UNIVERSITY OF BOTSWANA

FACULTY OF SOCIAL SCIENCES

DEPARTMENT OF ECONOMICS

THE RELATIONSHIP BETWEEN HIGHER EDUCATION AND ECONOMIC GROWTH: AN EMPIRICAL INVESTIGATION FOR BOTSWANA

By:

Karabo Charowe

(200206705)

Dissertation submitted to the Faculty of Social Science, Department of Economics, in partial fulfilment of the requirements for the Master's Arts in Economics.

19th January 2021

DECLARATION

I hereby declare that this dissertation is my own original work which has not been submitted to any other institution for similar purposes. Where other peoples' work has been used, acknowledgements have been made.

_____

Full Legal Name

_____

Signature

_____

Date

CERTIFICATE OF APPROVAL

I declare that this dissertation represents the student's own work and effort and has been submitted with my approval.

Signature: _____ Date: _____

Dr. K. Mangadi

Supervisor

Signature: _____ Date: _____

HoD Economics

DEDICATION

I dedicate this work to my family. Your unconditional love, spiritual, emotional and financial support kept me going throughout the two years of study. I love you so much!

ACKNOWLEDGEMENTS

Firstly, I would like to thank University of Botswana community for accepting me as one of students in the school. Secondly the School of Graduate and Department of Economics and all lecturers who taught me for imparting me with a knowledge of economics which enabled me to write this paper.

I would also want to thank my supervisors, **Dr K. Mangadi** and **Mr M. Rathedi** for their support and guidance during the time I was working on this dissertation. I could not have imagined having a better supervisor and mentor for this study. Their encouragements have been of great help towards this work.

Special thanks should go to Ministry of Investment, Trade and Industry management who nominated me to further my studies. Thank you for making it possible for me by availing all resources I needed in order to do this study. You are appreciated!/

I would also like to thank the African Research Consortium for according me the opportunity to go and study for my electives at the Joint Faculty of Electives at Kenya. If it wasn't for your support and sponsorship I shouldn't have managed to write such a paper. Thank you so much.

I would finally like to thank my fellow classmates for helping me by proof reading this paper and all their encouragement, **Dimpho Mhlabano**, **Refiloe Jabari** and Katlego Tseladikae. Guys thank you so much, I wouldn't have made it if it was not for your support. Thank you

ABSTRACT

The study investigates the role of higher education in economic growth for Botswana between 1981 and 2016 using the application of Auto Regressive Distributed Lag Model and Toda & Yamamoto (1995) Causality approach in Vector Autoregressive (VAR) framework. The analysis showed no evidence of long run relationship between economic growth and higher education. The results imply that higher education do not play any role in bringing economic growth to equilibrium.

The empirical results of causality test indicate that there is no direction of causality between economic growth and higher education which suggests that for the case of Botswana when considering revenues without mineral proceeds economic growth is independent from higher education.

Keywords: Botswana, Higher Education, Economic Growth, Cointegration and Causality.

Table of Contents

Abbreviations

Abbreviation	Meaning
ADBR	African Development Report
ARDL	Auto Regressive Distributed Lag
BOTA	Botswana Training Authority
GDP	Gross Domestic Product
ETSSP	Education and Training Sector Strategic Plan
GMM	Gaussian Mixture Model
KPSS	Kwiatkowski Phillips Schmidt Shin
MFED	Ministry of Finance and Economic Development
MELSD	Ministry of Employment, Labour and Skills Development
MOBE	Ministry of Basic Education
MoESD	Ministry of Education and Skills Development
MOTE	Ministry of Tertiary Education, Research Science and Technology
MWALD	Modified Wald
OECD	Organisation for Economic Co-operation and Development
OLS	Ordinary Least Squares
RNPE	Revised National Policy on Education
SAARC	South Asian Association for Regional Cooperation
TEC	Tertiary Education Council
VAR	Vector Auto Regressive
VECM	Vector Error Correction Model
WDI	World Development Indicators

List of figures and tables

CHAPTER 1

INTRODUCTION

1.1 Background of the study

Higher education has been found to be extremely important for nations and individuals around the world, in a period when pricing of intellectual capital is increasing (Chaudhary *et al.,* 2009). It can produce critical innovators and thinkers, as well as healthy, informed and engaged citizens. According to Lucas (1993), the main engine of growth is the accumulation of knowledge or human capital, and the main source of disparities in living standards among countries is differences in human capital. Physical capital plays an essential but decidedly subsidiary role. In the context of this study, higher education is captured or referred to all tertiary education enrolments.

Chaudhary *et al.,* (2009) further argue that higher education maintains high standard of living and social mobility and can combat current public policy challenges including democratic renewal and health care. Moreover, the world's higher education universities and institutions have driven research that has provided the facilities for innovative business ideas and political theories that have had a significant impact on development of various disciplines. Shah *et al*. (2011) indicates that education is generally considered as an essential and powerful instrument in promoting economic growth, enhancing earnings at private level, discouraging and reducing poverty, empowering people, encouraging health and flexibility in environment and developing competitiveness in the economy.

In general terms, the theoretical growth literature stresses at least three mechanisms through which education may influence economic growth. First, the human capital characteristics in the labour force can be increased by education, which intensifies labour productivity and thus transitional growth toward a higher equilibrium level of output as augmented in neoclassical growth theories (Mankiw *et al*., 1992). Second, as in theories of

endogenous growth (see Lucas, (1988) and Romer, (1990)) education can increase the innovative capacity of the economy, and the knowledge on new technologies, products, and processes promotes growth. Third, education can promote economic growth by facilitating the dissemination of knowledge needed to understand and process new information and to successfully implement new technologies developed by others (Benhabib and Spiegel, 1994).

However, even with the overwhelming evidence of the positive relationship between higher education and economic growth, the casual relationship as well as the short run and long run dynamics between the two variables remain unclear. For instance, Dahal (2010) and Viracheat and Dash (2011) both argue that there is unidirectional causality from real GDP to higher education enrolment. Furthermore, evidence from studies by Huang *et al*., (2009) and Afzal *et al*. (2010) shows that there is existence of a long run relationship between higher education enrolment and actual GDP per capita. In addition, studies such as Afzal *et al*. (2010) found that there is an inverse relationship in the short run while Reza and Valeecha (2012) support the fact that education and economic growth are not related in the short run. Even though they have a long term relationship in which education enhances growth. However in the short term Beskaya *et al.,* (2010) are of the view that education granger causes real income. The results on the long term relationship were confirmed by Reza and Valeecha (2012). Javed *et al*. (2013) argued that primary enrolments have negative impact on the short run while secondary enrolments has positive impact on economic growth in the long run. Malangeni and Phiri (2018) argue that there is insignificant relationship between higher education and economic growth.

Based on the discussion above, it is evident that empirical studies have failed to agree on the existence and nature of the relationship between higher education and economic growth in the short and long run. In addition to this, the direction of causality remains unclear.

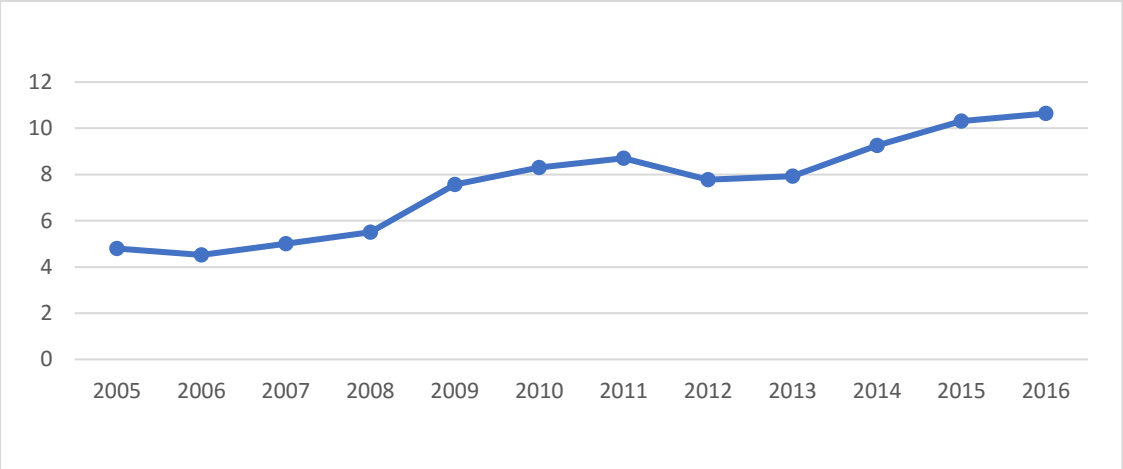
Therefore, the debate on the relationship between higher education and economic growth is still inconclusive and warrants further research.

1.2 Statement of the problem

The government of Botswana has always viewed expenditure on education, in particular higher education, as an investment in human capital. By promoting a well-educated and informed nation, government's objective is essentially to create an effective shock absorber for the economy and to create pathways and opportunities for economic diversification. To this end, in 2016 the government divided the ministry of education into two ministries, namely Ministry of Basic Education and Ministry of Tertiary Education, Research Science and Technology in order to give tertiary education the attention it deserves, as the ministry was overwhelmed by the pressure of school results and tertiary education financing was not given the required budget.

The education sector has thus received preferential treatment over the years. This is evident from the amount of funding that it has received from the government. From 2005 to date, the sector has been receiving the largest share of the recurrent budget. This is a clear indication of the attention the education has received from the government. The chart below shows government expenditure on education from 2005 to 2016.

Figure 1.1: *Government expenditure on education (P'Billiion) from 2005 to 2016*



Source: Author's computations based on the 2005-2016 budget speeches

It is clear from the figure above that the funding allocated to the education sector has been on an upward trajectory, with decline in funding recorded only in 2013 and 2014. Although the ratio of education funding to total recurrent budget may vary from one year to the other, it is evident that the education sector still received the largest share of the budget. For instance, in 2005, 30% of the recurrent budget was allocated to education, then declined to 27% in 2006. The largest ratio was observed in 2011, where 31.1% of the recurrent budget was allocated to education. Currently, funding to the Ministry of Tertiary Education, Research, Science and Technology accounts for P4.89 billion of the recurrent budget, which represents the fifth largest share of the proposed Ministerial Recurrent Budget. The main items on the recommended budget include the costs of tertiary students' bursaries, as well as subventions to Government tertiary institutions (MFED, 2020).

Growth theories suggest that education or human capital promotes economic growth. These theories have been the bedrock of policy on education and growth for many developing economies, including Botswana. For example, recently, the government of Botswana adopted a policy of a "knowledge-based economy". This policy suggests that the economy of Botswana will be fueled by brainpower which will lead to new innovative ideas, efficient production techniques and technology and improved labor productivity.

Despite aggressive investments in human capital through education funding and training, as well as the adoption of novel policies to support knowledge creation, non-mining GDP continues to decline. For instance, non-mining GDP growth rate was well above 16% between 2005 and 2008 but declined to an average of about 12% between 2009 and 2013. In 2015, the growth of non-mining GDP was less than 5% while expenditure on education and level of enrolment continued to increase as it stands at 27% in the same year.

Additionally, Botswana has relied on diamond mining as an important engine of growth. However, given the finite nature of the mineral and the associated challenges that come

with an undiversified economy, the country is now committing to becoming a knowledge-based economy as enshrined in the vision 2036. This calls for the transformation from resource driven growth to more knowledge intensive and innovative economy, and this transformation is closely linked to the provision of education, in particular at tertiary levels in order to ensure that the set goals are met. Therefore, it is crucial to explore the key economic aggregates that could potentially contribute to this transformation. In particular, it is important to investigate the potential role of higher education in achieving economic growth.

1.3 Objectives of the study

The main objective of the study is to investigate the relationship between higher education and economic growth in Botswana over the period of 1981 to 2016.

Specifically this study attempts to:

1. Empirically determine causal relationship between higher education and economic growth in Botswana.
2. Investigate the short run and long run impact of higher education on economic growth.

1.4 Significance of the study

Past empirical work on higher education and economic growth in Botswana focused on the relationship between quality of education and economic growth by employing a VECM framework (for example, Mbulawa and Mehta, 2016). A related domestic study by AlSamarrai (2003) examined the relationship between education outcomes and expenditure on education for three countries including Botswana.

The current study departs from Alsamarrai (2003) by carrying out a country-specific analysis instead in order to capture the unique features of the Botswana economy which may otherwise be lost in a panel approach. While Mbulawa and Mehta (2016) investigated the quality of education as measured by secondary and tertiary enrolments, and its relationship to growth as measured by aggregate GDP, this study focus on relationship between higher

education enrolment and non-mining GDP so as to see the impact of other sectors without mining revenues. This approach helps to analyse the effect of higher education on economic growth in resource-rich countries taking aside the growth that happens due to booms in mining sector. Mbulawa and Mehta (2016) only used traditional Granger causality test which are sometimes biased while this study employs Toda and Yamamoto (1995) causality test which are not biased.

The results of this study could assist the Botswana government to undertake appropriate policy actions in order to achieve the desired outcomes from growth in educational spending; to aid in the transformation of the economy towards making it more knowledge-based and to combat macroeconomic problems such as unemployment and poverty.

1.5 Organisation of study

The remaining section of this study are organised as follows: chapter two presents theoretical and empirical review of economic growth. The background of the economy of Botswana is presented in chapter three. The empirical model is specified and presented in chapter four while chapter five presents data analysis and findings and conclusions and policy recommendations are presented in chapter six.

CHAPTER 2

BACKGROUND OF BOTSWANA ECONOMY

2.0 Introduction

The chapter elaborates the macroeconomic developments in Botswana and the sectors of the economy. The contribution of each sector to GDP is presented and discussed for the selected years. The chapter also covers how the economy of Botswana performed in regard to education reforms and education financing overtime. The chapter is divided in to four sections. This introduction section is followed by the discussion on the overview of economic growth in Botswana is captured in section 2.1, while section 2.2 captures the structure of GDP in Botswana. Section 2.3 discusses education reforms in Botswana while education financing is discussed in section 2.4. The trend of economic growth and higher education during the entire research period is discussed in section 2.5 while 2.6 concludes the chapter.

2.1 Overview of economic growth in Botswana

Botswana has been among the fastest growing economies in the world for the past decades. It was one of the poorest countries at independence in 1966 but it is currently rated upper-middle income country. The reason for fast growth is owed to good macroeconomic policies and strong governance. The rapid economic growth and general development in Botswana have been driven by the mining sector, particularly the diamond industry. After independence, average economic growth rate was about 9% per year from 1966 to 1999 (KPMG, 2014). Per capita income increased from USD 5,700 in 2006 to USD 7,000 in 2007, thereby making Botswana an upper-middle-income country (United Nations, 2009).

The mining sector contributed 42.2 percent of GDP for the period 1984 to 1995, the contribution declined to 30.9 in 1995 to 2004 period which from there reduced to 22.0 from 2004 to 2014. In 2015, the economic growth contracted because of weak demand for diamond exports but was boosted again in 2016 by recovery in diamond and good performance of other

sectors. The country survived the resource curse and Dutch disease phenomena which are experienced by resource-rich countries. Even though the country has been doing well, 16.1 percent of the population is living below the poverty line (World Bank, 2019). These are people who live in rural areas and are mainly female-headed households.

2.2 Structure of GDP growth in Botswana

The economy of Botswana consists of primary, secondary and tertiary sectors. The table below shows the contribution of the sectors to GDP from 1966 when the country gained its independence to 2017.

Table 2.1: *Shares of Economic activities to GDP for the years 1966 to 2017*

ECONOMIC SECTOR	1966	1985	2006	2011	2014	2017
Agriculture	42.7	5.6	1.9	2.8	1.3	2.2
Mining and Quarrying	-	48.9	46.1	25.9	24.2	19.9
Manufacturing	5.7	3.9	3.5	6.4	6.5	5.6
Electricity, gas and water	0.6	2.0	2.7	-0.1	6.5	0.8
Construction	7.8	4.6	4.3	6.6	5.1	7.0
Trade, Hotels and Restaurants	9.0	6.3	11.1	16.5	7.7	21.6
Transport and Communication	4.3	2.5	3.9	5.4	5.4	6.5
Finance and Business Services	20.1	6.4	6.2	14.7	8.8	15.3
General Government	9.8	12.8	16.4	15.6	6.0	15.2
Other services	0.6	7.0	3.9	6.2	28.5	6.0

Source: African Economic Outlook, 2017

From Table 1 above, it is evident that agriculture was the major contributor of GDP in 1966, the contribution declined over the years until it reached 1.3 percent in 2014. Agricultural output declined as a result of drought, climate change and animal diseases. The government intervened to improve the agricultural sector and its output is slightly increasing.

At the time of independence, the mining sector did not exist. The diamonds were discovered in the 1970's, the mining and quarrying sector increased from nothing in 1966 to 48.9 percent in 1985. Though its contribution has been declining over the years, it is still the major component of GDP.

The financial sector has the sizeable share to GDP, in 1966, the sector contributed 20.1 percent. Due to global financial crisis in 2008/09, its contribution declined but rose again in 2017 where it was 15.3 percent of GDP. Other sectors have a low yet stable contribution to GDP.

2.3 Botswana Education reforms

Mbulawa and Mehta (2016) argued that human capital investment in Botswana is a priority as the country is focused in building an innovation driven economy. By reinforcing current public-private partnerships and opening up to international investors the country could be transformed into a regional education hub (Velde and Cali, 2007). Botswana is now classified a middle income economy with a population of 1.9 million as of 2007.

In 1977, with the aim to improve access to education the education sector in Botswana went through a reform program known as Education for Kagisano, which referred to as social harmony. The aim was to be achieved through providing basic education up to completion of form two. The program was in place until 1993 when the Revised National Policy on Education (RNPE) was put in place which facilitated the formulation of Tertiary Education Council (TEC) in 1999 which was an oversight board for all tertiary institutions. TEC had the duty to check the quality of education programs being offered by both public and private tertiary institutions, coordination of long term planning in education, give advice in the formulation of policy on tertiary education, promotes research linked to industry and human development and accreditation of private tertiary institutions. Vocational Training Act in 2000 established the Botswana Training Authority (BOTA) as a parastatal under the Ministry of Labour and Home

Affairs[1]. It was mandated to reform, operationalize and monitor vocational training system in Botswana. It also had the mandate to accredit both institutions and trainers with its main focus on education levels up to certificate which meant that there was duplication of activities which were also covered by TEC (Ministry of Education and Skills Development (MoESD), 2008).

The entire economy of Botswana's performance and management has been above board and financing all the key economic activities with most of locally generated resources, especially from diamonds which are a key revenue source. A recognised number of Botswana citizens around the 1970s managed to gain entry into tertiary education level (MoESD, 2008). According to African Development Bank Report (ADBR) (2009) the average literacy rate of Botswana was at 82% in 2009 which can be compared to a rate of 54.8% in 1991. The literacy levels of the country have increased over the years as indicated that in 1993 it was 68.9%, 81.2% in 2003 and 88.6% in 2014. To contribute to economic development the country should come up with useful policies and programmes, (Statistics Botswana, 2015).

Botswana on it's journey of transforming the economy from resource based to knowledge- driven economy has some national development plans to guide its education sector. Currently the there is a strategic plan namely the Education and Training Sector Strategic Plan (ETSSP) which runs from 2015 to 2020 which is intended to guide the guide the education sector. The Education and Training Sector Strategic Plan emphasizes the importance of five key deliverables in education, that is, laying a solid foundation at pre-primary education level, enhanced participation of private sector and parents, teacher education and professionalism, technical and vocational education and lastly the sector's strategic role as a catalyst in national development and economic transformation, (Ministry of Education and Skills Development, 2015).

[1] See http://www.bota.org.bw/

Unicef (2018) indicates that in 2016 the government separated the portfolios of Basic education and Higher education which lead to formation of two ministries under education being Ministry of Basic Education (MOBE) and Ministry of Tertiary Education, Research and Technology (MOTE). Ministry of Basic Education is responsible for pre-primary, primary and secondary education, while Ministry of Tertiary Education, Research and Technology focuses on vocational and technical education and teacher training, as well as other tertiary education and student bursaries. The portfolio of skills development was also transferred to the Ministry of Employment, Labour and Skills Development (MELSD), that is, (MELSD) was then given the responsibility of skills development in the country.

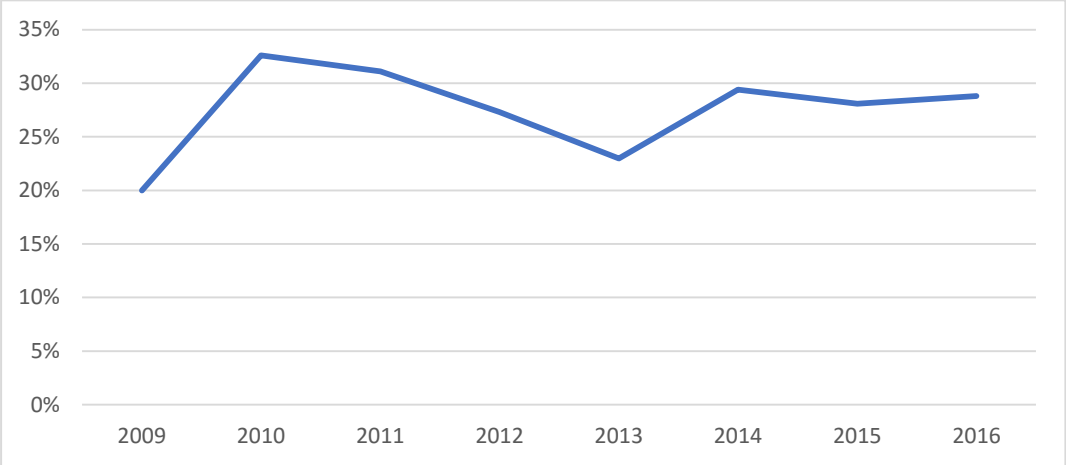
2.4 Education Financing

The government has been of late allocating quite a sizeable amount of money to the education sector in terms of giving priority to financing education. Public expenditure on education has been steady over the past years averaging, 22 per cent of total budget between 2014/15 and 2018/19, at 20 and 18 per cent, respectively. The trend of the budget allocation to education sector is presented in figure 2.1 below.

The trend shows the education sector have been allocated a sizable amount of funds for the past years and it was fluctuating between twenty and thirty percent of the entire budget. Even after the ministry of education was separated into two ministries the ministry responsible for higher education continued to get the lion's share 10.7% in 2017, 10.5% in 2018 and 9.7% in 2019[2].

[2] Ministry of Finance and Economic development, Botswana, Budget speech (2017-2019). Retrieved from: http://www.finance.gov.bw

Figure 2.1: *% budget allocation to ministry responsible for higher education financing from 2009 to 2016*



Author's Computation from ministry of finance website[3]

The government of Botswana has shown how committed it is in improving both quality of education and access to education by allocating the MoESD the largest share in 2012 national budget. Even though it was lower in percentage terms than what was allocated in the previous year's budget it was due to the fall in number of bursaries allocated for tertiary education students in foreign institutions[4]. Education and Training Strategic Plan was launched by the government in the year 2012 in order to guide in fostering improvements in delivery of education, to guide on the prioritization and allocation of resources and guide skills development in Botswana. In 2013 the development budget for the education ministry accounted for 82% of the money which was set aside for expansion and maintenance of secondary schools and other development purposes[5]. It was observed that, the education ministry received a lion's share in each budget period, even though percentages appeared to be

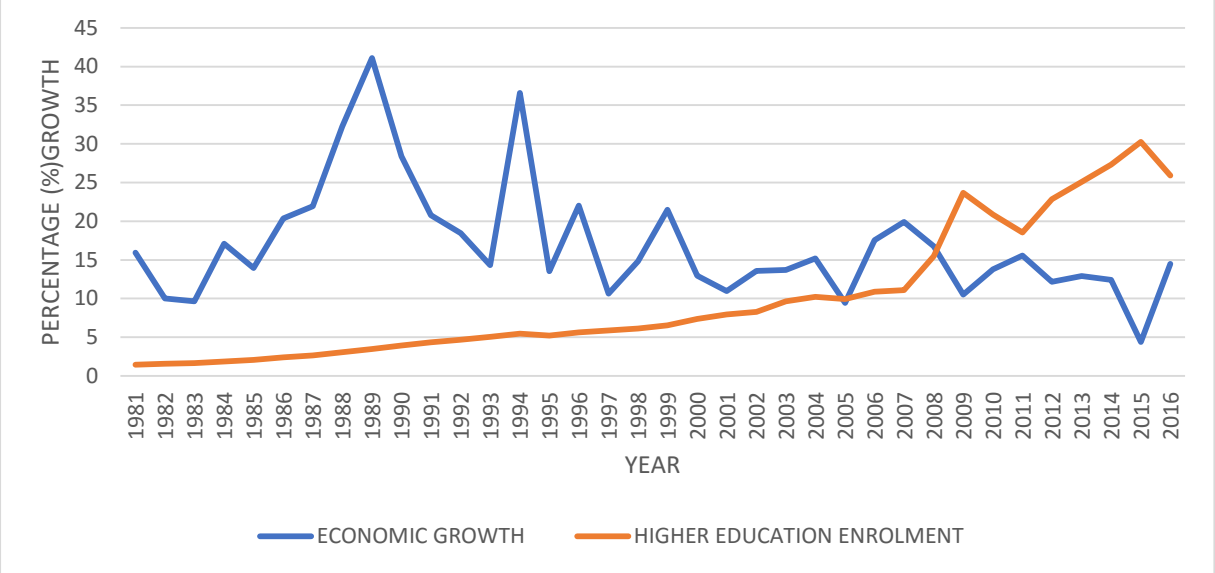
[3] Ministry of Finance and Development Planning, Botswana, Budget speech (2009-2016). Retrieved from: http://www.finance.gov.bw
[4] Ministry of Finance and Development Planning, Botswana, Budget speech 2012. Retrieved from: http://www.finance.gov.bw
[5] Ministry of Finance and Development Planning, Botswana, Budget speech 2013. Retrieved from: http://www.finance.gov.bw

falling compared to previous years and one must observe that even after the portfolios of education were separated education sector seems to benefit more.

2.5 Trend of economic growth and higher education for the study period

The trend of economic growth and higher education for the study period is depicted in figure 2.2 below. This figure is a computed from non-mining GDP growth data gathered from Statistics Botswana and higher education enrolment annual growth gathered from Statistics Botswana and World Development Indicators.

Figure 2.2: *economic growth and higher education enrolment annual % growth for Botswana from 1981 to 2016*



Authors Computations from data gathered from Statistics Botswana and WDI.

Economic growth (non-mining GDP growth) of Botswana increased from 10% to about 41% in 1989 and dropped to 15% in 2016 while higher education enrolments steadily increased from 2% 1n 1981 to 25% in 2016. During the global economic recession of 2008 higher education enrolment increased from 10% to 22% for the period 2008 to 2009, while economic growth dropped from 20% to 10% for the same period. The chart clearly shows that growth rate was high between 1980s and 1990s. However, non-mining GDP growth was sluggish from mid 1990s, and began to decline from early 2000s. Notwithstanding the above statement,

higher education enrolment was increasing at an increasing rate from the early 1980s. The chart also shows that the rate of enrolment surpassed the rate of economic growth in 2008.

2.6 Conclusion

The purpose of this chapter was to discuss the overview of economic growth in Botswana, discuss structure of Botswana economy, capture education reforms in Botswana, education financing and finally to capture the trend of economic growth and higher education annual growth in Botswana. This chapter discusses in detail, the transition of economic growth in Botswana since the country gained independence. Agriculture was the main contributor to GDP in the 1960s but its share decreased tremendously due to drought. The larger share of GDP is from the mining sector since the discovery of diamonds in 1970. The reforms of the education system were undertaken and they led to separation of higher education from basic education. The financing of education has increased over the years and has reached 29 percent of total budget in 2016.

CHAPTER 3

LITERATURE REVIEW

3.0 Introduction

This chapter focuses on both theoretical and empirical literature review of economic growth. The relevant theories of economic growth that introduces education in the analysis are fully discussed and the empirical studies that examine the effect of education on economic growth are synthesised. This chapter is categorised into four sections. After this introduction section 3.1 discusses theoretical review captured in two subsections 3.11 and 3.12 which discusses exogenous and endogenous growth theories respectively. Section 3.2 discusses the empirical literature on the relationship of higher education and economic growth while the last section 3.3 namely the overview of the literature summarises the literature review and presents the contribution of this study to existing literature.

3.1 Theoretical review

This section discusses models which shows how higher education affects economic growth. These are growth models namely exogenous growth model (Solow model) and endogenous growth models.

3.1.1 Exogenous growth model: Solow model

The model was established by Solow (1956) and it explains output growth in terms of the economy's saving rate, technological progress and population growth. The analysis by Solow showed how output is dependent not only on labour and capital, but technological progress also. Technology essentially determines how much output can be produced with a given amount of labour and capital, it raises the efficiency of labour. Technological progress reduces the number of workers required to produce a given amount of output and it increases the amount of output that can be produced by a given number of workers. This is called labour-augmenting technology.

The Solow model was augmented to include human capital by Mankiw *et al.* (1992) using cross-country evidence. Mankiw *et al*. (1992) postulated that the human capital characteristics in the labour force can be increased by education, which intensifies labour productivity and thus transitional growth toward a higher equilibrium level of output as augmented in neoclassical growth theories Benhabib and Spiegel, (1994) also argued that education can promote economic growth by facilitating the dissemination of knowledge needed to understand and process new information and to successfully implement new technologies developed by others.

3.1.2 Endogenous growth models

Lucas (1988) developed the endogenous growth model, which measured human capital as one of the factor of production and education as a means of human capital accumulation. According to Lucas (1988), education was a vehicle for human capital accumulation and was treated as a factor of production besides labour and physical capital. This means that progress in the educational achievements of the labour force has a positive effect on productivity that leads to better economic performance at aggregate level.

Education facilitates and helps in the adoption and implementation of continuously invented new technologies, (Nelson and Phelps, 1966). Schultz (1961) posits that educated human capital understands and encourages the use and importance of technology. But, technology is implemented or used in organizations by educated people. Education can play a basic and important role in growth determination. Domestic technological progress is a result from the search for better and improved innovations, (Romer, 1990a; Grossman and Helpman, 1991).

However, Pritchett (1996) indicated that higher growth rates may not be associated with schooling because educated workers may be interested in participating in socially unproductive activities such as unauthorized use or reproduction of other people's work. Poor quality of

schooling has not shown any positive results which indicated any increase in human capital and a lot of skilled labour has suppressed wages and reduced growth. Human Capital theory- accounts for mechanisms such as skills formation, education & work experience. (Hoeffler, 2002).

Furthermore, Glewwe *et al.* (2012) states that an insignificant relationship between educational achievement and economic growth is possible for less developed countries since their main concern is based on quality education as opposed to quantity of educated persons.

As stated in the introduction there are three potential channels in which higher education affects economic growth; the accumulation of productive skills and capabilities which is the neoclassical growth theory, the generation of new knowledge through innovation namely the endogenous growth theory and lastly the and innovation and adoption of technologies that enables quicker adoption of existing cutting-edge technologies. The theory of endogenous growth (see Lucas, (1988) and Romer, (1990)) education can increase the innovative capacity of the economy, and the knowledge on new technologies, products, and processes promotes growth.

As in the innovation and adoption of technologies the role of knowledge and non-rival human capital is also emphasised in Romer, (1986) model of endogenous growth. Investments in new machinery can create new knowledge which can be shared amongst firms who have not made the same physical capital investments. So, for example, if a firm invests in installing a new piece of machinery in a factory it generates new skills as workers use the machinery and knowledge about how to produce a particular good more efficiently. Therefore, if firms can ensure individuals are suitably equipped and educated on how to operate machines and to absorb this knowledge in the workplace this will eventually lead to higher economic growth rates. Consequently, a number of authors have placed an emphasis on scientific and

mathematical skills as being key to linking schooling with long run economic growth (Hanushek and Kimko, 2000). Although such skills can be developed in a number of ways, an increase through higher education would, holding everything else constant, lead to more growth.

3.2 Empirical Review

Malangeni and Phiri (2018) investigated the long-run and short-run cointegration relations between education and economic growth in South Africa using the bounds approach to autoregressive distributive lag model. The finding from the study contradicts both existing empirical and theoretical postulations. The empirical results as indicated in the study showed that there exist an insignificant relationship between education and economic growth in South Africa.

The paper by Kobzev Kotásková *et al*. (2018) attempted to add and improve on previous publications and by introducing some unique insight which were paired with contemporary evidence about the relationship between education and economic growth in India from 1975 to 2016 by focusing on primary, secondary and tertiary levels of education. The relationships were examined by applications granger causality and the cointegration methods of econometric estimations. These methods were used in order to create a benchmark that could be used to examine the claim that education plays a central and significant role in economic growth of India and these methods could consequently be used as an example for similar countries in around the world and even in other Asian countries. The findings of their work indicated and proved compelling evidence of a positive association or relationship between education levels and economic growth in India which might encourage governmental actions and shape the future of India.

In another recent study by Obradovic *et al.* (2016) a unidirectional causality between higher education and real GDP per capita was found. The study was a research panel sample

of the selected OECD countries with the data for the time period from 2000 to 2011. The study is titled the influence of economic growth on regional disparities; Empirical evidence from OECD. The relationship was positive, but not jointly reinforcing. Pandey (2016) on the study entitled growth of higher education in India after independence observed that, education is one of the most empowering tools for an individual. Education also prepares and trains workers at all levels to manage administration, capital and technology services at every sector in the economy. It lays the foundation for a better life for individuals.

Ali *et al*. (2016) on their paper to study the relationship between higher education and economic growth in Pakistan in which they used the Granger causality test and the Johansen co-integration test for the period of 1982-2014, found a unidirectional relationship (granger causality) running from gross domestic product to higher education enrolment. There was no other causal relationship which was found running from higher education enrolment to gross domestic product in Pakistan.

Hanif and Arshed (2016) conducted a study on the SAARC countries by use of three proxies for human capital in order to see whether higher education proxy has better significant impact on the growth of the selected countries. A sample period range from 1960 to 2013, that is, a period of 53 years was selected and used for this study in a panel data of SAARC countries. The data was collected from WDI official website for smooth analysis of their proposed model. They performed a pooled OLS regression model and the fixed effect regression model in the study. The dynamic panel data models results indicated that tertiary education enrolment has highest effect on growth as compared to primary and secondary education enrolment.

Nowak and Dahal (2016) used OLS and VECM estimation techniques to investigate whether there is a long run relationship between education and economic growth in Nepal between 1995 and 2013. The results confirmed a positive relationship between education and real GDP per capita that is, secondary and higher education contributes significantly to real per

capita GDP. Mariana (2015) found out that education has a positive influence in economic growth in the long run for the Romanian economy between the sample periods of 1980 to 2013. Pegkas and Tsamadias (2014) apply the vector error correction model (VECM) to investigate the cointegration relationship between education and economic growth in Greece over a period spanning from 1960 to 2009. The study found a positive link between education attainment and economic growth for the data by use of similar VECM modelling techniques.

Another study found a positive association between higher education and economic growth using the data covering the period 1980-2011. Qazi et al., (2014) used the ARDL bound testing approach in Pakistan and found out that higher education can positively influence economic growth in the long run as well as in the short run. Similarly, Holmes, (2013) on another study investigated the influence of primary, secondary and higher education on economic growth in the UK. The findings of the analysis of the study showed that during the past forty years there was positive relationship which were found in between secondary and primary education, research activity, technical skills, and measures of capital accumulation, whereas the higher education has no significant influence on economic growth.

Also for Pakistan data collected between 1981 and 2010, Reza and Valeecha (2012) by use of a simple OLS regression analysis investigated the education-growth relationship. The study failed to establish any relationship between the two variables in the short-run but find a significant long-run relationship. Shaihani *et al*. (2011) also examined the impact of education level on economic growth in Malaysia for the period 1978–2007 using the ARDL modelling approach. The results of the study showed that primary and tertiary education has a negatively significant relationship to economic growth while secondary education had a positive and significant relationship on economic growth in the short run, and also it is clearly indicated that in the long run, only tertiary education showed a positive and significant association on economic growth.

On the other hand, Afzal *et al*. (2010) employed the ARDL bounds testing approach to cointegration in order to investigate the short-run and long-run linkage between school education and economic growth in Pakistan using annual data for the period 1970–71 to 2008–09 and found evidence of cointegration between school education and economic growth. The results of the study depicted a direct association between school education and economic growth in Pakistan, in both the short-run and the long-run. The results were found to have a positive relationship between education and economic growth.

Cooray (2010) in the study entitled 'The role of education on Economic growth' examined the effect of the quantity and quality of education on economic growth by applying the OLS model and GMM estimation. The study used different number of proxy variables to estimate the quantity and quality of education in a cross section of low and medium income countries, the study found out that when education quantity is measured by enrolment ratios it explicitly influences economic growth. The data for the study was a single cross-section data from WDI averaged over the 1999-2005 period. The impact of government expenditure on economic growth is largely indirect through its effect on improved education quality. Katircioglu (2010) also investigated the relationship between higher education enrolment and economic growth of North Cyprus by use of annual data from the period of 1977 to 2007, on the study entitled International tourism, higher education and economic growth. The empirical results of the ARDL cointegration test proved a positive and significant association between higher education and economic growth.

Chaudhary *et al*. (2009) investigated the role of higher education in economic growth for Pakistan between years 1972 to 2005 by use of Johansen Cointegration test and Toda & Yamamoto (1995) granger causality approach in VAR framework. The study examined whether higher education affect economic growth in Pakistan in the long run. The findings of the study suggested that these variables are necessary for each other, which implies that there

is a long run relationship between economic growth and higher education. The empirical results of causality test indicated that there exists a unidirectional causality running from economic growth to higher education and no other direction of causality found between these variables.

Khorasgani (2008) on the study titled higher education development and economic growth in Iran, analysed the impact of higher education development on economic growth of Iran by using the annual data from the period of 1959 to 2005 by use of Autoregressive distributed lag (ARDL) cointegration and error correction models. Results of this study indicated that higher education has a positive and significant effect on economic growth of Iran in long run as well as in short run. Another study which reviewed the impact of quality education on economic growth in the U.S. drew a conclusion there was a significant and strong effect of the quality of education on economic growth (Hanushek *et al.*, 2008).

Gyimah-Brempong *et al*. (2005) used panel data for the period 1960–2000 to investigate the effect of higher education human capital on economic growth in African countries. The results of the study showed that all levels of education human capital, including higher education human capital, have a positive and statistically significant effect on the growth rate of per capita income in African counties. The estimated growth elasticity of higher education human capital was found to be twice as large as the growth impact of physical capital investment, that is, it was found to be about 0.09. Although this result is obviously an overestimate of the impact of higher education on growth, it is vigorous to different specifications and points to the need for African countries to use higher education human capital effectively in growth policies.

Other study by AlSamarrai (2003) examined the relationship between education outcomes and expenditure on education for three countries including Botswana and found out that there was a weak connection between education outcomes and resources. That is, institutional composition governing resources was vital in producing better outcomes. The

other important finding is that improved access to primary education was rather demand driven. Though the study was on the subject of education it did not take into account the causality between education and economic growth.

3.3 Overview and contribution to existing literature

While there are sound theoretical arguments that suggest that there is a positive relationship between education and economic growth, empirical findings remain ambiguous. There are researchers who reported evidence to support theory that education promotes growth[6]. Others reported that direction of causality runs from economic growth to education[7], while others found no causal relationship between education and economic growth[8] .

The ambiguity of the empirical studies suggests that results of causality tests may depend on proxies (for both economic growth and education) used and may also be sensitive to the region or country which the study is being conducted. Therefore, the results of other studies cannot be generalized. Thus, a need to investigate the case of Botswana. However, there seem to be lack of empirical studies done in Botswana[9] Both studies used standard Granger-causality test. Due to its limitations, their findings may be misleading. As a result, the current study uses a more superior test, Toda and Yamamoto (1995) causality test. Furthermore, these studies did not consider the role and influence of the mining sector on the growth of Botswana's economy. The current study corrects for this bias caused by mining sector by using non-mining GDP as a proxy for economic growth.

[6] See for example Hanif and Arshed (2016), Mariana (2015), Qazi et al. (2014) and Beskaya et al, (2010)
[7] See for example Ali et al. (2016), Virachet and Dash (2011) and Dahal (2010)
[8] See for example Malangeni and Phiri (2018), Holmes (2013) and Reza and Valeecha (2012)
[9] To the best knowledge of the author, the studies done in Botswana are (Mbulawa and Mheta (2016); AlSamarrai (2003))

CHAPTER 4

METHODOLOGY

4.0 Introduction

Chapter 3 of this study sheds some light on the relationship between higher education and economic growth. This chapter specifies the model to be used to establish the relationship between economic growth and higher education together with other investigating variables. The data to be used in the model is also identified in this chapter. The chapter is divided into three sections. Following this introduction is section 4.1 which indicates a theoretical model that links higher education and economic growth. Empirical model specification follows in section 4.2 which has one subsection which captures measurements of variables and their expectations. Unit root tests follows in section 4.3, cointegration test in 4.4, granger causality tests under VECM in section 4.5, granger causality under Toda & Yamamoto procedure under section 4.6 and long run and short run estimation under section 4.7, as review of the estimation of procedures. Section 4.8 identifies data to be used in the study. Section 4.9 concludes the chapter.

4.1 Theoretical Model Specification

This study follows a number of specifications directed by theoretical literature. Existing empirical works used similar approaches, hence these specifications are not new as used in this paper. Therefore, the theoretical underpinning for this study is the neoclassical model which was originally proposed by Solow (1956). The level of output, capital and labour represented by Y, K and L, respectively and are all linked through the production function equation

$$Y_t = A_t\, K_t^{\alpha} L_t^{1-\alpha} e_t \quad ; \text{t} = 1, 2, 3\ldots \qquad (4.1)$$

Where A_t is total factor productivity, and e_t is the error term.

The model was then extended by Mankiw, Romer and Weil (1992) to include or account for human capital. This model is written in the general form as:

$$Y_t = A_t\, K_t^{\alpha} H_t^{\beta} L_t^{1-\alpha-\beta} e_t \text{ ; t = 1, 2, 3…} \qquad (4.2)$$

Where Y_t is aggregate production of the economy, A_t is total factor productivity, K_t is real capital stock, L_t is employed labour force, H_t captures human capital at time t. That is, it is the total contribution of workers of different skill levels to production. It includes the contributions of both raw labour and human capital (that is, skills that individuals are endowed with and those that they acquired). With regard to the amount of human capital created from a given set of inputs, the model assumes that each worker's human capital depends only on his or her years of education. This is equivalent to assuming that the only input into the production function for human capital is students' time.

4.2 Econometric Model Specification

To investigate the relationship between higher education and economic growth, the study will follow the specification which was used by Chaudhary *et al*. (2009). Following from the theoretical model,

$$Y_t = A_t\, K_t^{\alpha} H_t^{\beta} L_t^{1-\alpha-\beta} e_t \text{; t = 1, 2, 3…} \qquad (4.3)$$

Where Y_t is aggregate production of the economy, A_t is total factor productivity, K_t is real capital stock, L_t is employed labour force, H_t captures human capital at time t.

Taking natural logs (*Ln*) on both sides of equation (4.3) gives an estimable linear function:

$$LnY_t = LnA_t + \alpha LnK_t + \beta LnH_t + \gamma LnL_t + e_t \quad \text{; t = 1, 2, 3… (4.4)}$$

Where *α,* is elasticity of production for capital*, β,* elasticity of production with respect to higher education and elasticity of production with respect to labour is γ *(1-α-β)* and a constant parameter is *Ln* A_t, and e_t is the error term, which reflects the influence of all other factors.

In order to empirically investigate the causal relationship between higher education and economic growth in Botswana, this study employs a VAR framework. VAR models are

advantageous because they are easy to estimate, they have good forecasting capabilities, the researcher does not need to specify which variables are endogenous or exogenous, that is all variables are endogenous and lastly in a VAR system is very easy to test for Granger non-causality. This study added inflation rate and foreign direct investment in the model in order to avoid model misspecification which according to Gujarati and Porter (2009) can result in omitted variable bias. All variables are not logged as are already all in percentage form.

$$\begin{bmatrix} Y_t \\ K_t \\ H_t \\ L_t \\ INF_t \\ FDI_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \end{bmatrix} + \sum_{i=1}^{k} \begin{bmatrix} \beta_{11i}\beta_{12i}\beta_{13i}\beta_{14i}\beta_{15i}\beta_{16i} \\ \beta_{21i}\beta_{22i}\beta_{23i}\beta_{24i}\beta_{25i}\beta_{26i} \\ \beta_{31i}\beta_{32i}\beta_{33i}\beta_{34i}\beta_{35i}\beta_{56i} \\ \beta_{41i}\beta_{42i}\beta_{43i}\beta_{44i}\beta_{45i}\beta_{46i} \\ \beta_{51i}\beta_{52i}\beta_{53i}\beta_{54i}\beta_{55i}\beta_{56i} \\ \beta_{61i}\beta_{62i}\beta_{63i}\beta_{64i}\beta_{65i}\beta_{66i} \end{bmatrix} \begin{bmatrix} Y_{t-i} \\ K_{t-i} \\ H_{t-i} \\ L_{t-i} \\ INF_{t-i} \\ FDI_{t-i} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \\ \varepsilon_{6t} \end{bmatrix} \quad \ldots\ldots\ldots\ldots (4.5)$$

Where: Y_t, is output and measured by non-mining GDP growth (proxy variable for economic growth),

K_t, represents gross fixed capital formation (proxy variable for physical capital).

H_t, is higher education and represents growth of enrolment at university level (gross higher education enrolment growth).

L_t, represents labour force participation rate as a proxy for employed labour.

INF_t, represents inflation rate.

FDI_t, represents net capital inflows as %of GDP as a proxy of foreign direct investment.

α's are intercepts

β's are coefficients of lagged variables

ε_{it} are white noise error terms

4.2.1 Measurement of variables and expectations

Table 4.1 indicate expected signs of coefficients variables in the study. Higher education, physical capital, employed labour and foreign direct investment are expected to have a positive influence to economic growth while inflation rate is expected to have negative influence on economic growth.

From economic theory, capital is the important determinant of economic growth (Solow 1956). Capital is the physical stock of capital which includes machinery, plant and equipment. The coefficient of capital is expected to have a positive sign as more capital increases productivity.

Most empirical studies found that higher education has a positive and significant influence towards economic growth. Higher education is measured by growth of enrolment into tertiary education and it is the growth of ratio of total tertiary enrolment to the population of the age group that officially corresponds to tertiary level of education. Theories of human capital development emphasize that investment in education increases productivity and efficiency, therefore higher education coefficient is expected to have a positive sign.

FDI – Foreign direct investment is net inflows (% of GDP) of investment made by a firm or individual in one country into business interests located in another country. FDI creates employment in the recipient country, this leads to higher output and better standard of living (Dinh et al., 2019), and hence foreign direct investment coefficient is expected to be positive.

Labour represents labour force which is the number of people who are employed and people who are unemployed but are seeking jobs. The coefficient of labour is expected to have a positive sign because increase in labour leads to increased output.

Inflation rate is included to capture macroeconomic stability. Most of studies which were conducted found that inflation negatively affect economic growth, those studies include

study by Barro (1996) and Bruno and Easterly (1998). The coefficient is expected to be negative.

Table 4.1: *Variables to be used in the study and their expected signs*

Name of Variable	**Expected sign**
Higher education enrolment	+
Capital stock	+
Employed labour	+
Inflation rate (Consumer price index)	-
Foreign Direct Investment	+

Source: Source based on surveyed literature

4.3 Unit Root Test

To test for stationarity of variables, the study employs ADF unit root test. One of the conditions that are to be met in order to run a Granger causality test is that the variables be integrated of the same order. That is, it is necessary that the time series be integrated of order 1 prior to conducting the Granger causality test since. One of the assumptions of the ADF test is that the error is independently and identically distributed. ADF is thus specified as follows:

$$\Delta Z_t = \alpha_0 + \alpha_2 t + \rho Z_{t-1} + \sum_{i=0}^{p} \beta_i \Delta Z_{t-i} + U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.6)$$

The equation above, which is more general allows for the presence of a non-zero mean and a constant deterministic drift (Greene, 2012). It has been documented that presence of a deterministic time trend reduces the power of the test (see Enders, 2014; Baltagi, 2005; Wooldridge, 2016). However, Enders (2014) suggests a test to determine the significance of the deterministic time trend in the ADF regressions. The test is a ϕ statistic which test for the joint significance of the coefficients. First step is to run a unit root test by ADF in its general form (with deterministic trend and intercept). If the null hypothesis of unit root is rejected,

there is no need to test for significance of time trend and intercept. If the null hypothesis is not rejected, test for significance of time trend. Should the ϕ statistic reveal that the time trend is insignificant, estimate ADF regressions without time trend. In the instance that the test continues to show that the series has unit, ϕ statistic is then used to test for the significance of the intercept. If the intercept is found to be insignificant, another ADF regression is estimated without both the time trend and intercept. The ϕ statistic is given as follows.

$$\phi_i = \left[\frac{(SSR_{restricted} - SSR_{unrestricted})/r}{SSR_{Unrestricted}/(T-K)}\right] \quad \text{(4.7)}$$

Where $SSR_{restricted}$ and $SSR_{unrestricted}$ represent the sum of residuals from the restricted and unrestricted models respectively, r is the number of restrictions, T-K is the degree of freedom in the unrestricted model. The null hypothesis of this test is that time trend is insignificant. Null hypothesis is rejected if computed ϕ statistic is greater than the tabulated ϕ_1.

According to Carnerio *et al.* (2004) the power of ADF and Phillips-Perron to distinguish between series that are purely non-stationery processes and those with near unit roots is limited. Therefore, in addition to the ADF unit root test this study employed the Kwiatkowski Phillips Schmidt Shin (KPSS) unit root test which is superior to the ADF test.

4.4 Cointegration

Cointegration means that the variables may divert away from each other in the short run, but they will move together in the long run. Enders (2004) states that if a linear combination of I(1) variables is a stationery process of I(0), then the variables are cointegrated. Cointegration test is done to find out whether or not linear combinations of the series are stationary. Granger causality test requires the variables to be I(1) and cointegrated. Therefore, the current study employs the Johansen cointegration test to test for levels relationship. It is

important to note that if cointegration does not exist among the variables of the study the Granger causality test is conducted under a VAR model.

On the other hand, if there is cointegration then the Granger causality test is conducted under a VECM model, where the error correction term is included to avoid the problem of model misspecification and also to determine the direction of the causality. VECM is VAR which has been designed for use with nonstationary data having cointegration relationship (Enders, 2014). VECM is one of the time series models which can directly estimate the level to which a variable can be brought back to equilibrium condition after a shock on other variables. VECM is very useful by which to estimate the short-term effect for both variables and the long run effect of the time series data.

4.5 Granger causality based on VECM Approach

This study uses the VECM to test for the long run relationship between higher education and economic growth. The multivariate model under VECM will be estimated as follows:

$$\begin{bmatrix} \Delta Y_t \\ \Delta K_t \\ \Delta H_t \\ \Delta L_t \\ \Delta INF_t \\ \Delta FDI_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \end{bmatrix} + \sum_{i=1}^{k-1} \begin{bmatrix} \delta_{11i}\delta_{12i}\delta_{13i}\delta_{14i}\delta_{15i}\delta_{16i} \\ \delta_{21i}\delta_{22i}\delta_{23i}\delta_{24i}\delta_{25i}\delta_{26i} \\ \delta_{31i}\delta_{32i}\delta_{33i}\delta_{34i}\delta_{35i}\delta_{36i} \\ \delta_{41i}\delta_{42i}\delta_{43i}\delta_{44i}\delta_{45i}\delta_{46i} \\ \delta_{51i}\delta_{52i}\delta_{53i}\delta_{54i}\delta_{55i}\delta_{56i} \\ \delta_{61i}\delta_{62i}\delta_{63i}\delta_{64i}\delta_{65i}\delta_{66i} \end{bmatrix} \begin{bmatrix} \Delta Y_{t-i} \\ \Delta K_{t-i} \\ \Delta H_{t-i} \\ \Delta L_{t-i} \\ \Delta INF_{t-i} \\ \Delta FDI_{t-i} \end{bmatrix} + \begin{bmatrix} \theta_1\tau_{t-1} \\ \theta_2\tau_{t-1} \\ \theta_3\tau_{t-1} \\ \theta_4\tau_{t-1} \\ \theta_5\tau_{t-1} \\ \theta_6\tau_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_{7t} \\ \varepsilon_{8t} \\ \varepsilon_{9t} \\ \varepsilon_{10t} \\ \varepsilon_{11t} \\ \varepsilon_{12t} \end{bmatrix} \quad \ldots\ldots (4.8)$$

Estimation of single equations is as follows:

$$\Delta Y_t = \alpha_1 + \sum_{i=1}^{k-1} \delta_{i1}\Delta Y_{t-i} + \sum_{j=1}^{k-1} \delta_{i2}\Delta K_{t-j} + \sum_{l=1}^{k-1} \delta_{i3}\Delta H_{t-l} + \sum_{m=1}^{k-1} \delta_{i4}\Delta L_{t-m} + \sum_{n=1}^{k-1} \delta_{i5}\Delta INF_{t-n} + \sum_{o=1}^{k-1} \delta_{i6}\Delta FDI_{t-o} + \theta_1\tau_{t-1} + \mu_{5t} \quad \ldots\ldots (4.9)$$

$$\Delta H_t = \alpha_3 + \sum_{i=1}^{k-1} \delta_{i1}\Delta Y_{t-i} + \sum_{j=1}^{k-1} \delta_{i2}\Delta K_{t-j} + \sum_{l=1}^{k-1} \delta_{i3}\Delta H_{t-l} + \sum_{m=1}^{k-1} \delta_{i4}\Delta L_{t-m} + \sum_{n=1}^{k-1} \delta_{i5}\Delta INF_{t-n} + \sum_{o=1}^{k-1} \delta_{i6}\Delta FDI_{t-o} + \theta_3\tau_{t-1} + \varepsilon_{7t} \quad \ldots\ldots (4.10)$$

Where: Y_t, is output and measured by non-mining GDP growth (proxy variable for economic growth),

K_t, represents gross fixed capital formation (proxy variable for physical capital).

H_t is higher education and represents growth of enrolment at university level (gross higher education enrolment growth).

L_t, represents labour force participation rate as a proxy for employed labour.

INF_t, represents inflation rate.

FDI_t, represents net capital inflows as %of GDP as a proxy of foreign direct investment.

$\alpha's$ are the intercepts.

k-1 = the lag length is reduced by 1.

$\delta's$ = short run dynamic coefficient of the model's adjustment long run equilibrium.

$\theta's$ = speed of adjustment parameter with a negative sign.

τ_{t-1} = the error correction term in the lagged value of residuals obtained from the cointegrating regression of the dependent variable on the regression. Contains long run information derived from the long run cointegrating relationship.

ε_{it} = residuals.

In this case if the coefficients of δ_{i3} are jointly significant then we reject the null hypothesis in equation 4.9 that economic growth does not granger causes higher education growth. Similarly from equation 4.10 the null hypothesis that higher education growth does not granger causes economic growth is rejected if the coefficient of δ_{i1} are jointly significant.

4.6 Granger causality based on the Toda-Yamamoto Approach

In order to check the robustness of the results the study uses Toda and Yamamoto (1995) causality test. This test is used because traditional granger causality tests sometimes give bias results. The advantage of using the Toda and Yamamoto (1995) granger causality approach is that it is not necessary to pre-test the variables for the integration and cointegration properties and therefore avoids the possible pre-test biases, as this test does not require the variables to be integrated of the same order nor does it require them to be cointegrated. Therefore, it is not as restrictive as the standard Granger causality test. Furthermore, Toda and Yamamoto (1995) report that their causality test does not suffer from misspecification or omitted variable bias as much as the standard Granger causality test. This is because the standard Granger causality test is a bivariate test, hence many times it may omit relevant variables in the regression while Toda and Yamamoto (1995) causality test is multivariate test, thus significantly reduce this bias. To avoid functional biasedness the study will estimate the following VAR (j+e) model:

$$\begin{bmatrix} Y_t \\ K_t \\ H_t \\ L_t \\ INF_t \\ FDI_t \end{bmatrix} = \begin{bmatrix} \alpha_1 \\ \alpha_2 \\ \alpha_3 \\ \alpha_4 \\ \alpha_5 \\ \alpha_6 \end{bmatrix} + \sum_{i=1}^{j+e} \begin{bmatrix} \beta_{11i}\beta_{12i}\beta_{13i}\beta_{14i}\beta_{15i}\beta_{16i} \\ \beta_{21i}\beta_{22i}\beta_{23i}\beta_{24i}\beta_{25i}\beta_{26i} \\ \beta_{31i}\beta_{32i}\beta_{33i}\beta_{34i}\beta_{35i}\beta_{56i} \\ \beta_{41i}\beta_{42i}\beta_{43i}\beta_{44i}\beta_{45i}\beta_{46i} \\ \beta_{51i}\beta_{52i}\beta_{53i}\beta_{54i}\beta_{55i}\beta_{56i} \\ \beta_{61i}\beta_{62i}\beta_{63i}\beta_{64i}\beta_{65i}\beta_{66i} \end{bmatrix} \begin{bmatrix} Y_{t-i} \\ K_{t-i} \\ H_{t-i} \\ L_{t-i} \\ INF_{t-i} \\ FDI_{t-i} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \\ \varepsilon_{4t} \\ \varepsilon_{5t} \\ \varepsilon_{6t} \end{bmatrix} \quad \text{….. (4.11)}$$

Where: Y_t, is output and measured by non-mining GDP growth (proxy variable for economic growth),

K_t, represents gross fixed capital formation (proxy variable for physical capital).

H_t is higher education and represents growth of enrolment at university level (gross higher education enrolment growth).

L_t, represents labour force participation rate as a proxy for employed labour.

INF_t, represents inflation rate.

FDI_t, represents net capital inflows as %of GDP as a proxy of foreign direct investment.

j = optimal lag order of VAR

e = maximal order of integration of the series in the system,

$\alpha's$ are the intercepts,

$\beta's$ are the coefficients of the variables,

ε_{it} are assumed to be white noise error terms.

Wald tests will be applied to the j coefficient matrices using the standard chi-square statistics. The Wald Chi-square test statistic is the squared ratio of the estimate to the standard error of the respective predictor, in this case, the j coefficient matrices.

The hypothesis of Toda and Yamamoto (1995) causality test is that the independent variable does not Granger-cause the dependent variable. That is, there are two null hypotheses of this test. The first null hypothesis is that higher education Granger-causes economic growth (non-mining GDP growth) and the second null hypothesis is that economic growth Granger-causes higher education.

There are four possible causalities or relationships between economic growth (Y_t) and higher education growth (H_t).

1. Economic growth (Y_t) induced higher education enrolment growth (H_t).

   This is also a type of association or relationship between the variables which indicates unidirectional causality but running from economic growth (Y_t) to higher education enrolment growth (H_t). It means that economic growth (Y_t) tends to induce higher

education enrolment growth (H_t). That is, change in economic growth can results in higher education.

2. Higher education enrolment growth (H_t) induced economic growth (Y_t).

This type of relationship between variables indicates the unidirectional causality, which is running from higher education enrolment growth (H_t) to economic growth (Y_t). It means that higher education enrolment growth (H_t) also induces economic growth (Y_t). That is, increase in higher education can results in increase in economic growth.

3. Two-way causality between higher education enrolment (H_t) and economic growth (Y_t).

This type of relationship between variables indicates the bidirectional causality between higher education enrolment growth (H_t) and economic growth (Y_t). It indicates two-way causation; this means higher education enrolment growth (H_t) granger causes economic growth (Y_t) and economic growth (Y_t) granger causes higher education enrolment growth (H_t).

4. Independent relationship

The independent relationship between variables indicates that there is no association or causality between higher education enrolment growth (H_t) and economic growth (Y_t).

Other hypothesis can be drawn for unidirectional and bidirectional causality among rest of the other investigating variables, in a similar manner for example; Economic growth granger causes labour; Y_t "Granger-causes" L_t if $\beta_{i4} \neq 0$ and economic growth granger causes capital; Y_t "Granger-causes" K_t if $\beta_{i2} \neq 0$ and vice versa.

4.7 Long run and Short run estimation

In order to investigate the long run and short run impact of higher education on economic growth (or impact of economic growth on higher education), VAR models may be used if all variables are integrated of order 1, that is, I(1). A standard VAR is used if the I(1) variables are

not cointegrated. Therefore, it is important to test for cointegration, Johansen test can be used in this case. If the variables are not cointegrated, VECM can be used to study the short run dynamics.

In the instance that unit root tests reveal that variables are a mixture of I(0) and I(1), An Auto Regressive Distributed Lag (ARDL) bounds testing is used instead of Johansen test. This is because one of the conditions to use a Johansen test of cointegration is that variables must be I(1). If there are a mixture of I(0) and I(1), Johansen test is no longer valid. Moreover, VAR and VECM will no longer be valid as well.

The main advantage of using ARDL, as already discussed is that it does not require the variables to be integrated of the same order. Consequently, unit root testing is not a requirement, but necessary to ensure that all variables are not integrated of order 2 or higher. Other advantages are that ARDL gives parsimonious estimates even with small samples. Additionally, ARDL uses a simple reduced form equation instead of estimating levels relationship within a context of a system of equations (Pesaran, 1999; 2015).

According to Pesaran *et al* (2001), ARDL bounds test consists of the following steps. First, estimate error correction model as follows:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{n} \beta_{1i} \Delta Y_{t-1} + \sum_{i=1}^{n} \beta_{2i} \Delta K_{t-1} + \sum_{i=1}^{n} \beta_{3i} \Delta H_{t-1} + \sum_{i=1}^{n} \beta_{4i} \Delta L_{t-1} + \sum_{i=1}^{n} \beta_{5i} \Delta FDI_{t-1} + \sum_{i=1}^{n} \beta_{6i} \Delta INF_{t-1} + \delta_1 Y_{t-1} + \delta_2 K_{t-1} + \delta_3 H_{t-1} + \delta_4 L_{t-1} + \delta_5 FDI_{t-1} + \delta_6 INF_{t-1} + U_t \quad \text{.......} (4.12)$$

Where $\beta_{1i} \ldots \beta_{6i}$ and $\delta_1 \ldots \delta_6$ are short run and long run coefficients, respectively and n is lag length. The second step is to compute the Wald or F-statistic for testing the null hypothesis of bounds test which states that there is no levels relationship. That is;

$$H_0 = \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = \delta_6 = 0 \quad \text{.......} (4.13)$$

The null hypothesis is rejected if the computed F-statistic is greater than the upper bound critical values. If the computed F-statistic is found to be less than lower bound critical values, leads to failure to reject the null hypothesis. The test is inconclusive if the computed F-statistic lies between the upper and lower bounds.

If the bounds test reveal that a levels relationship exists, then the following error correction model in the form of ARDL is estimated.

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{n} \beta_{1i}\, \Delta Y_{t-i} + \sum_{i=1}^{n} \beta_{2i}\, \Delta K_{t-i} + \sum_{i=1}^{n} \beta_{3i}\, \Delta H_{t-i} + \sum_{i=1}^{n} \beta_{4i}\, \Delta L_{t-i} + \sum_{i=1}^{n} \beta_{5i}\, \Delta FDI_{t-i} + \sum_{i=1}^{n} \beta_{6i}\, \Delta INF_{t-i} + \emptyset ECT_{t-1} + U_t \quad \text{..... (4.14)}$$

Where ECT is the error correction term and ∅ is the speed of adjustment.

4.8 Data Sources

The data for the study are annual time series data covering the time period 1981-2016. The data on Gross Fixed Capital formation (annual % growth) and Higher education enrolment (annual % growth) were gathered from the Economic Survey of WDI and Statistics Botswana, data on Non-Mining GDP growth (annual %) and Labour Force Participation Rate, total (% of total population ages 15-64) (modeled ILO estimate) were collected from Statistics Botswana. Data for Inflation rate and Foreign Direct Investment were gathered from WDI.

4.9 Conclusion

The chapter specified the model that is used to establish the relationship between economic growth and higher education growth together with other variables under investigation. The variables which are used in the tests non-mining GDP growth, labour force participation rate, gross fixed capital formation, higher education enrolment growth, inflation rate and foreign direct investment. The model uses the Augmented Dickey-Fuller test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test for unit root. Johansen (1995) cointegration technique based on VAR is employed in this study to determine the long-run relationship between economic growth and its explanatory variables. VECM and Toda & Yamamoto are

employed to check granger causality between economic growth and higher education. In order to test for the long run and short run effects the study use ARDL approach.

CHAPTER 5

DATA ANALYSIS AND FINDINGS

5.0 Introduction

This chapter focuses on data analysis. Firstly descriptive statistics are presented. Data is then tested for stationarity by use of ADF and KPSS unit root tests. Cointegration is conducted in order to establish the long run relationship among variables by employing a Johansen Cointegration test, which is then followed by standard granger causality test as well as Toda and Yamamoto (1995) causality test. Following that is the long run and short run estimations and residual diagnostic tests. Finally, a conclusion of the chapter.

5.1 Descriptive Statistics

Table 5.1 below shows summary statistics of the data used in this study. Summary statistics gives basic characteristics of the data.

Table 5.1: *Summary Statistics of the Variables*

Variable	Obs	Mean	Std.Dev	Min	Max
Y_t	36	16.93586	7.610399	4.376785	41.08452
L_t	36	1.087209	3.986517	-6.512486	10.66003
K_t	36	7.371396	10.03469	-8.574417	40.19482
H_t	36	9.226441	12.14898	-14.31404	53.00888
INF_t	36	2.809449	2.853589	-6.89768	8.93102
FDI_t	36	2.608947	2.711483	-6.89768	8.93102

Source: Author's Computations

Table 5.1 above shows that the average growth rate of non-mining GDP was about 17%. The range (36.7%) and standard deviation suggests that growth rate of non-mining GDP was highly volatile in the period considered in this study. Similarly, physical capital was also highly volatile and negative mining value suggests a period of negative growth or declining

physical capital accumulation. The same is true for growth rate of tertiary enrolment, with periods of negative growth rates. Average rate of inflation of 2.8% is within the 3-6% target of the central bank. The summary statistics further reveal a steady increase in FDI inflows, with an average of 2.6% of GDP.

5.2 Unit root tests

To reiterate, the study employs the Augmented Dickey Fuller (ADF) and the Kwiatkowski Phillips Schmidt Shin (KPSS) tests to check the data series for unit root. ADF and KPSS unit root test results are presented in tables 5.1 and 5.2 respectively. The null hypothesis of the ADF test is that time series properties of a variable have a unit root. That is to say, a variable is non-stationary. The KPSS on the other hand, tests the null hypothesis that a variable is stationary (does not have a unit root). Although the two tests do not test the same null hypothesis, the decision rule remains the same. If the probability value (P-value) of a series is statistically significant at conventional levels (1%, 5% and 10%), then the null hypothesis is rejected in favour of the alternative hypothesis. Alternatively, the null hypothesis is rejected if the computed test statistic is greater than the critical or tabulated value of the statistic at the given significance level. ADF is tested in 3 stages, as explained in chapter 4.

Table 5.2: *Augmented Dickey-Fuller (ADF) Test for Unit Root*

Variable	**Levels**			**First Difference**		
	Trend and Intercept	Without Trend	Without Trend and Intercept	Trend and Intercept	Without Trend	Without Trend and Intercept
	t-statistic	t-statistic	t-statistic	t-statistic	t-statistic	t-statistic
Y_t	-4.045253 (0.0161)**	-	-	-4.728070 (0.0034)***	-	-
L_t	-2.483917 (0.3335)	-2.470250 (0.1314)	1.234239 (0.9416)	-3.475419 (0.0583)*	-	-
K_t	-3.349582 (0.0750)*	-	-	-6.304027 (0.0000)***	-	-
H_t	-5.691129 (0.0002)***	-	-	-6.556814 (0.0000)***	-	-
INF_t	-4.088771 (0.0145)**	-	-	-8.019737 (0.0000)***	-	-
FDI_t	-3.470428 (0.0585)*	-	-	-7.913933 (0.0000)***	-	-

Source: Author's computations *,** and *** indicate significant at 10%, 5% and 1% respectively

P-values in parenthesis "()"

Results on Table 5.2 show that only labour participation rate (Lt) is non-stationary at levels, indicating that it is an I(1) variable while the remaining variables are stationary at levels, making them I(0) variables. Since the null hypothesis is rejected in the most general ADF equation (with trend and intercept), there is no need to test for unit root test in the restrictive models of ADF (without trend and intercept).[10]

Table 5.3: *Kwiatkowski Phillips Schmidt Shin (KPSS) unit root test*

Variables	**Levels**	
	LM Statistic	Critical Value at 10%
Y_t	0.101331	0.119000
L_t	0.102089	0.119000
K_t	0.055591	0.119000
H_t	0.094014	0.119000
INF_t	0.121249	0.119000
FDI_t	0.105031	0.119000

Source: Author's computations

[10] In the case of labour force participation rate, the restrictions were found to be non-binding as the sum of square residuals from the restricted and unrestricted models were very close, hence the test statistic was very small (ϕ statistic), leading to a rejection of the restricted model. Therefore, a conclusion can be made that both the intercept and time trend are found to be insignificant in the ADF regression.

The discussion on chapter 4 indicate that the null hypothesis of KPSS which states that a variable or time series is stationary (does not have a unit root) is rejected if the computed LM statistic is greater than the critical or tabulated statistic. Table 5.3 clearly shows that all variables are stationary at levels, as indicated by failure to reject the null hypothesis. The critical values increase from 10% significance level to 1%. The failure to reject the null hypothesis at 10% implies that it cannot be rejected at 5% or 1% either. As a result, the conclusion of the KPSS is that all variables considered in this study are I(0) variables. Therefore, there is no need to difference the variables and test for unit root since all variables are stationary at level.

The results of these unit root tests have implications on the standard Granger causality test as well as the Johansen cointegration test. As discussed in chapter 4, In order to run a Johansen cointegration test, all variables must be I(1), as it is the case with the standard Granger causality test (Johansen & Juselius, 1990; Granger, 1988). However, ADF revealed that variables are a mixture of I(1) and I(0) variables while KPSS revealed that all variables are stationary at levels, hence are I(0) variables, thus do not meet the requirements to run both Johansen cointegration test and Granger causality test.

5.3 Causality based on Toda-Yamamoto Approach

Since a standard Granger causality test is no longer valid, the study runs a more superior test proposed by Toda and Yamamoto (1995), which does not require variables to be integrated of the same order nor does it require the variables to be cointegrated. This makes unit root and cointegration test redundant in this section. The results of Toda and Yamamoto causality test are presented in table 5.4. The optimum lag length of VAR is j =1 based on SIC criterion, results attached at the appendices. So, we estimate a system of VAR at levels with a total of e_{max}+ j = 1 + 1 = 2 lags.

Table 5.4: *Granger causality test results between variables based on Toda-Yamamoto (1995) procedure*

Dependent Variable	Modified Wald-Statistic					
	Y_t	L_t	K_t	H_t	INF_t	FDI_t
Y_t	---	0.198016 (0.6563)	10.30851* (0.0013)	0.053494 (0.8171)	0.052132 (08194)	0.037209 (08470)
L_t	1.408137 (0.4946)	---	4.037993 (0.1328)	1.808914 (0.4048)	0.135516 (0.9345)	0.145374 (09299)
K_t	0.496191 (0.4812)	0.226722 (0.6340)	---	0.009418 (0.9227)	0.225410 (0.6349)	0.082090 (0.7745)
H_t	2.615264 (0.1058)	0.187299 (0.6652)	1.953343 (0.1622)	---	0.257414 (0.6119)	1.836189 (0.1754)
INF_t	0.041588 (0.8384)	0.483844 (0.4867)	0.290825 (0.5897)	0.154900 (0.6939)	---	0.956048 (0.3282)
FDI_t	1.049439 (0.3056)	1.191642 (0.2750)	0.219770 (0.6392)	2.258414 (0.1329)	1.079937 (0.2987)	---

Source: Author's computations *,** and *** indicate significant at 10%, 5% and 1% respectively

P-values in parenthesis "()"

The results in table 5.4 show that all other relationships are statistically insignificant except for the growth-capital relationship. Toda and Yamamoto causality test indicate that a unidirectional relationship exists between economic growth and capital, running from capital to economic growth. This is consistent with the findings of Chaudhary *et al*. (2009), Qazi et al., (2014) and Mbulawa and Mehta (2016). However, the direction of causality reported in table 5.3 is well within expectations because greater physical capital implies more output. A simple production function suggests that output is a function of labour and capital. Therefore, an increase in capital results in an increase in output, leading to economic growth. Physical capital can affect productivity in two ways. First, an increase in working capital (more machinery and equipment). Second, an increase in the quality of physical capital. That is, better machinery and equipment, lead to efficient production output.

The variables of interest in this study are economic growth and higher education. The results of the causality test between these two variables are rather peculiar. The causality test reveal show that there is no relationship between these variables. That is, growth does not Granger cause higher education nor does higher education Granger cause growth. Clearly

empirical findings do not support both the endogenous and Solow growth theories that suggest that education promotes growth. Furthermore, these findings are contradictory to the findings of (Mbulawa and Mehta (2016); Dahal (2010), and Chaudhary *et al*. (2009)). While the findings of this study are surprising, the study posits two possible explanations for these findings. First, the previous studies only used a standard Granger causality test which has some limitations, particularly the misspecification error which may give misleading results. Additionally, these studies did not consider the role of mining sector on the growth of Botswana's economy, which may have influenced the higher education-growth nexus in Botswana.

Second, neoclassical economists explained that education promotes economic growth through enhanced human capital in the labour force, leading to increase in labour productivity. On the other hand, education can increase innovation capacity and knowledge, leading to improved technologies. These theories assume that the labour force is active in the labour markets. However, the case of Botswana is unique in the sense that the main sector of Botswana's economy (mining sector) is capital intensive sector, which leads to low absorptive capacity of labour markets, especially among graduates (Sihna & Tseladikae, 2018). As a result, investment in education led to an increase in unemployed graduates.

5.4 Short and Long run estimation

One of the objectives of this paper is to investigate the long and short run impact of higher education on economic growth. Unit root tests have eliminated Johansen cointegration test, consequently eliminating the use of VAR or VECM to study the long and short run dynamics of the empirical model specified in chapter 4. Therefore, the current study adopts the use of ARDL estimation techniques, including ARDL bounds tests for cointegration. One of the advantages of using ARDL is that it allows both stationary and non-stationary variables, provided that the order of integration is not more than one. Therefore, unit toot testing is not a pre-requisite, but is necessary to ensure that none of the variables are not integrated of order 2.

While ARDL estimation gives both long run and short run estimates, a formal test for cointegration must be conducted to ensure that a levels relationship exits.

5.5 ARDL Bounds test

To test for cointegration, a bounds test is conducted. The results of the bounds test are presented in table 5.5 below.

Table 5.5: *F-Bounds Test*

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	2.732785	10%	2.08	3
K	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15
Actual Sample Size	35		Finite Sample: n=35	
		10%	2.331	3.417
		5%	2.804	4.013
		1%	3.9	5.419

Source: Author's computation

The results in table 5.5 indicate failure to reject the null hypothesis of no levels relationship. Therefore, the variables do not converge to a long run equilibrium. That is, the variables are cointegrated since the F-statistic is less than the lower bound at 1%. However, the test is inconclusive at 2.5%. 5% and 10%.

The Engle-Granger representation theorem posits that cointegration always implies an error correction mechanism. However, if the residuals of I(1) variables do not converge into a long-run equilibrium, an error correction model cannot be estimated as such a mechanism does not exist when there is no levels relationship. Since ARDL bounds test revealed that there is no levels relationship, an error correction mechanism does not exist and as a result, an error correction model cannot be estimated. The implication of this is that both the long run and short run dynamics cannot be estimated.

Notwithstanding, ARDL bounds test provides conditional short-run estimates. The conditional short run estimates, in the appendix, show that only two variables are statistically

significant in the short run, lagged dependent variable and capital. The short run estimates suggest that economic growth of the previous year has a positive impact on the economic growth of the current year. Capital is also found to positively influence economic growth in the short run. A 1% increase in capital leads to a 0.28% increase in economic growth. This is consistent with the findings of Hanif and Arshed (2016).

Higher education is found to be statistically insignificant. This implies that changes in higher education do not significantly explain variations in economic growth. This is consistent with the results of Toda and Yamamoto (1995) causality test that revealed that no relationship exists between economic growth and higher education.

5.6 Residual Diagnostic tests

This section is concerned about the robustness of the ARDL estimates. The squared cumulative sum of recursive residuals (CUSUMSQ) test is conducted to test the stability of the coefficients of the model. The null hypothesis of this test is that coefficients are stable. The null hypothesis is rejected if either of the 5% significance lines is crossed. The test revealed parameter stability.

Jarque-Bera test is used to test for normality. The null hypothesis of this test is that residuals are multivariate normal (normally distributed), and this hypothesis is rejected if the P-value is statistically significant at conventional levels.[11] The test revealed that residuals are normally distributed. Breusch-Pagan-Godfrey and Breusch-Pagan LM test for heteroskedasticity and serial correlation revealed that residuals are homoscedastic and that there is no problem of higher order serial correlation. The null hypothesis of each test is homoscedastic residuals and no serially correlated residuals, respectively. Additionally, Durbin

[11] Note that all null hypotheses are rejected if the P-value is statistically significant at conventional levels under this section.

Watson statistic shows that there is no problem of first order serial correlation. Find results of all the tests in the appendix.

CHAPTER 6

CONCLUSIONS AND POLICY RECOMMENDATIONS

6.0 Introduction

The chapter summarises and draw conclusions of this study. The chapter is outlined in three sections being section 6.2 summary and conclusions, section 6.3 policy recommendations and section 6.4 which presents limitations and areas of further studies.

6.1 Summary and conclusions

There are strong theoretical arguments to support the hypothesis that education enhances economic growth. However, empirical research offers ambiguous findings on the relationship between education and economic growth. Moreover, the relationship between these two variables in Botswana is rather peculiar in the sense that higher education (measured by growth rates of tertiary education enrolment) has been increasing while non-mining GDP growth rate has been declining in the period considered in this study. This is contradictory to economic theory as well as empirical findings of Mbulawa and Mheta (2016) and AlSamarrai (2003). The main aim of this study was to this anomaly.

In order to investigate this anomaly, several statistical and econometric techniques were used. First, direction of causality test was performed by employing Toda and Yamamoto (1995) causality test. A standard Granger causality test was not applicable as two conditions were not met. The first condition is that all variables of interest must be integrated of the same order. That is, all variables must be I(1). The second condition that was not met was that the variables must be cointegrated. ADF and KPSS unit root test revealed that the variables violate the first condition. Consequently, Johansen test for cointegration could not be performed, thus VAR and VECM were also not applicable.

Toda and Yamamoto (1995) causality test revealed that higher education and economic growth are independent of each other. That is, there is no causal relationship between these two variables. Given the causality results, it is not surprising ARDL bounds test revealed that there

is no levels relationship and that the conditional error correction model showed that higher education is statistically insignificant in the growth model.

6.2 Policy Recommendations

Empirical findings of this study revealed that there is no relationship between education and economic growth. Therefore, policies adopted by the government such as "knowledge-based economy" are only based on theoretical considerations and may be misleading. The author recommends that a review of all policies regarding education and economic growth should be undertaken. Policy reforms should be based on empirical research rather than theoretical understanding. While it may be true that education is important to effectively and efficiently run the economy. The government of Botswana should make parallel investments into other sectors to diversify the economy in order to increase the absorptive capacity of the labour markets. The author recommends investments be made in the manufacturing and services sector. The reason is that these two sectors are labour-intensive. This may lead to decline in unemployment and underemployment rates as improvements in human capital lead to advancements and growth in manufacturing and services sectors through innovative ideas, technology and improvement in labour productivity. Consequently, leading to expansion of the overall economy

6.3 Limitations and areas of further studies

The limitation of the study was data availability as it limited the number of years analysed in the study as no data was available for most of years in some of the selected variables. However, although the study couldn't include many years the selected sample represent the true reflection of the economy of Botswana. Even though the empirical results and evidence provided by this study might be affected by the limitation of data availability, their effects are assumed to be minimal as it passed all the diagnostics tests.

In suggesting areas for future studies, scholars are encouraged to consider examining the effects of government expenditure on higher education towards economic growth so as, for

the country to find out whether spending more on higher education has impacted or played any role in improving economic growth.

References

Afzal, M., Farooq, M., Ahmad, H., Begam, I., Quddus, A. (2010), Relationship between school education and economic growth in Pakistan: ARDL bounds testing approach to cointegration. *Pakistan Economic and Social Review, 48(1),* 36-60.

Ahmad, N., & Luqman, M. (2013). Secondary education and economic growth in developing countries: A case study of Pakistan. *Interdisciplinary Journal of Contemporary Research in Business, 4(3):* 306-313.

Al-Samarrai, S. (2003). Financing primary education for all: Public expenditure and education outcomes in Africa. *Institute of Development Studies, University of Sussex.* Retrieved from http://www.unescobkk.org/ (Accessed 12 November 2019).

Ali, A., Hakim, R. A., & Abdullah, H. (2016). The relationships between higher education and economic growth in Pakistan. *Journal of Management and Training for Industries*, *3*(2), 16.

Awan, N. W., Shah, S. M., & Rasheed, H. (2011). A Dynamic analysis of education and economic growth in Pakistan: Analysis in form of co-integration. *Islamabad, Pakistan: Department of Educational Planning and Management, Allama Iqbal Open University*.

Baltagi, B. H. (2005). *Econometric analysis of panel data* (Vol. 3). New York: Wiley.

Bank of Botswana (2018), Botswana Financial Statistics, Bank of Botswana, Gaborone, Botswana.

Barro, R. (1996). Inflation and growth. *Federal Reserve Bank of St Louis Review 78*: 153–69.

Benhabib, J., & Spiegel, M. (1994). The role of human capital in economic development evidence from aggregate cross-country data. Journal of Monetary Economics, 34(2), 143-173.

Beskaya, A., Savas, B., & Samiloglu, F. (2010). The impact of education on economic growth in Turkey. *Journal of Faculty of Economics and Administrative Sciences, 15(3)*: 43-62.

Blomstrom, M., Lipsey, R., & Zejan, M. (1992). What explains developing country growth. *NBER Working Paper No. 4132*.

Bruno, M. and Easterly, W. (1998). Inflation crises and long-run growth. *Journal of Monetary Economics 41:* 3–26.

Carneiro, F., Faria, J. R., & Barry, B. S. (2004). "Government revenues and expenditures in Guinea-Bissau: causality and cointegration,'' *World Bank, African Region Working Paper Series No. 65.*

Chaudhary, A. R., Iqbal, A., & Gillani, S. Y. M. (2009). The nexus between higher education and economic growth: An empirical investigation for Pakistan. *Pakistan Journal of Commerce and Social Sciences (PJCSS), 3*, 1-9.

Cooray, A. (2010). The role of education in economic growth. *School of Economics, University of Wollongong, NSW, Australia*.

Dahal, M.P., 2010. Higher educational enrolment, school teachers and GDP in Nepal: A causality analysis. *Economics Journal of Development Issues, 11 & 12(1-2):* 69-91.

Dinh, T. T. H., Vo, D. H., & Nguyen, T. C. (2019). Foreign direct investment and economic growth in the short run and long run: Empirical evidence from developing countries. *Journal of Risk and Financial Management*, 12(4), 176

Enders, W. (2004) Applied Econometric Time Series, 2nd Edition. In Wiley Series in Probability and Statistics, John Wiley & Sons, Inc., Hoboken.

Enders W. Applied econometric time series. New York: John Wiley and Sons; 2015. p. 1–63.

Fernandez, R. M. (2001). Skill-biased technological change and wage inequality: Evidence from a plant retooling. *American Journal of Sociology*, 107(2), 273-320.

Glewwe, P., & Kassouf, A. L. (2012). The impact of the Bolsa Escola/Familia conditional cash transfer program on enrolment, dropout rates and grade promotion in Brazil. *Journal of development Economics*, *97*(2), 505-517.

Granger, C.W.J. (1969). Investigating causal relations by econometric models and cross spectral methods, *Econometrica*, vol. 37: pp. 428-438.

Granger, C.W.J., & Newbold, P. (1974). Spurious regressions in econometrics. *Journal of Econometrics* 2, 111–20.

Granger, C.W.J. (1988). Some recent development in a concept of causality, *Journal of Econometrics*, Vol. 39: 199-211

Grossman, G., Helpman, E. (1991), Innovation and growth in the global economy. *Cambridge: MIT Press*.

Gujarati D. N. and Porter D. C. (2009), Basic Econometrics: 5th Edition: Avenue of the Americas, New York*: McGraw-Hill/Irwin*

Gyimah-Brempong, K., Paddison, O., & Mitiku, W. (2005). Higher education and economic growth in Africa. *Journal of Development Studies*, 42(3), 509-529.

Hanif, N., & Arshed, N. (2016). Relationship between school education and economic growth: SAARC countries. *International Journal of Economics and Financial Issues*, *6*(1), 294-300.

Hanuschek, E. and Kimko, D. (2000). Schooling, labour force quality, and the growth of nations. *American Economic Review*, 90, pp. 1184–208

Hanushek, E. A., Jamison, D. T., Jamison, E. A., & Woessmann, L. (2008). Education and economic growth: It's not just going to school, but learning something while there that matters. *Education Next*, *8*(2), 62-71.

Holmes, C. (2013). Has the expansion of higher education led to greater economic growth?. *National Institute Economic Review*, *224*(1), R29-R47.

Huang, F., Jin, L., & Sun, X. (2009). Relationship between scale of higher education and economic growth in China. *Asian Social Science,* 5(11): 125-141.

Javed, M., Abbas, S., Fatima, A., Azeem, M.M., & Zafar, S. (2013). Impact of human capital development on economic growth of Pakistan: A public expenditure approach. *World Applied Sciences Journal*, *24(3)*: 408-413.

Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with application for the demand for money, *Oxford Bulletin of Economics and Statistics*, vol. 52: 169-210.

Katircioğlu, S. T. (2010). International tourism, higher education and economic growth: The case of North Cyprus. *The World Economy*, *33*(12), 1955-1972.

Khorasgani, M.F.: Higher education development and economic growth in Iran. *Educ. Bus. Soc. Contemp. Middle. Eastern*. Issues. 1, 162–174 (2008)

Kobzev Kotásková, S., Procházka, P., Smutka, L., Maitah, M., Kuzmenko, E., Kopecká, M., & Hönig, V. (2018). The impact of education on economic growth: the case of India. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis*, *66*(1), 253-262.

Lucas, R. (1988). On the mechanics of economic development. Journal of Monetary Economics, 22(1), 3-42.

Lucas Jr, R. E. (1993). Making a miracle. *Econometrica: Journal of the Econometric Society*, 251-272.

Malangeni, L., & Phiri, A. (2018). Education and economic growth in post-apartheid South Africa: An autoregressive distributive lag approach. *International Journal of Economics and Financial Issues*, *8*(2), 101-107.

Mankiw, G., Romer, D., & Weil, D. (1992). A contribution to the empirics of economic growth. *The Quarterly Journal of Economics*, 107(2), 407-437.

Mariana, D. R. (2015). Education as a determinant of the economic growth. The case of Romania. *Procedia-Social and Behavioral Sciences*, *197*, 404-412.

Mbulawa, S., & Mehta, P. (2016). The Effect of Access and Quality of Education on Economic Development in Botswana. *International Journal of Business, Economics and Management*, *3*(11), 144-159.

Ministry of Education and Skills Development (2008). Towards a knowledge society: tertiary education policy, Ministry of Education and Skills Development, [Gaborone], (Accessed 09 Nov 2019).

Ministry of Finance and Development Planning, (2013). Mid-term review of NDP10. Retrieved from http://www.finance.gov.bw/ (Accessed 07 November 2019).

Nelson, R.R., Phelps, E.S. (1966), Investment in humans, technological diffusion, and economic growth. *The American Economic Review*, 56, 69-75

Nowak, Z., Dahal, G. (2016). The contribution of education to economic growth: Evidence from Nepal. *International Journal of Economic Sciences,* 5(2), 22-41.

Obradović, S., Lojanica, N., & Janković, O. (2016). The influence of economic growth on regional disparities: Empirical evidence from OECD. *Zbornik radova Ekonomskog fakulteta u Rijeci: časopis za ekonomsku teoriju i praksu*, *34*(1), 161-186.

Pandey, S. K. (2016). Growth of higher education in India after independence. *International Education and Research Journal*, *2*(10).

Pesaran, M., Shin, Y. and Smith, R. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, 16(3): 289-326.

Pesaran, M. H. (2015). *Time series and panel data econometrics*. Oxford University Press.

Pegkas, P., Tsamadias, C. (2014). Does higher education affect growth? The case of Greece. *International Economic Journal*, 28(3), 425-444.

Powell, W. W., & Snellman, K. (2004). The knowledge economy. *Annual Review Sociology*, 30, 199-220.

Pritchett, L. (1996). Where has all the education gone? The World Bank. *Policy Research Working Paper, 1581*.

Qazi, W., Raza, S. A., & Jawaid, S. T. (2014). Higher education and growth performance of Pakistan: evidence from multivariate framework. *Quality & Quantity*, *48*(3), 1651-1665.

Reza, A., & Valeecha, S. (2012). Impact of education on economic growth of Pakistan: Econometric analysis. *IOSR Journal of Business and Management*, *5*(4), 20-27.

Romer, P. (1986). Increasing returns and long run economic growth. *Journal of Political Economy*, 94(5), pp. 1002–37.

Romer, P. (1990a). Endogenous technological change. *Journal of Political Economy* 99(5), S71-S102.

Romer, P. (1990). Endogenous technological change. *Journal of Political Economy*, 98(5), 71-102.

Salem, M. I. (2014). The role of universities in building a knowledge-based economy in Saudi Arabia. *International Business & Economics Research Journal (IBER)*, *13*(5), 1047-1056.

Schultz, T.W. (1961), Investment in human capital. *The American Economic Review*, 51(1), 1-17

Shah, A. (2011). Pakistan Economic Survey 2010-2011: Manufacturing and Mining. *Government of Pakistan*.

Shaihani, M., Haris, A., Ismail, N., & Said R. (2011). Long run and short run effects of educational levels: Case in Malaysia. International Journal of Economic Research, 2(6), 77-87.

Sinha, N., & Tseladikae, K. (2018). Economic Growth and Unemployment Rate for the Economy of Botswana: An Empirical Study. *FOCUS: Journal of International Business*, *5*(2), 1-25.

Solow, R.M. (1956). A Contribution to the Theory of Economic Growth, *Quarterly Journal of Economics*, *vol. 70*, pp. 65-94.

Solow, R. (1957). Technical change and the aggregate production function, Review of Economics and Statistics, vol. 39, pp. 312–320.

Statistics Botswana, (2015). Literacy survey 2014 stats brief. Retrieved from http://www.cso.gov.bw [Accessed 08 November 2019].

Statistics Botswana, (2019). Labour survey 2018 stats brief. Retrieved from http://www.cso.gov.bw [Accessed 21 November 2019].

Toda, H.Y. and Yamamoto, T. (1995). Statistical inference in vector auto regressions with possibly integrated processes, *Journal of Econometrics,* vol. 66, pp. 225-250.

Unicef. (2019). Public expenditure review of the basic education sector in Botswana.

Viracheat, I. and Dash, T.R. (2011). Growth of higher education and its relationship with per capita gross domestic product in Cambodia. *International Journal of Business and Social Science, 2(12):* 53-61.

Velde, D.W. and Cali, M. (2007). Assessment of Botswana's services sector. United Kingdom: Overseas Development Institute.

Wooldridge, J. M. (2016). *Introductory econometrics: A modern approach*. Nelson Education.

Appendices

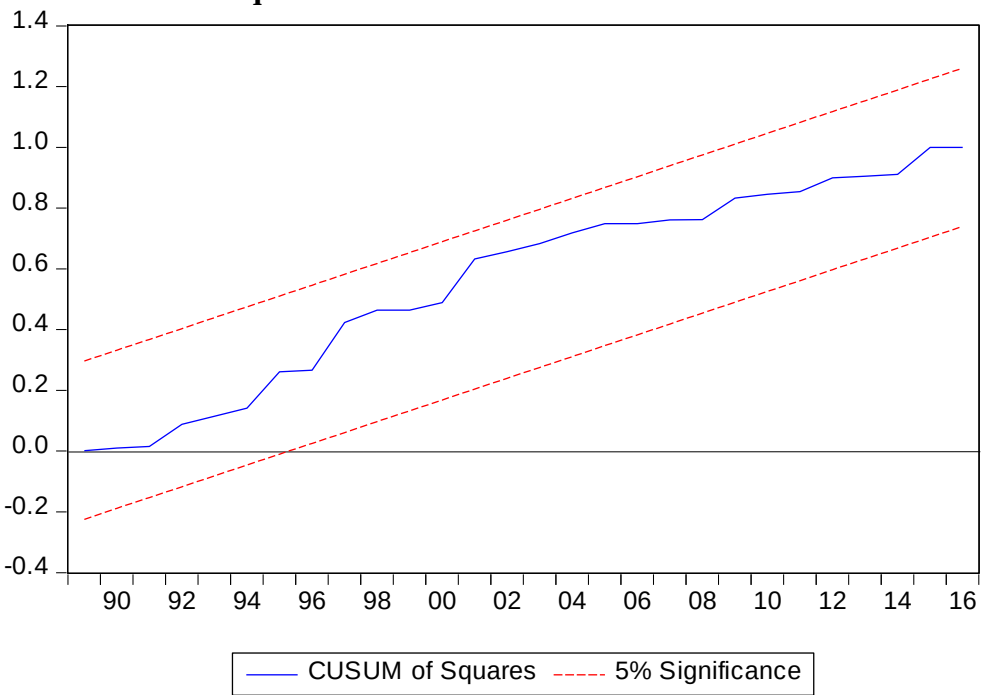
1. Optimal lag order

VAR Lag Order Selection Criteria
Endogenous variables: YT KT LT HT IT FT
Exogenous variables: C
Date: 11/09/20 Time: 09:16
Sample: 1981 2016
Included observations: 32

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-587.5318	NA	5.20e+08	37.09574	37.37056	37.18684
1	-416.3501	267.4714*	116161.3	28.64688	30.57066*	29.28456
2	-384.7190	37.56201	197010.7	28.91993	32.49267	30.10419
3	-343.7520	33.28563	314423.7	28.60950	33.83119	30.34034
4	-232.9892	48.45876	24770.44*	23.93682*	30.80746	26.21424*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

2. CUSUM Square test



3. Heteroskedasticity test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.676258	Prob. F(6,28)	0.6698
Obs*R-squared	4.429974	Prob. Chi-Square(6)	0.6187
Scaled explained SS	7.319857	Prob. Chi-Square(6)	0.2923

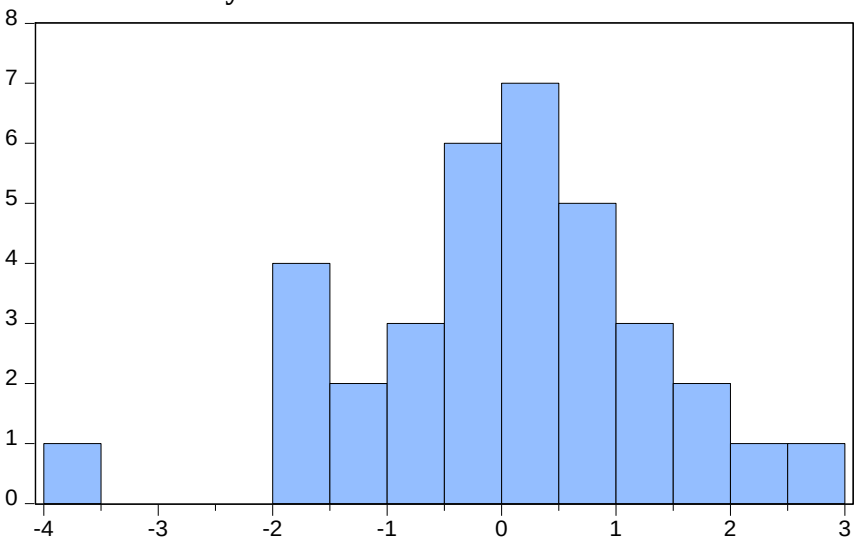
Source: Author's computations

4. LM serial correlation test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.819700	Prob. F(3,21)	0.1745
Obs*R-squared	7.221278	Prob. Chi-Square(4)	0.1652

5. Normality test



Series: Residuals
Sample 1983 2016
Observations 34

Mean	3.33e-16
Median	0.085987
Maximum	2.767176
Minimum	-3.925773
Std. Dev.	1.307878
Skewness	-0.487089
Kurtosis	4.088264
Jarque-Bera	3.111125
Probability	0.211071

6. Conditional Short-run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.002348	13.04076	0.536958	0.5955
YT(-1)	0.718778	0.181030	-3.970493	0.0005
LT	0.131699	0.434109	0.303378	0.7638
KT	0.284986	0.126668	2.249876	0.0325
INFT	-0.562702	0.546755	-1.029166	0.3122
HT	0.094980	0.108629	0.874354	0.3894
FDIT	-0.017441	0.543665	-0.032080	0.9746

Source: Author's computations