION FOR THE STUDY

The study will contribute towards the scarce literature in the field. Because the study covers all the different levels of education from primary level to tertiary level, the outcome thereof will serve to inform and sensitise those in power and authority, not only about the importance of education, but also about the most critical level to focus more attention on and to invest more in.

All the levels of education play a critical role towards the final level of higher education, for example basic cognitive skills are developed at a primary level and are taken up to the tertiary level. Tertiary education and training are recognised as the main contributors to the promotion of creativity, technology, innovation, research and development skills (Schultz, 1971; Sakamota & Powers, 1995; Psacharopoulos & Woodhall, 1997). In turn these skills are regarded as crucial tools required for enhanced productivity, economic growth and sustainable development.

Expansion of the magnitude, worth and diversity of higher education in South Africa is crucially vital and without this, it is difficult to identify how the country can meet critical national goals (NCHE, 2011). Economic growth, development of a highly skilled labour force, entrepreneurship, unemployment and poverty reduction, reinforcement of the domestic supply of well-equipped educators all rest on admittance to tertiary education and its quality (Mthembu, 2016). Investing in human capital through education and skills is regarded as the principal driver of increased productivity and economic growth (Bloom et al., 2006). Identifying the main level of education that contributes more to economic growth will assist the policy makers in making decisions on education expenditure budget. Because the study will also look at the discipline of study, it will provide an insight on what skills to pay much focus on at the early education levels of learners. The assessment of the impact of postgraduate studies will address the innovation requirements and will suggest research funding models that can be utilised by the authorities.

1.4 FOCUS OF THE STUDY

The main focus of the study is to understand if there is a link between education and economic growth in South Africa, focusing on all its nine provinces. This focusses mainly on primary and secondary enrolment, matric and tertiary achievements. The latter two levels are the main levels that generally provide entry to better and high paying job opportunities.

1.5 PROBLEM STATEMENT

According to the theoretical literature, there is a causal relationship between education and economic growth (Bloom et al., 2006; Hanushek & Wößmann, 2007; Wadhwa, Gereffi, Rissing & Ong, 2007; Hanushek, Jamison & Woessmann, 2008). This is also supported by the empirical literature which advocates that countries with a larger percentage of their population as tertiary graduates benefit from quicker economic growth than those with less educated workers (Jaoul, 2004; Pradham, 2009; Ray, Pal & Ray, 2011; Hussin, Muhammad, Abu & Razaki, 2012; Nkohla, 2014; Mthembu, 2016).

In an attempt to improve on this economic growth, since 1994, South Africa provides free basic education up to the secondary level, and financial support to students from disadvantaged backgrounds at a tertiary school level through the National Students Funding Aid Schemes (NSFAS). From this, Jansen and Taylor (2003) reported an increase in education enrolment at all levels with total enrolment ratios averaging around 100% at primary school level and above 70% at secondary school level in South Africa. An upsurge in enrolment magnitudes of disadvantaged South Africans in higher education institutions was subsequently also realised.

Despite all these interventions, the South African economy continues to encounter problems, such as income inequalities, high poverty rates, high unemployment rates, high fees charged by the private sector educational institutions, poor conditions of the public sector educational institutions and poor educational policies (Jansen & Taylor, 2003; Burger, Van Der Berg & Von Fintel, 2012; Burger & Teal, 2013). The economy of South Africa is growing at a slow rate, at 0.8% at the end of 2017, from 4.9% in 2005, with a forecast of 1.1% economic growth for 2018. Considering that not much research has been conducted in South Africa on the relationship between economic growth and education, except for studies conducted by Nkohla (2014) and Mthembu (2016), this study seeks to establish the impact of education on economic growth of South Africa.

1.6 PURPOSE OF THE STUDY

Theoretical literature suggests that education has a positive effect on economic growth (Romer, 2006; Earle, 2010; Barro, 2015) This is based on the three theoretical models of human capital theory (Garba, 2002; Ayeni, 2003; Cohen & Soto, 2007; Olaniyan & Okemakinde, 2008; Barro & Lee, 2010), innovation theory (Olaniyan & Okemakinde, 2008; Earle, 2010; Westmore, 2013; Barro, 2015; Pece, 2015) and knowledge transfer theory (Romer, 2006; Earle, 2010; Barro, 2015). Empirical literature does attest to the theoretical literature but exhibits mixed results on whether relationship of the economic growth and education is uni-directional (Babalola, 2011; Hussiin et al., 2012; Ray et al., 2012; Solaki, 2012; Zivengwa, Hazvina, Ndedzu & Mavesere, 2013; Islam, 2014; Nkohla, 2014; Mthembu, 2015) or bi-directional (Al-Yousif, 2006; Omojimite, 2010). This presents some inconclusive arguments and gaps in the understanding of the causal relationship between the two parameters.

The purpose of the study is to address a causal link, or lack thereof, between education attainment and the economic growth of South Africa. Since there is not much research done on this topic in South Africa, this study will contribute towards closing that gap.

1.7 OBJECTIVES OF THE STUDY

The main objective of the study is to determine the impact of different levels of education on economic growth in South Africa.

The specific objectives that were considered for the study were as follows:

- To examine trends in the different levels of education and economic growth in nine provinces of South Africa.
- To analyse the relationship between economic growth and different levels of education, such as:
    - Primary school enrolment
    - Secondary school enrolment
    - Matric attainment
    - Tertiary attainment

- To analyse the impact of the knock-on effects or positive externalities of education, such as:
    - Salaries
    - Field of study, and
    - Innovation, research and development, on the economic growth of South Africa.

1.8 RESEARCH QUESTIONS

The research questions to be answered were as follows:

- What are the trends of economic growth and different levels of education in the nine provinces of South Africa?
- What is the impact of different levels of education on economic growth in South Africa?
- What is the impact of the knock-on effects or positive externalities of education, such as salaries, field of study, and innovation, research and development, on economic growth in South Africa?

1.9 DELIMITATIONS

It should be noted that the study relies on secondary data and will be used as available without any modifications; the level of its accuracy will not be determined or measured. The study would also extensively explore the impact of the quality of education on the economic growth but this is too broad and would form a separate study area (thesis) on its own. Further extensive interrogation of the impact of the field of study, such as science and engineering, and others, on the economic growth would also be undertaken, if it was not for time constraints of the current study period. An in-depth investigation of other factors that affect economic growth such as poverty and unemployment rates would be also explored, if it was not for time limitations of this study.

1.10 THESIS OUTLINE

The study is divided into eight chapters as outlined below.

Chapter One Introduction

This chapter provides introduction to the study of education and economic growth in South Africa. It highlights the main focus and problem statement that this study seeks to address. Research objectives and questions that the study will uncover are outlined, followed by delimitations.

Chapter Two Conceptual Framework of Education and Economic Growth

This chapter provides a conceptual framework of the current study. This provides a synopsis of how the different levels of education interlink with the economic growth. It also outlines other different variables that education provides a knock-on effect on, towards economic growth. These variables include employment, better salaries, high productivity, and innovation, research and development.

Chapter Three Literature Review of Education and Economic Growth in South Africa

This chapter outlines a comprehensive review of the literature around the study of the impact of education on economic growth in South Africa. The chapter reveals some of the theoretical models that exist in literature around the topic as well as the empirical models from which the econometrics simulations for the current study will be deduced. It reviews the research that has been conducted in other countries around the world and closes up with those that are particular to South Africa, as few as they are.

The impact of education, field of study on salaries and a subsequent impact on economic growth will be reviewed.

Chapter Four Overview of Education and Economic Growth in South Africa

This chapter provides an overview of education and economic growth in South Africa. The chapter opens up with a background of the South African population and its literacy levels. This is followed by the educational enrolments, attainments and a review of the postgraduate advancements. A review of the economy of South Africa is also presented with the examination of highly employing and better paying sectors. The chapter closes up with a brief analysis of the unemployment and poverty levels in South Africa.

Chapter Five Research Methodology and Framework

This chapter outlines the research approach, methodologies and the analytical framework that were used towards achieving the objectives of the study. It starts with the presentation of the model specifications, data sources and the definition of the variables employed in the study. An overview of the analytical framework, data analysis package, estimation techniques, pre-statistical tests to be engaged in the study are presented. The chapter wraps up with the stationarity test techniques, co-integration models and verification simulations thus used.

Chapter Six Data Analysis and Presentation

This chapter gives a comprehensive account of the empirical estimation techniques that were commenced, together with a detailed presentation and interpretation of the results obtained. Initially, raw data and graphical analysis results are presented for the GDP and the education levels for all the nine provinces of South Africa, followed by the descriptive statistical analysis results. The stationarity tests are presented for all the variables, after which the co-integration results between economic growth and all the independent variables investigated are tabulated. The chapter finishes off with diagnostic/verification checks which ascertain that the model utilised in the study is in indeed appropriate.

Chapter Seven Discussion of the Findings

This chapter mainly focuses on the discussion of the results presented, addressing all the variables presented in the conceptual framework with the aim of addressing all the objectives and answering the research questions set out for the study. The chapter discusses the findings of the existence or non-existence of the causal relationship between economic growth as a dependent variable and all the dependent variables presented in the conceptual frameworks. Each of the objectives is further reflected on.

Chapter Eight Conclusion, Recommendations and Limitations

This chapter draws conclusion on the data analysis, results and the discussion presented. The chapter concludes by summarising the quantitative investigation, discussing the overall significance and the meaning of the results and their relevance to field of study. The limitations of the study and recommendations for further research are also presented.

CHAPTER TWO

CONCEPTUAL FRAMEWORK OF EDUCATION AND ECONOMIC GROWTH

2.1 INTRODUCTION

The study seeks to uncover the link between education (independent variable) and economic growth (dependent variable) in South Africa. Econometrics models will be used to determine the existence of the causal link between these two parameters. A conceptual framework that would assist in understanding the relationship between the main variables under investigation, such as education and economic growth was therefore developed.

A conceptual framework characterizes the researcher’s fusion of literature on how to elucidate a phenomenon. It actually charts out the activities essential in the progression of the study assuming the researcher’s preceding understanding of other investigators’ observations, and the implications thereof on the subject under study (Sekaran & Bougie, 2014). It serves to identify the interconnections of particular variables with each other, thus serving as a map in undertaking the researcher’s investigation.

This chapter presents the two conceptual frameworks that have been deduced for this study, namely the general and comprehensive conceptual frameworks. The variables used in the study for subsequent construction of the conceptual frameworks are briefly discussed.

2.2 GENERAL CONCEPTUAL FRAMEWORK OF THE STUDY

The general conceptual framework as shown in Figure 2.1 depicts a direct primary link between economic growth (dependent variable) and the different levels of education (independent variable). The main proxies of education were identified as primary school enrolment, secondary school enrolment, matric attainment and tertiary attainment. The measure used for economic growth is real GDP (RGDP). These are further discussed in detail in the following pages.

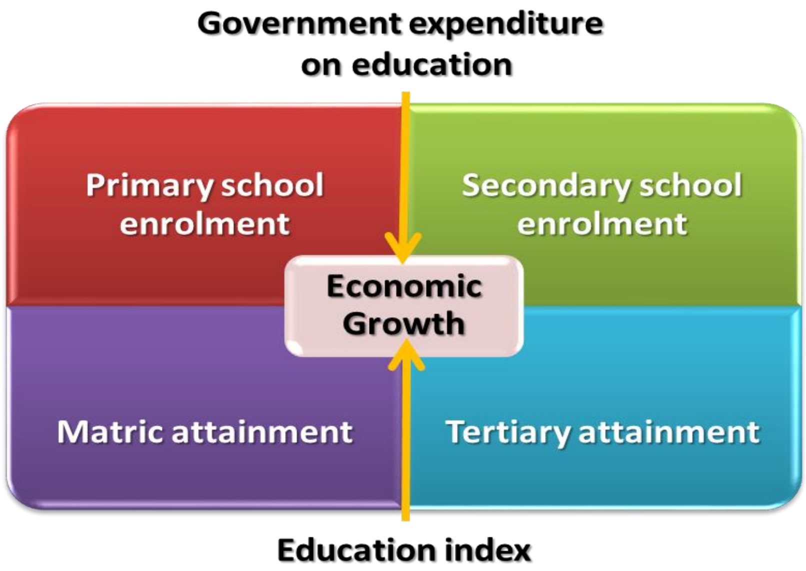


Figure 2.1: General conceptual framework for economic growth (dependent variable) and levels of education (independent variables) (Source: compiled by the author)

2.2.1 Definitions of Variables and Proxies

The main variables used in the study as part of the economic growth and education are further described in the following paragraphs.

2.2.2 Economic Growth

Economic growth is an increase in a country's capability to produce goods and services over a period of time. It is evidenced by increased aggregate productivity levels in the economy. A growth in productivity which leads to increased economic growth is indicative of an improvement in standards of living for citizens and subsequent poverty reduction, and a subsequent increase in economic growth. Real gross domestic product (RGDP) growth is commonly used as a measure of economic growth (Rebelo, 1991; Huang, Jin & Sun, 2009). A positive correlation is expected between GDP and increased levels of education (Chaudhary et al., 2009; Huang et al., 2009; Afzal, Rehman, Farooq & Sarwar, 2011).

2.2.3 Education

Education does not have a universal measure and therefore it is measured by different indicators such as education index, primary school enrolment, secondary school enrolment, matric and tertiary attainment and total expenditure on education. This study applied primary and secondary enrolment, matric and tertiary attainment, total expenditure on education, and education index as proxies of education. The education index consists of expected years of schooling (18 years) and mean years of schooling (15 years). All these variables have been used previously in the literature (Afzal et al., 2011; Zivengwa, Hazvina, Ndedzu & Mavesere, 2013; Clarke, Jones & Lacy, 2015). A positive relationship between education variables and GDP is expected and this is supported by the literature (Moav & Neeman, 2008; Hakim, Razak & Ismail, 2010).

The empirical literature discussed in the following chapters has shown that education is a vital empowering apparatus for human capital investment and that it significantly contributes towards economic growth and poverty reduction.

The variables thus used as proxies for education are presented. Primary school enrolment is used as a foundation stage for cognitive skills. Secondary school enrolment is also used even though not all students from the secondary school will finish matric and create skilled human capital in the economy. Secondary education may also only play a role in economic growth after a sizeably long period. For this reason matric attainment was used as a better measure. Tertiary education achievement was assumed as the most reliable measure of skilled human capital that directly relates to the quality of education in South Africa which contributes directly to economic growth. These four levels of education will be explored for all the nine provinces of South Africa. Because, it is not easy to quantify education index and government expenditure on education by province, these two variables will be investigated for South Africa holistically.

2.3 COMPREHENSIVE CONCEPTUAL FRAMEWORK OF THE STUDY

The comprehensive conceptual framework looks at the variables that education has a knock-on effect on, which subsequently play a significant role towards economic growth. Education also leads to innovation, research and development, employment, better salaries, poverty reduction and high productivity. These are also dependent variables of education and together they result in improved economic growth. However this study only managed to statistically quantify and analyse salaries, innovation and field of study, thus presented in Figure 2.2.

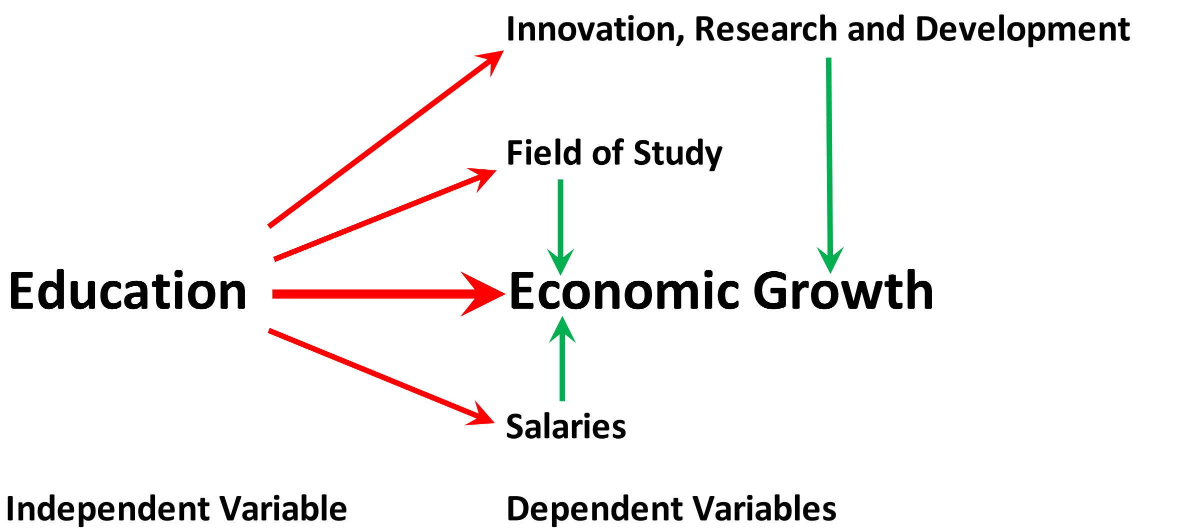


Figure 2.2: Comprehensive conceptual framework of education (independent variable) and economic growth (dependent variable) (Source: compiled by the author)

2.3.1 Innovation, Research and Development

According to the innovation theory, innovation is very significant towards providing a step change in economic output through high productivity. Innovation is directly linked to research and development (Earle, 2010; OECD, 2012, Bayarcelik & Tasel, 2012; Adak, 2015; Pece, 2015). The consequence of innovation on productivity is to diminish the amount of effort required to produce the same volume of outputs and to increase the volume of outputs produced for the same amount of effort. It also results in swings towards higher value-added products for the same or similar amount of investment (Aghion, Boustan, Hoxby & Vandenbussche, 2009; Earle. 2010; OECD, 2012).

Ulku (2004) investigated the connection between economic growth, innovation, research and development expenditures, for 20 Organisation for Economic Co-operation and Development (OECD) countries and 10 countries that are not OECD members. The results attained from the study afforded confirmation that innovations have a positive impact on GDP/capita, both for developed and emerging economies. It was further established that only developed OECD countries can increase the level of innovation based on research and development expenditures. Interdependence between OECD countries was also reported and attributed to the possibility that some countries confirm their innovation by using the knowledge from other OECD countries. In South Africa, Mthembu (2016) also presented a long run relationship between innovation and economic growth.

Because in South Africa, innovation, research and development (IRD) are usually undertaken at postgraduate level, the current study employed postgraduate attainment as a proxy to measure IRD. A number of research publications per province could be used as a proxy, but this data could not be obtained. A positive correlation between IRD and economic growth is expected in this study.

2.3.2 Salaries

Several studies presented a positive correlation between the number of years spent at school and economic growth (Krueger & Lindahl, 2001; Barro, 2002; OECD, 2006, 2007; Hanushek & Wößmann, 2007; Katircioglu, 2009; Earle, 2010). Krueger and Lindahl (2001) reported that in the United States, each extra year spent at school is likely to raise employees' income by 10%. In two separate studies, Earle (2010) also established a significant and positive correlation on the years of school education at secondary and tertiary levels with 0.44% subsequent increase in economic growth for every year spent at school, which exhibits a huge impact on the overall GDP over time.

The current study also investigated the role of education on salaries and economic growth. As much as there is evidence on the fact that unskilled employees earn less than skilled ones (OECD, 2010, 2012; IDC, 2016) unfortunately, it was not easy to identify from the salary how much portion is due to tertiary graduates or those who do not have a tertiary qualification. Therefore a congregate national salary for South Africa was used as a proxy in this study as presented in GDP tables reported by StatsSA (2015c).

2.3.3 Field of Study

There is enough evidence in literature that the field of study plays a significant role in economic growth (Earle, 2010; Barro, 2015). Hanushek & Wößmann (2007) and Wadhwa et al. (2007) reported that countries that have more engineering graduates tend to grow faster than those with more law graduates. A positive correlation between the number of doctorate graduates in engineering and technology and economic growth was demonstrated by these studies.

Lin (2004) also observed that the fields of engineering and natural sciences showed the greatest economic output effect, with a 1% growth in higher education qualifications comprising college, junior college, university or any graduate school yielding a 0.35% increase in industrial output and a further 1% rise in natural sciences or engineering graduates; whereas a 0.15% increase was noted in agricultural output. Gittleman & Wolff (1993) also revealed a positive correlation between tertiary education enrolment and labour productivity growth with the quantity of engineers and scientists per capita well proportionally associated with economic growth.

This study will investigate the causal link between the different fields of studies undertaken and the economic growth in South Africa.

2.4 CONCLUDING REMARKS

The variables presented in this chapter form the fundamental and principal aspects and variables for the entire analytical framework of this thesis. Each of the variables to be investigated was briefly described in this chapter with a detailed discussion of each to be presented in the Literature Review.

This chapter presented the two conceptual frameworks which will be used as road maps for the current study. The study started with an overview of the general framework with a specific focus on the different levels of education. The positive externalities that education exhibits had to be also visited, with an intention to assess their impact on economic growth. These were discussed as the part of the comprehensive framework.

CHAPTER THREE
LITERATURE REVIEW OF EDUCATION AND ECONOMIC GROWTH IN SOUTH AFRICA

3.1 INTRODUCTION

This chapter covers a review of the literature that will provide some answers to the main focus of this study, which is to understand whether there is a causal relationship between education and economic growth or not. The literature survey is divided into theoretical and empirical reviews. An understanding of the concepts supporting this study and related works assist in formulation of a model specification in the next chapters. The literature search presented below was conducted with the intention of answering all the research questions and meeting the research/study objectives that were initially identified. The main search engines were research journals, reviewed sources, textbooks, published and unpublished reports, South African data centres such as Statistics South Africa (StatsSA), trading economics, published and unpublished theses as well as the internet.

This literature review will cover both the theoretical and empirical framework. The theoretical framework will reveal some of the theoretical models that have been employed previously by other researchers in answering whether there is a relationship between education and economic growth. The empirical literature will uncover some of the methodologies and data analytical methods that have been covered by other researchers. This section will assist towards realising the most appropriate and relevant methods to use for this particular study. The review will provide some information on what research has been conducted on the impact of education and economic growth in other countries and how it can be applied in the South African context. Extensive theoretical and empirical literature review will help to determine some of the conclusions or inconsistencies there are from the previous research in this field. This will inform the current study on some of the gaps that are in existence in this field of research, and how this particular study can assist in closing some of those gaps.

3.2 THEORETICAL LITERATURE

The theories underpinning this study suggest that higher education is a determining factor of the employee's income, and can yield both public and private benefits that will result in the economic growth of the country (Bloom et al., 2006; Hanushek & Wößmann, 2007; Wadhwa et al., 2007; Hanushek, Jamison, Jamison & Woessmann, 2008). Three theories that gained popularity in the field of education and economic growth (Stevens & Weale, 2003; Hanushek & Wößmann, 2007; Wadhwa et al., 2007; Aghion et al., 2009; Earle, 2010; Zivengwa et al., 2013; Farace & Mazzotta, 2015) are presented below and discussed in detail in the following pages:

- Human capital theory
- Innovation theory and
- Knowledge transfer theory

Farace & Mazzotta (2015) formulated a theoretical framework establishing a link between these three theories in Figure 3.1.

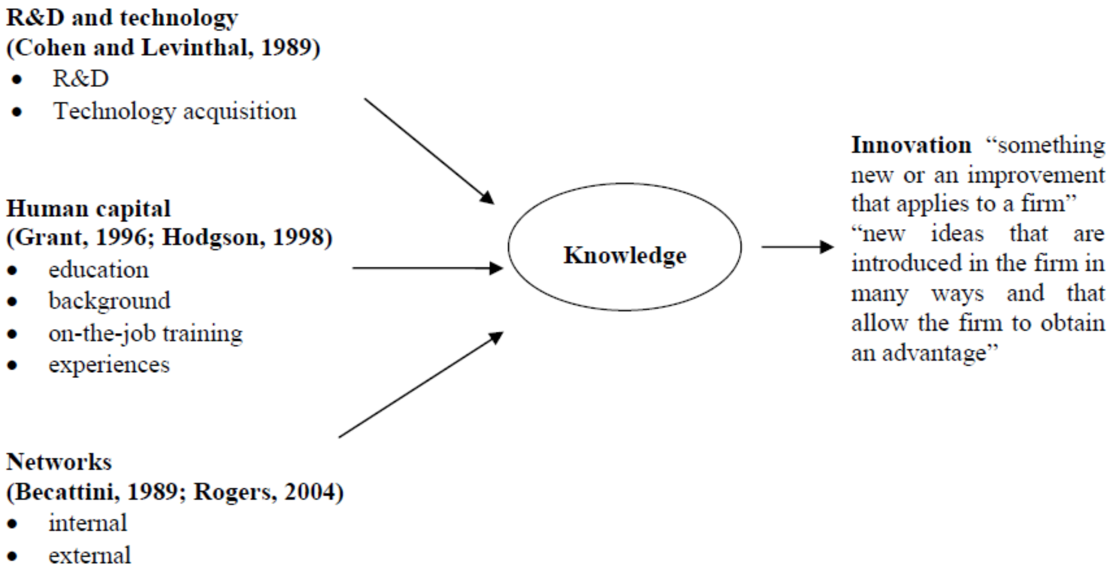


Figure 3.1: Theoretical framework of knowledge creation and innovation (Source: Adopted from Farace & Mazzotta, 2015, p. 6)

Babalola (2011) postulated three arguments which form the basis for the notion arising from these theories:

- That the upcoming new generation must be nurtured with the suitable set of the knowledge and skills which have been long generated by previous generations;
- That new generation should be trained on how to utilise the existing knowledge to cultivate new products, to generate new innovative developments and production systems and social services; and
- That the workforce must be motivated to initiate completely new concepts, products, practices and techniques through creative innovative and pioneering approaches.

3.2.1 Human Capital Theory

The human capital theory recognises that education develops the overall skills and capabilities of the labour force, resulting in higher productivity and enriched capability to use existing technology, thus subsequently contributing to economic growth. This theory is based upon the work that was conducted by Schultz (1971), Sakamota & Powers (1995), Psacharopoulos & Woodhall (1997) and relies on the assumption that higher education is highly influential and essential to advance the production capacity of an educated population, and thus a productive population. A more educated labour force tends to achieve faster innovation rates (Nelson & Phelps, 1966; Benhabib & Spiegal, 1994). It was also observed by Lucas (1988) and Mankiw, Romer and Weil (1992) that the development of human capital increases the productivity of other factors and thus raises growth of the economy. High productivity is achieved through the contribution of skills and the innovative capabilities of an educated workforce. Lucas's (1988) and Mankiw et al's (1992) models attest that a state's rate of growth mainly depends on the rate of build-up of human capital.

The human capital theorists (Schultz, 1971; Sakamota & Powers, 1995; Psacharopoulos & Woodhall, 1997) indicate that an educated nation is a productive nation and stress that education escalates the efficiency and productivity of the workforce by accumulating the quantity of cognitive stock of economically productive human capability which in turn is a product of inherent capabilities and investment in human beings.

Government expenditure on education is seen to institute a form of investment in the sense that it amplifies individual's human capital and results in greater yields for society and enhanced earnings for the individual worker. It augments the employees' chances of employment in the labour market, and allows them to secure monetary and non-monetary returns and also affords them prospects for job flexibility. Ayeni (2003) also emphasises that education as an investment has future rewards of creation of good economic status, job security and other monetary benefits.

Fagerlind & Saha (1997) confirmed that human capital theory reveals a fundamental rationalisation for large public expenditure on education both in developing and developed countries. According to these authors, endorsement of investment in human capital resulted in speedy economic growth for the society. For individuals, this investment provided returns in the shape of individual economic success and attainment. Economists (Nelson & Phelps, 1966; Schultz, 1971; Sakamota & Powers, 1995; Benhabib & Spiegal, 1994; Psacharopoulos & Woodhall, 1997; Benhabib & Spiegal, 1994) attest that it is human resources of the country, not its capital nor its physical resources that eventually define the appeal and strides of its economic and social improvement.

As quoted from Psacharopoulos & Woodhall (1997, p. 102), "Human resources constitute the ultimate basis of wealth of nations. Capital and natural resources are passive factors of production, human beings are the active agencies who accumulate capital, exploit natural resources, build social, economic and political organization, and carry forward national development."

3.2.2 Innovation Theory

In addition to the human capital theory, innovation and knowledge transfer also play important roles in modelling the role of education on economic growth and development process. In essence, human capital is an essential input for innovations, research and development activities. This is supported by Odenkule (2001) who asserts that investment in human capital has significant effects on the supply of entrepreneurial activity and technological innovation.

Schumpeter (1912, 1939) is amongst the first economists who introduced the innovation model, which focuses on innovation, research and development, advocating that what keeps the industrial engine in motion comes from the new consumers, goods, the new methods of production or transportation, the new markets, the new forms of industrial organization. Schumpeter (1912, 1939) also added that innovation is a source of economic change where economic expansion is spear-headed by innovation through a dynamic process in which new technologies replace the old. He indicated that innovation consists of the following five conditions (Schumpeter, 1912, 1939):

- introduction of a new good;
- introduction of a new method of production
- opening of a new market;
- conquest of a new source of supply of raw materials or semi-manufactured goods
- implementation of a new form of organization

Schumpeter (1912, 1939) also stipulated two different types of innovation, such as radical and incremental innovations. Radical innovations are essential alterations that represent revolutionary changes in technology, where the transformation of existing products, services, processes or technologies make current products or designs obsolete (Godin, 2008). Incremental innovations are minor enhancements or simple alterations in the current technology (Chandy & Tellis, 2000). Therefore, in incremental innovation existing products, services, processes or technologies are refined or improved by the companies (Hall, 1996). The major distinguishing factor for radical and incremental innovations is the magnitude of original technological process content embodied in the innovation and hence, the extent of new knowledge entrenched in the innovation (Rabiei, 2011).

Innovation is very significant towards providing a step change in economic output through high productivity, thus diminishing the amount of effort required to produce the same volume of outputs and to increase the volume of outputs produced for the same amount of effort (Aghion et al., 2009; Earle, 2010; OECD, 2012). From this viewpoint, education is appreciated as an input into calculated entrepreneurial exertion to increase the resources needed for creating new ideas, new technology and new products (Olaniyan & Okemakinde, 2008; Pece et al., 2015). Therefore any intensification in education directly fast-tracks technological evolution. According to Van-Den-Berg (2001), the nations that are ahead in technology and innovation also have the most educated inhabitants.

The empirical evidence of the positive impact of innovation, research and development on economic growth has been presented by several researchers in many countries such as Sweden and Ireland (Pessoa, 2007), Nepal (Braunerhjelm, 2010), European countries (Petrariu et al, 2013, Shukarov & Maric, 2016), Turkey (Bayarcelik & Tasel, 2012), Greece (Solaki, 2012; Pekgas, 2014), CEE countries, Poland, Czech Republic and Hungary (Pece et al., 2015). The outcome of the studies suggested that there was a significantly strong link between research and development expenditures and economic growth.

An analysis of the innovation process for manufacturing industry from both developed and emerging countries established that innovation has a major impact on financial performance of the companies (Norris, Kersting & Verdier, 2010). The same study analysed the association between innovation, performance and capital markets and determined that the positive effect of innovation on companies' performance is facilitated through capital markets. The positive impact of innovation on productivity was found to be significantly higher in countries with developed capital markets.

Earle (2010) investigated several barriers to innovation, with a direct focus on access to intellectual property rights, lack of information, lack of cooperation with other businesses, lack of marketing expertise, lack of appropriate personnel, government regulation, lack of management resources (eg. time) and costs to develop or introduce. The most frequently reported barrier was the cost to develop or introduce the innovation, followed by lack of management resource and lack of appropriate personnel. Lack of information was infrequently reported as an aspect hindering innovation. Therefore a combination of lack of resources (time and money) and skills (technical and managerial) was found to be the dominant impediment to innovation (Earle, 2010).

3.2.3 Knowledge Transfer Theory

The knowledge transfer approach, which is an extension of the innovation approach, acknowledges education as a mean of dispersing the innovative knowledge that is needed to apply new ideas, processes and developments, products and technologies. The transfer of this innovation knowledge is very significant because it elevates economic output. Its knock-on consequence on productivity is to diminish the amount of effort required to produce the same volume of outputs and to increase the volume of outputs produced for the same amount of effort. It also results in swings towards higher value-added products for the same or similar amount of investment (Aghion et al., 2009; Earle, 2010).

To function and compete effectively in a knowledge economy, businesses need to be knowledge-centred in their attitude to business activities. As advanced technologies flourish and new products become outdated much quicker than before, organisations that exploit the opportunities looming from the availability of knowledge assets and descend the most value from them will be the industry winners, while those who cannot will be left behind as industry losers. As such, corporates are taking opportunities of identifying effective means of gathering all sorts of knowledge assets so that they can differentiate themselves from competitors based on new management initiatives (Gold, Malhotra & Segars, 2001). It appears that knowledge-intensive enterprises will soon be obligatory for organisational survival.

The OECD policy (2001; 2002) emphasises the significant role the new technology based firms and entrepreneurship play in the technology transfer process. The European Council in 2000 also set up an objective of becoming the most competitive and vibrant knowledge based economy in the world with high proficiency in sustainable growth, more and better jobs and larger social cohesion. The OECD report (2002) also accentuates that young technology based businesses must play a crucial role in connecting science to the markets. And that government must prioritise encouraging spin-offs from public research in order to motivate innovation.

The US Council on Competitiveness (1998, p. 9) advocates for knowledge transfer as quoted, "The nation that fosters an infrastructure of linkages among and between firms, universities and government gains competitive advantage through quicker information diffusion and product deployment."

3.2.4 Bloom's Conceptual Theory

Bloom et al. (2006) also developed a conceptual theory that highlights many possible paths through which higher education can benefit the economy of a country, as shown in Figure 3.2.

The benefits may include:

- Better health and improved quality of life, thus setting off a desired spiral for better life expectancy improvements, which allow employees to work more productively over a longer time.
- Further boosting of the employee's lifetime earnings.
- Poverty reduction.
- Contribution to diminished population growth.
- Development of technology, strengthening of governance and reduced demand on state finances (Bloom et al. 2006).

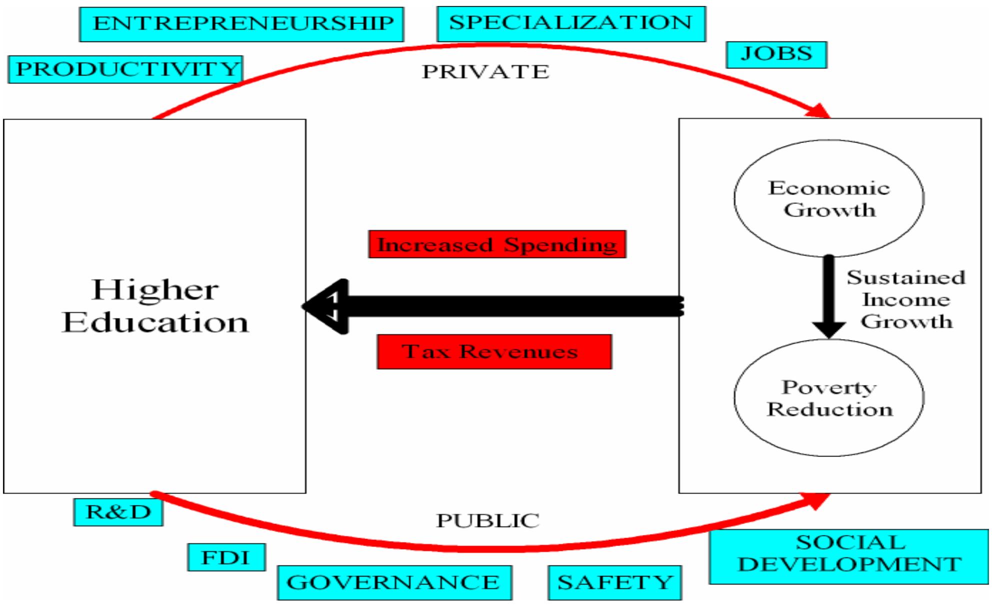


Figure 3.2: A conceptual theory that links tertiary education and economic growth (Source: Bloom et al., 2006)

3.4 EMPIRICAL LITERATURE

The endogenous growth theory motivated many economists (Barro, 2002; OECD; 2006, 2007; Hanushek & Wößmann, 2007; Katircioglu, 2009; Earle, 2010; Zivengwa et. al., 2013; Islam, 2014; Nkohla, 2014; Farace & Mazotta, 2015; Mthembu, 2015; Seetanah, 2016) to scrutinize the empirical indication of the relationship between education and economic growth. These research studies (Zivengwa et. al., 2013; Islam, 2014; Nkohla, 2014; Farace & Mazotta, 2015; Mthembu, 2015; Seetanah, 2016) look at a wide range of a period of data over 10 years, in both developing and developed countries. The econometrics methods used for data analysis for each study will be briefly highlighted below.

3.4.1 The Impact of Education on Economic Growth in Other Countries

The impact of education on economic growth has been extensively researched in several countries and will be presented in the following paragraphs. This information is, however, limited in South Africa as not much research has been conducted around the topic.

3.4.1.1 European and American Countries

A study that was conducted by de Meulemeester & Rochat (1995) on six developed countries utilising the Augmented Dickey- Fuller (ADF) stationarity test method and the Granger causality test between higher education enrolments and economic growth in these countries, revealed that tertiary education showed a uni-directional causal effect on economic growth in United Kingdom, France and Sweden, but a bi-directional causal impact was shown in Italy and Australia. The uni-directional causality results were supported by those piloted by Jaoul (2004) in France for the era before the Second World War.

In Greece, Pegkas (2014) examined the link between educational levels and economic growth and estimated the potential impact of the different educational levels on economic growth in Greece over the period of 1960 to 2009. Over this period, educational expansion had taken place especially in the secondary and higher education. The study applied the ADF, PP and Perron stationarity tests as well as Johansen co-integration and Vector Error-Correction Models (VECM). The empirical analysis revealed a long-run relationship between educational levels and GDP, with the overall results showing that secondary and higher education had a statistically significant positive impact on economic growth, whereas primary education did not contribute to economic growth. The results also suggested evidence of unidirectional long-run causality from primary education to economic growth, bidirectional long-run causality between secondary and economic growth, long-run and short-run causality between higher education to economic growth.

Solaki (2012) also conducted a study on the relationship between education and GDP growth, a bi-variate causality analysis for Greece from 1961 to 2006 using the ADF, the PP and the Kwiatkowski, Phillips, Schmidt & Shin (KPSS, 1992) models to investigate the degree of stationarity of the variables. For empirical analysis he employed three different estimation models, namely, Granger, Phillips-Hansen and Johansen approaches to test for co-integration in a human capital and economic growth bi-variate model. The empirical results from the study suggested that real GDP per capita is affected by changes in primary, secondary, tertiary education and educational public expenditures. Conclusions that were drawn from this study were used to convince educational policy makers to invest in education with a motivation for the government to intensify the public expenses on education and to increase the number of students in tertiary education.

Pece et al. (2016) used multiple regression models to analyze whether long term economic growth is influenced by the innovation potential of an economy for Central and Eastern European countries, namely Poland, Czech Republic and Hungary. The study applied various variables, such as number of patents, number of trademarks, R&D expenditures, as proxies to quantify innovation. The results provide evidence of a positive relationship between economic growth and innovation for all the countries.

3.4.1.2 Asian Countries

Ray et al. (2011), who investigated a different 1961-1962 to 2010-2011 time series data in India, also confirmed the existence of a long run equilibrium relationship between the two variables of education and economic growth. However, the

Granger causality test finally confirmed that there is no existence of short-run causality between economic growth and education. Other studies that demonstrated a uni-directional causal relationship between education and economic growth are those reported by Aka & Dumont (2008) and Chaudhary et al. (2009), who used an ADF stationarity test and the Johansen co-integration tests in the USA and Pakistan, respectively, and Pradham (2009) in India using annual data from 1951-2002 by means of an error correction modelling technique.

In Turkey, Bayarcelik & Tasel (2012) applied the panel regression model on the panel data from 1998 to 2010 to empirically examine the relationship between innovation and economic growth. The innovation indicators used were, the researchers employed in R&D departments, R&D expenditures, patent. GDP was used as economic growth indicator. The results indicated a positive and significant influence of relation between R&D expenditure and the number of R&D employees towards economic growth.

In Malaysia, Hussin et al. (2012) investigated the impact of government educational expenditure on economic growth by employing the ADF, Phillips and Perron (PP), and the Johansen and Granger analytical methods for the period 1970-2010. The study revealed that the GDP showed a significant long-run relationship with labour force participation, the fixed capital formation and government spending on education with a long-run relationship of economic growth. The findings demonstrated that education quality is vital to the improvement of the country's economic growth and human capital capabilities. A short- and long- run causal relationship between education and economic growth in Bangladesh was also examined, using annual time series data covering the period from 1973 to 2010 by Islam (2014), by means of ADF, Johansen and Granger tests. The study proved existence of a uni-directional, statistically significant causal relationship between educational expenditure and economic growth.

A study by Al-Yousif (2006), that explored the relationship between education expenditure and economic growth for the Gulf Cooperation Council (GCC) countries, such as Saudi Arabia, Kuwait, UAE, Oman, Bahrain, Qatar using data covering a period from 1977 to 2004, employing the ADF, PP and Granger tests, demonstrated that the causality between economic growth and education is bi-directional, which disproved the existing literature which states that the causal relationship is from education to economic growth. The results also proved to be country-specific, with variations depending on the proxies used by each country to determine human capital. This meant that the relationship between education and economic growth cannot be generalised for all the countries.

3.4.1.3 African Countries

Two separate studies conducted in Nigeria by different authors for the same data series period of 1980 to 2005 (Omojimite, 2010; Babalola, 2011) used the ADF, PP as well as the Granger causality tests and also reported uni-directional causality between education and economic growth in Nigeria. Their results suggested that investing in education is important for economic growth and recommended that government and the private sector, through public-private partnerships, should focus more on policies that will advance the education system. Omojimite (2010) further examined the view that formal education accelerates economic growth whilst also studying if government expenditures on education and primary school enrolment are co-integrated. Bi-directional causality between recurring expenditure on education and economic growth was revealed, which suggested that enhancements in the quantity and quality of manpower in schools had positive effects on economic growth. There was no causal relationship between primary school enrolment and economic growth and this was attributed to the fact that primary school curriculum was not modelled after the Western education system.

In Zimbabwe, Zivengwa et al. (2013), for the period of 1980 to 2008, utilised the ADF and Granger tests that also confirmed existences of uni-directional causality relationship between education and economic growth.

3.4.1.4 South Africa

As mentioned previously, the literature around this field of study is very scant in South Africa. Only two studies were picked up from the literature survey.

In South Africa, Nkohla (2014) investigated the causal relationship between education and economic growth in the nine provinces of the country, employing the panel data from 1990 to 2011. The variables investigated were poverty, capital investment, education and economic growth. The study utilised real GDP as a proxy for economic growth, and per capita consumption as the proxy for poverty. Gross fixed capital formation was used as a proxy for capital investment. Because education does not have a standard proxy, primary, secondary and tertiary enrolment and total expenditure on education, were used as proxies for education.

The study made use of the ADF and PP unit root tests to test for stationarity of the variables. The Johansen and Granger Causality were applied to assess co-integration between economic growth and the above stated variables. The Hausman test was used for regression analysis, and Pedroni and Lagrange Multiplier was utilised for residual co-integration test which revealed a positive correlation. According to Nkohla (2014) the impact varies across the provinces depending on the educational policies employed in each province.

In another study in South Africa, Mthembu (2016) employed a Cob-Douglas production model to evaluate the relationship between economic growth as measured by GDP and its determinants i.e. labour capital, tertiary enrolment, education expenditure and innovation for South African economy over a period 1983 to 2012. The primary objective of the study was to investigate how labour, capital, education expenditure, tertiary enrolment and innovation impacts on economic growth in South Africa.

The econometrics models utilised in the study included ADF and PP unit root tests to test for stationarity, Johansen co-integration model to test for co-integration between education and the for key determinants of economic growth such as labour, capital, tertiary enrolment, education expenditure as well as innovation.

The study conducted the statistical analysis using advanced methodologies such as VECM, ordinary least squares (OLS) and autoregressive distributed lag (ARDL) in attempt to study the dynamic interactions between the economic growth and the mentioned variables in order to identify long and short run relationships.

The study strongly suggested the existence of a long run co-integrating relationship between economic growth, labour, capital, enrolment, expenditure and innovation which is consistent with economic theory.

3.4.2 An Overview of the Literature Survey

Table 3.1 gives an overview of the overall empirical literature review of some studies that investigated causal relationships between education and economic growth and the data analyses methods employed. Some studies show uni-directional and others show bi-directional causality. In uni-directional causality, education (independent variable) causes an effect on economic growth (dependent variable). In bi-directional causality, both independent (education) and dependent (economic growth) variables will cause an effect on each other.

Table 3.1: Overview of empirical literature review of causality studies between education and economic growth (Source: compiled by the author)

Author (Year)	Country	Data Analysis Method	Causality Findings Uni-directional/Bi-directional
De Meulemeester Rochat (1995)	Japan, United Kingdom, France & Sweden Italy & Australia	ADF & Granger	Uni-directional Bi-directional
Al-Yousif (2006)	GCC countries, Saudi Arabia, Kuwait, UAE, Oman, Bahrain & Qatar	ADF, PP, Granger	Bi-directional
Aka & Dumont (2008)	USA	ADF & Granger	Uni-directional
Chaudhary, Iqbal and Gillani (2009)	Pakistan	Johansen & Tod & Yamamoto causality	Uni-directional
Omojimite (2010) Babalola (2011)	Nigeria	ADF, Johansen, Granger & VECM ADF, PP & Granger	Bi-directional Uni-directional
Bayarcelik & Tasel (2012)	Turkey	OLS	Uni-directional (R&D and economic growth)

Hussain et al. (2012)	Bangladesh	ADF, PP, Johansen & Granger	Uni-directional
Ray et al. (2012)	India	ADF, Johansen, Granger & VECM	Uni-directional
Solaki (2012)	Greece	ADF, PP, KKSP, Granger, Phillips-Hansen, Johansen	Uni-directional
Pegkas (2014)		ADF, PP, Perron, Johansen& VECM	Unidirectional (Primary) Bi-directional (Secondary) Long-run & short-run (Higher Education)
Zivengwa et al. (2013)	Zimbabwe	ADF & Granger	Uni-directional
Islam (2014)	Bangladesh	ADF, PP, KPSS, Granger & VECM	Uni-directional
Nkohla (2014)	South Africa	ADF, PP, Johansen, Granger, Hausman & Pedroni	Uni-directional
Mthembu (2015)		ADF, PP, Johansen & Langrange multiplier	Uni-directional
Pece et al. (2016)	Poland, Czech Republic and Hungary.	OLS	Uni-directional (Innovation & Economic Growth)

3.4.3 Inconsistencies in the Literature

An overview of the empirical literature across the various countries strongly suggests that there is a causal relationship between education and economic growth. However, the main contradiction noted was that some studies in other countries either show uni-directional or bi-directional causality. A study that was conducted by de Meulemeester & Rochat (1995) for six countries for the same time series showed a uni-directional relationship between education and economic growth for Japan, United Kingdom, France and Sweden, but a bi-directional causality for Italy and Australia. What is of most importance is to realise that this relationship is, however country- specific, and also that the quality of the education thereof is even more critical. Bi-directional causality was realised in a study covering other six countries such as Saudi Arabia, Kuwait, UAE, Oman, Bahrain and Qatar (Al-Yousif, 2006).

Another study that investigated both short and long run causalities in India (Ray et al., 2011) showed a uni-lateral and bi-lateral relationship for short and long-term run effects, respectively. The inconsistencies may be due to the choice of the econometrics methods used. Studies on this topic have to ensure that the correct and relevant econometrics methods are employed.

3.5 EDUCATION, SALARIES AND ECONOMIC GROWTH IN OTHER COUNTRIES

A number of researchers have demonstrated a positive correlation between the number of years spent at school and economic growth (Barro & Sala-i-Martin, 1995; Krueger & Lindahl, 2001; Barro, 2002; OECD; 2006, 2007; Hanushek & Wößmann, 2007; Katircioglu, 2009; Earle, 2010). Krueger & Lindahl (2001) suggested that in the United States, each extra year spent at school is likely to raise employees' income by 10%. This view was also substantiated by Hanushek & Wößmann (2007), who related school attainment and intellectual skills thus achieved from such, to higher productivity, and subsequently, a higher income. The Organisation for Economic Corporation and Development (OECD) Growth Project also projected that the long-standing consequence on economic output of one additional year of education in the adult population, generally, ranges between 3% and 6% (OECD, 2006). Further research showed that a country that can achieve literacy scores that are 1% higher than the global average, realizes higher levels of labour productivity and GDP per capita that are 2.5 and 1.5% higher, respectively, than their counterparts (OECD, 2006).

The findings of the OECD report (2012) demonstrate that the GDP growth in its affiliate countries is strongly related to workforce salary growth amongst tertiary educationally qualified persons who earn twice as much than those without higher secondary education. Across OECD countries, on average, a person without an upper secondary education earns USD 38 000, that with an upper secondary education gets USD 46 000, and the tertiary educated one earns USD 68 000 per year. The most enticing salaries for tertiary educated people are reportedly found in Austria, Australia, Ireland, Netherlands, Luxembourg, the United States and the United Kingdom, where employers pay at least USD 20 000 more than the OECD average to employ individuals with tertiary degrees (OECD, 2006). In Switzerland, France, the United Kingdom and Norway, tertiary educated employees contribute 60% or more to the GDP growth. The OECD report (2010) also presented larger

GDP growth in countries such as Russia, Canada, Japan, Israel and America, where the population, has, on average, finished more years of schooling, especially tertiary education, or has attained the highest score on cognitive achievement. Earle (2010) also established a significant and positive correlation on the years of school education at secondary and tertiary levels with 0.44% subsequent increase in economic growth for every year spent at school, which exhibits a huge impact on the overall GDP over time.

3.6 SCIENCE AND ENGINEERING FIELDS OF STUDY

An interesting observation that was made by Hanushek and Wößmann (2007) on the impact of the field of study was that countries that have reasonably more engineering graduates tend to grow faster than those with more law graduates. Also of significant importance is the association that was presented by Wadhwa et al. (2007) on the positive correlation between the number of doctorate graduates in engineering and technology and economic growth in India, China and United States. They firmly believe that the development of engineering skills and talent, together with the ability to inter-connect on a global basis, can fast-track the marginalization of the ancient industrial innovation models by increasing the efficiency of technical design that empower a country's do- it -yourself (DIY) service and other forms of co-production.

Another study that was conducted in Taiwan scrutinised the impact of concentrating in different career disciplines and observed that the fields of engineering and natural sciences showed the greatest economic output effect (Lin, 2004). It was noted that a 1% growth in higher education qualifications comprising college, junior college, university or any graduate school yielded a 0.35% increase in industrial output and a further 1% rise in natural sciences or engineering graduates, resulted in a 0.15% increase in agricultural output. Still on the science and engineering front, Gittleman and Wolff (1993) also revealed a correlation between tertiary education enrolment and labour productivity growth with the quantity of engineers and scientists per capita well proportionally associated with economic growth. Through their cross-country regression analysis World Bank study, Kruss, McGarth, Petersen & Gastrow (2015) showed that research and development (R&D), mainly through companies and tertiary institutions, boost both economic and production growth with a 78% rate of return on R&D. Hanushek et al. (2008) also believe that the more undeviating measure of a country's human capital is the performance of students in mathematics and science subjects, referred to as cognitive skills amongst those entering a country's work force. They believe that accumulating the average number of years of schooling attained by the work force will only boost the economy when the former also boosts cognitive comprehensive system of testing.

3.7 DEBATE ON THE TOPIC

The main debate that has risen out of this study is on the quality of education that the graduates receive (THFE, 2000; Bloom et al., 2010; Earle, 2010; Hussin et al., 2012; OECD, 2012). It is argued that it is rather the quality of education, the tangible skills thus produced and their availability to the national and global economy and competitiveness that are of utmost importance to the country's economic growth and human capital capabilities, than the amount of time spent at school. Earle (2010) based this argument on the performance of New Zealand which is a well-educated country compared to other developed countries, with high increasing proportion of people with tertiary education and a reasonably high proportion with good literacy and numeracy skills. Despite all this high education attainment, New Zealand's labour productivity remains low relative to the level of high educational attainment. The quality of the skills graduates bring to their work is more important than simply the number of people in the workforce holding educational qualifications. The labour force holding these skills are most productive where businesses have the capital, management skills, scale and links to international markets to support innovation and productivity gains (Earle, 2010; Hussin et al., 2012). The OECD report (2012) also emphasised that higher education, on its own, will not make a difference in economic growth if other barriers to development contribute negatively. For example, without sensible macro-economic management, new graduates will be much less likely to find creative jobs. Good governance and openness to trade of the country are other contributing factors. Indeed, higher education generates the prospects, but governments and private sectors must snatch the opportunities.

3.8 CONCLUDING REMARKS

This chapter provided some insight into the theoretical and empirical literature that exists from other researchers on the causal impact of education on economic growth in other countries. Studies reported existence of uni-directional and bi-directional causality. The empirical literature review revealed information on many possible data analysis models that had been used in other studies. Emanating from the empirical literature information, the current study is going to focus on the ADF, PP and KPSS unit root tests, the Johansen co-integration model, as well as the Vector Error Residual Modelling diagnostic frameworks.

CHAPTER FOUR

OVERVIEW OF EDUCATION AND ECONOMIC GROWTH IN SOUTH AFRICA

4.1 INTRODUCTION

Even though there is extensive research on the relationship between education and economic growth, especially in developed countries, this particular research is very scarce in South Africa. The studies conducted in other countries provided mixed results, with most presenting uni-directional causality and very few showing bi-directional causality. This section looks at the education and economic overview of South Africa, from which the sourced data will be used to test for the causal relationship.

4.2 EDUCATION IN SOUTH AFRICA

To understand educational achievements in South Africa, it is imperative to first acquire information on the population thereof. Such understanding of the population will therefore provide some understanding of the educated percentage of the country. At the end of 2014, the population of South Africa was estimated at 54 956 900 with the highest representations in Gauteng, at 13 200 300 (24%), and in KwaZulu-Natal, at 10 919 100 (19.9%), as shown in Table 4.2. Because most of the statistical data at our disposal during this study period is only up to the year 2014, further statistical data presented and discussed/interpreted throughout this thesis is only based up to the year 2014.

Table 4.1: 2014 South African population estimates by province (Source: StatsSA, 2015a)

Province	**2014**	
	Population (‘000)	**% of total population**
Eastern Cape (EC)	6916,2	12.6
Free State (FS)	2817,9	5.1
Gauteng (GP)	13200,3	24.0
KwaZulu-Natal (KZN)	10919,1	19.9
Limpopo (LP)	5726,8	10.4
Mpumalanga (MP)	4283,9	7.8
Northern Cape (NC)	1185,6	2.2
North West (NW)	3707,1	6.7
Western Cape (WC)	6200,1	11.3
Total	**54956,9**	**100.0**

Out of the 2014 population, a percentage of those who were attending any form of schooling are depicted in Table 3.2. Only 29% of South Africans, 5 years and older, were attending school in 2014. Of this overall percentage, 87.3% attended school from Grade 1 to 12. Only 4.9% attended tertiary institutions, whereas 2.5% were at Further Education and Training (FET) colleges.

A high representation of higher/tertiary education attendance was noted for Gauteng (10%), followed by the Western Cape (7.5%) and the Free State (4.9%). The lowest figures were in the Eastern Cape and Limpopo. KwaZulu-Natal came at number 5 with a 3.5% of higher education attendance in 2014. Looking at the population of South Africa by province, one would expect KwaZulu-Natal (2nd highest population) to be ranked number 2 in the tertiary education enrolment.

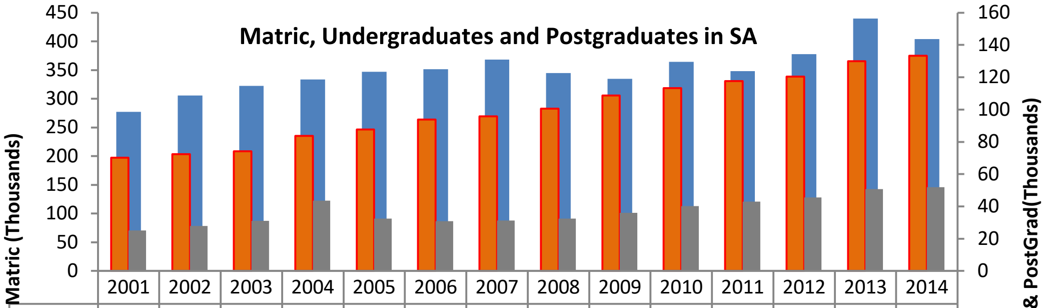
Table 4.2: Percentage of individuals aged 5 years and above who are attending educational institutions by province and type of institution attended in 2014 (Source: StatsSA, 2015a)

Type of institution	**Province (%)**									
	EC	**FS**	**GP**	**KZN**	**MP**	**NC**	**NW**	**LP**	**WC**	**SA**
Pre-school	1.5	3,9	5.0	3.0	2.8	4.6	2.7	1.2	4.5	3.1
School	92,5	83.5	78.1	90.4	90,7	88,5	87.7	92,8	83,3	87.3
ABET	0,5	1.3	0,7	0,4	0,5	0,3	1,7	0,3	0,6	0,6
Literacy classes	0.0	0.1	0.1	0.1	0.0	0.1	0.1	0.0	0.1	0.1
Higher education Institutions	2,2	4,9	10.0	3,5	2,4	2.8	4,4	2,2	7,5	4,9
FET	2.0	4.8	3,4	1,7	2,0	3.2	2,5	2,6	2.4	2,5
Other colleges	0,6	1.3	1,8	0,6	1.1	0.0	0,7	0,7	1,0	1.0
Home Schooling	0.1	0.3	0.3	0.2	0.1	0.0	0.3	0.0	0.3	0.1
Other	0,2	0,3	0,6	0,2	0,3	0,3	0,3	0,2	0,3	0,3
Sub-total ('000)	2265	845	3188	3491	1288	329	1042	1954	1498	15901
Unspecified ('000)	15	9	64	19	6	11	7	7	16	160
Total ('000)	2280	854	3252	3521	1300	330	1041	2017	1961	16061
Total Population ('000)	6916	2817	13200	10919	4284	1185	3707	5726	6200	54957
% Population attending school	33.0	30.3	24.6	32.2	30.3	27.9	28.1	35.2	31.6	29.2

4.2.1 Education Enrolment and Attainment in South Africa

The educational levels of focus for this study are primary and secondary enrolment as well as matric and tertiary (graduate) attainment. Enrolment figures may not give a clear picture of the actual secondary achievement as some students may leave school before acquiring the matric certificate. Hence some focus on the actual matric attainment must be considered as well. A matric certificate is regarded as the main passport to entry to higher education. Also, with a matric certificate, people can be trained towards certain skills without them attending tertiary institutions for a number of years, e.g., in the South African Defence Force (SADF) and the South African Police Services (SAPS). Tertiary education still remains the main phase of skills development and training for the country (South Africa). However, it is acknowledged that a firm foundation has to be laid at primary and secondary levels for a fruitful outcome at the tertiary level, in South Africa.

Figure 4.1 presents the total number of matriculants, undergraduates (UG) and postgraduates (PG) in South Africa from 2001 to 2014. It is encouraging to note a 31% nation-wide increase in the number of matriculants from 277 306 in 2001, to 403 874 in 2014. This was followed by a 47% significant rise in the number of graduates, and a 51% upsurge for postgraduates in 2014. Progression to higher degrees is of great significance for the country, because this is where the innovation, research and development skills, which also contribute more to the country's economic development, are enhanced. The output of academic research in a country also depends on masters and doctorate student enrolment.

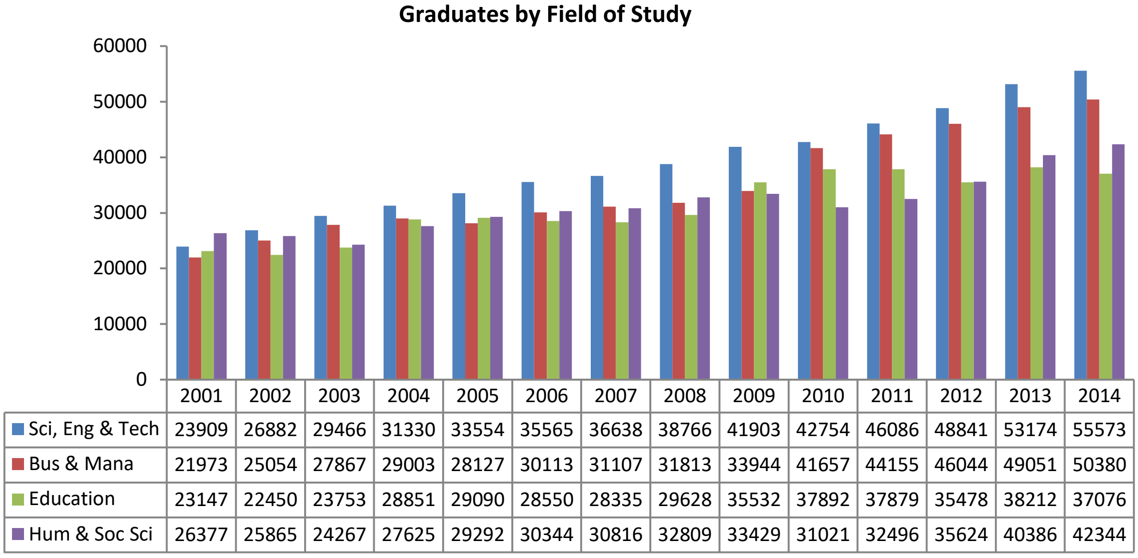


	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Matric	277,30	305,77	322,49	333,71	347,18	351,50	368,21	344,79	334,71	364,51	348,11	377,84	439,76	403,87
UG	70,155	72,417	74,166	83,650	87,652	93,717	95,806	100,52	108,77	113,18	117,55	120,39	130,05	133,37
PG	25174	27,825	30,988	43,561	32,411	30,964	31,348	32,540	36,083	40,142	43,066	45,597	50,773	52,002

UG – Undergraduate; **PG** – Postgraduate

Figure 4.1: Matric, undergraduates and postgraduates in SA, 2001 to 2014 (Source: CHET, 2009 – 2014; DBE, 2001 – 2014)

Figure 4.2 displays the total number of graduates with both undergraduate and postgraduate (PG) qualifications per field of study from 2001 to 2014. It is encouraging to note an increase of 94% in the total number of graduates from 2001 to 2014, from 95 406 to 185 373. A whopping 132% upsurge was realised in the science, engineering and technology field, followed by business and management studies, at 129% increase. Such a significant increase in graduates in the science, engineering and technology studies is highly commendable. Progression from undergraduate level to postgraduate level is also noteworthy even though further developments would be highly encouraged. On average, advancement from undergraduates to postgraduates in all the presented fields is at a 27% increase, with the exception of the education field, which is averaging at 35% per year.



Sci, Eng & Tech – Science, Engineering and Technology; **Bus & Mana** – Business and Management; **Hum & Soc Sci** – Humanities and Social Sciences.

Figure 4.2: Number of graduates by field of study in South Africa, 2001 to 2014 (Source: CHET, 2009- 2014; DOE, 2001 – 2009; DHET, 2009 - 2016)

Table 4.3 summarises the percentage change in the number of graduates for all the different levels and various study fields, from 2001 to 2014. The science, engineering and technology field has experienced a growth of 28%, 19%, 39% and 44%, at undergraduate, honours, masters and doctorate levels, respectively.
The business and management studies portray a remarkable growth from 34% to 76%, for undergraduate and doctorate levels, respectively. The interest in education studies at undergraduate level dropped by 10% from 2001 to 2014. However, those that had already acquired undergraduate degrees seem to show interest in further enrolment to the doctoral level.

Table 4.3: Percentage growth of graduates per study field from 2001 to 2014 (Source: CHET, 2009- 2014; DOE, 2001 – 2009; DHET, 2009 - 2016)

	% Growth, per degree per field (2001-2014)			
Field	**UG**	**Hons**	**MSc**	**PhD**
Sci, Eng & Tech	28	19	39	44
Bus & Mana	34	48	44	76
Education	-10	29	12	51
Hum & Soc Sci	26	8	12	35

Sci, Eng & Tech – Science, Engineering and Technology; **Bus & Mana** – Business and Management; **Hum & Soc Sci** – Humanities and Social Sciences; **UG** – Undergraduate; **Hons** - Honours; **MSc** – Masters; **PhD** – Doctorate

The tertiary education statistics for South Africa, presented above, paints a positive picture about the number of graduates in the urgent and critical skills cluster that were identified by the Joint Initiative for Priority Skills Acquisition (JIPSA) in 2008 (Mantashe, 2008), which were the following:

- High level, world class managerial, planning and engineering skills;
- Town, city and regional planning skills;
- Artisan and technician skills;
- Management and planning skills for public health and education;
- Mathematics, science, information and communications technology (ICT) and language competence teaching in public schools.

The first three are encompassed under the engineering and technology skills, which revealed a 129% increase in the number of graduates from 2005 to 2014 and a progression of 28% to the masters and doctorate levels. This signifies the promising success of JIPSA's initiative in the engineering skills. This improvement in graduate attainment also addresses the skill of science and mathematics competencies in public schools. Of concern though is the relatively lower progression to masters and doctoral degrees in humanities and social sciences.

The discussion above warrants a need for the South African government to align their education developments, and policies, towards encouraging more science and engineering graduates and also to foster the culture of education progression to the higher level masters and doctoral degrees.

4.2.2 Government Interventions in Skills Development in South Africa

As part of government's intervention in education and upskilling towards improving the economy, it was acknowledged that to realise and uphold 6% plus growth in the economy, heavy investment in education and skills is the key determinant, amongst other things (Mantashe, 2008). As government continued to invest in infrastructure development, the skills shortage became more evident. This led to the formation and intervention of the Joint Initiative for Priority Skills Acquisition (JIPSA), whose principal role was to determine collections of critical skills shortages with the necessary sets of interventions, who highlighted bottlenecks towards recommending solutions to curb the shortage. This initiative identified five urgent and critical skills clusters which are mentioned in the previous section. From this, targets of additional 1 000 graduate engineers and 50 000 new artisans per annum, by 2010, were set. This meant that tertiary institutions had to produce an average of 2 500 graduate engineers per annum, notwithstanding the fact that a proper process had to be followed between institutions and businesses to develop these graduates to professional engineers, thus retaining them in practice (Mantashe, 2008). As mentioned above, the JIPSA's interventions appear to be fruitful, with a 27% increase in output of engineering graduates from 2005 to 2014.

4.3 ECONOMIC GROWTH IN SOUTH AFRICA

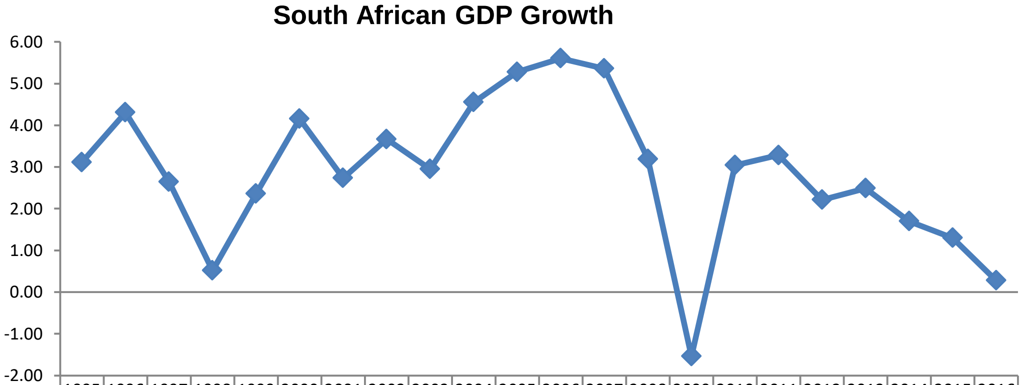
The South African GDP economy is made up of three main sectors: primary, secondary and tertiary sectors (Pritzker, Arnold & Moyer, 2015). The primary sector is the one that is closest to natural resources and includes both agriculture and mining which work directly on the natural raw products found on or under the soil. The secondary sector consists of activities that process raw materials into manufactured products or material goods that are readily used by consumers. The tertiary sector is even distantly detached from natural resources and its activities belong to the service sector, where manufactured goods are sold and marketed under a particular brand identity. Table 4.4 shows the sub-sectors that fall in each of the main sectors.

Table 4.4: Sectors of the South African Economy (Source: StatsSA, 2015b)

Main Sector	Sub-Sectors
Primary	Mining and Quarrying
	Agriculture, Forestry and Fishing
Secondary	Manufacturing
	Electricity, Gas and Water (utilities)
	Construction
Tertiary	Finance, insurance, real estate and business services
	General Government
	Wholesale, retail, and motor trade; catering and accommodation
	Transport and communications

The South African GDP growth has been reasonably strong from 1995, having grown on average by 2.8% in the period 1995 to 2016. High growth was experienced between 2003 and 2007, with an average of 4.8%, reaching a high of 5.6% in 2006. During this period, the underlying GDP contributing parameters, such as employment rate and investment, increased; the unemployment rate, inflation and interest rate decreased drastically. The global financial crisis that was experienced in 2008 led the South African economy into a domestic recession in 2009, resulting into a GDP contraction of 1.5%. The recession put a halt to the growth progress and deterred all the gains that the economy had experienced until 2007.

From 2010 to 2016, GDP growth has been slow and trending downwards with an average growth of 2.1% as shown in Figure 4.3.



	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
GDP Growth	3.12	4.31	2.65	0.52	2.36	4.15	2.74	3.67	2.95	4.55	5.28	5.60	5.36	3.19	-1.54	3.04	3.28	2.21	2.49	1.70	1.30	0.28

Figure 4.3: GDP growth rate in South Africa (Source: StatsSA, 2017)

Figure 4.4 shows the contributions of the various sectors to the South African economy in 2015.

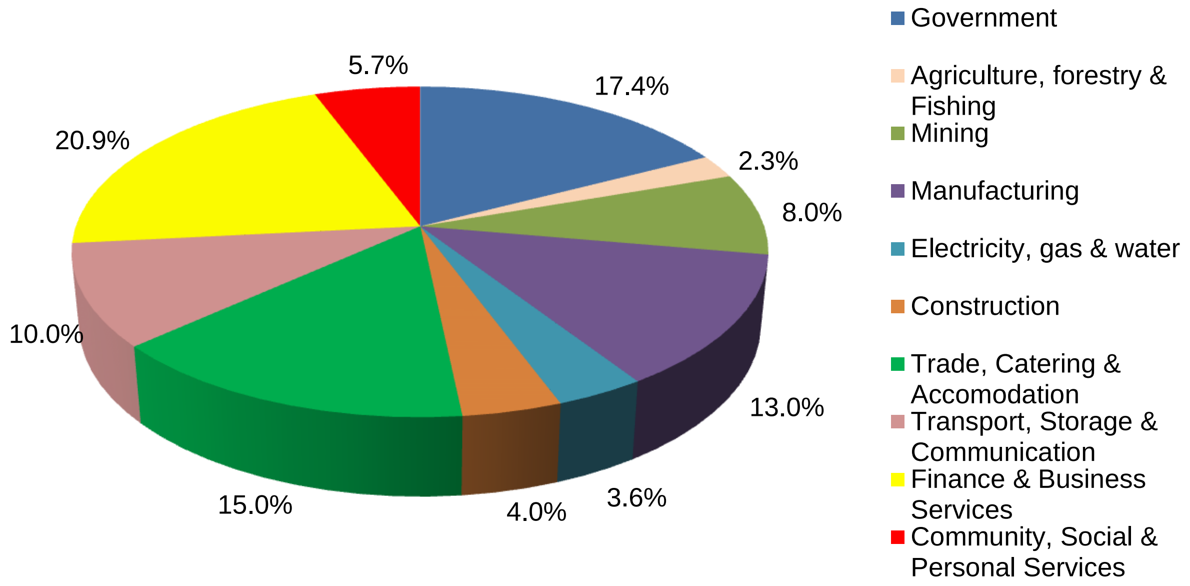


Figure 4.4: Contributions of the various economy sectors to the South African GDP (Source: IDC, 2016 and compiled by the author)

This justifies that the South African GDP has moved from being steered by the agriculture, mining and manufacturing sectors. If general government services were to be excluded, the current main drivers of the economy are finance, and business services; followed by trade, catering and accommodation; then manufacturing at 20.9%, 15.0% and 13.0%, respectively (IDC, 2016). The agriculture and mining sectors are overwhelmed by low-skilled employees who happen to be the first to be affected by job losses during a recession, as these sectors' segments of the economy declines. Economic growth is still prejudiced towards capital and skill- rigorous sectors which cannot captivate a big pool of unskilled workers, thus resulting in high unemployment rates.

Tying up with sector contributions to the GDP, finance and business services sector is the biggest employer at 20,4%, followed by trade catering and accommodation and manufacturing at 19.2% and 11.5%, respectively. This is in exclusion of government services (Figure 4.5).

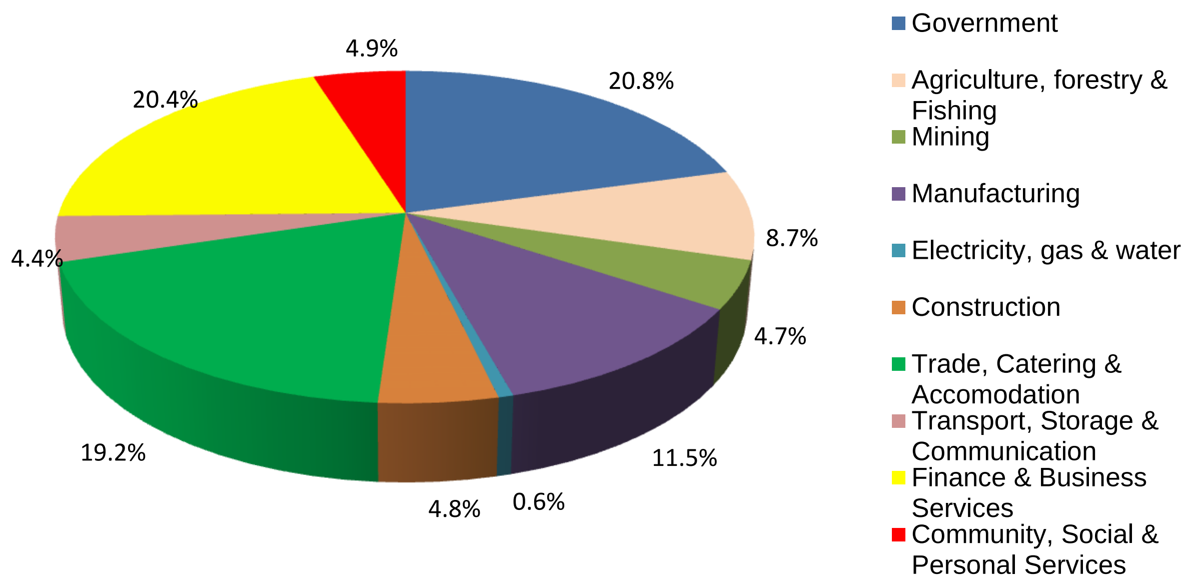


Figure 4.5: Economy sectoral composition of employment in South Africa in 2015 (Source: IDC, 2016 and compiled by the author)

Intertwined with economic growth and employing sectors, are the salaries that employees earn in different sectors as shown in Figure 4.6. It is evident that, with the exclusion of general government services, the highly paid employees are in the finance and manufacturing sectors, as stated above. These two sectors require highly skilled scientists, engineers, technologists and accountants. Hence the anticipated correlation between the number of graduates in these particular fields and economic growth is noticeable.

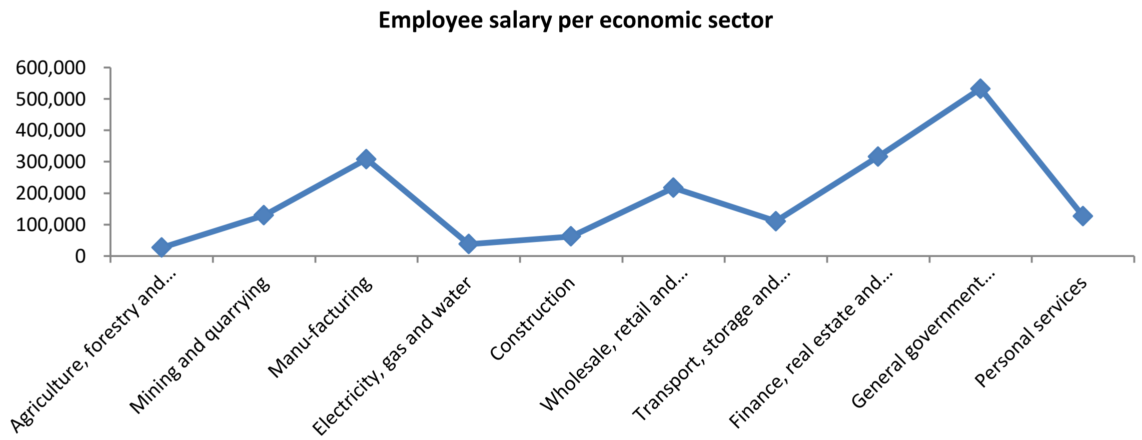


Figure 4.6: Employee salaries in different economic sectors (Source: StatsSA, 2015c)

4.4 RGDP, TERTIARY GRADUATES AND SALARIES IN SOUTH AFRICA

Figure 4.7 shows the relationship between RGDP, salaries and the number of graduates per year from 2005 to 2014 in South Africa. As expected, there is a positive correlation between the three parameters. The highly qualified the members of the economy are, the higher the salaries, and also as the aggregate number of graduates increases, the aggregate salary rises. This results in higher consumer spending which increases the RGDP growth. In addition, as the output skills level goes up, the higher is the productivity of the employees, and in turn more goods and services are produced in a short space of time.

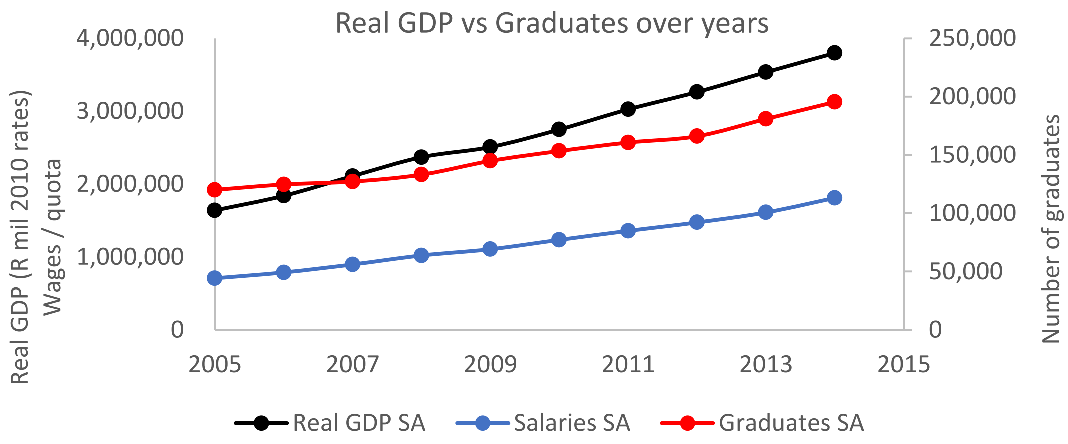


Figure 4.7: Relationship between education, salaries and RGDP (Source: CHET, 2009- 2014; DOE, 2001 – 2009; DHET, 2009 – 2016; StatsSA, 2015b, 2015c)

4.5 UNEMPLOYMENT RATES AND POVERTY LEVELS IN SOUTH AFRICA

As much as this study particularly focuses on the impact of education on economic growth, it is acknowledged that, in addition to education, there are other critical factors that affect the economic growth, such as poverty and unemployment rates. These two factors are briefly discussed in the following paragraphs.

4.5.1 Unemployment Rates

South Africa is struck by very high unemployment rates. The South African youth are the most affected by the high unemployment rates. StatsSA (2017) reported an increase from 32.7% to 36.1% in youth unemployment rate in the post recessionary period between 2008 and 2014. Over this period, every province exhibited a drop in the youth percentage of the working age population as well as in employment rates. The unemployment rate has been steadily higher by 20% amongst youth than among adults. This is concerning considering that the youth should be the main drivers of the economy. The unemployment rate drops with age, with unemployment rates highest among 15–19 year olds. Unemployment rates are also linked to education achievement. The less educated population is more prone to being unemployed. StatsSA (2017) reported that those with education achievements less than matric constitute 57.4% of the unemployed population.

The current overall unemployment rate in South Africa is 27.7% (StatsSA, 2017). In 2017, the increase in employment was largely compelled by finance and other business services economic sectors, followed by community, social and personal services as well as transport. All the other industries reported employment growth quarter-to-quarter except manufacturing, construction and agriculture which reported a decline in employment growth. It should be noted that construction and agriculture employ a big cohort of unskilled and uneducated labour force (StatsSA, 2017).

Eastern Cape and Limpopo followed by KwaZulu-Natal show the highest unemployment rates (StatsSA, 2017). This is in line with the education statistics presented in the previous pages, where the Eastern Cape and Limpopo showed the lowest enrolment at tertiary level.

4.5.2 Poverty Levels

The percentage of the population living in poverty in South Africa has not changed considerably between 2006 and 2013 (Lehohla, 2017). Lehohla's study revealed an increase in the food poverty line (FPL), which is the rand value below which persons are unable to purchase or consume enough food to supply them with the minimum per-capita-per-day energy consumption for adequate health, from R219/person/month to R531/person/month) in 2006 to 2017, respectively.

The impact of the 'social wage' mechanism that was introduced by government in an effort to improve people's lives and reduce their cost of living since 1994 is highly acknowledged (Lehohla, 2017). This is achieved through the Reconstruction and Development Plan (RDP) houses, social grants for the elderly and children, free health care, free basic education and provision of free basic services such as water, electricity and sanitation. The success of this ‘social wage’ intervention was witnessed through the South Africa Multidimensional Poverty Index (SAMPI) which showed a drop in poverty levels from 17, 9% in 2001 to 8.0% in 2011, with a further drop to 7.0% in 2016 (Lehohla, 2017). Despite this 1% promising drop in poverty levels from 2011 to 2016, the households suffered some financial well-being due to other factors such as stagnant economic growth, increasing unemployment rates and higher food and goods prices. Poverty levels increased in 2015, with a 55.5% increase in the poverty headcount in from 53.2 % in 2011, with 30.4 million South Africans living in poverty. This translates to more than one out of two South Africans living in poverty, from a population of 55 million, in 2015 (Lehohla, 2017).

Eastern Cape, Limpopo and KwaZulu-Natal are the most poverty stricken provinces in South Africa faced with critical challenges of high unemployment rates, poor education quality, inadequate and poor location of infrastructure and poor quality public health systems (Lehohla, 2017).

The high poverty levels of these provinces justify the low economic growth presented in the previous chapters.

4.6 CONCLUDING REMARKS

This chapter provided an overview of the economic state and education achievements of South Africa. An overall increase in the number of education enrolments and achievements was noted. Reasonable progressions to postgraduate levels for all the different fields of study were also realised. A decline in economic growth that was revealed is worrisome. The information herein presented forms the basis for analysis and discussion of these variables in the following chapters.

CHAPTER FIVE
RESEARCH METHODOLOGY AND FRAMEWORK

5.1 INTRODUCTION

This chapter aims to unearth the research design and strategy that will be followed to determine if there is any causal relationship between education (independent variable) and economic growth (dependent variable). The sources of data and the attainment thereof will also be covered as well as the econometric models that will be used to analyse and verify the data. This will start with stationarity/unit root tests, followed by co-integration tests, and then the data validation and diagnostics tests.

5.2 MODEL SPECIFICATION

The study will employ panel data methodology, where yearly panel data will be utilised to investigate the relationship of the different levels of education in all the provinces, education index and government expenditure on education, as well as innovation, research and development, salaries and field of study on education.

The current study employed XLSTAT econometrics model for panel data analysis. Panel data applies the internal data transformation, by taking first differences if the second dimension of the panel is an appropriate time series to deal with encounters with overlooked individual heterogeneity (Hsiao, 2003). It also permits for the growth of dynamic panel data (DPD) models, which allow modelling of partial modification as they contain one or more lagged dependent variables. Panel data analysis also employs control for variables that cannot be observed or measured, which may interfere with the tested variables, such as cultural factors, poverty, race, gender, or differences in business practices across companies, or any variables that change over time but not across entities, such as national policies or international agreements (Wooldridge, 2002; Lüktepohl, 2005).

The main models that will be used in the study are briefly discussed below. The unit roots will be discussed later in the chapter.

XLSTAT offers four different possibilities for transforming a time series {Xt} into {Yt}, (t=1,…,n), to achieve stationarity.

This study will employ the Box-Cox transformation in order to improve the normality of the time series, to make the panel data stationary.

The Box-Cox transformation is defined by the following equation:

$$Y_t = \begin{cases} \frac{X_t^{\lambda}-1}{\lambda}, & (X_t > 0, \lambda \neq 0) \; or \; (X_t \geq 0, \lambda > 0) \\ \ln (X_t), & X_t > 0, \lambda = 0 \end{cases} \qquad 5.1$$

XLSTAT accepts a fixed value of l, or it can find the value that maximizes the likelihood of the residuals, the model being a simple linear model with the time as sole explanatory variable.

Once stationarity has been achieved, the variables will be subjected to co-integration. XLSTAT uses the maximum likelihood methodology proposed by Johansen (1988, 1991) which is based on Vector Autoregressive (VAR) models as described below:

The levels VAR(*P*) model for *Yt* have to be considered where:

Yt is a *K*-vector of I(1) time series:

$$Y_t = \Phi D_t + \Pi_1 Y_{t-1} + \ldots + \Pi_p Y_{t-p} + \varepsilon_t \qquad for \;\; t = 1, \ldots, T \qquad 5.2$$

Dt contains deterministic terms such as constant or trend and

ε_t is the vector of innovations.

The parameter *P* is the VAR order and is one of the input parameter to Johansen's methodology for testing co-integration.

According to the Granger representation theorem (Granger; 1981), a VAR(*P*) model with I(1) variables can equivalently be represented as a Vector Error Correction Model (VECM):

$$\Delta Y_t = \Phi D_t + \Pi Y_{t-1} + \Gamma_1 \Delta Y_{t-1} + \ldots + \Gamma_{p-1} \Delta Y_{t-p+1} + \varepsilon_t \qquad 5.3$$

Δ denotes the difference operator,

$$\Pi = \Pi_1 + \ldots + \Pi_{p-1} - I_k \quad 5.4$$

$$\Gamma_l = -\sum_{j=l+1}^{p} \Pi_j \quad 5.5$$

In this representation, ΔY and its lags are all I(0). The term Y_{t-1} is the only potentially non-stationary component. Therefore for the above equation to hold (a linear combination of I(0) terms is also I(0), the term $\Pi\, Y_{t-1}$ must contain the co-integration relationship if it exists.

Two sequential procedures proposed by Johansen are implemented to evaluate the co-integration rank using the following equations:

The λmax test (or lambda max) uses the statistic:

$$LR_{max}(r_0) = -T \ln(1 - \hat{\lambda}_{r_0+1}) \quad 5.6$$

the trace test for which the statistic is: $LR_{trace}(r_0) = -T \sum_{i=r_0+1}^{n} \ln(1 - \hat{\lambda}_i)$ 5.7

where LR is the Likelihood Ratio.

5.3 VARIABLES, PROXIES AND DATA SOURCES

The study will use yearly panel data from 2001 to 2014 for the variables such as primary and secondary school enrolment as well as matric and tertiary school attainment, in order to analyse the effects of education on economic growth. The education index and government expenditure on education were also utilised as proxies for the country's education measure. The school enrolment and attainment data and GDP data that will be used is the readily available secondary data obtained from Statistics South Africa (StatsSA), the Department of Higher Education and Training (DHET), the Department of Basic Education (DBE), Productivity South Africa and the World Bank. The education data is usually released a year or two later. Therefore data presented in this study might be delayed by approximately two years; hence the study only covers until 2014.

The main variables used in the study are economic growth and education. These are presented in Table 5.1 and further described in the following paragraphs.

Table 5.1: Variables and proxies (Source: compiled by the author)

Variable	Proxies	Data Source
Economic growth	Real gross domestic product	StatsSA
Education	Primary school enrolment	Department of Basic Education
	Secondary school enrolment	Department of Basic Education
	Matric attainment	Department of Basic Education
	Tertiary school attainment	Department of Higher Education and Training
	Government expenditure on education	World Bank/Productivity South Africa
	Education Index	World Bank/Productivity South Africa

Table 5.1 shows the variables thus used. Primary school enrolment is used as a foundation stage for cognitive skills. Secondary school enrolment is also used even though not all students from the secondary school will finish matric and create skilled human capital in the economy. Secondary education may also only play a role in economic growth after a sizeably long period. For this reason matric attainment was used as a better measure. Tertiary education achievement was assumed as the most reliable measure of skilled human capital that directly relates to the quality of education in South Africa which contributes directly to economic growth.

5.4 DATA ANALYSIS AND ECONOMETRICS SOFTWARE

Prior to econometrics modelling, descriptive statistical analysis will be conducted to determine whether the data follows a normal distribution or not.

Data analysis will be conducted following the empirical econometrics methods that were identified from the empirical literature survey. Such methods include the Phillips-Perron (PP), Kwiatkowski, Phillips, Schmidt and Shin (KPSS) and Augmented Dickey-Fuller (ADF) stationarity tests, as well as the Johansen co-integration tests. These will be briefly explained in the next few pages.

The econometrics software that will be used for all the data analysis is XLSTAT, which is an econometrics advanced version of Excel. The statistical data thus produced from the programme will be analysed and interpreted as it is, with no modifications.

5.5 GRAPHICAL PRESENTATIONS AND DESCRIPTIVE STATISTICS

One of the vital statistical analyses in descriptive statistics is the characterization of the location and variability of the data set. Such further characterization of the data comprises kurtosis and skewness.

Skewness is the degree of symmetry, or lack of symmetry, in a data set. A data set or distribution is symmetric if it appears to be the same to the left (as indicated by a negative sign) and to the right (positive sign) of the mean or center point. The higher the value, the more the distribution differs from a normal distribution (Trochim & Donnelly, 2006; Field, 2000, 2009; Gravetter & Wallnau, 2014). A figure of zero implies no skewness at all. A huge negative figure represents a negatively skewed distribution whereas a large positive value indicates a positively skewed data set.

Kurtosis is a measure or degree of how heavy-tailed or light-tailed the data set is relative to a normal distribution. The data sets with high kurtosis are indicated by heavy tails, or outliers, whereas that with low kurtosis is likely to have light tails, or no outliers (Trochim & Donnelly, 2006; Field, 2000 & 2009; Gravetter & Wallnau, 2014).

The acceptable values for skewness/asymmetry and kurtosis are ±2 for considerable evidence of normal distribution in the data set (Trochim & Donnelly, 2006; Field, 2000, 2009; George & Mallery, 2010; Gravetter & Wallnau, 2014).

5.6 REVIEW OF THE ESTIMATION TECHNIQUES

To be in a position to determine if there is a causal relationship between education and economic growth, a series of econometric tests needs to be conducted. Since a longitudinal panel time series data is used for the study, stationarity or unit root tests have to be conducted so that false regressions may be eliminated. This will be followed by a co-integration technique which estimates whether there are any long-run relationships that exist between the education variables and economic growth. This will be concluded with data validation and diagnostic checks.

5.6.1 Testing for Stationarity / Unit Root Testing

Time series, where Yt (t = 1,2...), are regarded as stationary when their statistical attributes such as the mean, variance and autocorrelation do not fluctuate with time (Said & Dickey, 1984; Brockwell & Davis, 1996). If non-stationarity is identified, the time series is said to possess a unit root. Once non-stationarity is identified, it is imperative to further analyse where it is coming from. For example, a time series can be stationary in difference where Y_t may not be stationary but the difference Y_t - Y_{t-1} may be stationary. Time series can also be stationary in trend.

Stationarity is a key notion underlying time series data analysis and it is imperative to test the data for stationarity before identifying any possible long- run relationships. A number of economic variables that are used for policy and strategy analysis and forecasting are characterized by high persistence of non-stationarity behaviour. It is common practice in applied economics to subject these data series to pre-tests for unit roots prior to co-integration and Vector AutoRegressive (VAR) analysis (Greene, 2010). This aims to determine suitable transformations that will deem the data stationary.

The well-known unit root tests are Phillips-Perron (PP), Kwiatkowski, Phillips, Schmidt and Shin (KPSS) and Augmented Dickey-Fuller (ADF) tests. They assist in determining stationarity and are mostly based on formal statistical tests.

The current study will employ the ADF, PP and KPSS tests. Comparison of results obtained from these different tests will also be made.

5.6.1.1 The Augmented Dickey Fuller (ADF) Test

The Augmented Dickey-Fuller (ADF) test comprises extra lagged terms of the dependent variable which aid in eliminating autocorrelation (Dickey & Fuller, 1979, Fuller, 1996). The ADF has additional lagged differenced term on the right-hand side of the equation which corrects for high order serial correlation. Below is the ADF equation:

$$\Delta \boldsymbol{Y_t} = \emptyset \boldsymbol{Y_{t-1}} + \sum_{i-1}^{m} \boldsymbol{\alpha_i} \Delta \boldsymbol{Y_{t-1}} + \boldsymbol{\varepsilon_t} \quad 5.8$$

The null hypothesis of the ADF test is that there is a unit root in the non-stationary time series, whereas the alternative hypothesis assumes that the time series is stationary, with no unit root (Claessens & Thomas, 1997), as presented below.

H_0 (Null): There is a unit root for the series

H_a (Alternate): There is no unit root for the series

If the null hypothesis is not rejected, transformation of the series is necessary, in order to enable analysis of the time series and to make further predictions.

On series transformation, there are two possible alternative hypotheses such as:

H_{a1}: the series is stationary

H_{a2}: the series is explosive

The statistics used in the Dickey-Fuller test are computed using a linear regression model, and correspond to the *t* statistic computed by dividing the coefficient of the model by its standard error.

Dickey and Fuller (1979) define 3 different models assuming:

- without an intercept (no constant)
- with an intercept (constant, *μ)*
- with an intercept (constant, *μ)* and a linear trend function of *t*

5.6.1.2 Phillips-Perron (PP) Test

The Phillips-Perron (PP) test is an alternate simplification of the Dickey-Fuller test to more composite data generation developments which was introduced by Phillips (1987) and further developed by Perron (1988) and Phillips & Perron (1988).

Just like the DF test, the PP test, also considers three possible regressions, namely:

- without an intercept,
- with an intercept and
- with an intercept and a time trend,

as given in the following regression equations, respectively:

$$X_t = \rho X_{t-1} + \varepsilon_t \quad 5.9$$

$$X_t = \rho X_{t-1} + \alpha + \varepsilon_t \quad 5.10$$

$$X_t = \rho X_{t-1} + \alpha + \beta \cdot \left(t - {}^{T}/_{2}\right) + \varepsilon_t \quad 5.11$$

One of the distinguishing features of the PP test is that, unlike the Augmented Dickey-Fuller (ADF) test, it does not deal with serial correlation at the regression level. Instead, it applies a non-parametric correction to the statistic itself to accommodate possible effects of heteroscedasticity (to be further discussed later) and serial correlations on the adjustment residuals.

The PP test uses the same distribution as the DF or ADF t-statistic. Critical value and p-value estimates are made following the surface regression approach proposed by MacKinnon (1996), or by using Monte Carlo simulations.

5.6.1.3 Kwiatkowski, Phillips, Schmidt and Shin (KPSS) Test

The ADF and PP tests will be supplemented by the KPSS test. This test was developed by the authors Kwiatkowski, Phillips, Schmidt & Shin (1992), hence KPSS.

Liang and Teng (2006) have shown that the KPSS test generally has greater power than other unit root tests. Unlike the ADF test, this test tests the null hypothesis that the time series is stationary, versus non-stationary. Thus, under stationarity tests, the data will appear stationary by default if there is little information in the sample. The test is based on the residuals from the Ordinary Least Squares (OLS) regression of the dependent variable on the explanatory variables. The KPSS test is similar to the ADF test but the former includes an automatic correction for auto correlated residuals (Brooks, 2004, 2008) and does not suffer from small sample problems.

The KPSS test is conducted using the t-statistic following the same method as the ADF test approach. The calculated t-statistic is compared with the KPSS test (1992) critical values in order to make a conclusion about the stationarity of a series. The null hypothesis (of stationarity) is rejected when the calculated t-value is greater than the critical t-value using the 5% level of significance.

5.6.2 Co-integration Tests

Economic theory often suggests that certain pairs of economic or financial variables should be linked by a long-run economic relationship. Many economic or financial time series appear to be of order I(1) where variables are likely to deviate at time, $T \rightarrow \infty$ because their unconditional variances are proportional to time (MacKinnon, Haug & Michellis, 1998). Because the variables are order I(1), it may appear that they would never be expected to follow any sort of long-run equilibrium relationship. However, it is possible for two (or more) variables to be I(1), and yet exhibit a certain linear combination of order I(0). Such variables are regarded as co-integrated. Co-integrated variables obey an equilibrium relationship in the long-run, even though they may deviate substantially from such equilibrium in the short run (Engle & Granger, 1987).

In summary, co-integration is an equilibrium relationship between time series that individually are not in equilibrium correlation, thus describing a linear relationship. It is useful because it allows econometricians to incorporate both short-term dynamics (deviations from equilibrium) and long-run expectations (corrections to equilibrium) into the tested series.

In economics and finance, researchers utilize co-integrated variables to assess possible economic relationships, based on the hypothesis of a long-run equilibrium between non-stationary time series.

For the time series data, it is important to perform co-integration instead of R-squared correlation between non-stationary variables X or Y to establish a linear relationship. It often happens that standard regression analysis, with high R-squared values and low p-values, can be misleading when dealing with non-stationary variables, resulting in spurious regressions that suggest existing relationships when there are actually none (Granger & Newbold, 1974).

Once the variables have been found to be stationary, the next step is to determine whether there exists any long-term relationship between them. This requires testing the possibility of co-integration among the variables thus investigated. The process of conversion of non-stationary data into stationary data loses the long-run relationship between the variables, which might be the case in the current study. Therefore, testing of co-integration of the variables will be relevant for this study. The main tests used are the Granger causality test and the Johansen technique.

5.6.2.1 Granger Causality Test

The Granger causality test is used to assess whether one variable is useful in predicting another variable and vice-versa. Granger's (1981) work is dominant in the literature, and is popularly known as the Granger causality test. Generally, a time series X is known to Granger cause another time series Y if it can be shown that the series X values provide statistically significant information about the upcoming values of series Y, if not, X does not Granger cause Y. This is verified through a probability value that falls within the range of 1% and 10% or an F-statistic that takes an absolute value of at least 2. The higher the value, the more significant it becomes.

5.6.2.2 Johansen Co-integration Test

The initial multi-variate procedure for assessing long-run relationships was established by Johansen (1988). This method uses a maximum likelihood procedure to assess the presence of co-integrating vectors in a set of non-stationary time series. The null hypothesis assumes that there is no co-integration amongst the series whilst the alternative states that there is at least one co-integrated series.

The current study will use the Johansen model for co-integration tests as it permits estimation of a dynamic error correction specification, which affords estimates of both the short- and the long-run dynamics in the tool. It allows for testing of restricted forms of the co-integrated vectors (Johansen & Juselius, 1990).

Generally the number of co-integration relationships amongst the *p* variables is not known but the limits are 0 to k, even though the economic theory might provide a guide to the number of equilibrium relationships. In practice the Johansen (1991) full maximum likehood (λmax) procedure is commonly used to estimate co-integration relationships.

The initial step in the Johansen procedure, which differentiates between equilibrium and dynamic adjustment to equilibrium, encompasses the estimation of a congruent, unrestricted, closed *p*th order VAR in a k variables, the Lag order. For this framework linearity is assumed in logs of the variables. The VAR is pth order in the sense that longest lag length p, which becomes $p-1$ on the Δyt in the VECM is chosen to eliminate serial correlation among error terms. There are k equations in the VAR/VECM model therefore no variables are left unexplained implying that the system is closed.

5.6.2.2.1 Lag Order Selection Criteria

A significant aspect in the analysis of VAR models is the determination of the lag length of the VAR model. The lag length and the information criteria (IC) sets (ie. the yt and zt vectors) are formulated in a practical application. The model design criteria require that the estimated model must exhibit congruency such that the estimated residuals must not reveal serial correlation (autocorrelation) and there should be no heteroscedasticity on the data set, and in addition the residuals must be normally distributed. In an attempt to achieve autocorrelation free residuals, the vital decision is the choice of the lag length *p* via the use of AIC, SBC or Lagrange multiplier interests. The most popular information criteria (IC) applied in order to determine the optimum IC for identifying the correct lag structure of a two-variable co-integrated process are the Akaike Information Criterion, AIC (Akaike, 1973), Corrected Akaike's Information, BIC (Akaike, 1974), Schwarz Information Criterion, SIC (Schwarz, 1978) and Hannan-Quinn Information Criterion, HQ (Hannah & Quinn, 1979).

Patterson (2000) recommends that the AIC and SIC tests should be used in selecting the order (p) of the VAR model. The choice of the appropriate lag length is critical for obtaining models whose disturbance terms exhibit 'white noise'. XLSTAT multivariate menu under the VAR option provides an option to choose "Automatic" for the VAR order where the software selecting the most reliable and maximum lag length based on the data of the variables analysed. The selection procedure involves choosing the VAR(p) model with the highest value of the AIC or SIC. Pesaran and Shin (1997) advocate that in using both criteria it is important that the maximum VAR (p) order chosen is high enough for high order VAR specifications to have a reasonable chance of being selected.

The approach that will be employed for the determination of the lag length in this study is to choose the highest value selected by AIC.

The Johansen co-integration test is based on Vector Autoregressive (VAR) models. It formulates co-integrated variables directly on maximum likelihood (λmax) estimation instead of relying on OLS estimation. The Johansen tests are referred to as maximum eigenvalue test and trace tests which indicate the likelihood of co-integration. They are based on the rank (r) of Π which represents the number of co-integrating vectors. Both tests assess the null hypothesis of no co-integration against the alternative hypothesis of existing co-integration.

5.6.2.2.2 Maximum Eigenvalue Test

The maximum eigenvalue (λmax) test assesses whether the largest eigenvalue is zero relative to the alternative hypothesis that the next largest eigenvalue is zero. The null hypothesis presents that the matrix rank Π = 0, whereas the alternative hypothesis suggests that the matrix rank Π = 1. The test uses the largest eigenvalue, λ, where, if the matrix rank is zero, i.e., largest eigenvalue is zero (λ = 0), there is no co-integration. If the largest eigenvalue is non-zero, the rank of the matrix may be at least one and there is a possibility of more co-integrating vectors. The Johansen test permits a choice amongst three existing options regarding the deterministic time trend of data such as: no trend, linear trend and quadratic trend. The appropriate nature of trend has to be selected based on the tested series.

5.6.2.2.3 Trace Test

This test is referred to as the trace test because its statistic's asymptotic distribution is the trace of a matrix based on functions of Brownian motion or standard Wiener processes (Johansen, 1991), which is a building block of all stochastic processes.

The trace test assesses whether the rank of the matrix Π is r_0. The null hypothesis is such that matrix rank (Π) = r_0 against the alternative hypothesis of $r0 < \text{rank}(\Pi) \leq n$, where n is the maximum number of possible co-integrating vectors.

5.7 DIAGNOSTIC MODELS/ VECTOR ERROR CORRECTION MODELLING (VECM)

Once the co-integration estimation results are attained, it is imperative to conduct a further series of diagnostic models to ascertain the adequacy and efficiency of the chosen models. Diagnostic tests are a critical step for validation of the variable estimation results that the model produces. These models will determine if the chosen estimation techniques can be trusted and if sound conclusions can be drawn from them. The ideal model design criteria requires that the estimated model must be such that estimated residuals must not reveal serial correlation (autocorrelation) and there should be no heteroscedasticity on the data set, and that the residuals must be normally distributed.

To check for acceptability of the model, Johansen (1991) suggests the use of residuals from the unrestricted model, the Lagrange Multiplier (LM) test, which tests the autocorrelation in the residuals and checks for variable cross-sectional dependence (Pesaran, 2004). Another diagnostic model is the Jarque-Bera, which tests for normal distribution of the residuals.

This study will utilise both the Lagrange Multiplier and Jarque-Bera tests to test for serial autocorrelation and normal distribution.

5.7.1 Lagrange Multiplier (LM) Test

Most econometricians acknowledge that autocorrelation does not always genuinely originate from the behavioural characteristics of the residuals. It can also be a result of mis-specification of the model or when an important role player variable has been omitted from the regression. This test permits identification of cases of heteroscedasticity, which causes the classical estimators of the factors of the linear regression to be erratic (Newey & West, 1987).

Heteroscedasticity describes the case wherein the variance of errors of the model, also referred to as residuals, is not the same for all observations. Standard estimation methods are inefficient when the errors are heteroscedastic or have non-constant variance. The opposite thereof is homoscedasticity, which assumes a basic hypothesis that the variances are homogeneous and that the errors of the model (residuals) are identically distributed. Heteroscedacticity is tested using the Lagrange Multiplier (LM) as proposed by Koenker (1981) using the following equation:

$$LM = nR^2 \qquad 5.12$$

The null hypothesis of the LM test will be that there is correlation between education and economic growth. The LM test puts more emphasis on the value of the R^2 of the regression. If one or more coefficients in an equation are statistically significant, then the value of R^2 for that equation will be low and relatively significant.

The null and alternate hypotheses are such that:

H0: The residuals are homoscedastic

Ha: The residuals are heteroscedastic

If the data are homoscedastic, the coefficient of determination R^2 should then not be equal to 0. If H0 is not rejected it can be concluded that heteroscedasticity does not exist.

This statistic has the advantage of asymptotically following a chi-square distribution with p degrees of freedom, where p is the number of explanatory variables. If the residuals are heteroscedastic, thus rejecting the null hypothesis, it becomes necessary to transform the data before the regression is performed or to use modelling methods that account for the variability of the variance.

5.7.2 Jarque-Bera Test

The Jarque-Bera test was also exercised to evaluate if the VECM residuals obtained in linear regression are normally distributed. This normality attribute is required for valid inference when performing hypotheses testing. It describes the quality of the confidence intervals surrounding certain parameters and predictions. For the Jarque-Bera test, the lower the p-value, the more likely is the normality of the sample.

The null hypothesis of normality is rejected if the calculated test statistic exceeds a critical value from the distribution. The null hypothesis is that residuals are normally distributed. If $p < 0.05$, the null hypothesis is rejected.

5.8 ETHICAL CONSIDERATION

Even though the study employs the data that is readily available from the public domains specified earlier, the study proposal was submitted for ethical considerations, and was approved with the ethical clearance certificate issued.

5.9 CONCLUDING REMARKS

The chapter gave insight into the analytical framework that will be utilised in the study to investigate the causal relationship between education and economic growth in South Africa. The dependent variable is economic growth and the independent variables were identified as primary and secondary education enrolment, as well as matric and tertiary education graduation/attainment.

The estimation and verification models to be employed are the ADF, PP and KPSS stationarity tests, the Johansen test as a co-integration model, and the Lagrange Multiplier (LM) as well as Jarque-Bera tests, for assessment of the model and diagnostics tests for the reliability of causal relationship between education and economic growth.

CHAPTER SIX
DATA ANALYSIS AND PRESENTATION

6.1 INTRODUCTION

This chapter adopts the econometrics models presented in the preceding research framework chapter. The results demonstrated herein attempt to address the main research objections of whether the levels of education enrolment and attainment have an impact on the economic growth of South Africa, with particular focus in all of its nine provinces.

6.2 GRAPHICAL PRESENTATION AND ANALYSIS OF THE GDP AND EDUCATIONAL DATA FOR THE NINE PROVINCES OF SOUTH AFRICA

Graphs were drawn from the secondary data that was obtained from the sources disclosed in Chapter 5 (for the period 2001 to 2014), for all the main independent parameters, primary and secondary school enrolment as well as tertiary graduation from the secondary. The dependent variable, economic growth, is also discussed (data from 1995 to 2015).

6.2.1 Real GDP (RGDP) Trends for the Nine Individual Provinces and South Africa

Figure 6.1 displays the economic trends (R'000) for the nine provinces as well as that of South Africa. The economic data presented throughout this chapter is Real GDP (RGDP) at 2010 constant prices. It is apparent that RGDP is increasing in all the provinces. The effects of the 2008/9 global financial crisis are quite noticeable with a drop in RGDP in all the provinces. Overall, the Free State, North West and Limpopo provinces experienced a slow, and in some years, stagnant economic growth. The North West province also suffered a stagnant economic growth between 2010 and 2014. The biggest contributing provinces to the country's economy are Gauteng, KwaZulu-Natal and Western Cape, with the Northern Cape being the least contributor. This is understandable for the Northern Cape considering their lowest population in the country. The Eastern Cape, Limpopo and Mpumalanga provinces share the same RGDP of around R220 million.

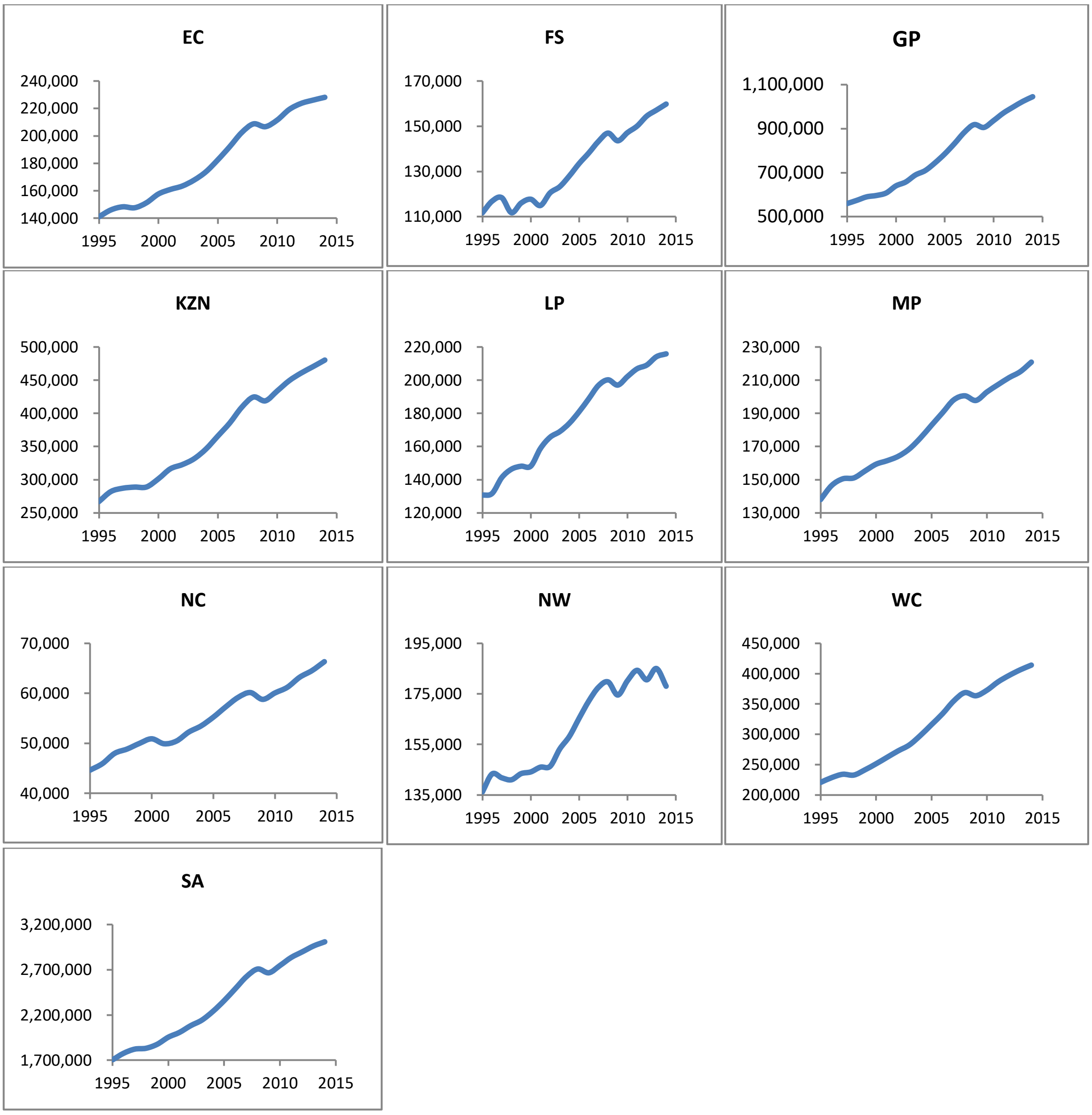


Figure 6.1: RGDP trends (R'000) by province and in South Africa, 1995 to 2015 (Source: StatsSA, 2015)

6.2.2 Education Trends by Province and for South Africa

The education trends interrogated are for primary and secondary education enrolment, matric and tertiary education attainment.

6.2.2.1 Primary Education Enrolment

The primary education enrolment is demonstrated in Figure 6.2. It is worrying to note that the primary education enrolment has been constantly declining throughout the years covered in this study in at least five provinces, namely the Eastern Cape, KwaZulu-Natal, Free State, Limpopo and North West, up to 2010, despite the increase in population size. However, a motivating upward trend from around 2011 for most of these provinces was realised. These five provinces seem to influence the overall South African primary education enrolment, in line with the population they each hold in to the overall South African population. As expected, the primary education enrolment in Gauteng, Western Cape and Northern Cape provinces is trending upwards, from 2005, with Gauteng displaying a very sharp increase. It is not clear why a 6% drop in national primary school enrolment was realised from 2007 to 2011. However, Branson and Lam (2010) reported a 6.2% to 13.2% percentage increase in students repeating grades at primary level, around this same period. This 6% decline could be attributed to such, considering that repeating students actually take space for potential new admissions.

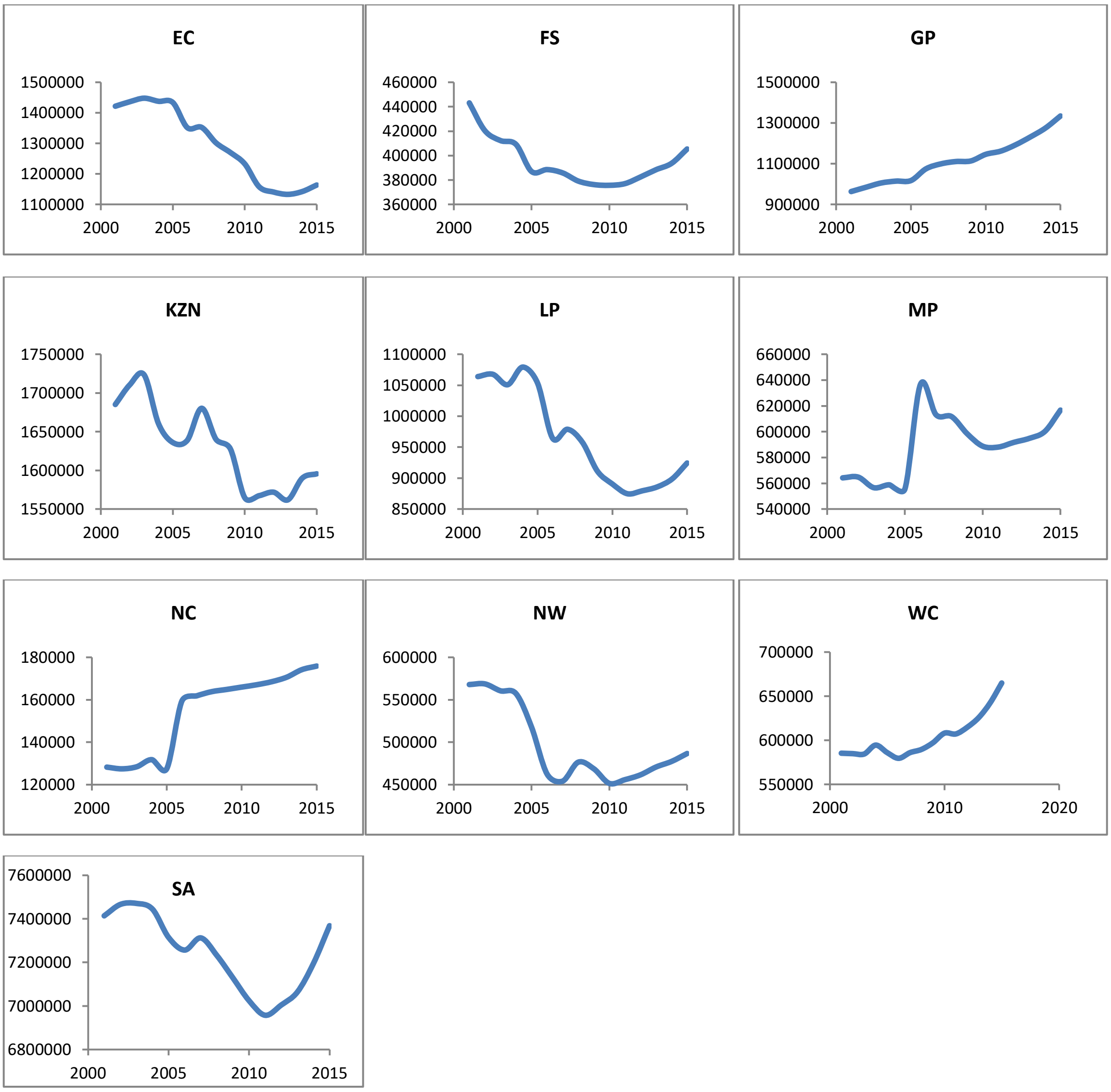


Figure 6.2: Primary education enrolment by province and in South Africa, 2001 to 2014 (Source: DBE, 2001 – 2016; DOE, 2001 - 2009)

6.2.2.2 Secondary Education Enrolment

Figure 6.3 demonstrates secondary education enrolment in South Africa. A decline in secondary school enrolment was experienced by all the provinces between 2006 and 2009. The drop continued in the North West and Free State provinces throughout the years covered in the study. It is not clear whether this decrease could be linked to the global financial crisis experienced in 2008 – 2009. As observed with primary enrolment, Gauteng, Northern Cape and Western Cape Provinces display distinctively high secondary education levels. Most of the provinces, such as the Eastern Cape, Limpopo and Mpumalanga, battled to pick up from the 2008 decline and appear to be stagnant throughout the years.

Figure 6.3: Secondary education enrolment by province and in South Africa, 2001 to 2014 (Source: DBE, 2001 – 2016; DOE, 2001 - 2009)

6.2.2.3 Matric Attainment

It is acknowledged that secondary enrolment does not guarantee matric attainment, as some students may drop out even before matric. As such, the impact of matric pass rates on the economic growth was also assessed as shown in Figure 6.4.

All the provinces are showing no recognisable trend with a number of rises and troughs noted. All the provinces also portray an increase from 2011 to 2012 turning into a decline in the number for matriculants from 2013. Limpopo and the North West provinces were on a sharp decline from 2006 to 2009, showing no change in the number of matriculants from 2001 to 2014. The Western Cape was stagnant until 2011, with a steep increase noted from 2012 to 2014. A 2.4% decline in number of matriculants was noted from 2013 to 2014, for South Africa which could be due to high failure rates or that since 2013, secondary schools do not accept learners who failed matric back at school to repeat the same grade.

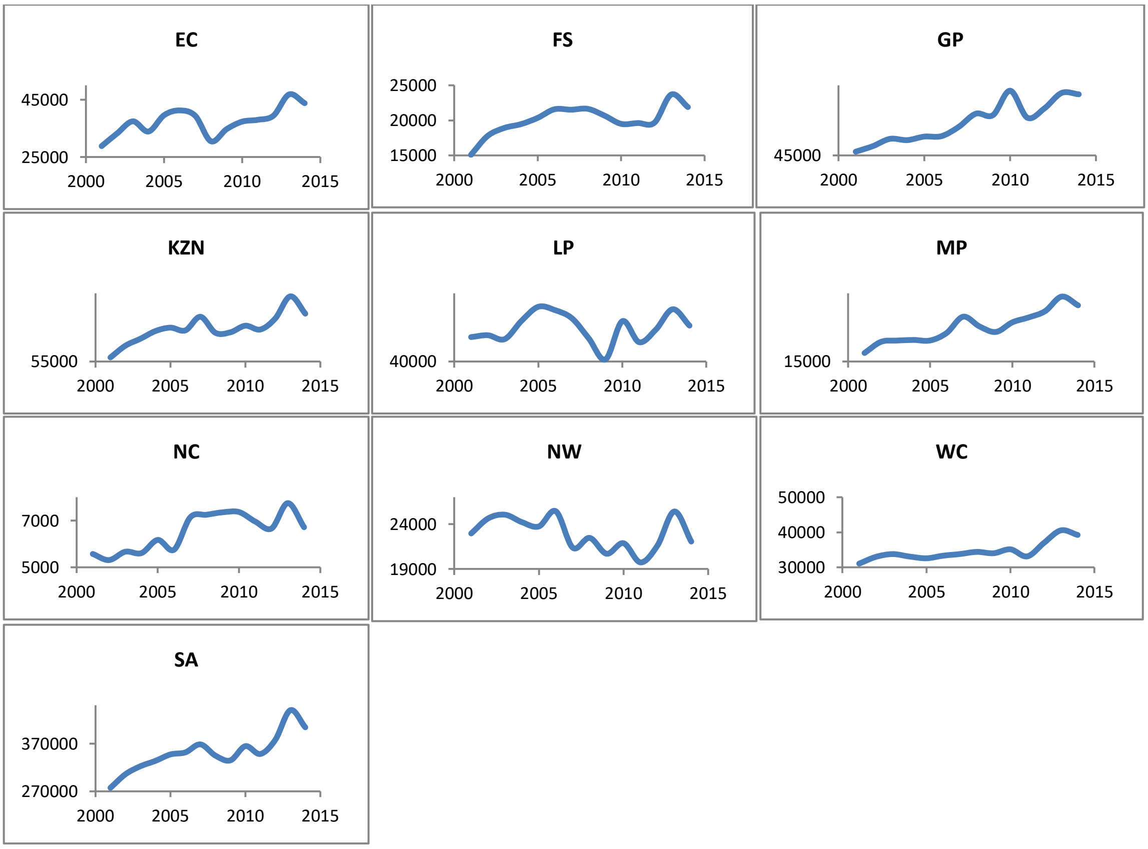


Figure 6.4: Matriculants by province and in South Africa, 2001 to 2014 (Source: DBE, 2001 – 2016; DOE, 2001 - 2009)

6.2.2.4 Tertiary Education Attainment

This parameter measures the number of graduates at all degree levels from colleges, former technikons and traditional universities in each province. It must be noted that Mpumalanga and Northern Cape provinces do not have tertiary institutions and there is no presentation of the data for such provinces. It is explicable to assume that students from these two provinces pursue their tertiary education at other provinces as most do not always pursue such studies in their native provinces anyway.

As shown in Figure 6.5, all the provinces exhibit an upward trend in tertiary education graduation with Gauteng, Western Cape, KwaZulu-Natal and North West provinces showing the sharpest increase. Gauteng, Western Cape and KwaZulu-Natal provinces revealed the highest number of graduates. This could also tie up with the number of the institutions as well population density in these provinces. Limpopo and the Free State provinces produced the lowest number of graduates, with the Eastern Cape province showed a number of troughs and uptrends until 2008, and thereafter drastically picked up. A drop in tertiary school graduates between 2013 and 2014 seems to move with the drop in matric attainment.

Van Broekhuizen, Van der Berg and Hofmeyer (2016) attribute this to substantial delayed entry into university after matric. They suggest that only between 59% and 69% of the learners who enter undergraduate studies within four years of writing matric examinations do so in the year immediately after matric.

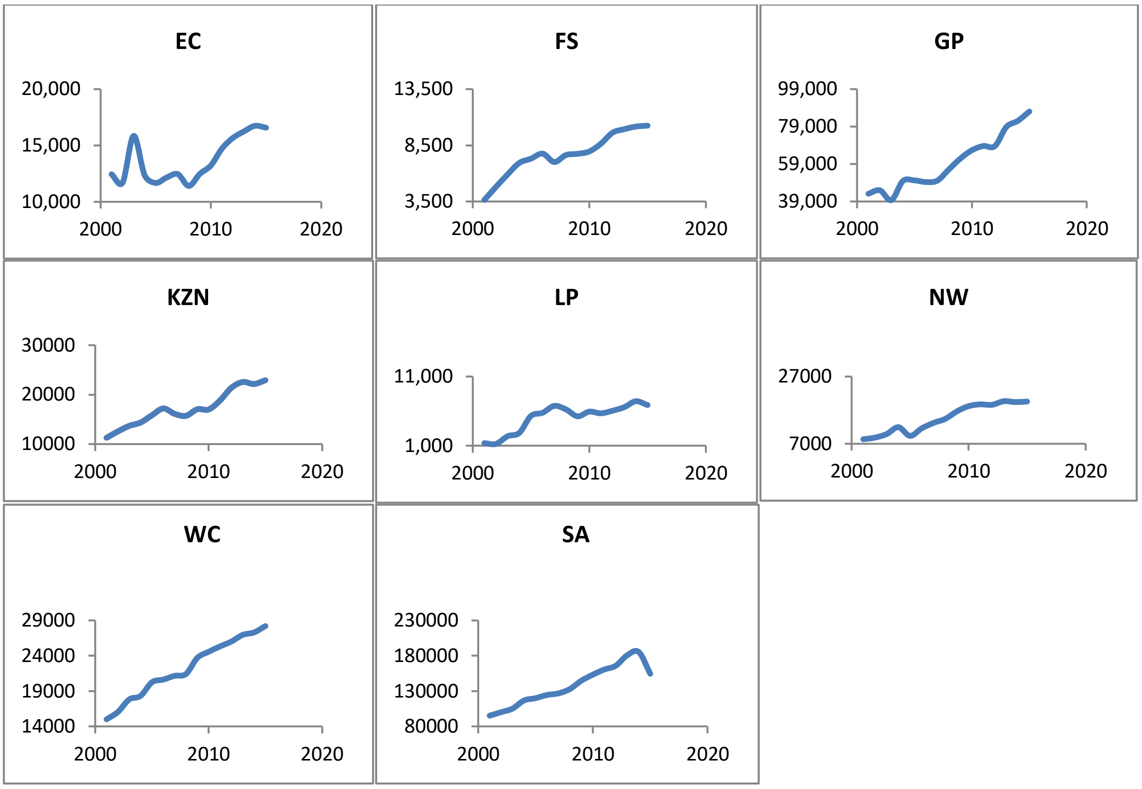


Figure 6.5: Tertiary education graduates by province and in South Africa, 2001 to 2014 (Source: DHET, 2009 – 2016; DOE, 2001 - 2009)

6.3 DESCRIPTIVE STATISTICS FOR RGDP AND EDUCATIONAL DATA FOR THE NINE PROVINCES OF SOUTH AFRICA

Tables 6.1 to 6.5 demonstrate the descriptive statistics conducted from the secondary data obtained for the period 2001 to 2014, for the RGDP, primary and secondary enrolment and tertiary education graduates. It must be noted that for the entire series data, the median and the mean are not more than 10% far apart from each other, which highlights that the series in the data are symmetric. Also, all the series skewness and kurtosis figures are within the acceptable range of ±2, indicating that the data sets are normally distributed.

Table 6.1: Descriptive statistics for RGDP (R'million), 2001 to 2014 (Source: StatsSA, 2015)

Statistic	EC	FS	GP	KZN	LP	MP	NC	NW	WC	SA
No. of Obs.	14	14	14	14	14	14	14	14	14	14
Minimum	141, 09	111,74	559,92	267,06	130, 63	137,98	44,63	136,18	220,56	1703,54
Maximum	228,160	159,82	1045,63	480,33	215,89	220,88	66,34	185,05	414,15	3009,28
Range	87,06	48,08	485,74	213,27	85,24	82,90	21,729	48,87	193,58	1305,83
Median	178,23	130,79	765,39	355,98	177,53	178,99	54,35	161,77	307,02	2299,97
Mean	182,92	132,69	783,84	366,50	176,29	179,86	55,02	161,55	311,89	2337.31
Std. Dev. (n)	298,03	161,14	162,24	69,984	27,89	25,24	6,292	17,20	65,40	432,81
Skewness (Fisher)	0.142	0.226	0.146	0.184	-0.185	0.015	0.130	-0.019	0.095	0.082
Kurtosis (Fisher)	-1.601	-1.532	-1.522	-1.520	-1.416	-1.430	-1.162	-1.831	-1.581	-1.559
SE (Mean)	6837	3697	37224	16055	6398	5791	1443	3947	15005	99293

On average, the RGDP ranges from R55 million to R784 million, for Northern Cape to Gauteng provinces. This is justifiable for the Northern Cape province, because they hold the least population in South Africa. KwaZulu-Natal and the Western Cape provinces follow Gauteng province, at R366 million and R312 million, respectively, way below half that of the latter. The average for North West, Limpopo, Mpumalanga and Eastern Cape provinces is R161, R176, R179 and R183 million, respectively.

Table 6.2: Descriptive statistics for primary education enrolment, 2001 to 2014 (Source: DBE, 2001 – 2016; DOE, 2001 - 2009)

Statistic	EC	FS	GP	KZN	LP	MP	NC	NW	WC	SA
No. of Obs.	14	14	14	14	14	14	14	14	14	14
Minimum	160977	114954	657912	316312	158825	161447	49910	145990	262034	2007549
Maximum	228160	159824	1045659	480335	215888	220883	66343	185052	414147	3009283
Median	204559	143445	894797	413894	196956	197931	58986	176074	359248	2645891
Mean	197677	140088	864805	401046	191408	192621	58009	170093	344959	2555747
Std. Dev. (n)	23197	13618	124418	54535	18073	18666	4969	13291	49263	325499
Skewness (Fisher)	-0.319	-0.403	-0.248	-0.213	-0.427	-0.345	-0.143	-0.812	-0.337	-0.336
Kurtosis (Fisher)	-1.434	-0.950	-1.287	-1.389	-1.141	-1.117	-0.946	-0.831	-1.259	-1.273
SE (Mean)	6434	3777	34507	15125	5013	5177	1378	3686	13663	90277

The average primary education enrolment ranges from 58 009 to 864 805 pupils, for the Northern Cape and Gauteng provinces. As observed with RGDP, North West, Limpopo, Mpumalanga and Eastern Cape provinces, showed the lowest enrolments rates at an average of 170 093, 191 408, 192 621 and 197 677 pupils, respectively. Similarly to the RGDP trend, the average primary education enrolment in KwaZulu-Natal and the Western Cape provinces is below half that of Gauteng province.

Table 6.3: Descriptive statistics for secondary education enrolment, 2001 to 2014 (Source: DOE, 2001 - 2009; DBE, 2001 - 2016)

Statistic	EC	FS	GP	KZN	LP	MP	NW	NC	WC	SA
No. of Obs.	14	14	14	14	14	14	14	14	14	14
Minimum	585998	239199	568178	931615	647917	331829	263499	63448	317820	4029274
Maximum	661114	270073	793114	1109168	751290	413491	334308	95363	363862	4611095
Range	75116	30874	224936	177553	103373	81662	70809	31915	46042	581821
Median	637060	252249	722966	1030755	704150	394512	276266	91074	348418	4471468
Mean	633790	253153	705824	1028978	702704	378419	290782	84540	347886	4426063
Std. Dev. (n)	17899	9074	69667	60000	25523	28360	25325	12148	13498	180778
Skewness (Fisher)	-1.244	0.131	-0.719	-0.109	-0.276	-0.682	0.620	-0.867	-0.777	-1.054
Kurtosis (Fisher)	1.249	-0.920	-0.684	-1.375	0.557	-1.451	-1.485	-1.196	-0.081	0.041
SE (Mean)	4784	2425	18619	16036	6821	7579	6768	3247	3608	48315

An interestingly high average secondary education enrolment of 1 028 978 pupils was noted for KwaZulu-Natal, followed by Gauteng, Limpopo and Eastern Cape provinces, at 705 824, 702 704 and 633 790 students, respectively. The lowest enrolment exhibited by the Northern Cape province is admissible, because of its lowest population. Mpumalanga and the Western Cape provinces displayed the same average of 378 419 and 347 886, respectively.

Table 6.4: Descriptive statistics for matric attainment, 2001 to 2014 (Source: DOE, 2001 - 2009; DBE, 2001 - 2016)

Statistic	EC	FS	GP	KZN	LP	MP	NW	NC	WC	SA
No. of Obs.	14	14	14	14	14	14	14	14	14	14
Minimum	28825	15073	47368	58620	40776	18136	19737	5309	31049	277306
Maximum	46840	23689	86556	112403	60087	38820	25440	7749	40542	439764
Range	18015	8616	39188	53783	19311	20684	5703	2440	9493	162458
Median	37733	20016	66252	82832	52462	26868	22717	6688	33778	347651
Mean	37457	20099	66391	84255	52276	27706	22950	6520	34569	351416
Std. Dev. (n)	4743	2007	12650	12413	5256	5679	1766	790	2537	38532
Skewness (Fisher)	0.034	-0.792	0.257	0.204	-0.366	0.327	-0.086	-0.118	1.300	0.453
Kurtosis (Fisher)	-0.090	1.762	-1.240	1.341	-0.112	-0.619	-1.130	-1.589	1.184	1.160
SE (mean)	1315	557	3508	3443	1458	1575	490	219	704	10687

On average, KwaZulu-Natal province shows the highest number of matriculants. This ties up with the highest secondary education enrolment displayed by the province. The trend is the same as that noticed for the secondary education enrolment with KwaZulu-Natal province, followed by Gauteng, Limpopo and Eastern Cape provinces.

Table 6.5: Descriptive statistics for tertiary education graduates, 2001 to 2014 (Source: DHET, 2009 – 2016; DOE, 2001 - 2009)

Statistic	**EC**	**FS**	**GP**	**KZN**	**LP**	**NW**	**WC**	**SA**
No. of Obs	14	14	14	14	14	14	14	14
Minimum	11407	3634	39740	11298	1274	8361	15012	95329
Maximum	16751	10254	87093	22935	7433	19662	28205	185373
Range	5344	6620	47353	11637	6159	11301	13193	90044
Median	12476	7749	56143	17023	5771	14402	21428	133016
Mean	13716	7692	59838	17265	5058	14563	22187	137849
Std. Dev. (n)	1935	1857	14397	3543	1969	4190	4069	27494
Skewness (Fisher)	0.459	-0.530	0.496	0.224	-0.984	-0.148	-0.207	0.166
Kurtosis (Fisher)	-1.653	0.043	-0.939	-0.914	-0.452	-1.749	-1.139	-1.043
SE (Mean)	517	496	3848	947	526	1120	1087	7348

Gauteng province reclaimed its first position in the number of tertiary education graduates with an average of 59 838 graduates, followed by the Western Cape, KwaZulu-Natal, North West and Eastern Cape provinces, at 22 187, 17 265, 14 563 and 13 716, respectively. It appears that, although KwaZulu-Natal province seems to enrol the highest number of pupils at secondary education level, this does not filter up to the tertiary education level, thus producing fewer tertiary education graduates. This could be due to the delayed entry in university after matric as observed by Van Broekhuizen et. al. (2016) who suggest that only between 59% and 69% of the learners who enter undergraduate studies within four years of writing matric examinations do so in the year immediately after matric.

The majority of economic and financial time series are known to hold a unit root. If econometric analysis is undertaken on such series, spurious results will be obtained. It is therefore imperative to test for the presence of unit roots or stationarity of the time series, hence referred to as the order of integration.

The following pages present the results of the unit root tests conducted for all the variables.

6.4 ECONOMETRICS ANALYSIS RESULTS

The results for the stationarity, co-integration and diagnostics tests that were conducted are presented below.

6.4.1 Stationarity / Unit Root Test Results

Non-stationarity in a time series occurs when there is no constant mean, no constant variance, or both of these properties. It can originate from various sources but the most important one is the unit root.

Each variable had to be tested for the presence of a unit root. This is done because co-integration requires that the tested variables be of the same order. Several trend assumptions were undertaken: individual intercept, individual intercept and trend, and lastly none. Because, in most cases the investigated time series data is strongly trending, it is acceptable to allow for both individual time trends and intercept. Therefore the results mostly considered and presented for these currently examined time series are intercept and trend.

Tables 6.6 to 6.8 display the results of the panel unit root tests under the trend and intercept assumption for the three unit root tests, ADF, PP and KPSS, at a confidence level of 5% ($p = 0.05$). For the ADF and PP tests, the null hypothesis is that there is a unit root whereas the KPSS test assumes that there is stationarity. The KPSS test assumed the trend option. If p is < 0.05 the null hypothesis is rejected and the alternate hypothesis rules. This will mean that the series contains a unit root.

The ADF and PP test results for primary education enrolment and RGDP unit root tests show a p-value > 0.05 thus indicating existence of a unit root for all the series, as presented in Table 6.6. The KPSS test supports this notion with p-values < 0.05.

According to Bergmeir & Hyndman (2014), Proietti & Lutkepohl (2011, 2013), many time series variables do not assume the requirements of parametric statistical tests in the sense that they are either not normally distributed or the standard deviations are not homogeneous, or even both. Conducting a descriptive statistical analysis and econometrics tests on such data may give misleading and spurious results. In most cases, transforming the data will make it fit the normal distribution assumptions better or it will improve the normality of the series. To achieve this for the explored time series data, both differencing and Box-Cox power transformation were exercised. The Box-Cox natural logarithm transformation was applied for all the series data because of its popularity in economics and finance time series and also it has been researched quite extensively (Bergmeir & Hyndman, 2014; Proietti & Lutkepohl, 2011, 2013).

The unit root before and after transformation is presented in Table 6.6 – 6.8. The data for each province before transformation is denoted by the province abbreviation, e.g., EC for the Eastern Cape, and that after transformation is denoted by prefix T, e.g., TEC for transformed Eastern Cape data. It must be noted that Mpumalanga and Northern Cape provinces do not have tertiary institutions; there is no tertiary data for these provinces in Table 6.8. Also, there is no provincial data for other variables presented such as education index, government expenditure, field and level of study, salaries, etc. and unit root test results for entire SA are reported as presented in Table 6.8.

The actual statistics value is presented followed by the p-value in brackets. As mentioned previously, a p-value > 0.05 indicates existence of a unit root for the series data for the ADF and PP tests. For the KPSS test, p-values > 0.05 indicate stationarity.

The null hypothesis is that is there is a unit root and we fail to accept that at 5% level of significance, meaning the series is stationary. The results in Tables 6.6 to 6.8 show that all variables are stationary after transformation at the 5% significance level, with p-values < 0.05 for the ADF and PP tests, and are supported by the KPSS test, with p-values > 0.05.

It can therefore be inferred that all the variables are non-stationary, each containing at least one unit root, thus meaning that they are integrated of order one, $I(1)$.

Table 6.6: Unit root test results for RGDP and primary education enrolment

Variable	**Primary**			**RGDP**		
	ADF	**PP**	**KPSS**	**ADF**	**PP**	**KPSS**
EC	-1.89(0.623)	-2.08(0.603)	0.16(0.039)	-0.84(0.932)	-1.13(0.932)	0.24(0.02)
TEC	-2.11(0.037)	-1.80(0.037)	0.12(0.129)	-0.62(0.035)	-0.75(0.035)	0.11(0.148)
FS	-1.15(0.212)	-0.96(0.212)	0.34(0.000)	-0.73(0.134)	-1.44(0.134)	0.28(0.005)
TFS	-3.28(0.035)	-3.05(0.035)	0.17(0.202)	-1.98(0.005)	-2.46(0.05)	0.11(0.151)
GP	5.88(1.000)	5.74(1.000)	0.21(0.001)	4.85(1.000)	4.49(1.000)	0.25(0.001)
TGP	-5.38(0.001)	-5.27(0.001)	0.11(0.158)	-5.02(0.001)	-5.41(0.001)	0.15(0.151)
KZN	5.69(1.000)	5.88(1.000)	0.31(0.001)	5.99(1.000)	5.31(1.000)	0.23(0.003)
TKZN	-0.79(0.035)	-0.87(0.035)	0.16(0.202)	-1.98(0.050)	-2.46(0.050)	0.11(0.147)
LP	-0.89(0.928)	-1.00(0.928)	0.35(0.011)	4.92(1.000)	5.01(1.000)	0.31(0.000)
TLP	-0.39(0.040)	-1.19(0.040)	0.12(0.129)	-0.20(0.040)	-0.34(0.040)	0.15(0.171)
MP	0.51(0.810)	0.61(0.810)	0.22(0.021)	5.23(1.000)	5.43(1.000)	0.25(0.001)
TMP	0.21(0.008)	0.21(0.008)	0.14(0.062)	-3.05(0.035)	-3.12(0.035)	0.11(0.132)
NW	-0.41(0.33)	0.31(0.330)	0.32(0.006)	4.71(0.968)	5.01(0.968)	0.19(0.012)
TNW	-0.26(0.040)	-0.87(0.040)	0.19(0.302)	-2.14(0.045)	-3.12(0.045)	0.09(0.211)
NC	1.37(0.948)	1.64(0.948)	0.31(0.020)	5.48(1.000)	5.56(1.000)	0.15(0.001)
TNC	0.30(0.011)	0.403(0.011)	0.196(0.238)	-1.785(0.048)	-1.823(0.048)	0.141(0.119)
WC	2.59(0.995)	2.11(0.995)	0.30(0.001)	5.15(1.000)	5.31(1.000)	0.09(0.211)
TWC	0.62(0.012)	0.62(0.012)	0.19(0.213)	-0.96(0.044)	-1.21(0.044)	0.34(0.021)
SA	**-0.16(0.609)**	**-0.13(0.609)**	**0.22(0.006)**	**4.99(1.000)**	**5.01(1.000)**	**1.15(0.187)**
TSA	**-0.19(0.043)**	**-0.09(0.043)**	**0.15(0.081)**	**-3.28(0.035)**	**-3.13(0.035)**	**0.32(0.011)**

Table 6.7: Unit root test results for secondary enrolment and matric attainment

	Secondary			Matric		
Variable	**ADF**	**PP**	**KPSS**	**ADF**	**PP**	**KPSS**
EC	1.11(0.921)	1.13(0.921)	0.24(0.002)	0.68(0.850)	0.98(0.850)	0.16(0.039)
TEC	-3.54(0.023)	-3.94(0.023)	0.12(0.129)	-2.11(0.037)	-1.80(0.037)	0.12(0.129)
FS	-0.88(0.316)	-0.89(0.316)	0.17(0.027)	0.95(0.899)	1.03(0.899)	0.18(0.019)
TFS	-2.41(0.030)	-2.41(0.030)	0.12(0.201)	-3.51(0.026)	-3.62(0.026)	0.11(0.201)
GP	3.15(0.998)	2.66(0.998)	0.28(0.000)	1.99(0.999)	2.34(0.999)	0.19(0.012)
TGP	-2.55(0.042)	-2.57(0.042)	0.07(0.282)	-1.27(0.026)	-2.11(0.026)	0.14(0.191)
KZN	1.85(0.978)	1.25(0.978	0.22(0.008)	-2.17(0.468)	-2.26(0.468)	0.32(0.000)
TKZN	-2.73(0.008)	-2.29(0.008)	0.10(0.202)	-0.18(0.037)	-0.21(0.037)	0.10(0.202)
LP	0.56(0.822)	0.62(0.822)	0.21(0.080)	4.73(1.000)	4.30(1.000)	0.28(0.000)
TLP	-2.81(0.040)	-2.85 (0.040)	0.13(0.210)	-0.39(0.034)	-0.96(0.034)	0.07(0.101)
MP	0.77(0.867)	0.99(0.867)	0.21(0.007)	5.64(1.000)	4.65(1.000)	0.21(0.009)
TMP	-3.64(0.042)	-2.20(0.042)	0.16(0.411)	-0.08(0.025)	-0.27(0.025)	0.08(0.121)
NW	0.71(0.121)	1.15(0.121)	0.29(0.000)	-0.27(0.569)	-0.27(0.569)	0.16(0.038)
TNW	-0.25(0.049)	-0.67(0.049)	0.01(0.107)	-2.44(0.041)	-2.45(0.041)	0.11(0.153)
NC	-1.58(0.353)	-1.62(0.353)	0.25(0.002)	0.29(0.755)	0.52(0.755)	0.29(0.001)
TNC	-1.42(0.021)	-1.52(0.021)	0.131(0.061)	-1.04(0.202)	-1.51(0.202)	0.07(0.128)
WC	0.97(0.581)	1.01(0.581)	0.02(0.042)	2.49(0.994)	2.06(0.994)	0.32(0.001)
TWC	-3.01(0.043)	-3.11(0.043)	0.15(0.321)	0.62(0.012)	0.96(0.012)	0.09(0.228)
SA	**2.01(0.986)**	**2.11(0.986)**	**0.32(0.000)**	**5.93(1.000)**	**4.89(1.000)**	**0.31(0.000)**
TSA	**-3.21(0.010)**	**-1.83(0.010)**	**0.09(0.154)**	**-0.19(0.043)**	**-0.09(0.043)**	**0.11(0.147)**

Table 6.8: Unit root test results for tertiary education attainment other education variables

Variable	Tertiary		
	ADF	PP	KPSS
EC	1.18(0.893)	1.95(0.893)	0.22(0.005)
TEC	-3.51(0.026)	-3.63(0.026)	0.10(0.211)
FS	1.29(0.941)	1.31(0.941)	0.19(0.013)
TFS	-5.09(0.002)	-4.26(0.002)	0.16(0.141)
GP	0.89(0.928)	1.00(0.928)	0.23(0.004)
TGP	-1.69(0.038)	0.49(0.038)	0.10(0.194)
KZN	2.11(0.621)	2.87(0.621)	0.26(0.001)
TKZN	-0.23(0.041)	-0.31(0.041)	0.09(0.217)
LP	0.91(0.892)	0.71(0.892)	0.31(0.000)
TLP	-4.13(0.033)	-2.49(0.033)	0.12(0.130)
NW	-0.85(0.146)	-1.44(0.146)	0.34(0.000)
TNW	-2.11(0.037)	-1.95(0.037)	0.12(0.130)
WC	-2.45(0.144)	-3.31(0.144)	0.25(0.002)
TWC	-0.09(0.043)	-0.11(0.053)	0.11(0.181)
SA	**-0.74(0.126)**	**-1.85(0.126)**	**0.16(0.038)**
TSA	**-0.22(0.039)**	**-0.31(0.039)**	**0.12(0.121)**

	ADF	PP	KPSS
Education Index			
SA	1.12(0.876)	1.85(0.876)	0.31(0.002)
TSA	-2.94(0.021)	-2.67(0.021)	0.11(0.221)
Government Exposure on Education			
SA	1.32(0.989)	1.82(0.985)	0.21(0.021)
TSA	-3.42(0.031)	-3.47(0.031)	0.14(0.174)
Science & Engineering			
SA	2.03(0.781)	2.47(0.781)	0.26(0.001)
TSA	-1.14(0.042)	-1.21(0.042)	0.14(0.147)
Business			
SA	1.21(0.984)	1.95(0.984)	0.31(0.000)
TSA	-2.97(0.031)	-3.11(0.031)	0.11(0.191)
Education			
SA	0.94(0.921)	1.98(0.921)	0.31(0.002)
TSA	-0.91(0.02)	-1.10(0.02)	0.15(0.211)
Social Sciences			
SA	2.41(0.521)	2.76(0.521)	0.30(0.000)
TSA	-3.41(0.019)	-3.52(0.019)	0.10(0.211)
Undergraduates			
SA	0.92(0.931)	1.92(0.931)	0.21(0.001)
TSA	-2.37(0.031)	-3.09(0.031)	0.09(0.311)
Postgraduates			
SA	2.31(0.422)	2.84(0.422)	0.31(0.001)
TSA	-3.51(0.024)	-3.74(0.024)	0.11(0.241)
Salaries			
SA	0.82(0.942)	1.78(0.942)	0.34(0.000)
TSA	-3.97(0.031)	-4.01(0.031)	0.09(0.297)

It was noted that after data transformation, stationarity was achieved for all the variables. In the absence of unit roots, co-integration tests are therefore essential to provide confirmation that these variables are co-integrated in the long run. This was achieved through the Johansen test.

6.4.2 Co-integration Test Results

Once series transformation had been conducted, the data was then subjected to co-integration assessment. The existence of co-integration, i.e., long-run equilibria between the variables, which have to be fulfilled for VECM construction, was assessed. Table 6.9 shows the null and alternate hypothesis for the Johansen Eigenvalue (λmax) and trace tests.

Table 6.9: Hypothesis for Eigenvalue and Trace Tests

Eigenvalue		**Trace**	
Null	Alternate	Null	Alternate
r = 0	r = 1	r = 0	r ≥ 1
r = 1	r = 2	r ≤1	r = 2

6.4.2.1 Lag Order Selection Criteria

As mentioned in Chapter 5, it is essential to first determine the correct lag length before performing the co-integration test. The model design criteria chosen must be such that the estimated residuals must not have serial correlation (autocorrelation) and that the residuals must be normally distributed. The choice of the appropriate lag length is critical for obtaining models whose disturbance terms exhibit ‘white noise’

According to Patterson (2000), the AIC and SIC tests should be used in selecting the order (p) of the VAR model. The selection procedure involves choosing the VAR (p) model with the highest negative value of the AIC or SIC. The XLSTAT model used for this study does not show the SIC results. Therefore, the AIC criterion was used to determine the lag order.

A test of various lags was conducted and the maximum number of lags established was three for all the series data. Tables 6.10 presents a typical lag test result with a VAR order estimate of 3 according to AIC.

Table 6.10: Lag-order selection criteria

Number of lags	AIC	HQ	BIC	FPE
1	-15.344	-15.527	-15.055	0.000
2	-15.208	-15.482	-14.774	0.000
3	**-17.963**	**-18.327**	**-17.384**	0.000

AIC - Akaike Information Criterion; BIC - Corrected Akaike’s Information; Hannan-Quinn Information Criterion (HQ)

As previously indicated, four information criteria for determination of the lag length, such as the AIC, BIC, HQ and FPE, were utilised in the study. Ideally, the model with the highest negative IC estimate was chosen as the best fitting model. Based on the typical results presented in Table 6.10, a lag length of 3 was chosen for all variables using the AIC and BIC criteria.

6.4.2.2 Johansen Co-integration Test Results

A sample of the results produced from the Johansen co-integration test is shown in Table 6.11. The rest of the series test results are presented in Table 6.12.

Table 6.11: Typical results of the Johansen co-integration test

VAR order estimation:					**Comment**
Number of lags	AIC	HQ	BIC	FPE	
1	-15.344	-15.527	-15.055	0.000	The VAR order estimate according to AIC is 3.
2	-15.208	-15.482	-14.774	0.000	
3	**-17.963**	-18.327	-17.384	0.000	
Lambda max test:					
H0 (No. of co-integrating equations)	Eigenvalue	Statistic	Critical Value	p-value	Lambda max test indicates 1 co-integrating relation(s) at the 0.05 level.
None	0.819	18.813	15.892	0.017	
At most 1	0.582	9.583	9.164	0.042	
Trace test:					
H0 (No. of co-integrating equations)	Eigenvalue	Statistic	Critical Value	p-value	Trace test indicates 1 co-integrating relation(s) at the 0.05 level.
None	0.819	28.396	20.262	0.003	
At most 1	0.582	9.583	9.164	0.042	

The null hypothesis assumes that there is no co-integration amongst the series whilst the alternative states that there is at least one co-integrated series. If the test statistic is > critical value, the null hypothesis of no co-integration is rejected. This will go with a p-value > 0.05, also indicating that there is no co-integration.

This set of results shows that the test statistic is less than the critical value, and it can thus be concluded that at most there is one co-integrating vector present.

The main co-integration driving parameter is r = 0 (None). When r = 0, p < 0.05, the null hypothesis that there is no co-integration is rejected, and the alternate hypothesis of at least 1 co-integrating relation(s) at the 0.05 level is accepted. At r = 1, p < 0.05, the null hypothesis, that there is at least 1 co-integrating vector, is rejected.

Tables 6.12 and 6.13 show the Johansen co-integration results for RGDP (dependent variable) and independent variables tested, such as primary and secondary school education enrolment as well as matric attainment and tertiary education graduation, for all the individual provinces, and South Africa. The statistic value is presented, followed by a p-value in brackets. At r = 0, a p-value > 0.05 indicates no co-integration. The critical values for both Eigenvalue and λ trace are shown as 15.89 and 20.26 for r = 0, respectively. The Eigenvalue and λ trace values for r = 1 are the same at 9.16.

Given that for most variables, both Eigenvalue and trace test statistic values exceed the critical value (5%), with p-values < 0.05 when the null is *r* = 0, it can be concluded that at least one co-integrating vector exists between RGDP and education in most of the provinces and South Africa, thus indicating existence of co-integration between RGDP and the different levels of education. Those equations that do not show co-integration between RGDP and education are highlighted in red as exceptions.

Table 6.12: Johansen co-integration results for RGDP vs. primary and secondary school education enrolment

	Primary		**Secondary**	
	r= 0	r = 1	r = 0	r = 1
Critical Values	None	At most 1	None	At most 1
Eigenvalue	15.89	9.16	15.89	9.16
λ trace	20.26	9.16	20.26	9.16
		EC		
Eigenvalue	18.81 (0.017)	9.58 (0.042)	18.078 (0.022)	9.65 (0.046)
λ trace	28.39 (0.003)	9.58 (0.042)	25.731(0.008)	9.65 (0.046)
		FS		
Eigenvalue	19.65 (0.012)	2.83 (0.613)	16.76 (0.042)	8.05 (0.081)

λ trace	22.48 (0.024)	2.83 (0.613)	20.05 (0.031)	8.05 (0.081)
		KZN		
Eigenvalue	23.69 (0.002)	6.16 (0.179)	23.69 (0.02)	5.62 (0.222)
λ trace	29.85 (0.002)	6.16 (0.179)	29.85 (0.02)	5.62 (0.222)
		GP		
Eigenvalue	23.65 (0.002)	5.82 (0.205)	44.87 (0.000)	7.91 (0.086)
λ trace	29.47 (0.002)	5.82 (0.205)	52.79 (0.000)	7.91 (0.086)
		LP		
Eigenvalue	7.36 (0.625)	4.74 (0.314)	48.27 (0.000)	6.72 (0.142)
λ trace	12.09 (0.440)	4.74 (0.314)	54.98 (0.000)	6.72 (0.142)
		MP		
Eigenvalue	31.06 (<0.000)	7.67 (0.095)	33.42 (0.000)	4.79 (0.306)
λ trace	39.27 (<0.000)	7.67 (0.095)	38.22 (0.000)	4.79 (0.306)
		NW		
Eigenvalue	18.69 (0.018)	2.69 (0.639)	21.54 (0.006)	14.05 (0.006)
λ trace	21.38 (0.035)	2.69 (0.639)	35.59 (0.000)	14.05 (0.006)
		NC		
Eigenvalue	15.95 (0.286)	9.16 (0.454)	14.28 (0.088)	4.01 (0.411)
λ trace	20.26 (0.270)	9.16 (0.454)	18.29 (0.091)	4.01 (0.411)
		WC		
Eigenvalue	27.65 (0.000)	6.78 (0.138)	29.42 (0.000)	9.26 (0.048)
λ trace	34.44 (0.000)	6.78 (0.138)	38.68 (0.000)	9.26 (0.048)
		SA		
Eigenvalue	**23.47 (0.003)**	**6.15 (0.179)**	**22.61 (0.004)**	**11.96 (0.000)**
λ trace	**29.62 (0.002)**	**6.15 (0.179)**	**34.58 (0.014)**	**11.96 (0.000)**

Table 6.13: Johansen co-integration results for RGDP vs. matric and tertiary school education attainment

	Matric		**Tertiary**	
	r = 0	r = 1	r = 0	r = 1
Critical Values	None	At most 1	None	At most 1
Eigenvalue	15.89	9.16	15.89	9.16
λ trace	20.26	9.16	20.26	9.16
		EC		
Eigenvalue	7.03 (0.666))	2.91 (0.598)	23.19 (0.003)	9.22 (0.049)
λ trace	9.93 (0.646)	2.91 (0.598)	32.41 (0.001)	9.22 (0.049)
		FS		
Eigenvalue	13.26 (0.124)	6.84 (0.135)	17.88 (0.024)	5.33 (0.249)
λ trace	16.26 (0.163)	6.84 (0.135)	23.20 (0.249)	5.33 (0.249)
		KZN		
Eigenvalue	25.41 (0.001)	15.20 (0.003)	16.48 (0.040)	3.16 (0.550)
λ trace	40.61 (0.001)	15.20 (0.003)	19.26 (0.042)	3.16 (0.550)

GP				
Eigenvalue	7.56 (0.601)	4.28 (0.372)	24.42 (0.002)	5.18 (0.265)
λ trace	11.84 (0.463)	4.28 (0.372)	29.59 (0.002)	5.18 (0.265)
LP				
Eigenvalue	11.91 (0.191)	7.45 (0.104)	19.20 (0.015)	9.17 (0.050)
λ trace	19.36 (0.066)	7.45 (0.104)	28.38 (0.003)	9.17 (0.050)
MP				
Eigenvalue	21.29 (0.006)	3.25 (0.534)		
λ trace	24.55 (0.012)	3.25 (0.534)		
NW				
Eigenvalue	11.91 (0.192)	2.79 (0.619)	14.59 (0.079)	4.91 (0.294)
λ trace	14.70 (0.244)	2.79 (0.619))	19.50 (0.093)	4.91 (0.294)
NC				
Eigenvalue	11.91 (0.192)	2.79 (0.621)		
λ trace	14.70 (0.244)	2.79 (0.621)		
WC				
Eigenvalue	13.37 (0.121)	2.47 (0.683)	24.42 (0.002)	10.42 (0.029)
λ trace	15.84 (0.182)	2.47 (0.683)	34.84 (0.000)	10.42 (0.029)
SA				
Eigenvalue	**11.45 (0.220)**	**6.30 (0.169)**	**18.60 (0.018)**	**4.96 (0.288)**
λ trace	**17.75 (0.107)**	**6.30 (0.169)**	**23.56 (0.017)**	**4.96 (0.288)**

Exceptions have been noted for the following provinces:

Limpopo Province (RGDP vs. Primary Education Enrolment)

- Both eigenvalue and trace tests for RGDP and primary education enrolment for Limpopo province indicate a 0 co-integration relationship at the 0.05 level.

Northern Cape (RGDP vs. Primary and Secondary Education Enrolment)

- Both eigenvalue and trace tests for RGDP vs. primary and secondary education enrolment for Northern Cape province indicate a 0 co-integration relationship at the 0.05 level.

The co-integration test between RGDP and matric achievement showed that there is no correlation between the two variables for all the provinces, even for South Africa overall, except for KwaZulu-Natal and Mpumalanga provinces.

From the above estimations, it can be concluded that education at all levels, except for matric for most provinces, has a positive effect on economic growth and that the outcome fluctuates across the provinces.

The impact of the country's government expenditure on education and education index on economic growth was also assessed. As shown in Table 6.14, co-integration exists between RGDP and these two variables indicating the positive impact they have on economic growth.

Table 6.14: Johansen co-integration results for RGDP vs. government expenditure on education and education index

	r = 0	r = 1
Critical Values	None	At most 1
Eigenvalue	15.89	9.16
λ trace	20.26	9.16
Government expenditure on education		
Eigenvalue	28.99 (0.000)	10.24 (0.031)
λ trace	39.23 (0.000)	10.24 (0.031)
Education index		
Eigenvalue	33.22 (0.000)	9.16 (0.005)
λ trace	47.50 (0.000)	9.16 (0.005)

As presented in the comprehensive framework in Chapter Two, it is important to understand the impact of the knock-on effects of education through salaries, the field of study, and innovation, research and development (IRD) on economic growth. The proxy that was employed for IRD is the number of postgraduates. This was chosen because it was not easy to obtain the number of research publications for the country over the assessed years. The postgraduate level is the ideal level where innovation, research and development output is observed, hence employment of the number of postgraduates.

In an attempt to understand whether the field of study has an impact on the economic growth, co-integration tests were conducted for RGDP and the four major fields such as science, engineering and technology, business and management, education and human and social sciences. Co-integration was also tested between RGDP and salaries earned in the different sectors of the economy. Table 6.15 presents this data.

Table 6.15: Johansen co-integration results for RGDP vs. field of study, undergraduates and postgraduates and salaries

	r = 0	r = 1
	None	At most 1
Critical Value	15.89	9.16
λ trace	20.26	9.16
Science & Engineering		
Eigenvalue	21.44 (0.006)	2.94 (0.592)
λ trace	24.38 (0.013)	2.94 (0.592)
Business		
Eigenvalue	20.04 (0.010)	4.78 (0.308)
λ trace	24.83 (0.011)	4.78 (0.308)
Education		
Eigenvalue	36.67 (0.000)	10.18 (0.032)
λ trace	46.85 (0.000)	10.18 (0.032
Social Sciences		
Eigenvalue	10.82 (0.265)	1.65 (0.847)
λ trace	12.47 (0.408)	1.65 (0.847)
Undergraduates		
Eigenvalue	27.72 (0.000)	8.06 (0.081)
λ trace	35.78 (0.000)	8.06 (0.081)
Postgraduates		
Eigenvalue	18.09 (0.022)	4.46 (0.348)
λ trace	22.55 (0.024)	4.45 (0.348)
Salaries		
Eigenvalue	19.09 (0.018)	5.46 (0.213)
λ trace	23.37 (0.028)	5.45 (0.213)

It is clear that in the overall South African context, the number of graduates produced from different study fields has a positive impact on the country's economic growth, with an exception of the social sciences discipline. As anticipated, a positive correlation between undergraduates and postgraduates and economic growth was revealed. For some reason, the country's number of matriculants did not portray a significant co-integration with RGDP. The latter could be so because some matriculants do not get to advance to tertiary education because of, amongst other reasons, a lack of funds. This is despite the government's effort to subsidize education through NSFAS. It is however, assumed that the funds may not be enough to accommodate all the needy or disadvantaged students. This opens a call for government to increase their expenditure towards education so that more students can benefit from this opportunity.

6.5 DIAGNOSTIC CHECKS/ VECTOR ERROR CORRECTION MODELLING (VECM) RESULTS

According to the Granger illustration theorem (Granger, 1981), when series variables are co-integrated, there also exists Vector Error Correction Model (VECM) that defines the short-run subtleties or variations of the co-integrated variables towards their equilibrium values.

VECM contains one-period lagged co-integrating equation and the lagged first transformed series differences of the endogenous variables. ECM can be estimated using the Vector Autoregression (VAR) method.

Considering that the variables under investigation were only stationary in first transformation and co-integrated, a VECM estimate had to be formulated. The estimated error-correction equations were tested for residual autocorrelation and residual normality.

The ideal model design criteria requires that the estimated model must be such that estimated residuals must not reveal serial correlation (autocorrelation) and there should be no heteroscedasticity on the data set, and that the residuals must be normally distributed. To check for acceptability of the model, Johansen (1991) suggests the use of residuals from the unrestricted model, the Lagrange Multiplier (LM) test, which tests the autocorrelation in the residuals and checks for variable cross-sectional dependence (Pesaran, 2004). Another diagnostic model is the Jarque-Bera, which tests for normal distribution of the residuals.

Based on this information, it became imperative to conduct a further series of diagnostic autocorrelation and normality residual tests to ascertain the adequacy and efficiency of the chosen models. These diagnostic tests will determine if the models can be trusted and whether a sound conclusion can be drawn from them.

This study applied the Lagrange-Multiplier (LM) and the Jarque-Bera tests to test for autocorrelation in the residuals and for normal distribution of the residuals, respectively.

The null and alternate hypotheses are such that:
H0: The residuals are homoscedastic,
Ha: The residuals are heteroscedastic

6.5.1 Lagrange-Multiplier (LM) VECM Test Results

The Lagrange Multiplier test uses autocorrelation tests, such as Breusch-Pagan and White (Wooldridge, 2003) tests (Breusch & Pagan, 1979), whose results are displayed in Table 6.16. The p-values for each are presented next to each test value. It should be recalled from the previous pages that the lag order as determined by the AIC lag order selection criteria was 3 as it appears in Table 6.16.

As the computed p-value is greater than the significance level alpha = 0.05, the null hypothesis H0, that residuals are homoscedastic (autocorrelation), cannot be rejected. Also, the observed value is less than the critical value for all the provinces.

Table 6.16: LM Test for autocorrelation (VECM with 3 lags)

	Breusch-Pagan	P-value	White	P-value	Breusch-Pagan	P-value	White	P-value
(Critical value)	3.841		5.991		3.841		5.991	
	RGDP				**Secondary**			
EC	1.043	0.307	0.685	0.710	0.124	0.725	2.209	0.331
FS	1.004	0.316	1.811	0.404	3.353	0.067	0.815	0.665
GP	0.710	0.399	0.334	0.846	0.010	0.919	0.868	0.648

KZN	0.000	0.983	0.509	0.775	0.152	0.696	0.015	0.992
LP	0.297	0.586	0.837	0.658	3.716	0.056	3.551	0.169
MP	0.075	0.784	1.508	0.471	2.313	0.128	0.050	0.975
NC	0.051	0.822	4.199	0.123	1.418	0.234	1.502	0.472
NW	0.239	0.625	0.003	0.998	1.520	0.218	0.070	0.966
WC	0.022	0.883	0.363	0.834	0.03	0.954	2.685	0.261
SA	0.298	0.585	0.831	0.660	0.424	0.515	3.649	0.161
	Primary				**Tertiary**			
EC	1.170	0.280	2.434	0.296	0.505	0.477	0.810	0.667
FS	1.687	0.194	0.004	0.998	3.245	0.082	5.341	0.072
GP	0.057	0.811	0.130	0.937	3.282	0.087	5.413	0.075
KZN	0.054	0.816	0.000	1.000	0.038	0.845	1.058	0.589
LP	0.002	0.963	0.197	0.906	2.510	0.113	5.128	0.077
MP	3.541	0.063	0.354	0.838				
NC	0.831	0.362	3.901	0.142				
NW	1.557	0.212	0.450	0.798	0.117	0.733	0.927	0.629
WC	0.728	0.394	0.521	0.771	1.759	0.185	3.491	0.175
SA	1.028	0.311	0.676	0.713	0.290	0.590	1.117	0.572
Government expenditure on education								
SA	0.140	0.708	0.434	0.805				
Education Index								
SA	2.555	0.110	8.001	0.018				
Science and Engineering								
SA	0.082	0.913	0.032	0.916				
Business								
SA	0.823	0.376	0.921	0.634				
Education								
SA	0.978	0.354	0.332	0.843				
Social Sciences								
SA	1.187	0.312	0.956	0.631				
Undergraduate								
SA	1.856	0.113	0.312	0.857				
Postgraduate								
SA	0.795	0.411	0.967	0.713				
Salaries								
SA	0.534	0.425	0.811	0.654				

The Lagrange Multiplier test for residual serial correlation presents evidence of serial correlation. Therefore the null hypothesis of correlation and homoscedasticity fails to be rejected.

Finally, the diagnostic tests of Breusch-Pagan and White conducted confirm the random effects assumption made and existence of autocorrelation; therefore the specification and estimations have been validated. Based on the diagnostic results, the chosen model was found to be efficient and adequate.

6.5.2 Jarque-Bera Test

The null hypothesis of normality is rejected if the calculated test statistic exceeds a critical value from the distribution. The null hypothesis is that: residuals are normally distributed. If $p < 0.05$, the null hypothesis is rejected. All the results show $p > 0.05$ (Table 6.17), suggesting that the residuals are normally distributed.

Table 6.17: Jarque-Bera normality test (VECM with 3 lags)

	Chi^2	Prob > Chi^2 P-value	Chi^2	Prob > Chi^2 P-value	Chi^2	Prob > Chi^2 P-value	Chi^2	Prob > Chi2 P-value
Equation	**RGDP**		**Primary**		**Secondary**		**Tertiary**	
EC	0.756	0.685	0.611	0.737	0.115	0.944	0.961	0.618
FS	0.599	0.741	1.087	0.581	1.129	0.569	0.856	0.652
GP	1.200	0.549	0.640	0.726	2.067	0.356	0.618	0.734
KZN	1.243	0.537	0.619	0.734	2.159	0.340	0.482	0.786
LP	1.758	0.415	0.817	0.665	3.478	0.154	0.551	0.759
MP	1.857	0.395	4.175	0.124	3.564	0.168	0.456	0.796
NC	1.779	0.411	0.205	0.903	2.418	0.298		
NW	0.892	0.640	0.738	0.692	0.965	0.617		
WC	1.014	0.602	0.280	0.869	0.926	0.629	0.470	0.790
SA	1.469	0.480	0.737	0.692	0.828	0.661	0.419	0.811
Government expenditure on education								
SA	0.140	0.708	0.434	0.805				
Education Index								
SA	3.033	0.281	0.301	0.821				
Science and Engineering								
SA	0.322	0.672	0.875	0.654				
Business								
SA	0.523	0.753	0.542	0.831				
Education								
SA	1.542	0.486	0.985	0.623				

Social Sciences								
SA	1.134	0.587	0.467	0.798				
Undergraduate								
SA	1.756	0.431	0.532	0.745				
Postgraduate								
SA	1.986	0.312	0.321	0.813				
Salaries								
SA	1.143	0.621	0.411	0.812				

The Jarque-Bera test of normality revealed that the data series are normally distributed.

If the LM and Jarque-Bera tests were to fail, that would be an indication of an insufficient number of lags chosen and included in the model. This was not the case for this study, thus providing assurance that the correct number of lags and the adequate models were chosen.

The VECM results presented above confirmed the previous co-integration results. These results confirm a positive and significant contribution of education on economic growth in the long run.

6.6 CONCLUDING REMARKS

This chapter analysed and presented the results obtained for the analysis of a causal relationship between education and economic growth, as obtained from the statistical estimations commenced. The estimations started with the descriptive statistics on the time series data set, followed by the determination of the existence of unit roots for all the variables. On detection of non-stationarity, the time series had to be transformed to deem them stationary before co-integration tests could be conducted. Co-integration tests revealed a positive correlation between education and RGDP at all levels of education, in all the provinces except for matric in KwaZulu-Natal. A positive correlation was also exhibited between the education index and government expenditure on education.

The poorest performing provinces in education were the Eastern Cape, Limpopo, Mpumalanga, and North West, while Gauteng, Western Cape and KwaZulu-Natal provinces seemed to show the best performance. This correlates with RGDP growth as Gauteng, the Western Cape and KwaZulu-Natal provinces contributed the most to the country's RGDP. Northern Cape exhibited the lowest education levels and RGDP growth all attributable to its smallest population.

Amongst the investigated variables, matric education did not show positive correlation with RGDP in all the provinces, except for KwaZulu-Natal and Mpumalanga provinces.

From the diagnostic Lagrange Multiplier residual autocorrelation and Jarque-Bera residual normality tests conducted, it can be justified that the long run co-integration results obtained are statistically sound.

CHAPTER SEVEN
DISCUSSION OF THE FINDINGS

7.1 INTRODUCTION

The previous chapter formulated results of the model estimates for all the variables in all the provinces. Overall, the descriptive statistics, unit root tests and co-integration tests as well as diagnostic checks indicate a positive relationship between education and economic growth in South Africa.

7.2 EDUCATION AND RGDP TRENDS IN SOUTH AFRICA AND ITS NINE PROVINCES

Descriptive statistics shows that even though KwaZulu-Natal province portrays the highest enrolment at secondary level, Gauteng and the Western Cape, followed by Free State province, always report the highest matric pass rates. Mpumalanga and Eastern Cape provinces exhibit high secondary enrolment levels but lower matric attainments which clearly indicate a high number of drop outs before matric. Also, they show that Gauteng province remains a leader in the number of graduates. The highest number of graduates in Gauteng and Western Cape ties in very well with their high economic growth levels. Northern Cape contributed the lowest percentage to the economic growth of South Africa because of its small population density.

The results infer that South Africa should try and improve the focus on the development of education at all the different levels as they appear to portray a relevant impact on the economic growth. A decline in primary and secondary school education enrolment that was observed in the Eastern Cape, Free State, KwaZulu-Natal, Limpopo and North West provinces is of concern. Relevant educational policies need to be implemented to address this decline. In the light of this observation, the extremely low economic growth observed from these provinces is justifiable, considering the role of education on the former.

7.3. IMPACT OF EDUCATION LEVELS, EDUCATION INDEX AND GOVERNMENT EXPENDITURE ON EDUCATION AND ECONOMIC GROWTH

The study also reported existence of a positive relationship between government expenditure on education as well as education index and economic growth as the null hypothesis of no co-integration was rejected at the 5% level of significance. This supports the notion that as education enrolment increases, education index also increases and more skills are subsidising the growth of the economy, thus, making investment in education one of the determinants of economic growth. This concurs with the extensive research that has been conducted in several countries, on this correlation. Hussin et al. (2012), in Malaysia, reported a long run relationship between government expenditure on education and economic growth. In Nigeria, Omojite (2010) and Babalola (2011) also revealed uni-directional causality between investing in education and economic growth in Nigeria.

In South Africa, Nkohla (2014) also reported a significant effect of education index on economic growth. She highlighted that a unit increase in education index, which is composed of 67% adult literacy and 33% gross school enrolment will lead to more economic activity with an elasticity of 0.32. From this she anticipates that that as more adults become literate and/or school enrolment rises, the chances of increasing economic activity are imminent.

In the United States, Clarke et al. (2015) also attested that increased education spending is critical towards boosting the human capital of the country. They acclaimed that countries relying on a work force with low education levels, such as just a high school degree or matric, are bound to battle to achieve good economic growth. They, however, argued that, increasing education expenditure, with an aim to respond to the need for an educated labour force, does not necessarily relate to economic growth. This could be the reason this current study did not witness a causal relationship between matric results and RGDP. In a quest to curb this, the South African government should prepare and fund more students towards post-matric education.

This study recommends that if education could be instilled at a primary level, there would be more students with matric education attainment and a subsequent increase in tertiary education graduates. The ripple effect that primary education enrolment exhibits in poverty, employment, salaries, and economic growth cannot be under-estimated. This is so because, without a firm primary education foundation, it becomes difficult for pupils to progress to higher levels of education. More focus in education enrolment and achievement will increase the economic growth even further. As mentioned by Seetanah (2016), if a country seeks to increase its economic growth, the increase in advancement of technology and innovation as well as contribution of higher skills through tertiary education has to be encouraged. The research conducted by Bils & Klow (2000) on human capital-economic growth nexus for a cross-section of countries, revealed that an additional year of schooling enrolment is directly associated with a 0.3% annual growth over the same period. This indicates that education is indeed a vital empowering apparatus for human capital investment and that it significantly contributes towards economic growth and poverty reduction.

In their comprehensive study, Hanif and Arshed (2016) compared the impact of the different levels of education and government expenditure, relative to the benefits of economic growth. They attest that a 1% increase in primary school admission results in a 1.29% decline in the GDP. This is attributed to the cost associated with managing this level of education. It appears to reduce the GDP, than actually boosting the economy. A 1% increase in secondary education enrolment was reported to increase the GDP by 0.36%, thus confirming that secondary education can play a positive role in the economy. An increase in tertiary education by 1%, reportedly increased the GDP by 0.37%.

The results of this study are in agreement with those reported by Seetanah (2016), who suggested a direct relationship between economic growth and human capital. His research utilised educational enrolment as one of the proxies for human capital. Empirical results that were also presented by Zivengwa et. al. (2013), demonstrated uni-directional causality between education and economic growth, in Zimbabwe. The study also confirmed that investing more resources in human capital development through education is crucial for labour productivity and a subsequent growth of the economy.

The positive impact of tertiary education on economic growth that was examined in this study was also supported by Wolff and Gittleman (1993), who indicated a causal link between economic growth and tertiary education attainment, and work force efficiency as the number of engineers and scientists increases.

7.4 IMPACT OF DIFFERENT FIELDS OF STUDY ON ECONOMIC GROWTH

The field of study plays a significant role towards the contribution to economic growth. This study revealed non-existence of co-integration between the economy of South Africa and social science graduates, whilst all the other fields demonstrated such co-integration. This does not necessarily mean that these skills are not as significant towards the improvement of the economic status of the country. The exhibition is that, statistically, they do not seem to play such a remarkable role. Hanushek & Wößmann (2007) concur that countries that have reasonably more engineering graduates are more inclined towards faster economic growth than those with more law graduates.

In South Africa, Nkohla (2014) noted that education is inter-related to economic growth through its influence on the advancement of cognitive skills such as mathematics and science. Through enhancement of cognitive skills, productivity of labour is augmented, eventually fast-tracking innovation and technological evolvement, and subsequent increase in economic growth. The study conveyed that the impact of education positively affects the economic activity and varies significantly across the nine provinces, with Gauteng province being the main driver of economic growth.

Nkohla’s study concurred with Hanushek et al. (2008), who also believe that the more steadfast valuation of a nation’s human capital is the proficiency of students in mathematics and science subjects, referred to as cognitive skills, amongst those entering a country’s labour force. They believe that accruing the average number of years of education accomplished by the workforce can only enrich the economy when the former also boosts the cognitive comprehensive system of testing.

The causal relationship between the number of science, engineering and technology graduates and economic growth is demonstrated in this study. This is in agreement with the findings of the research conducted by Bloom et al. (2006) and Berger & Fischer (2013) that the economic growth of a country stems from its engineering, technological and innovative capacity.

The initiative and intervention of the Joint Initiative for Priority Skills Acquisition, JIPSA (Mantashe, 2008) to define critical skills shortages, which science and engineering are some of, seems to be bearing fruits with a collective figure of 55 573 graduates in the science, engineering and technology fields produced in 2014. The set target was an annual production of 2500 graduate engineers (Mantashe, 2008) who would be absorbed by private business for further training and development into professional engineers.

7.5 IMPACT OF INNOVATION, RESEARCH AND DEVELOPMENT ON ECONOMIC GROWTH

The significant role played by research output from postgraduate achievement cannot be under-estimated. It was encouraging to witness a remarkable increase in the number of Masters and Doctoral postgraduates with an increase ranging from 35 to 76%, for the latter. An improvement in postgraduate enrolment in the science, engineering and technology field should be encouraged. The cross-country World Bank regression analysis pursued by Kruss et. al. (2015) demonstrated that research and development (R&D), largely through business corporations and tertiary institutions, both enhance production and economic growth, with a 78% rate of return on R&D. This is in support of the innovation and knowledge transfer theories, which associate education with advancement of the growth and capacity of the economy through the development of new ideas and technologies (Olaniyan & Okemakinde 2008; Barro 2010; Earle 2010; Westmore 2013; Barro 2015; Pece 2015). Education is acknowledged as a tool for dispersing the innovative knowledge that is needed to apply new ideas, processes and developments, products and technologies (Earle 2010; Barro 2010, 2015).

A positive correlation between the number of doctoral graduates in engineering and technology and economic growth in India, China and United States was also exposed by Wadhwa et al. (2007). The authors demonstrated that the joint fusion of engineering skills and the aptitude to inter-connect on a universal basis can accelerate the proficiency of technical design that permit a country's do- it-yourself (DIY) service and other forms of co-production.

A well-educated work force innovates faster (Nelson & Phelps, 1966; Benhabib & Spiegal, 1994). The consequence of innovation is that it reduces the amount of effort and time required to produce the same volume of products and improves the quantity of output manufactured for the same amount of effort (Aghion et al., 2009; Earle, 2010). Producing more products at reduced time and cost subsequently results in an increase in the number of goods the country can make, favourably boosting the economy.

In a study that was conducted in South Africa, Mthembu (2016) investigated the impact of labour, capital, tertiary enrolment, education expenditure and innovation and realised existence of a long run co-integrating relationship between economic growth, labour, capital, enrolment, expenditure and innovation which is consistent with economic theory.

7.6 IMPACT OF SALARIES EARNED ON ECONOMIC GROWTH

Examination of the salaries earned by employees in different sectors revealed that those in less skilled sectors, such as agriculture and mining, earn far less that skilled counterparts in finance and manufacturing, which encompass scientists, engineers and technologists. By virtue of such low salaries, they contribute far less towards the country's economic growth and are more prone to job losses should economic recession be encountered. This is in line with the investigation undertaken by Lin (2004) in Taiwan, which surveyed the impact of concentrating on diverse career fields. The analysis detected that the discipline of engineering and natural sciences exhibited the maximum economic yield.

To support the low impact of the agricultural sector on the economic growth, Lin (2004) also attested that a 1% progression in higher education attainment from colleges, university or any graduate school, produced a 0.35% upsurge in industrial production, with an additional 1% achieved from natural sciences or engineering graduates, whereas those from the agricultural sector output, resulted in a low 0.15% increase in economic growth.

The presentation provided by this study on the income earned by employees in different sectors supports the notion that higher education, and certain skills' attainment, are the determinants of the employees' income. An educated and better earning population nurtures good governance and lessens demand for state finances (Berger & Fischer, 2013). Educated employees also exhibit improved and healthier quality of life. This enables them to work more efficiently over a lengthier lifetime, thus enhancing lifetime earnings; which subsequently serves long term economic growth (Bloom et al., 2006).

7.7 CONCLUDING REMARKS

This study gave an overview of the causal link / co-integration that exists between education and the economic growth of the nice provinces and in South Africa, overall. All the different levels of education positively impact economic growth with the tertiary education level being the main contributor. Government expenditure on education should also be increased, with more attention to funding higher education. The number of science and engineering graduates is key to economic growth and needs to be enhanced. Also, if South Africa can engage more in innovation, research and technology, impressive economic growth could be realised.

CHAPTER EIGHT

CONCLUSION, RECOMMENDATIONS AND LIMITATIONS

8.1 INTRODUCTION

This study attempted to answer the main question of the investigation which was whether the different levels of education and their subsequent knock-on effects or externalities have an impact on economic growth in South Africa. This chapter provides a summary of the overall study and offers policy recommendations based on the findings, and also presents suggestions for areas of future research work. The study suggests that a causal relationship does exist between all levels of education, with the exception of the matric education level, in most provinces, and economic growth.

8.2 SUMMARY OF THE STUDY

This research study set out to establish the impact of the different levels of education on economic growth in all the nine provinces of South Africa. Education index and government expenditure on education were also assessed but in the overall context of South Africa. The study was extended to investigate the impact of other education knock-on effect variables such as employee salaries, field of study, and innovation, research and development. The interest on these latter variables arose from what was gathered from the empirical literature review. The fields of science and engineering were reported to be superior as far as technology development, salaries, high productivity and economic growth are concerned. Because an innovative nation tends to benefit from high productivity and experience rapid economic growth (Earle 2010; Barro 2010, 2015), the impact of progressions to postgraduate level in all the study fields was investigated.

The empirical literature review that was conducted led to the choice of ADF, PP and KPSS unit root tests as stationarity tests for this study. The Johansen co-integration exhibited a causal relationship between economic growth and education levels as well as other variables in most of the provinces and in South Africa generally. The diagnostics tests also confirmed the normality of the residuals and existence of homoscedasticity which is more ideal.

8.3 CONCLUSION OF THE STUDY

It was discovered that the impact of education on economic growth varies across all the nine provinces. Education was found to positively affect economic growth the most in Gauteng and Western Cape provinces. This is expected considering that these two provinces are high in education attainment at all levels. Secondary and tertiary education enrolment and attainment were shown to exhibit a positive correlation with economic growth. The decentralisation structure of the South African government makes disparities in education management across provinces very evident and reveals how efficient and proficient management of the education system can render economic prosperity (Mthembu, 2016).

The study also found that as education develops cognitive and other skills, through the undertaking of science and engineering studies, it will enhance the productivity of labour, ultimately accelerating innovation and technological progress and bringing higher economic growth (Lin, 2004; Kruss et. al., 2015). The progression of graduates to masters and doctorate levels will enhance innovation, research and development thus contributing more towards economic growth (Kruss et. al., 2015). It has been indicated that an innovative country tends to achieve increased economic growth (Westmore, 2013; Barro, 2015; Pece, 2015). The transfer of knowledge through innovation and research publications towards economic growth was identified in this study.

It is evident from this study, that tertiary education is the main contributor to economic growth. For South Africa to achieve reasonable and faster economic growth, government and the private sector, through public-private partnerships, should work together towards execution of policies that will advance the education system. Government can achieve better economic growth through heavy investment in all levels of education, particularly higher education (Mthembu, 2016; Seetanah, 2016). Investing in human capital skills will improve the physical capital production which will in turn lead to economic growth and subsequent poverty alleviation (Van-Den-Berg, 2001; Babalola, 2011; Nkohla, 2014).

Furthermore, this study attested that the sectors with low skilled labour such as agriculture contribute far less towards economic growth, by virtue of their low education levels. This is through the low salaries that employees in the agricultural sector earn because most of them do not have to be highly qualified to conduct the job. Those sectors that require scientists, engineers and finance managers are highly remunerating, with such employees being high contributors to economic growth. This implies the significance of the study discipline towards economic growth.

In summary, this study presents the significant impact of the different levels of education, education index, government expenditure towards education, different fields of study, salaries earned in different sectors as well as innovation, research and development (IRD) towards economic growth of South Africa.

The current study, herein presented, has contributed to the limited literature available in this field of study. It also comprehensively incorporated all these various proxies investigated by Nkohla (2014) and Mthembu (2016) with an objective to understand the impact of all the different levels of education and its positive externalities on economic growth in South Africa. Where possible, school level attainments e.g. for matric and tertiary were utilised, instead of enrolments which may not carry much weight considering that enrolments do not equate to attainments because not all enrolled students get to complete their studies and graduate. Such dropouts tend to contribute far less towards economic growth.

8.4 POLICY RECOMMENDATIONS

The South African government needs to assign more resources to both public and private education sector. As mentioned a number of times in this report, it is not only about the quantity of graduates produced that contributes more to the economy, but it is more the quality of the work force. More focus needs to be invested on the quality of the country's education.

The results and discussion presented in this study warrant an urgent necessity for the South African government to align their education advancements towards encouraging enrolment of more students in the science, engineering and technology fields. Also, the culture of education progression to masters and doctoral degrees needs to be nurtured.

The quality of education in public schools is known to be at its lowest. Better study conditions, such as the provision of teachers according to advancements in technology, need to be implemented. Parents must be encouraged to play a more enhanced role in their kids' education. Schools must employ fair admission policies and make it feasible and cost-effective for the general public to access education. Mthembu (2016) and Seetanah (2016) highlighted that as much as government has to spend much on primary education, as the basis of cognitive skills development, it is acknowledged that such spending may be a liability on the country's economy as such individuals are not well skilled and equipped enough to acquire jobs that may contribute towards economic growth.

Government needs to provide more funding towards higher education. It is however heart-warming to note that the Department of Higher Education and Training has made significant strides in providing more funding for disadvantaged schools through the National Student Financial Aid Scheme (NSFAS) and brought some enticements to universities in the form of more lecture rooms and laboratories to the extent that as at January 2015, there were 204 000 places available at universities, which is an increase from 2013 which was at 170 000. This is also manifested in the increasing number of university graduates presented in this study. The extension of NSFAS funding to the FET colleges also contributed towards an increase in the number of graduates. Despite all these significant strides, NSFAS is still underfunded and numerous students still do not gain access to higher education because of lack of funding for their studies. The policy generators and budget teams need to allocate more funding towards investment in education.

8.5 AREAS FOR FUTURE RESEARCH

The study endeavoured to establish the impact of different levels of education on economic growth. For matric education attainment that did not exhibit co-integration with economic growth, it would be worth investigating the fundamental causes thereof.

The study could have explored innovation, research and development further and used reasonable proxies such as number of publication and funding from research institutes as proxies for IRD.

It has been cited in many instances in this report that it is the quality of education and the workforce that that contributes more to economic growth, not only the quantity. Such further research on the impact of the quality of education on economic growth would be worth pursuing. It is recommended that this further investigation would have to encompass cognitive skills, with the main focus in mathematics and science.

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