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Abstract
Over the past 3 decades, Botswana has benefited immensely from rapid factor accumulation (both capital and labour), which has significantly spurred productivity and growth. In recent years, however, this growth seems to have run its course, while Total Factor Productivity (TFP) growth, which is understood to be a more sustainable driver of growth, has declined. This paper, therefore, examines the determinants of TFP growth in Botswana over the period 1977–2014. Using an Autoregressive Distributive Lag (ARDL) bounds testing econometric approach, the results show that economic diversification and human capital have significant positive impact on TFP growth. Openness is also significant, particularly in the long-run, but its impact on TFP growth was negative in the short-run. The findings of the study also suggests that there is a certain level of inflation in the Botswana economy which promotes growth, beyond which it becomes inimical to short run productivity and growth. The study concludes that, to enhance TFP growth and help reverse the observed slow-down in real economic growth in Botswana, policy makers should implement policies aimed at enhancing economic diversification, human capital development, improving openness to trade, while maintaining macroeconomic stability.

Key words: Total Factor Productivity; Autoregressive Distributive Lag; Determinants; Botswana

JEL Classification:
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# ACRONYMS

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<td>AIC</td>
<td>Akaike Information Criterion</td>
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<tr>
<td>ADF</td>
<td>Augmented Dickey-Fuller</td>
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<tr>
<td>ARDL</td>
<td>Autoregressive Distributive Lag</td>
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<tr>
<td>BoB</td>
<td>Bank of Botswana</td>
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<td>BSP</td>
<td>Budget Strategy Paper</td>
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<tr>
<td>CUSUM</td>
<td>Cumulative Sum of Recursive Residuals</td>
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<tr>
<td>ICT</td>
<td>Information Communication Technology</td>
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<td>ECM</td>
<td>Error Correction Model</td>
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<td>ECT</td>
<td>Error Correction Term</td>
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<td>FDI</td>
<td>Foreign Direct Investment</td>
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<td>GDP</td>
<td>Gross Domestic Product</td>
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<td>HQC</td>
<td>Hanna-Quin Criterion</td>
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<tr>
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<td>National Development Plan</td>
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<tr>
<td>OECD</td>
<td>Organisation for Economic Cooperation and Development</td>
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<tr>
<td>R &amp; D</td>
<td>Research and Development</td>
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<td>SBC</td>
<td>Schwarz Bayesian Criterion</td>
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<tr>
<td>SMIC</td>
<td>Small Middle income Countries</td>
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<td>SACU</td>
<td>Southern African Customs Union</td>
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1. INTRODUCTION

1.1. Background
In growth accounting, the production of goods and services occurs due to the impact of factors of production and technological progress - also known as Total Factor Productivity (TFP). The factor input driven growth model, which involves additional labour and capital to the production function has been widely applied in most developing countries, including Botswana. However, Solow (1956) suggest that long term growth may not be achieved if economic growth is driven by factors of production only, due to the diminishing marginal returns in both capital and labour in the production function. This type of growth model is therefore viewed unsustainable in the long run.

Total Factor Productivity, defined as growth in economic output that is not due to increases in labour and capital, leads to increasing and sustainable returns, has been the main source of growth for developed nations. Abdychev et al., (2015) argue that it contributes to long-term economic growth by improving resource allocation, providing new and improved methods of production, as well as generating international competitiveness. Syverson (2011) also adds that the TFP growth model is also associated with the opportunity to generate sustainable incomes and improve the welfare of citizens. In addition, TFP growth has been recognised as an important source of improvement in income and wealth as well as being key in assessing countries’ past and potential economic performance (World Bank, 2000).

Taking into consideration the benefits of TFP led growth such as the ability to generate sustainable income and an improvement in the welfare of citizens, the analysis of the determinants of TFP growth in Botswana is the subject matter of this study. It is, therefore, imperative to analyse the major trends in macroeconomic developments in Botswana, so as to give context to the empirical analysis of TFP growth. Over the past 3 decades, Botswana, like most other small-to-medium income countries (SMICs) has benefited

1 The factors of production referred to here are labour and capital.
immensely from rapid factor accumulation (both capital and labour), which has significantly spurred productivity and growth. The discovery of minerals (particularly diamonds) in the late 1960s helped Botswana to transform from being one of the poorest in the world with per capita Gross Domestic Product (GDP) of US$70 in the late 1960s to its current status of an upper middle income country with per capita GDP of US$7,240 (Botswana Government, National Development Plan (NDP) 10, and World Bank database (2016)). Official publications from Botswana (NDP 8 and 9) indicate that prior to the mineral boom, the country had around 12 kilometres of tarred road, only 22 secondary school graduates and cattle farming was the largest contributor to GDP, while international aid dominated the government budget.

In recent years, however, factor accumulation-led economic growth seems to have run its course, hence the renewed focus on increasing TFP growth, which is believed to be a more sustainable driver of growth. TFP growth in Botswana averaged 4.6 percent annually from 1981 to 2011, where capital inputs contributed 57 percent, and the differentiated labour force accounted for an additional 15.3 percent. The combined factor input contribution to output growth of 72.3 percent, implies that the balance of 27.7 percent could be attributed to TFP growth (Bank of Botswana Annual Report (2004)).

This has prompted the Government of Botswana to revive its focus on TFP, with an aim of identifying its evolution. Various editions of the Budget Strategy Papers (BSPs) have stressed the importance of productivity growth, both at the aggregate and at sectoral levels. For example, the 2015/16 BSP indicated that a decline in TFP growth was one of the main challenges that affected competitiveness of various industries in Botswana. In addition, the 2016/17 and the 2017/18 BSPs also identified the need to improve TFP growth as one of the key national priorities. The papers noted that the economy continued to experience negative TFP growth, which was an impediment to the country’s ability to operate at full potential. In this regard, the country recorded a TFP growth rate averaging -1.45 percent in the period 1991 to 2001, and declining further to an average of -1.64 percent in the period 2001 to 2011 (Ministry of Finance and Economic Development, BSP 2015/16).
The decline in TFP growth, with its consequences on real economic growth, has motivated this study, which seeks to understand the main factors and variables underpinning the slowdown in TFP growth.

1.2. Statement of Problem

Total Factor Productivity growth is understood to create an opportunity to accelerate long-run economic growth, generate sustainable increases in incomes and improve livelihoods of the entire population (Easterly and Levine, 2001). However, for Botswana, TFP growth has been declining in recent years. The slowdown of TFP growth is a major concern for Botswana, given its significance for sustainable long-term growth. In this regard, this study seeks to analyse the factors determining TFP growth in Botswana.

1.3. Research Questions

The study will attempt to answer the following questions:

(a) What are the drivers of TFP growth in Botswana?

(b) What policies should the government of Botswana implement to boost TFP growth?

1.4. Research Objectives

The main objective of this study is to examine factors that determine TFP growth in Botswana over the period 1977 – 2014. By analysing these factors, the study also seeks to establish the appropriate policies that policy makers can implement to raise TFP growth in Botswana. These policies may result in long-run sustainable economic growth and higher living standards for Batswana.

1.5. Research Hypothesis

Based on the objectives of the study, the following hypothesis will be tested.

Null Hypothesis: There is a NO significant relationship between TFP growth and its determinants in Botswana.
Alternative Hypothesis: There is a significant relationship between TFP growth and its determinants in Botswana.

1.6. Significance of the Study

Total Factor Productivity remains critical for the realisation of sustainable long-run economic growth. This is important as it creates an opportunity to increase the welfare of the society. It is, therefore, important to analyse factors that determine TFP growth with a view to stimulate economic growth. Analysing these determinants will assist in providing recommendations on factors that policy makers should focus on to increase TFP growth in Botswana. The study also contributes to the existing literature on the determinants of TFP growth, particularly in Botswana.

This study applies an Autoregressive Distributive Lag (ARDL) bounds testing economic approach developed by Pesaran et al., (2001) to estimate the model as opposed to the traditional cointegration techniques used in similar studies. This methodology is relevant and suitable for small sample sizes and accommodates variables that are both I(0) and I(1).

To our knowledge, there is no study from a time series perspective that employed the ARDL cointegration technique to examine the determinants of TFP growth in Botswana. Most studies that have explored this area have been cross country studies using panel data. The study also applies the Granger (1969) causality test to identify if there is any causality between TFP growth and its determinants. Such causality is important as policies targeting one variable may have implications on another. Lastly, an index of economic diversification is included as an independent variable because this is a topical issue in Botswana.

1.7. Structure of the Paper

The rest of the paper is structured as follows: Section 2 presents recent trends of TFP growth in Botswana and selected macroeconomic indicators. Section 3 reviews theoretical and empirical literature on TFP and growth. The fourth section presents the methodology. Section 5 presents the results while Section 6 concludes and provides recommendations.
2. RECENT TRENDS OF TOTAL FACTOR PRODUCTIVITY IN BOTSWANA AND SELECTED MACROECONOMIC INDICATORS

This section provides a background to the Botswana economy and comprises 2 parts. The first part presents recent trends of TFP growth while the second part gives an overview of selected macroeconomic indicators. This includes discussion of variables which are directly or indirectly relevant to this study, such as economic growth, consumer price inflation, the external sector, economic diversification and institutional quality indicators. The analysis is based primarily on Annual Reports of the Bank of Botswana, Reports of Government of Botswana (in particular, the Ministry of Finance and Economic Development) and Statistical Bulletins from Statistics Botswana. Other external sources such as the Global Competitiveness Report, Corruption Perception Index report and the Ease of Doing Business Report, are also utilised.

2.1. Total Factor Productivity in Botswana

Total Factor Productivity in Botswana has not been researched extensively over the years. The Botswana National Productivity Center, whose objective includes the provision of productivity statistics last published these statistics in 2005. However, recently, the Government of Botswana has revived its focus on TFP growth with various BSPs highlighting its importance for long term growth. The papers noted that the economy continued to experience negative total factor productivity growth, which was exacerbated by low and declining labour productivity (Figure 1). The decline in TFP growth was also viewed as an impediment to the country’s ability to operate at full potential. In this regard, TFP growth was identified as one of the national priorities, together with project implementation; human capital development and enhancing business environment since the 2015/16 financial year.
Figure 1: Trends in levels of Labour Productivity Growth, Capital Stock Growth & Total Productivity Growth, 1991 - 2011


Figure 2 presents annual TFP growth between 1995 and 2013 and shows that movements in TFP were mostly dominated by steep negative growth rates. This result suggests a decline in TFP over time in Botswana.

Figure 2: Annual TFP Growth, 1995 – 2013


The 2014 IMF Article IV consultation report also noted the decline in TFP growth over the years and suggested that in order for Botswana to return to historical periods of high growth rates, polices that can reinvigorate TFP growth need to be put in place. The report also suggests that Botswana should focus on enhancing the quality of public spending, reducing
regulatory burden and infrastructure bottlenecks, as well as improving access to finance by small and medium scale enterprises.

2.2. Selected Macroeconomic Indicators

2.2.1. Real GDP Growth

At independence in 1966, Botswana’s economic activity was dominated by the agricultural sector (particularly livestock and arable farming) which contributed around 42 percent to GDP. Moreover, about 90 percent of the economically active population was engaged in agricultural activities (Lewis and Harvey, 1990). In addition, foreign aid was a significant part of the government's resource envelop. The development of the extractive industry led to the transformation of the country in the early 1970s. Consequently, the mining sector surpassed the agriculture in terms of contribution to national output and growth.

The 2016 data from Statistics Botswana underscores the significance of the mining sector to economic growth in Botswana. This sector has been accounting for the largest share of GDP; dominating export earnings and significantly contributing to government revenue. Figure 3 presents real GDP growth rates between selected years, 2004-2014 while Figure 4 shows the Share of Mining in Total GDP (Percent). The historical sectoral shares are presented in Figure 8 and 9 in Annex 1.
In most years, economic output and the mining sector moved in the same direction, except at the beginning (2007) and the last years (2011-2012) (**Figure 3**). This figure also shows that during 2009, there was a significant decline in the share of mining in GDP, mainly due to the reduced global demand for diamonds\(^2\) as a result of the economic and financial crisis that occurred during the year. This led to an overall contraction in real GDP of 7.7 percent in the same year, which indicates the vulnerability of the economy to external shocks (Statistics Botswana, 2016) and underscores the need to diversify the economy.

**Figure 4: Share of Mining in Total GDP (Percent), current prices, 2004-2014**

![Graph showing share of mining in GDP from 2004 to 2014](source)

Figures 8 and 9 in Annex 1 indicate that the share of the mining industry to GDP has been declining over the years, from 53 percent in the mid-1980s to just above 20 percent in 2014. This may be attributed to some of the challenges that the industry has been facing over the years, including fluctuations in global mineral prices and global demand, and the growth of non-mining sectors. Although its contribution to GDP has declined, a share of above 20 percent for a single sector is significantly high, and this exposes the economy to sectoral concentration vulnerabilities.

### 2.2.2. Inflation Developments

\(^2\) Diamond mining GDP accounts for about 80 percent of mining GDP.
Between 1970 and 2007, consumer price inflation average around 10 percent. Increases in inflation was linked to among others, the impact of the increase in some administered prices, namely public transport fares, electricity tariffs and fuel prices. Following the introduction of the Bank of Botswana Medium-Term Inflation objective of 3-6 percent in 2008, consumer price inflation started declining and eventually reached the target in 2013 (Statistics Botswana, 2016). Low inflation promotes international competitiveness of local industries and also supports mobilization of savings. In addition, stable prices are important for maintaining macroeconomic stability, which is vital for long-term economic growth.

**Figure 5: Consumer Price Inflation, 1970 – 2015**

Source: Statistics Botswana, Selected Statistical Indicators, 2016

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2.2.3. Economic Diversification

Realising that over-dependence on the mining industry is a key weakness to Botswana’s outlook, economic diversification became a critical priority for the Government of Botswana and deliberate measures aimed at promoting economic diversity are continuously being implemented. These measures include various economic policies and broad strategies, as well as sector-specific strategies aimed at promoting and stimulating long-term growth and the productivity of the non-diamond industry. The policies include Trade Policy for Botswana (2009), The Special Economic Zones Policy (2010), Industrial Development Policy for Botswana (2014) and the Citizen Economic Empowerment Policy.
Some of the strategies are the Botswana National Export Strategy (2010), Investment Strategy for Botswana (2010), Private Sector Development Strategy (2008), Strategy for Selebi-Phikwe Regional Economic Diversification (2013) and the Economic Diversification Drive (2010). Some of the sector specific policies are the Strategy for Development of the Dairy Sector in Botswana (2013); Botswana Textile and Clothing Development Strategy (2013) and a High Level Strategy for the Development of the Leather Industry in Botswana (2012). Some progress has been achieved towards economic diversification as shown by the growth in non-mining, non-government GDP (proxy for private sector GDP). The private sector GDP as a share of total GDP increased to as high as 68 percentage in 2009 (Figure 6).

Figure 6: Non-Mining Non-Government Sector Value added to Total GDP, 1994-2014

Source: Statistics Botswana, National Accounts, 2016

Figure 7 presents total exports, mineral export and other exports trends between 1980 and 2011. The figure shows that the trend in total exports follows the movement in mineral exports while mineral exports account for the largest share in total exports. This also exposes the country to external shocks similar to those witnessed during the 2009 global economic and financial crisis (this is shown by the 2009 kink in the figure)
In short, Botswana’s economic growth has been propelled by the mining industry, leading to a substantial accumulation of official foreign reserves (Figure 10, Annex 2). Government continues to intensify its efforts to diversify the economy away from mining, consumer price inflation is stable while unemployment is still relatively high (Table 6, Annex 2). Corruption levels are low, the index of competitiveness is improving while the scope of eliminating impediments to the ease of doing business is visible (Annex 2). However, TFP growth has been declining over the years and this could undermine the achievement of sustainable long-run economic growth that the country seeks to achieve by 2036 (Botswana Government, 2016).
3. LITERATURE REVIEW

This section reviews the literature related to the determinants of TFP growth. It is divided into 3 sub sections. The first sub section is a theoretical review. The second and third sub sections explore the empirical literature on the determinants of TFP growth. Specifically, the second sub section reviews determinants of TFP growth in other countries while the third sub section presents a review of existing literature on Botswana.

3.1. Theoretical Literature

3.1.1. Situating TFP in the Economic Growth Models

Economic growth theory is a broad subject area whose literature has evolved over the years. Therefore, various schools of thought have given their inputs on the drivers of long term economic growth. Although the theories differ in terms of the context in which they place TFP in growth models, there is a general consensus that TFP is an important variable in the growth matrix. This gives impetus and motivation to the understanding of the determinants of TFP growth, given its significance in the economic growth dynamics.

In the 20th century, earlier growth models such as the Harrod - Domar model (1946) considered investment and savings as important determinants of long-term economic growth. The idea behind this school of thought is that in order to sustain full employment over time, savings and investment must be equal to the product of the rate of population increase and the required capital for labour productivity. The model also assumed that labour is not a constraint on production as it is available in infinite supply.

The earlier growth models were then followed by the Neo-Classical models. The most commonly referenced model in this category is the Solow (1956) growth model, which gives the framework for the development of TFP growth. The main takeaway from this model is that countries will not achieve long-term growth without technological progress or TFP growth. The model assumes that TFP is exogenous and is a primary determinant of long-term growth in per capita incomes.
Endogenous growth models, such as that of Romer (1986) put emphasis on investment in education and spillovers. These spillovers include knowledge, innovation and learning-by-doing. It is assumed that spillovers from capital investment in the economy alleviate diminishing returns to capital because an increase in capital leads to a rise in TFP growth. Romer (1990) added that Research and Development (R&D) also increased TFP while Lucas (1988) highlighted that human capital was a byproduct of work experience (learning by doing).

In summary, TFP is a residual and includes other factors other than labour and capital. Some of these factors include technical innovation, organisational or institutional changes, changes in both factor shares and labour skills, and scale effects or variations in work intensity.

3.1.2. Determinants of TFP

Over the years, various researchers have established different factors that determine TFP in both the developing and developed countries. Isaksson, (2007) highlights that the determinants of TFP can be grouped into 4 categories of (a) creation, transmission and absorption of knowledge; (b) factor supply and efficient allocation; (c) institutions, integration and invariants; and (d) competition, social dimension and environment. A brief explanation of these variables is summarized as follows:

3.1.2.1. Creation, Transmission and Absorption of knowledge

The determinants falling in this group include R&D, investment in Information and Communications Technology (ICT), and Foreign Direct Investment (FDI). Of these, most studies discuss the relationships between R & D and FDI with TFP growth. For instance, Cole, Helpman and Hoffmeister (2008), Khan and Luintel (2006) Bassanini et al., (2001) have highlighted that investment in R&D leads to exploration of new, improved and efficient methods of production, which, in the long-run, boosts TFP growth. Other researchers, however, such as Michelacci (2003) disagree that R & D leads to growth in TFP. In fact, they highlight that it is not R & D but innovation that leads to growth in TFP.
With respect to FDI, it is viewed as an important avenue in which advanced technology and innovation can be transferred to the host country. Griffith et al., (2003) highlighted that technological spillovers can lead to TFP growth, but on the contrary, Hanson (2001) refutes this, noting that FDI does not have spillovers that can enhance TFP growth.

3.1.2.2. Factor Supply and Efficient Allocation

The emphasis of this theory is on human capital, efficiency in the financial system and physical infrastructure. Human capital has been proxied by years of school enrolment and government expenditure on education, health and training while physical infrastructure focuses on the expenditure on items such as roads and electricity. This theory also looks at determinants such as the efficiency in both the allocation of resources to the most productive sectors and the financial system. The most researched determinants are human capital and the efficiency of the financial system.

On human capital, since the emergence of the endogenous growth models, economic literature has not reached an agreement on how human capital should be factored into growth models. For instance, Mankiw, et al., (1992) highlights that human capital performs better as an additional factor into the production function. On the other hand, Islam (1995), Benhabib and Spiegel (1994) disagree with the inclusion of human capital directly into the production function. They indicate that human capital does not directly influence growth, but impacts it through TFP. Other researchers such as Knowles and Owen (1997) agree with Islam (1995) that human capital, measured by both education and health, should not be regarded as a factor of production, but their point of departure is that it should be viewed as a supplement of labour. Nelson and Phelps (1966) extend Knowles' (1994) view by indicating that human capital (measured in terms of education) does not only enhance labour capacity, but also speeds up the ability of workers to adopt new technology. They also indicate that there is a positive relationship between returns on education and level of technology in the economy. Benavot (1989) noted that the main contribution of human capital (crudely measured in terms of years of school enrolments) is that it leads to a more skilled labour force and, in turn, raises TFP.
Abdychev et al., (2015) highlight that a rise in human capital base is vital as it can facilitate structural change and technological improvement. Their study also highlighted that a rise in human capital could have a higher catch-up rate of new technology from international trade and FDI. This view is consistent with other researchers such as Nelson and Phelps (1966), Barro, (2001), Berret and O’connel (1999), Black and Lynch (1996) Hall and Jones (1999), Hamid and Pichler (2009) and Baldwin, Deverty and Sabourin (1995), who also acknowledged that training was very important for TFP growth. Acemoglu and Zilibotti (2001) add that skill mismatch (that is the gap between the supply of, and demand for skills) could account for the decline in TFP growth, especially in low income countries that rely on technology transfer from industrialized countries.

In short, these studies linked the increase in human capital in various forms (e.g., training of staff to use existing and new technology, spillovers from innovations, and/or the level of education attainment, etc.) to positive increases in TFP. This study will explore the significance of some of the determinants of TFP growth, such as secondary school enrolment within the context of Botswana.

The efficiency of the financial system has also been linked to increased TFP growth. Financial markets avail credit to the private sector who use it for productive purposes. Howitt and Mayer-Foulkes (2005) highlight that efficient allocation of capital and financial development lead to innovation in the market, which will result in TFP growth. Tufail and Ahmed (2015) add that financial development reduces the distortions in the product market process and enhance TFP growth. Beck, Levine and Loayza (2000) suggest that finance affects economic growth through TFP. Aghion, Howitt and Mayer-Foulkes (2005) add that a good financial system enhances productivity through efficient capital reallocation and also brings in technological innovation.

3.1.2.3. Institutions, Integration and Invariants
Most studies (e.g. Mookerjee (2005) and Binam. et al, (2006) have analysed integration in the form of trade openness and its impact on economic growth. Institutions can be decomposed into political and economic ones. Political institutions mainly focus on variables such as autocracy and democracy while the economic ones deal with regulations, and property rights, amongst others. Some studies have highlighted that good institutions and an efficient regulatory environment can also be linked to an improvement in TFP. For instance, Abdychev et al., (2015), Acemoglu et al., (2003) noted that these institutions ensure resource reallocation efficiency and also create a conducive environment for investment, therefore leading to TFP growth. Also, a politically stable environment is associated with the ability to attract investments in innovations, and also reduces market distortions which in turn improved TFP growth.

On openness, several researchers have found out that economies that were open to trade grew quicker than their less open counterparts. In addition, various ways in which openness can boost TFP growth have been identified, and these include exploitation of comparative advantage, knowledge and technological transfer, exposure to competition and economies of scale. In addition, the importation of intermediate goods in the production process has also been linked to increases in TFP growth (Dowrick and Golley, 2004) and Siddiqui and Iqbal (2005). On the other hand, other studies, particularly those that looked at the Sub Saharan African (SSA) region, for example, Binam et al., (2006) have found openness to impact negatively on TFP growth, mainly due to inadequate infrastructure and governance structures, amongst others.

3.1.2.4. Competition, Social Dimension and Environment

This group of determinants is concerned with the role that competition, the social policy and the environment play in productivity growth. The competition aspect relates to market dynamics such as privatization, perfect competition and monopoly, while the social dimension relates to income distribution and wealth, amongst others. The impact of environmental regulation is also captured under this group. The few studies that have analysed this group of determinants argue that competition is the main determinant of
productivity growth, while environmental regulation can deter it. Isaksson (2007) notes that, since social policy works through an array of variables such as the accumulation of factors, incentives to invest, save and work, or through induced effects, it becomes difficult to measure its effects on TFP growth. Gray and Shadbegian (2003) highlight that environmental regulation negatively affects TFP growth, although not significantly.

In addition to these 4 groups, other studies included some determinants such as macroeconomic variables, sectoral composition and structural change. The macroeconomic variables that are viewed as key to TFP growth include exchange rates, inflation, size of government and fiscal deficits. Inflation and the size of government are the most researched. Most literature, such as De Gregorio (1993), Ghosh and Phillips (1998), Loko and Diouf (2009), Espinoza and Prasad (2012), and Barro (2013) find a negative relationship between inflation and productivity growth. Other studies such as Sarel (1996) found evidence of a structural break at an 8 percent inflation rate, where inflation and growth are positively correlated below 8 percent, but negatively correlated above that level.

Khan and Senhadji (2001) and Espinoza et al., (2012) re-examined this result and found that for developing countries and for oil producers, inflation becomes costly only when it exceeds 10 percent. The role of government is potentially an important factor in productivity growth. The size of the public sector is assumed to have potential to foster and/or hinder productivity growth. On sectoral composition and structural change, Abdychev et al., (2015) highlight that a less diversified economy is vulnerable to external shocks, which will, in turn, undermine TFP growth. Table 1 summarises the main determinants TFP growth coming out of the theoretical literature.
Table 1: Summary of main determinants of TFP

<table>
<thead>
<tr>
<th>Main Determinants of TFP from the Literature</th>
<th>Variables Used in the Analysis of TFP</th>
<th>References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Macroeconomic Conditions/Stability</td>
<td>Inflation</td>
<td>De Gregorio (1993); Ghosh and Phillips (1998); Loko and Diouf (2009); Espinoza and Prasad (2012); Barro (2013) and Sarel (1996)</td>
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<td></td>
<td>Government debt</td>
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<td></td>
<td>Domestic Borrowing (e.g., from banks)</td>
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<td></td>
<td>Public sector employment</td>
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<td></td>
<td>Monetary and Fiscal Policy variables</td>
<td></td>
</tr>
<tr>
<td>Openness, and Technology Creation and Transfer</td>
<td>Trade</td>
<td>Griffith et al., (2003); Hanson (2001); Dowrick and Golley (2004); Siddiqui and Iqbal (2005) and Binam. et al, (2006)</td>
</tr>
<tr>
<td></td>
<td>Tariffs and barriers</td>
<td></td>
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<td></td>
<td>FDI</td>
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<tr>
<td></td>
<td>Infrastructure Development</td>
<td></td>
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<tr>
<td></td>
<td>Skill mismatch indicators</td>
<td></td>
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<tr>
<td></td>
<td>Female labour force participation rate</td>
<td></td>
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<tr>
<td></td>
<td>Self-employment indicators</td>
<td></td>
</tr>
<tr>
<td>Economic Diversification - Sectoral Composition and Structural change</td>
<td>Sector shares of output</td>
<td>Abdychev et al., (2015); Hammouda et al., (2010)</td>
</tr>
<tr>
<td>Monetary and Financial Development</td>
<td>Economic diversification indicators</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bank/Financial Credit</td>
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<td></td>
<td>Market capitalization</td>
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<tr>
<td></td>
<td>Investment in R&amp;D and ICT Infrastructure</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Promotion of Innovation</td>
<td></td>
</tr>
</tbody>
</table>
3.2. Empirical Literature

Empirical literature on the determinants of TFP growth have mostly focused on a narrower range of variables, such as human capital, education, openness, financial development, inflation and FDI. Relevant empirical literature is summarized below.

Binam et al., (2006) calculated TFP for a sample of 27 SSA countries and assessed factors behind varying TFP rates across these countries over the period 1965-2000. The study evaluated the impact of factors such as openness to world trade, terms of trade variability, physical capital accumulation, financial depth, and population growth on the derived TFP indices. The study specified a Cobb-Douglas production function involving GDP per capita, capital per capita and the labour force, both with and without the stock of human capital as the independent variables. The determinants of the TFP growth were then introduced directly into the production function using (i) the cross-section estimation (use of 36-year averages), (ii) the fixed-effects estimation with annual data, (iii) the fixed effects estimation with data in 3-year averages, and (iv) the seemingly unrelated regression technique.

The study found out that openness to global trade contributed negatively to TFP growth in SSA countries. The study attributes this to the inability of these countries to support competition associated with trade, possibly due to supply constraints such as poor transport and communication infrastructure, erratic supply of electric energy, corruption and bad governance, cumbersome administration, insufficient education of the labour force, among
others. With respect to financial depth, the study found out that increases in private sector credit led to acquisition of new capital, which enhances productivity. This implied that financial development is important for TFP growth in the SSA region. In addition, increases in physical and human capital were also discussed and viewed as important in increasing TFP growth in the SSA region. These findings are in line with Abdychev et al., (2015). However, with regard to population growth, the study found that it had a positive relationship with TFP growth in some of the SSA countries and a negative relationship was observed in others.

Jajri (2007) analysed determinants of TFP growth in Malaysia between 1971 and 2004, and highlighted them as capital, the ratio of trade to GDP, percentage of foreign owned firms, output of the manufacturing sector, and the percentage of employed persons who have acquired tertiary education. The study used the Data Envelopment Analysis to estimate changes in the production frontier while the Malmquist production index was employed to decompose TFP into technological change and technological efficiency. The study found that, with the exception of capital, all the other variables were positively related to TFP growth. This is in-line with other studies such as Abdychev et al., (2015) who also came up with the same conclusions. On the capital structure, the study found a negative relationship with TFP growth. The study concluded that, the historical rapid economic growth that Malaysia recorded over the years was unsustainable in the long-run due to the fact that it was driven by factor inputs with little contribution from technological change. These characteristics are similar to those of the economy of Botswana.

Hammouda et al., (2010) investigated the relationship between economic growth, productivity and diversification in selected African economies in the period 1981 – 2000. Similar to Binam et al., (2006), the study quantified the contribution of TFP growth to economic growth using the Cobb-Douglas production function and then analysed the determinants of TFP growth for the SSA countries using panel data. Interestingly, the study included the index of economic diversification among the determinants of TFP growth, which included human capital, openness, financial development and conflict. On economic diversification, the study analyzed these variables within the context of 5 groups. These are
(i) countries with little economic diversification, (ii) countries that started the process of economic diversification but have not made any significant progress; (iii) countries that have deepened economic diversification process; (iv) countries that registered early positive diversification gains but later specialized on few products, and (v) countries with conflict and post conflict regimes.

For the surveyed countries, the study found that increases in economic diversification led to higher TFP growth. In addition, the study also found that trade openness and human capital (proxied by secondary school enrolment) were important determinants of TFP growth while financial deepening did not improve TFP growth. The findings on financial deepening are in contrast to some of the surveyed literature such as Howitt and Mayer-Foulkes (2005). Furthermore, the presence of conflict also had a negative impact of TFP growth. With respect to Botswana, surprisingly, the study only focused on its first objective of quantifying the contribution of TFP to economic growth. Its finding indicates that the contribution of TFP to economic growth has been declining over the study period.

Danquah et al., (2011) analysed the determinants of TFP growth for 20 Organisation for Economic Cooperation and Development (OECD) and 47 Non-OECD countries over the period 1960-2000. The study used panel data and the Bayesian model averaging methodology. The study highlighted that even though trade openness and consumption shares can be labelled as robust determinants of efficiency change, only the trade openness measure remained a robust determinant of technological progress across the countries in the sample. In addition, the study noted that countries with higher degrees of trade openness perform better in terms of catching up to the world technological frontier, but worse in terms of shifting the frontier. Having secondary education positively impacted TFP growth only in OECD countries while primary education had a positive relationship with TFP growth in all the 67 countries. The study also found that population growth had a positive impact on TFP growth across all the 67 countries.

Abdychev et al., (2015) used various panel data methods such as dynamic panel estimation, cointegration for heterogeneous panels and binary response model (panel probit analysis)
to identify the determinants of TFP growth for 33 SMIC in SSA including Botswana for the period 1980-2010. The use of various methods was motivated by the existence of endogeneity and cross-country heterogeneity among the economic variables, as well as limited data availability. Despite these challenges, the study found out that macroeconomic stability and trade openness (though not sufficient) were key for productivity growth. The study also found out that quality of government spending on education needed to be improved in order to minimize labour market skills mismatches. Furthermore, the impact of government debt on TFP growth was found to be negative, especially when government debt reached a certain threshold of GDP. They highlighted that reducing the regulatory burden on firms, improving access to finance by small and medium sized enterprises and creating a conducive environment to facilitate structural transformation will improve TFP growth in SMICs.

With respect to Botswana, the study found out that TFP growth has been declining over time. The study suggested that the lack of economic diversification, high reserve wage and skills mismatch, effectiveness of the tax system, quality of public spending were the structural impediments to productivity in Botswana. However, these variables were not empirically tested in the study and this provides an opportunity to do an analysis of some of them in the current study.

Akinlo and Adejumo (2016) examined the determinants of TFP growth in Nigeria over the period 1970–2009. They identified trade openness, FDI , human capital, inflation rate and the unemployment rate as key determinants of TFP in Nigeria. The study adopted a Cobb–Douglas production function to estimate TFP, while the Error Correction Model (ECM), impulse-response functions, as well as variance decompositions, were used to examine its determinants. Based on these methods, the study found that trade openness was negatively related to TFP growth. The results are similar to those by Binam et al., (2006), indicating that growth in Nigeria might also be affected by factors such as poor transport and communication infrastructure, corruption and bad governance, just to mention a few. Foreign Direct Investment had a positive relationship with TFP growth, indicating positive
spill overs (i.e., better technology, novel management and organizational skills) from FDI to the economy.

The study also found that human capital had a negative impact on TFP growth. Miller and Upadhyay (2002) also found the same results, and attributed this to various reasons such as the low-income level in the country, low quality of education which possibly constrain the economy’s capacity to carry out technological innovation. With respect to inflation, the study highlighted that it had a negative impact on TFP growth. The study associated this with high and unstable prices, which created a lot of economic uncertainties that discourages investment.

3.3. Empirical Literature Review on Botswana

A few papers that have examined the growth dynamics of the Botswana economy have focused on growth, rather than specifically on TFP growth. These include studies by Matovu and Yuguda (1999), which analyzed sources of growth in Botswana between 1978 and 1996; BoB Annual Report (2004), which analyzed how much labour, capital and TFP contributed to economic growth in Botswana, for over 3 decades (1975-2005) using a growth accounting approach; Tahari et al., (2004) who focused on investigating the sources of growth in SSA countries for over 4 decades (1960 to 2002); Abdychev et al., (2015) who studied growth trends in a number of SMICs, including Botswana, and observed that the decline in TFP growth was pulling down overall growth rates in the countries under study; as well as a study by Mokoti and Sediakgotla (2014), which applied the growth accounting framework for Botswana, based on a standard Cobb-Douglas production function. One common finding of these papers is that economic growth in Botswana has generally been on a downward trend, and that TFP growth has been among the important sources of growth. These findings, however, give motivation to the quest for understanding the determinants of TFP growth, since it appears to lie at the heart of Botswana’s growth prospects.
Leith (2005) calculated TFP growth for Botswana between 1975 and 2002 and found that the average TFP growth was zero. The research added that Botswana’s average rate of TFP growth was less than that of other developing countries. The results of the TFP growth were broken down into periods of 5 years and they showed that between 1975 and 1980, average TFP growth was 3.7 percent, mainly due to the massive investment in both infrastructure and human capital. The results also showed that a noticeable annual decline of 4.1 percent per annual was witnessed between 1995 and 2000, and a marginal recovery of -0.5 percent recorded in the following 2 years.

Apart from the study by Leith (2005), we could not find specific time series studies focusing on the determinants of TFP growth in Botswana. This shortfall in literature presents an opportunity for this study to contribute to the literature deficit on TFP growth in Botswana.

In summary, the major determinants of TFP growth coming out of theoretical and empirical review include trade openness, macroeconomic stability and human capital. Other factors like financial development and FDI do not feature as much as the above mentioned 3 variables. In addition, much of literature does not include the index of economic diversification in the analysis. Only Hammouda et al., (2010) investigated this link for some selected SSA countries, but excluded Botswana in the analysis. For studies that focused on Botswana, their analysis focused on decomposing Botswana’s growth and analysing the contribution of TFP to economic growth using the Cobb-Douglas production function. None of the studies reviewed herein, including those that included Botswana in their cross country analysis, used the ARDL bounds testing econometric approach. This study will, however, focus on the underexplored areas identified as gaps in literature by empirically analysing the following determinants of TFP growth in Botswana: the index of economic diversification, trade openness, human capital; macroeconomic stability and trade openness and financial deepening.
4. METHODOLOGY

This section presents the framework for analysing the determinants of TFP growth for Botswana. The section draws heavily on the literature reviewed in section 3, especially on the determinants of TFP growth. The section is divided into 5 sub sections. The first and second sub sections look at the theoretical and the ARDL bounds testing approach designed by Pesaran et al., (2001) model specification, respectively. Sub section 3 presents the data used in the study while sub section 4 presents the list of variables used to analyse the determinants of TFP growth in Botswana. The last sub section describes the estimation procedure.

4.1. Theoretical Framework

Solow (1957) proposed a growth accounting framework which associates growth that cannot be explained by factor inputs to TFP growth. Solow specified the following aggregate production function with Hicks-neutral technology:

\[ Y(t) = A(t) \cdot F[K(t), L(t)] \] 

Where:

- \( Y(t) \) is aggregate production;
- \( K(t) \) is the stock of physical capital used in production;
- \( L(t) \) is the mount of labour inputs and
- \( A(t) \) is TFP.

Equation 1 can be transformed into equation 2 such that

\[ \frac{Y(t)}{Y(t)} = \frac{A(t)}{A(t)} + a(t) \cdot \frac{K(t)}{K(t)} + b(t) \cdot \frac{L(t)}{L(t)}, \ a(t) + b(t) = 1 \] 

Where:

\[ Y(t) = A(t) \cdot F[K(t), L(t)] \] (1)
\( a(t) + b(t) \) are shares of capital and labour costs in total costs, respectively. Generally, since data on \( Y(t), K(t) \) and \( L(t) \) are readily available, \( \frac{\Delta A(t)}{A(t)} \) remains unknown and is therefore calculated as the residual such that the production function becomes;

\[
\frac{\Delta A(t)}{A(t)} = \frac{Y(t)}{Y(t)} - a(t) \cdot \frac{K(t)}{K(t)} - b(t) \cdot \frac{L(t)}{L(t)} \quad \text{................................................................. (3)}
\]

Mankiw, Romer, and Weil (1992) extend the Solow (1956) model by adding human capital accumulation and assume the following production function.

\[
Y(t) = K(t)^\alpha H(t)^\beta [A(t)L(t)]^{1-\alpha-\beta} \quad \text{................................................................. (4)}
\]

Where:

\( H(t) \) is the human capital stock. Similar to equation 1, equation 4 can be also be re-arranged to make TFP subject of the formula. This gives the framework for analysing the determinants of TFP growth.

**4.2 Specification of the model**

The current study approaches this from the time-series perspective, employing the test of cointegration using the ARDL approach. The ARDL econometric approach is preferred because of several reasons such as:

- When there is a single long-run relationship, the ARDL procedure can distinguish between dependent and explanatory variables. The approach assumes that only a single reduced form equation relationship exists between the dependent variable and the exogenous variables (Pesaran, Smith, and Shin, 2001);
- The major advantage of this approach lies in its identification of the cointegrating vectors where there are multiple cointegrating vectors;
- The ECM can be derived from the ARDL model through a simple linear transformation, which integrates short-run adjustments with long-run equilibrium.
without losing long run information. The associated ECM model takes a sufficient number of lags to capture the data generating process in general to specific modeling frameworks;

- Irrespective of whether the underlying variables are I(0) or I(1) or a combination of both, ARDL technique can be applied.
- If the F-statistics (Wald test) establishes that there is a single long run relationship and the sample data size is small or finite, the ARDL error correction representation becomes relatively more efficient.
- If the trace or Maximal eigenvalue or the F-statistics establishes that there is a single long-run relationship, ARDL approach can be applied rather than applying traditional structural modelling approach such as Johansen and Juselius approach.

The ARDL \((p,q_1,q_2,\ldots,q_k)\) model specification is given as follows:

\[
\Delta Y_t = \delta_{0t} + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-i} + \sum_{i=1}^{k} \alpha_2 \Delta X_{t-i} + \delta_1 Y_{t-1} + \delta_2 X_{t-1} \beta_4 + \nu_t \tag{5}
\]

Where:

- \(k\) is the ARDL model maximum lag order chosen through various methods such as Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC) or Hanna-Quinn Criterion (HQC).
- \(Y_t\) is the dependent variable;
- \(X_t\) vector of deterministic variables such as the intercept term, time trends, seasonal dummies, and exogenous variables with the fixed lags; \(t\) is the time period; \((\delta_1, \delta_2)\) correspond to the long-run relationship, while \((\alpha_1, \alpha_2)\) represent the short-run dynamics of the model.

The F-statistic is carried out on the joint null hypothesis that the coefficients of the lagged variables \((\delta_1 X_{t-1} \delta_1 Y_{t-1} \text{ or } \delta_1 Y_{t-1} \delta_1 X_{t-1})\) are zero.

The hypothesis that the coefficients of the lag level variables are zero is to be tested.
The null of non-existence of the long-run relationship is defined by:

Ho: $\delta_1 = \delta_2 = 0$ (null, i.e., the long run relationship does not exist) ……………………(6)

H1: $\delta_1 \neq \delta_2 \neq 0$ (Alternative, i.e., the long run relationship exists) …………………… (7)

4.3.Data

The study uses data spanning from 1977 to 2014 to analyse determinants of TFP growth for Botswana. The period of the study has been constrained by the availability of data for the selected variables. These variables include the TFP growth, index of economic diversification, human capital, openness, financial deepening, and macroeconomic stability. Data is readily available for human capital, openness, macroeconomic stability (inflation is used as a proxy) and financial deepening (credit to the private sector and money supply are used as proxies) and index of economic diversification, the Herfindahl – Hirschmann Index (HHI), i.e. Data on the inflation, money supply and credit to the private sector is collected from the Bank of Botswana Annual reports and Statistical Bulletins from Statistics Botswana. Data on human capital, openness and the index of diversification is collected from various Statistical Bulletins from Statistics Botswana.

4.4.The dependent variable - Total Factor Productivity Index (TFP)

The dependent variable in this study defined as growth in output that is not attributable to factor inputs. The study does not calculate its own TFP growth series, rather, it adopts the one generated by the Federal Reserve Bank of St. Louis. The other alternative is to use or adopt the ones Leith (2005) or Government of Botswana (2015/16). All these methodologies are based on the Cobb-Douglas production function and excludes mineral rents, which are approximated using the mineral revenues, since these are not attributable to labour or capital inputs. The capital stock series is calculated using the perpetual inventory method while the labour force series takes into account, the skilled and unskilled. However, this study adopts the Federal Reserve Bank of St. Louis estimates, which is similar to Leith (2005) or Government of Botswana (2015/16). The Federal Reserve Bank
of St. Louis estimates are updated on a regular basis which makes them more robust, as periodic revisions correct for previous errors.

4.4.1. Limitations of TFP

Even though literature regards TFP as a good estimator of technological efficiency, the way it is calculated (Solow residual) results in some limitations. As a residual, there are possibilities of measurement errors, omitted variables aggregation and misspecification. Furthermore, the Cobb-Douglas production function requires the factor input shares to be known, which is subject to errors. These errors may result from the way the factor inputs are calculated. In addition, for developing countries like Botswana, data reliability, availability and accuracy, especially capital inputs, is a challenge. Therefore, the calculation of capital inputs is also subject to errors. All this can lead to a misspecification of TFP growth. Alternatively, technology can also be estimated econometrically, taking into consideration, non-constant returns to scale, market distortions, and factor biased innovations. However, this alternative way can also lead to more errors associated with data challenges.

4.5. Explanatory Variables

The choice of the determinants of TFP growth is motivated by the availability of data and literature such as Hammouda et al., (2010); Narayan and Smyth (2005); Mookerjee (2005); Aghion et al., (2005) and Fischer (1993). In addition, this current study will enrich its objectives by adding the index of economic diversification as a determinant of TFP growth.

4.4.1. Index of Economic Diversification - (HHI)

Many studies, such as Sachs and Warner (1995), confirm the importance of structural changes in determining TFP, in terms of sectoral production, balanced distribution of employment and a more diversified export basket. For Botswana, the dominance of the mining industry on both economic output, government revenue and total exports has made economic diversification an important policy priority for the Government. In this regard, deliberate measures aimed at promoting economic diversification away from diamond
sector and achieving sustainable economic growth in Botswana continue to be implemented. This study follows Hammouda et al. (2010), who used the same variable in their model and concluded that there is a long-term economic relationship between TFP growth and economic diversification. This relationship occurs through 2 channels. The first channel is through an increase in TFP growth and the second channel is through risk minimization which stabilizes exports. The first transmission link between economic diversification and TFP growth is particularly relevant for this study. In this regard, a more diversified economy is expected to have a positive impact on TFP growth, which will, in turn, lead to a more sustainable growth in the long run, while a less diversified economy will reduce TFP growth.

The index of diversity can be calculated using various methodologies (United Nations, 2016). These include the Industrial Organisation Theory (absolute specialization indices); Economic Base Theory; Regional Business Cycle; Portfolio Theory; Location Theory; Economic Development Theory and the Input-Output model. The mostly used methods within economic theory are the HHI; the Ogive Index; and the Gini Index. Of these methods, the HHI is extensively used when measuring market concentration and economic diversity. This study used the HHI methodology due to its suitability and adaptability to the Botswana economy. The index follows work by Hirschman (1945, 1964) and Herfindahl (1950). It is used to measure trade and industry concentration or inequality, as well as concentration in household wealth or income, merger analysis, firm outputs (Rhoades, 1993), and revenue concentration in both the public and non-profit sectors (Suyderhoud, 1994). The index has also been widely used as a measure of trade and product diversification. The HHI is calculated as follows:

$$HHI = \sqrt{\sum_{p=1}^{P} \left( \frac{x^i_p}{\sum_{p=1}^{P} x^i_p} \right)^2} \quad \ldots \ldots \ (8)$$

Where:

- $x^i_p$: country’s $i$ exports of product $p$ to the world; $p$: any traded product; taking value $p = 1$ to $P$ (i.e. total number of traded products);
HHI\textsubscript{i}: Herfindahl-Hirschman index for country \textit{i}, may take values from \(1/P\) to 1; Note that by convention \(HHI\textsubscript{i} < 0.01\): high diversification; \(0.01 \leq HHI\textsubscript{i} < 0.15\): fair diversification; \(0.15 \leq HHI\textsubscript{i} \leq 0.25\): moderate diversification; \(HHI\textsubscript{i} > 0.25\): low diversification (or high concentration).

4.4.2. Enrolment in Secondary School Education - (SEC)

In line with endogenous growth theories, this study associates investment in human capital with improved productivity. From the empirical literature, the study borrows from various studies, such as Narayan and Smyth (2005) and uses enrollment in secondary school\textsuperscript{3} education as a proxy for human capital. The choice of this proxy, among the other measures of human capital in Botswana\textsuperscript{4}, is guided by the availability of data, which is sourced from the Statistics Botswana (various publications). Based on the reviewed economic theory, it is expected that this variable will be positively related to TFP growth. It should be noted, however, that some studies such as Benhabib and Spiegel (1994) and Hamid and Pichler (2009) used the average amount of government expenditure on education, average number of years of schooling of the labour force as proxies for human capital.

4.4.3. Openness (export + imports)/GDP- (OP)

Trade openness is important for increasing TFP growth. It also encourages FDI inflows, which is a key channel for the transfer of advanced technology and R&D knowledge. Mookerjee (2005) found that export orientation (or trade openness) is positively related to productivity growth. Based on this and the other literature reviewed, the relationship between this variable and TFP growth can either be negative or positive. On the positive side, openness to global trade is important for TFP growth as it exposes the country to new

\textsuperscript{3} It should be noted that Secondary School Enrolment is a measure of the increment to the stock of Human Capital and not a measure of the stock itself.

\textsuperscript{4} Apart from literature, for Botswana, the importance of human capital cannot be over emphasized. From having only 22 secondary school graduates at independence to about 175,509 in 2013. It should also be noted that focusing on secondary school enrolment does not imply that primary and vocational training have been neglected in Botswana. In fact, the country has made considerable strides in achieving universal primary education in line with the 2015 Millennium Development Goals. Vocational school enrolment has also increased from around 1700 in the late 1970s to about 10000 in 2007 (Statistics Botswana (2016))
ways of production, and transfer of technology, among others. On the other hand, where openness to trade was found to have a negative impact on TFP growth, it was attributed to the poor ease of doing business, such as weaknesses in infrastructure and institutions. Data used for calculating the degree of openness, that is, exports, imports and GDP is collected from Statistics Botswana (various publications).

**4.4.4. Consumer Price Index (CPI)**

Friedman (1977) argues that inflation volatility adversely affects allocative efficiency by increasing unemployment and decreasing growth. Fischer (1993) adds that high inflation reduces the output growth by reducing investment and productivity growth. In this regard, the evolution of prices in an economy can be viewed as an indicator of macroeconomic stability. An inflationary environment can signal instability, reduce the demand for money balances and after tax profits, which may deter investment. Other researchers such as Gokal and Hanif (2004) who analysed the relationship between inflation and growth highlighted that there exist a threshold beyond which inflation exerts a negative effect on growth. They indicate that inflation levels lower than the threshold levels will have no effect on growth, while rates higher than these threshold will have a significant negative effect on growth. They found out that the threshold is lower for industrialized countries (1 – 3 percent) than for developing countries (11 – 12 percent). These findings can provide useful insights on the benefits of maintaining price stability. For this study, the relationship between inflation and TFP growth is expected to be negative.

The inflation data are from Statistics Botswana and the Central Bank of Botswana. The inclusion of this variable is based on the characteristics of a small open landlocked economy, which imports around 43.8 percent of its consumables, including energy from its neighbouring countries. This exposes the country to some imported inflation and administered prices. In addition, the country is vulnerable to external shocks such as movements in international oil and food prices.

**4.4.5. Financial Deepening**
A good financial system has the ability to allocate savings to investments, reduce the distortions in the product market process and enhance TFP growth. Beck et al., (2000) suggest that finance affects economic growth through TFP. Aghion et al., (2005) also add that a good financial system enhances productivity through efficient capital reallocation and also brings in technological innovation. Financial deepening has been captured in literature through various ways. For instance, Hammouda et al., (2010) suggest that credit to the private sector; combined total of the credit by the banking sector (implying both credit to the private and public sectors) and broad money supply (M3) as a proportion of GDP, are possible measures of financial deepening. This study uses credit to the private sector as a measure for financial deepening in Botswana. Data on credit to the private sector is from Bank of Botswana.

4.4.6. Dum09

The 2016 national accounts data from Statistics Botswana indicate that, the economy contracted by 7.7 percent in 2009 (see Figure 3), from a growth rate of 3.8 percent in 2008. This contraction is linked to the impact of the global economic and financial crisis. The transmission channel of the crisis was through the trade channel, mostly affecting the diamond production and exports, which necessitated the closure of some diamond mines for nearly 4 months during 2009. In this regard, this study includes the dummy variable to accommodate the structural break in data that occurred in this period. The dummy variable take the value 1 in 2009 and 0 during the other years.

4.4.7. Expected Signs

From the theoretical point of view, there is a positive relationship between the index of economic diversification, secondary school enrolment, financial deepening and TFP growth, respectively. The relationship between openness and TFP growth has been found to be either positive or negative while macroeconomic stability (proxied by low inflation) is assumed to have a positive relationship with TFP growth. The expected signs for this study are summarized in Table 2 below:
Table 2: Expected signs of Explanatory Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Index of Diversification</th>
<th>Secondary School enrolment</th>
<th>Openness</th>
<th>Consumer Price Index</th>
<th>Financial Deepening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expected sign</td>
<td>(+) Positive</td>
<td>(+) Positive</td>
<td>(+)/(-) Either Positive or Negative</td>
<td>(-) Negative</td>
<td>(+) Positive</td>
</tr>
</tbody>
</table>

Source: Deduced from literature reviewed.

4.5. Estimation Procedure/Model Diagnostic Tests

4.5.1. Testing for Unit Root

The presence of a unit root implies that a time series under consideration is non-stationary, while the absence of it indicates that a time series is stationary. This study uses the Augmented Dickey-Fuller (ADF) (1979, 1981) test and the Phillips-Perron (1988) test to examine the presence of unit root in all the variables. The Phillips-Perron test supplements the ADF test in that it is takes into consideration structural changes. These two tests are employed to examine whether the series are either \( I(0) \), \( I(1) \) or \( I(2) \). As in Granger (1986), the unit root test is applied to avoid spurious regression results. The variables are tested based on the null hypothesis of the presence of unit roots against the alternative of no unit roots. The study fails to reject the null hypothesis that the variables are non-stationary in levels when the p-values of each variable are greater than 0.05 under both the ADF and Phillips-Perron test. On the other hand, the null hypothesis of non-stationarity after first differencing is rejected when the p-values under the ADF and Phillips-Perron tests are lower than 0.05. The Units roots tests in the study assume the presence of an intercept and trend. The regression of the ADF test is based on the following:

\[
\Delta Z_t = \beta_0 + \alpha_0 T + \alpha_1 Z_t + \sum_{i=1}^{p} \beta_i \Delta Z_{t-i} + \varepsilon_t \tag{9}
\]
Where;
T is a linear trend;
Z is the variable that is being tested for unit root;
Δ is the first difference operator;
ε_i is the Gaussian white noise term and
P is chosen to achieve white noise residuals.

It should be noted that, since most time series variables become stationary only after differencing once, there is a possibility of the loss of some data characteristics. Hence, using differenced variables for regressions imply loss of important long-run information of the equilibrium relationship between the variables under consideration, as demonstrated in Nkoro and Uko (2016). In this regard, cointegration makes it possible to regain these important long-run properties, which would otherwise be lost during the process of differencing the variables. The process assimilates both the short run dynamics with long run equilibrium and makes it easy to achieve accurate estimates of a model, which are needed for evidence-based policy making.

4.5.2. Testing For Cointegration

To analyse the long-run relationship between TFP growth and economic diversification; human capital; openness and macroeconomic stability and financial deepening, the study uses the ARDL bounds testing approach developed by Pesaran et al., (2001). The autoregressive nature of the model is such that, past values of the dependent variables are used to explain its present behaviour. The distributed lag aspect of the model implies that, it also takes into consideration the current values as well as past values of the explanatory variables.

4.5.3. Empirical Model Specification
The study formulates the following linear model for Botswana which assumes that TFP growth is determined by economic diversification; human capital; openness, macroeconomic stability and financial deepening.

\[
\text{ITFP}_t = \alpha_0 + \beta_1 \text{ITFP}_{t-1} + \beta_2 \text{HHI}_{t-1} + \beta_3 \text{IOP}_{t-1} + \beta_4 \text{SEC}_{t-1} + \beta_5 \text{CPI}_{t-1} + \beta_6 \text{FD}_{t-1} + \text{DUM09} + \epsilon_t \tag{10}
\]

Where;
ITFP, IHHI, IOP, ISEC, ICPI and IFD represent logs of the total factor productivity index; index of economic diversification; openness, enrolment in secondary education (proxy for change in human capital); consumer pricing index (proxy for macroeconomic stability) and credit to the private sector (proxy for financial deepening), respectively. The variables are transformed into logs in order to convert them from skewness to normal distribution and to report the results in percentages rather than original data. DUM09 captures the effect of the 2009 global economic and financial crisis while the error term factors any exogenous variable affecting TFP growth in Botswana which includes other variables such as institutional and regulatory factors (including democracy and political stability).

An ARDL representation of equation 10 is formulated as follows:

\[
\Delta \text{ITFP}_t = \alpha_0 + \beta_1 \text{ITFP}_{t-1} + \beta_2 \text{HHI}_{t-1} + \beta_3 \text{IOP}_{t-1} + \beta_4 \text{SEC}_{t-1} + \beta_5 \text{CPI}_{t-1} + \beta_6 \text{FD}_{t-1} + \sum_{i=1}^{p} \delta_i \Delta \text{ITFP}_{t-i} + \sum_{i=0}^{p} \delta_2 \Delta \text{HHI}_{t-i} + \sum_{i=0}^{p} \delta_3 \Delta \text{IOP}_{t-i} + \sum_{i=0}^{p} \delta_4 \Delta \text{SEC}_{t-i} + \sum_{i=0}^{p} \delta_5 \Delta \text{CPI}_{t-i} + \sum_{i=0}^{p} \delta_6 \Delta \text{FD}_{t-i} + \epsilon_t \tag{11}
\]

Where p is the ARDL model maximum lag order selected based on criteria such as: AIC, SBC or HQC.

The $\beta$s are the long run parameters to be estimated and $\delta$s are the short run parameters to be estimated. The first-difference operator is represented by $\Delta$. The time period and white noise error term are represented by $t$ and $\epsilon$ respectively. Cointegration of the variables is tested using the F-statistic (Wald test). The critical values for the test were supplied by
Pesaran et al., (2001). The hypothesis of non-existence of the long run relationship is defined by;

\[ H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0 \] (the long run relationship does not exist) ………………… (12)

\[ H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0 \] (the long run relationship exists) …………………… (13)

In this method, cointegration of the series is said to be established when the F-statistic from joint test of significance exceeds the critical values for upper and lower bounds. In addition, this bounds test approach enables examination of both short-run and long-run dynamics.

4.5.4. Error Correction Mechanism

After establishing the existence of the long-run relationship between variables using the bounds testing approach, the study then estimates the short-run ECM. The ECM representation of equation 11 is formulated as follows.

\[ NTPF = \alpha + \sum_{i=1}^{P} \delta_1 NTPF_{-i} + \sum_{i=0}^{P} \delta_2 NHH_{-i} + \sum_{i=0}^{P} \delta_3 NOP_{-i} + \sum_{i=0}^{P} \delta_4 NSEC_{-i} + \sum_{i=0}^{P} \delta_5 NCP_{-i} + \sum_{i=0}^{P} \delta_6 TFP_{-i} + \Omega ECT_{-i} + DUM9 + \mu_t \]

………………………………………………………………………………………………………………………… (14)

All the variables captured in equation 14 are as previously explained, \( \mu_t \) is the error term and \( \Omega \) is the coefficient of the Error Correction Term (ECT). The short-run dynamics are captured by the individual coefficients of the lagged terms. When the lagged explanatory variables are significant, this will imply that there is short run causality in the model. The ECT represents the speed of adjustment and presents the evidence of adjustment to long-run equilibrium. It also indicates the corrected magnitude of disequilibrium. Its values are supposed to be between 0 and -1. Pesaran and Pesaran (1997), suggest that, once the ECM has been estimated, there is need to test for the parameter stability using the cumulative sum of recursive residuals (CUSUM) and the CUSUM of square (CUSUMSQ) tests to assess the parameter constancy.

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4.5.5. Granger-Causality Analysis

Following the Granger (1969) approach, using lagged values of TFP growth, together with lagged values of economic diversification, human capital, openness, and macroeconomic stability, will lead to better forecasts of economic diversification, human capital, openness, and macroeconomic stability, compared to using lagged values of economic diversification, human capital, openness, macroeconomic stability and financial deepening alone.

Consequently, using lagged values of economic diversification, human capital, openness, macroeconomic stability and financial deepening together with lagged values of TFP growth will lead to better forecasts of TFP growth, compared to using lagged values of TFP growth alone. That is:

\[ \Delta \ln TFP_t = \alpha_0 + \sum_{i=1}^{k} \beta_{1,i} \Delta \ln TFP_{t-i} + \sum_{i=1}^{p} \beta_{i} (X_{t-i}) + \mu_t \]  

\[(15)\]

Where;

\( k \) is the lag length and \( X_t \) is a vector of determinants variables. If \( \beta_i = 0 \) (for all \( i = 1, 2, \ldots, k \)), then, \( X_t \) does not Granger-cause TFP growth. For this study, the detailed Granger causality models are presented by equations 16 to 23 as displayed in Annex 3.

The hypotheses are constructed as follows:

\( H_0: \) Economic diversification does not granger cause TFP growth;

\( H_1: \) TFP growth does not Granger cause Economic diversification;

\( H_0: \) Human capital does not Granger cause TFP growth;

\( H_1: \) TFP growth does not Granger cause human capital;

\( H_0: \) Openness does not Granger cause TFP growth;

\( H_1: \) TFP growth does not Granger cause openness;
H₀: Macroeconomic stability does not Granger cause TFP growth;
H₁: TFP growth does not Granger cause macroeconomic stability;

H₀: Financial deepening does not Granger cause TFP growth;
H₁: TFP growth does not Granger cause financial deepening;

The study uses the P-values to evaluate the above hypotheses. If P values are greater than 0.05, we fail to reject the null hypothesis.

This section has presented the empirical data, variables and empirical techniques that will be used in this study. The specification of the model follows from, and is driven by, the deductions made from recent trends in TFP growth in Botswana and selected macroeconomic variables, as discussed in section 2, and the theoretical and empirical guidelines, as discussed in section 3. The discussions in these sections have formed a basis for the formulation of hypotheses about interrelationships between TFP growth and economic diversification, human capital, openness, macroeconomic stability and financial deepening. The model is estimated in the next section, and used to analyse policy scenarios in the following sections.
5. **EMPIRICAL FINDINGS**

This section presents the results of the empirical model as described in the previous section. First, the section presents the findings from the unit roots tests. This is followed by the examination of residual and stability diagnostics as well as results from the bound testing exercise. The presentation and a brief review of the model results then follows.

**5.1. Unit Root Results**

Table 7 in Annex 4 shows that TFP growth, economic diversification, openness and macroeconomic stability as well as financial deepening are integrated in the first order. The table also shows that human capital is stationary at levels. Since none of the variables are $I(2)$, the ARDL approach is appropriate to be used.

Following the unit root test, the model was estimated and should be noted that the financial deepening variable did not have the expected sign and was insignificant at all levels. The variable also distorted the results and led the model to be unstable. Following this, the study explored alternatively, other measures on financial deepening variables such as total the credit by the banking sector and M3 as a proportion of GDP. Both these variables were tested for unit roots. Total credit to the banking sector was found to be $I(1)$ while M3 as a proportion of GDP was found to be $I(0)$. Similar to the credit to the private sector, these variables did not have the expected signs, and were insignificant at all levels of significance. They also distorted and destabilized the model. In this regard, the financial deepening variable was excluded from the final estimation of the model.

**5.2. Residual Diagnostics**

The residuals are normally distributed as shown by the Jarque-Bera test (a p value of greater than 0.05) in Table 4. In addition, the residuals do not exhibit any serial correlation as indicated by the Breusch-Godfrey Serial Correlation LM Test which, has a p value greater than 0.05. In this regard, the residuals in the model can be said to be white noise. The Wald test shows that the model coefficients are not statistically significant from zero while the
Breusch-Pagan-Godfrey Heteroscedacity test rejects the null hypothesis that there is Heteroscedacity.

5.3. Stability Diagnostics

As shown in Figures 11 and 12 in Annex 5, the CUSUM and the CUSUM sum of squares falls within the 5 percent significant levels, indicating the model is stable. This gives us some level of comfort in the results and conclusions of the model.

5.4. Bounds Testing Results

Table 3 presents bound test results for cointegration between TFP growth and economic diversification; human capital; openness and macroeconomic stability. The results show the rejection of the null hypothesis of no cointegration evident from the fact that the calculated F-statistic from the Wald-test exceeds the Narayan (2005) upper bound critical values at either 1, 5 and 10 per cent significance levels. The study did not use critical values in Pesaran et al., (2001), as they are based on large sample sizes and therefore not suitable for small sample sizes. In this regard, Narayan (2005) provides a set of critical values for small sample sizes, ranging from 30 to 80 observations.

Table 3: Bound Test for Cointegration Results

<table>
<thead>
<tr>
<th>Critical Value bounds of the F statistic: Intercept and no trend</th>
<th>90 percent level</th>
<th>95 percent level</th>
<th>99 percent level</th>
</tr>
</thead>
<tbody>
<tr>
<td>I (0)</td>
<td>2.427</td>
<td>2.893</td>
<td>3.967</td>
</tr>
<tr>
<td>I (1)</td>
<td>3.395</td>
<td>4.000</td>
<td>5.455</td>
</tr>
</tbody>
</table>

F- Statistic: **5.650084**

Sample Size: 38

Number of regressors: 4
5.5. Results of the Long-Run ARDL Model on the Determinants of TFP growth

Table 4: Long-Run Model Estimation Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistics</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>4.654028</td>
<td>0.183152</td>
<td>25.41067</td>
<td>0.0000**</td>
</tr>
<tr>
<td>LHHI</td>
<td>0.322777</td>
<td>0.045451</td>
<td>7.10159</td>
<td>0.0000**</td>
</tr>
<tr>
<td>LOPEN</td>
<td>0.226718</td>
<td>0.114871</td>
<td>1.973683</td>
<td>0.0600*</td>
</tr>
<tr>
<td>LSEC</td>
<td>0.221863</td>
<td>0.040119</td>
<td>5.530105</td>
<td>0.0000**</td>
</tr>
<tr>
<td>LCPI</td>
<td>-0.156886</td>
<td>0.028109</td>
<td>-5.58136</td>
<td>0.0000**</td>
</tr>
<tr>
<td>DUM09</td>
<td>-0.094506</td>
<td>0.066244</td>
<td>-1.426644</td>
<td>0.1666</td>
</tr>
</tbody>
</table>

Diagnostics Tests
- R-squared = 0.971442
- Adj R-squared = 0.955973
- Durbin-Watson = 2.239664
- Jarque-Bera = [1.042549] (0.593763)
- Wald Test = [75.06677] (0.0000)
- Breusch-Godfrey Serial Correlation LM Test = [1.689671] (0.0797)
- Heteroskedasticity Test: Breusch-Pagan-Godfrey = [1.481985] (0.2029)

Note: Values in brackets are F-statistics while values in parentheses are p-values
** Significant at 5%; Significant at 10%

The structure of the ARDL model that is estimated is ARDL (1, 1, 2, 1, 3). The model shows that 95 percent changes of TFP growth in Botswana is due to the identified explanatory variables. The long-run results also show that all the coefficients have the expected signs and are statistically significant, except the dummy variable which is insignificant. This suggests that TFP growth is likely to improve in the long-run, supported by short-run dynamics, showing the importance of a diversified economy, underpinned by a vibrant and well educated labour force. Such characteristics are not surprising, given that economic diversification is a long-term process, which is complemented by short run activities. Consistent with a priori expectations, the results show that investment in human capital has positive impact on TFP growth. This finding is in line with that of Romer (1990) who associated an improvement in human capital with the ability to apply innovation methods of production.
With regard to macroeconomic stability (proxied by CPI), the study found that in the long-run, it negatively affects TFP growth. The coefficient of CPI was -0.15 indicating that a 1 percent increase in consumer prices decreased TFP growth by 0.15 percent. This is because high price increases create uncertainties and also discourages investment in the long run. Akinlo and Adejumo (2016) also came to the same conclusion. The results of this study also show that openness to trade has a positive impact on TFP growth. The sign of the coefficient was consistent with *priori* expectations. For Botswana, a 1 percent improvement in openness leads to a 0.22 percent increase in TFP growth. This indicates that once the short run impediments to trade are reduced, the transfer of technology, innovation and new efficient ways of doing business will have a positive impact on TFP growth in Botswana. These relationships between these identified determinants of TFP growth in Botswana have important implications for policy formulation.

5.6. Error Correction Model for the Determinants of TFP growth

Table 5: Short-Run Model Estimation Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistics</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>D(LHII)</td>
<td>0.100048</td>
<td>0.037649</td>
<td>2.657412</td>
<td>0.01380**</td>
</tr>
<tr>
<td>D(LOPEN(-1))</td>
<td>-0.104352</td>
<td>0.054333</td>
<td>-1.920594</td>
<td>0.06670*</td>
</tr>
<tr>
<td>D(LSEC)</td>
<td>0.352019</td>
<td>0.051073</td>
<td>6.892437</td>
<td>0.00000**</td>
</tr>
<tr>
<td>D(LCPI(-1))</td>
<td>0.791351</td>
<td>0.248017</td>
<td>3.19071</td>
<td>0.00390**</td>
</tr>
<tr>
<td>DUM09</td>
<td>-0.081191</td>
<td>0.023979</td>
<td>-3.385861</td>
<td>0.00240**</td>
</tr>
<tr>
<td>ECT(-1)</td>
<td>-0.751226</td>
<td>0.110264</td>
<td>-6.813005</td>
<td>0.00000**</td>
</tr>
</tbody>
</table>

**significant at 5%; *significant at 10%**

With respect to the ECM, coefficients of all the variables are significant and have the expected signs, except the proxy for macroeconomic stability. The proxy for macroeconomic stability indicates that in Botswana, inflation has a positive impact on TFP growth in the short run. These findings are in line with those of Gokal and Hanif (2004)\(^5\) which suggest that some level of inflation can positively influence TFP growth in short run. For Botswana, below some inflation threshold, a 1 percent increase in inflation will lead to a 0.79 percent improvement in TFP growth. It should be noted, however, that the

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\(^5\) Even though Gokal and Hanif (2004) focused the relationship between inflation and growth, it can be argued that, factors that affect economic growth are likely to affect TFP growth.
threshold level of inflation, beyond which it becomes inimical to growth and productivity, varies from country to country.

With respect to economic diversification, the results indicate that diversifying the economy will lead to 0.10 percent improvement in TFP growth in the short-run. The coefficient of trade openness is negative in the short-run. This shows that the slow improvement in the ease of doing business indicators may be inhibiting trade, and in turn, having a negative impact on TFP growth. As expected, an increase in human capital (proxied by secondary school enrolment) is significant and leads to improvement in TFP growth. These findings are similar to those of Binam et al., (2006) and Abdychev et al., (2015). The dummy variable (dum09), which captures the effect of the 2009 global economic crisis, is significant and has the expected sign, indicating that the recent crisis had a negative impact on TFP growth in the short run. In this regard, the inclusion of this dummy variable is relevant for Botswana.

With respect to the speed of adjustment (ECT), the results indicate that it has the expected negative sign and is statistically significant. This is consistent with economic theory and it informs us about the adjustment measures towards long-run equilibrium. For Botswana, the coefficient for the speed of adjustment is -0.75. This suggests that 75 percent of the deviation of TFP growth from the long-run equilibrium level is corrected within a year. This amount of correction of disequilibrium is quite high, and this may be due to a number of factors such as: good governance and market based economy, the country also has strong checks and balances, such as ensuring public accountability, fiscal discipline and prudent management of the economy. In addition, political stability and good regulatory environment provides individuals and corporations with sufficient latitude to make the necessary adjustments in the face of policy changes. In addition, the country is still ranked the least corrupt country in Africa, and has one of the highest sovereign credit ratings in the region – characteristics which provide some measure of flexibility in terms of individual and business decision making.
5.7. Granger-Causality Analysis

The study uses the Granger-Causality test to investigate the direction of causality between the TFP growth and economic diversification; human capital; openness and macroeconomic stability. The results of the Granger-Causality test are based on equations 16 to 23 in Annex 3. Each regression was conducted separately for each of the determinants of TFP growth and the results are presented in Table 8 in Annex 6. The results indicate that there exists a unidirectional causality spanning from the index of economic diversification to TFP growth; human capital to TFP growth; and CPI to TFP growth. A unidirectional causality is also observed from TFP growth to trade openness. The Granger-Causality results between the TFP growth and its determinants support the general findings in this model that the selected determinants have strong impacts on TFP growth. In this regard, the development in these determinants will cause productivity growth to change.
6. CONCLUSIONS AND POLICY RECOMMENDATIONS

This study sought to empirically analyse the determinants of TFP growth in Botswana. To analyse these determinants, the ARDL bounds testing approach by Pesaran et al., (2001) was applied on a period of 1977-2014. The results on the cointegration and ECM showed that in Botswana, both the index of economic diversification and human capital development were significant and had positive impact on TFP growth in the short run and long-run. This underscores the importance of economic diversification and human capital development on TFP growth in Botswana. The impact of openness on TFP growth was found to be negative in the short-run and positive in the long-run, suggesting that authorities need to move with caution on the speed and sequencing of trade openness regimes. With respect to macroeconomic stability, proxied by inflation, the study found that, in the long run, increases in inflation will negatively affect TFP growth while, beyond certain thresholds, inflation becomes detrimental to TFP growth in the short-run. The study also found that the effects of the 2009 global financial crisis on TFP growth in Botswana were more pronounced in the short-run than in the long-run, in line with relative openness of the Botswana economy, and its vulnerability to external shocks such as the slump in international commodity prices.

The Granger-Causality test, suggesting existence of a unidirectional causality from all the selected variables to TFP growth, suggests that policy makers should pay particular attention to the factors identified in the study, as key determinants of TFP growth, as these will have implications for productivity and growth in the economy.

Based on the study findings and research implications, the following recommendations are suggested to improve TFP growth in Botswana.

a. To improve productivity in the economy, and help arrest the observed slowdown in real economic growth in Botswana, authorities should pay particular attention to the following main determinants of TFP growth: economic diversification;
promotion of trade openness; human capital development and maintenance of macroeconomic stability.

b. The study has shown that greater economic diversification leads to improvements in TFP growth. In this regard, to support economic diversification, Government should continue to speed up all policies aimed at a gradual transition of concentration from less productive to more value added productive sectors. Care should, however, be exercised in crafting the model of economic diversification and in identifying as well as utilising sectoral comparative advantages in the areas other than the dominant ones.

c. Impediments to trade and investor confidence be reduced and eventually eliminated. Improving the country’s ranking on competitiveness also suggest the need to focus on the ease of doing business, particularly in the area of starting a business, enforcing contracts, getting electricity, enforcing contracts, and protecting minority investors, amongst others. Therefore, an improvement in these indicators will improve TFP growth in the short-run, while making the country more competitiveness in the long run.

d. Policies aimed at enhancing human capital development should go beyond just increasing school enrolment, but must also emphasise the quality of education and investment in research and development. There is also need to address skills availability and skills mismatch in non-mineral sectors, to facilitate economic diversification. This is because the more educated the labour force is, the more likelihood of the adoption of new technologies, which may increase efficiency and productivity in the long run. Furthermore, we recommend that innovation should be embedded in the secondary school curriculum in order to raise awareness at an earlier age. Budget allocation should also continue to be biased towards education.

e. Macroeconomic stability is an enabler for all the other determinants of TFP growth and creates a conducive environment for investment and growth. There is a need for stronger macroeconomic policies to foster low inflation, stable macroeconomic
fundamentals and growth sustainability. In particular, low and stable inflation rates will, in turn, increase productivity and ensure sustainable growth in the economy.

### 4.6. Limitation of the Study and Areas of Future Research

This study analysed the determinants of TFP growth in Botswana using an advanced econometric methodology. As in other developing economies, sound economic analysis of the economy of Botswana is, to a large extent, hindered by problems of inadequate and poor quality data. However, the fact that quality data is important to produce reasonable and meaningful results and policy analysis does not, however, preclude attempts to empirically analyse the determinants of TFP growth in such situations. It is, however, necessary that the limitations imposed by these constraints should be borne in mind.

For further research, the study can be extended to include other determinants of TFP growth, such as R&D and some measures of innovation and growth, as well as other factors cited in literature, which could help explain TFP growth in Botswana. Future research on the subject matter could also explore other estimation methodologies such as the Generalized Method of Moments and Vector Error Correction Model, just to mention a few. In addition, motivated by the findings in this paper of a positive relationship between inflation and TFP growth in the short-run, further analysis could explore this relationship, with a view to establishing the acceptable inflation threshold for Botswana, beyond which inflation becomes inimical to growth. This would be critical for informing future policy formulation and analysis.
7. ANNEX 1: PERCENTAGE SHARE OF TOTAL GDP BY ECONOMIC ACTIVITY

These 2 figures have been shown separately in order to reflect the change in the reporting period from national accounts year to calendar year.

Figure 8: Percentage Share of Total GDP by Economic Activity, 1975/76 – 1993/94

![Chart showing percentage share of total GDP by economic activity from 1975/76 to 1993/94.]

Source: Statistics Botswana, National Accounts and IMF database, 2016

Figure 9: Percentage Share to Total GDP by Economic Activity, 1994-2014

![Chart showing percentage share of total GDP by economic activity from 1994 to 2014.]

Source: Statistics Botswana, National Accounts and IMF database, 2016
8. **ANNEX 2: SELECTED MACROECONOMIC INDICATORS**

**Balance of Payments and Foreign Exchange Reserves**

With respect to the external position, official data shows that the overall balance of payments has been tracking the movement of the current account balance (Figure 10). It should be noted that the current account balance is mostly driven by mineral exports and government current transfers in the form of Southern African Customs Union (SACU) receipts which are volatile in nature. The non-SACU, non-diamond current account balance would therefore indicate a wider deficit of the overall balance of payments.

**Figure 10: Balance of Payments, Current Account Balance, Official Reserves (P, millions), 1979-2015**

The Botswana mineral-led growth model, supported by national savings also led to the significant accumulation of official reserves. Figure 10 also shows that, with the exception of 2004 and 2009, official reserves maintained an upward trend since the late 1970s. The data shows that, as at 2015, official reserves were recorded at P84 billion. This represents 19 months of import cover.
Selected Institutional Quality Indicators

Based on the corruption perception index, Botswana has been ranked the least corrupt country in the SSA region (Transparency International, 2016). The global competitiveness index shows that the country moved up 7 places to position 64 in 2017 out of 140 countries (World Economic Forum, 2016). On the Ease of Doing Business, even though the overall indicators have been improving, the country has been slow in improving some indicators that are key for attracting investors. These include starting a business, enforcing contracts, getting electricity, and protecting minority investors. Currently, out of 190 countries surveyed, Botswana ranks 153, 132, 125 and 81, respectively for the doing business indicators mentioned above (World Bank, 2016).

Unemployment

The rapid economic growth experienced over years has not created enough employment opportunities for Batswana. Labour market dynamics, particularly skills mismatch and a lack of relevant skills, has also contributed to the persistently high unemployment rates. Furthermore, the Bank of Botswana Annual Report of 2015 indicates that the labour force participation rate has only increased by 4 percentage points over the last 3 decades, from 55 percent in 1981 to 59 percent in 2011. This is also consistent with the relatively high unemployment rate of about 20% in the country as presented in Table 6 below.
Table 6: National Unemployment Rate (%), Various Surveys, 1981 -2013

<table>
<thead>
<tr>
<th>Survey</th>
<th>Unemployment Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981 Census</td>
<td>10.2</td>
</tr>
<tr>
<td>1991 Census</td>
<td>13.9</td>
</tr>
<tr>
<td>1993/94 Household Income and expenditure Survey (HIES)</td>
<td>21.6</td>
</tr>
<tr>
<td>1995/96 Labour Force Survey (LFS)</td>
<td>21.5</td>
</tr>
<tr>
<td>1998 Demographic survey (DS)</td>
<td>20.8</td>
</tr>
<tr>
<td>2000 Multiple Indicator Survey (MIS)</td>
<td>15.8</td>
</tr>
<tr>
<td>2001 Census</td>
<td>19.5</td>
</tr>
<tr>
<td>2002/03 Household Income and expenditure Survey (HIES)</td>
<td>23.8</td>
</tr>
<tr>
<td>2004 Botswana AIDS Impact Survey II (BAIS II)</td>
<td>24.6</td>
</tr>
<tr>
<td>2005/6 Labour Force Survey (LFS)</td>
<td>17.5</td>
</tr>
<tr>
<td>2008 Botswana AIDS Impact Survey III (BAIS III)</td>
<td>26.2</td>
</tr>
<tr>
<td>2009/10 Botswana Core Welfare Indicators Survey (BCWS)</td>
<td>17.8</td>
</tr>
<tr>
<td>2011 Census</td>
<td>19.9</td>
</tr>
<tr>
<td>2013 Botswana AIDS Impact Survey IV (BAIS IV)</td>
<td>20</td>
</tr>
</tbody>
</table>

Source: Statistics Botswana, Selected Statistical Indicators, 2016
9. ANNEX 3: GRANGER CAUSALITY MODEL BETWEEN TFP GROWTH AND ITS DETERMINANTS

\[ ITPF_t = \alpha_0 + \alpha_1|TFP_{t-1}| + \ldots + \alpha_i|TFP_{t-l}| + \beta_1|HHI_{t-1}| + \ldots + \beta_i|HHI_{t-l}| + \epsilon_t \] …………………… (16)

\[ ITPF_t = \alpha_0 + \alpha_1|TFP_{t-1}| + \ldots + \alpha_i|TFP_{t-l}| + \beta_1|OP_{t-1}| + \ldots + \beta_i|OP_{t-l}| + \epsilon_{2t} \] ………………… (17)

\[ ITPF_t = \alpha_0 + \alpha_1|TFP_{t-1}| + \ldots + \alpha_i|TFP_{t-l}| + \beta_1|SEC_{t-1}| + \ldots + \beta_i|SEC_{t-l}| + \epsilon_{3t} \] ……………… (18)

\[ ITPF_t = \alpha_0 + \alpha_1|TFP_{t-1}| + \ldots + \alpha_i|TFP_{t-l}| + \beta_1|CPI_{t-1}| + \ldots + \beta_i|CPI_{t-l}| + \epsilon_{4t} \] ……… (19)

\[ |HHI| = \alpha_0 + \alpha_1|HHI_{t-1}| + \ldots + \alpha_i|HHI_{t-l}| + \beta_1|ITP_{t-1}| + \ldots + \beta_i|ITP_{t-l}| + \epsilon_{1t} \] ……………………… (20)

\[ |OP| = \alpha_0 + \alpha_1|OP_{t-1}| + \ldots + \alpha_i|OP_{t-l}| + \beta_1|ITP_{t-1}| + \ldots + \beta_i|ITP_{t-l}| + \epsilon_{2t} \] ………………… (21)

\[ |SEC| = \alpha_0 + \alpha_1|SEC_{t-1}| + \ldots + \alpha_i|SEC_{t-l}| + \beta_1|ITP_{t-1}| + \ldots + \beta_i|ITP_{t-l}| + \epsilon_{3t} \] ………………… (22)

\[ |CPI| = \alpha_0 + \alpha_1|CPI_{t-1}| + \ldots + \alpha_i|CPI_{t-l}| + \beta_1|ITP_{t-1}| + \ldots + \beta_i|ITP_{t-l}| + \epsilon_{4t} \] ……… (23)
10. ANNEX 4: ADF AND PP UNIT ROOT TEST RESULTS

Table 7: ADF and PP Unit Root Test Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>ADF-Statistic</th>
<th>PP Statistic</th>
<th>ADF-Statistic</th>
<th>PP Statistic</th>
<th>Variable order of Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td>TFP</td>
<td>-1.586722</td>
<td>-1.395369</td>
<td>-7.092792</td>
<td>-7.809348</td>
<td>I (1)</td>
</tr>
<tr>
<td></td>
<td>(0.7805)</td>
<td>(0.8471)</td>
<td>(0.0000)**</td>
<td>(0.0000)**</td>
<td></td>
</tr>
<tr>
<td>HHI</td>
<td>-2.765010</td>
<td>-2.107686</td>
<td>-5.815942</td>
<td>-5.814352</td>
<td>I (1)</td>
</tr>
<tr>
<td></td>
<td>(0.2189)</td>
<td>(0.5260)</td>
<td>(0.0001)**</td>
<td>(0.0001)**</td>
<td></td>
</tr>
<tr>
<td>OPEN</td>
<td>-1.373755</td>
<td>-1.534121</td>
<td>-6.087987</td>
<td>-6.115000</td>
<td>I (1)</td>
</tr>
<tr>
<td></td>
<td>(0.8535)</td>
<td>(0.8007)</td>
<td>(0.0000)**</td>
<td>(0.0001)**</td>
<td></td>
</tr>
<tr>
<td>CPI</td>
<td>10.70161</td>
<td>8.769859</td>
<td>-4.767955</td>
<td>-4.954324</td>
<td>I (1)</td>
</tr>
<tr>
<td></td>
<td>(1.0000)</td>
<td>(1.0000)</td>
<td>(0.0023)**</td>
<td>(0.0014)**</td>
<td></td>
</tr>
<tr>
<td>SEC</td>
<td>-4.311394</td>
<td>-4.147676</td>
<td></td>
<td></td>
<td>I(0)</td>
</tr>
<tr>
<td></td>
<td>(0.0015)**</td>
<td>(0.0023)**</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FD</td>
<td>6.723067</td>
<td>14.78389</td>
<td>-4.489650</td>
<td>-4.421346</td>
<td>I(1)</td>
</tr>
<tr>
<td></td>
<td>(1.0000)</td>
<td>(1.0000)</td>
<td>(0.0049)</td>
<td>(0.0058)</td>
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</tr>
</tbody>
</table>

Note: Values in parenthesis are p-values.
**Significant at 5%
11. ANNEX 5: CUSUM - STABILITY TEST AND CUSUM SUM OF SQUARES - STABILITY TEST

Figure 11: CUSUM - Stability Test

Figure 12: Cusum Sum of Squares - Stability Test
12. ANNEX 6: GRANGER-CAUSALITY RESULTS

Table 8: Granger-Causality Results

<table>
<thead>
<tr>
<th>Null Hypothesis</th>
<th>F-Statistic</th>
<th>P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LTFP does not Granger Cause LHII</td>
<td>0.39499</td>
<td>0.6767</td>
</tr>
<tr>
<td>LHII does not Granger Cause LTFP</td>
<td>4.94560</td>
<td>0.0130**</td>
</tr>
<tr>
<td>LTFP does not Granger Cause LOPEN</td>
<td>2.59363</td>
<td>0.0895*</td>
</tr>
<tr>
<td>LOPEN does not Granger Cause LTFP</td>
<td>2.29744</td>
<td>0.1159</td>
</tr>
<tr>
<td>LTFP does not Granger Cause LSEC</td>
<td>1.48100</td>
<td>0.2417</td>
</tr>
<tr>
<td>LSEC does not Granger Cause LTFP</td>
<td>3.36378</td>
<td>0.0465**</td>
</tr>
<tr>
<td>LTFP does not Granger Cause LCPI</td>
<td>1.57177</td>
<td>0.2224</td>
</tr>
<tr>
<td>LCPI does not Granger Cause LTFP</td>
<td>4.15138</td>
<td>0.0244**</td>
</tr>
</tbody>
</table>

** significant at 5%; * significant at 10%
13. REFERENCES


Botswana Productivity Statistics (2005), available at [www.bnpc.bw](http://www.bnpc.bw)


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University of Groningen and University of California, Davis, (2017). Total Factor Productivity at Constant National Prices for Botswana, retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/RTFPNABWA632NRUG.

