Testing the asymmetric effects of Interest Rates in Botswana: A NARDL Approach to the McKinnon-Shaw hypothesis.

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List of Acronyms

APDB	Average Population Density per Bank
ARDL	Autoregressive Distributed Lag Model
CUSUM	Cumulative Sum of recursive residuals test
CUSUMQ	Cumulative Sum of Squares of recursive residuals test
FDI	Direct Investment Inflows or Outflows
FLI	Financial Liberalisation Index
GFCF	Gross Fixed Capital Formation
IMF	International Monetary Fund
K	Capital Stock
L	Labour Force
MSH	McKinnon-Shaw Hypothesis
NARDL	Nonlinear Autoregressive Distributed Lag Model
OLS	Ordinary Least Square
RDR	Real Deposit Rates
RBLR	Real Bank Lending Rates
RGDP	Real Gross Domestic Product per Capita
TBC	Total Bank Credit to the Private Sector
TFS	Total Financial Savings

1. INTRODUCTION

Financial liberalisation is the establishment of higher interest rates that equate the demand for, and the supply of savings. Financial liberalisation hypothesises a positive relationship between real interest rates and the level of savings so that the deregulation of interest rates (higher interest rates) would enhance higher financial savings, increase credit supply, foster investment and ultimately boost economic growth (McKinnon, 1973 and Shaw, 1973). However, various strands of literature have emerged with mixed results and conclusions on the importance of financial liberalisation/repression in emerging economies.

Studies by Balassa (1990); Wy plosz (2002); Schiantarelli, Galindo, and Weiss (2002); Hamdi and Jlassi (2014); Klomp and De Haan (2015); Guisinger and Brune (2017) and Piñeiro, Tamazian, and Vadlamannati (2017) have been conducted on financial liberalisation in developing countries. A common finding among these studies is that financial liberalisation is imperative for optimal macroeconomic performance.

Conversely, there is some empirical evidence that supports financial repression (legal restrictions on interest rates and credit allocations) on savings and investment levels in emerging economies. These studies include: Sabry (1990); Abiad, Detragiache, and Tressel (2008); Okon and Waziri (2018) and Loizos (2018). They argue that the cost of investment should be considerably low to stimulate investment, given the associated risk of investment in developing economies.

The studies above use linear models to explain the effect of financial liberalisation in boosting level of savings, investment, and higher economic growth. However, there is need to examine the differential effects of interest rate decreases and increases because the nonlinearity of many macroeconomic variables and processes have being recognised (Shin, Yu, and Greenwood-Nimmo, 2013). As noted by Eboreime, Elisha, and Ude-abosi (2016), many relationships among macroeconomic variables tend to follow a nonlinear path in contrast to the more common linear assumptions. This has been supported by empirical studies that have shown asymmetric effects of interest rates, i.e. that the impacts of interest rate increases differ from those of decreases. This phenomenon could possibly obscure the findings of linear models (Billgert, 2018).

However, the majority of the studies continue to make investigations with the implicit assumption that the relationship of financial liberalisation and repression on savings, investment and economic growth may be represented as a symmetric linear combination of

nonstationary stochastic regressions (Shin et al., 2013). These authors further note that little research has been devoted to the analysis of nonlinear cointegration. This study seeks to redress this deficiency using the Nonlinear Autoregressive Distributed Lag Model (NARDL) proposed by Shin et al., (2013) *vis*-à-*vis* a linear methodology.

In testing for asymmetry in the impacts of financial repression, this paper is asking whether the effects of increases in interest rates differ in magnitude from equivalent decreases. Two basic questions are asked: what are the asymmetric effects of interest rates on the level of savings and investment? And, what is the impact of

(proxied by stock market capitalisation/GDP) on economic growth in Botswana? The economy of Botswana was chosen as a case study because of easy access to research data, implementation of polices towards financial liberalisation as well as to fill the gap in the literature. The study uses quarterly data for the period 1995:Q1–2017:Q4 (full sample) and 2004:Q1–2017:Q4 (sub-sample).

The study finds a positive relationship between real deposit rates and saving rates as well as a negative association between real bank lending rates and investment levels in the short run for the full sample. The results of this study are in line with findings that liberalisation of interest rates generates more savings, investment, and consequently growth in the short run. However, the inverse is found for both models in the long run. Regarding the growth model, the short run results are in line with findings reporting that liberalisation of interest rates generate more savings, investment, and consequently growth, while the long run results are not.

The remainder of the paper is divided into six sections. In section 2, we discuss a brief overview of the economy, with more emphasis on the role of structural reforms in Botswana. The third section reviews relevant literature on the relationship of financial liberalisation and repression on savings, investment and economic growth. The fourth section provides a detailed description of the NARDL co-integration technique. Section 5 presents the description of variables used in the study, while section 6 focuses on data analysis and interpretation of the results. Finally, the conclusion, recommendations and limitations of this study are provided in section 7.

2. OVERVIEW OF THE ECONOMY

The economy of Botswana commenced a major policy change in the early 1990s, encompassing a movement from financial repression to financial liberalisation (Muyambiri and Odhiambo, 2015). Harvey (1996) described the case of Botswana as 'untypical' as the measures to liberalise were not in response to financial crisis, and therefore, were not part of the International Monetary Fund (IMF) or World Bank adjustment programs. However, Themba and Narayana (2014) note that the policy regime was aimed at facilitating the entry of new banks to augment healthy competition and efficacy within the commercial banking industry.

Since its independence in 1966, Botswana had been a member of the South African monetary system, using South African currency. During this period, the banking policies regarding requirements of liquidity and capital as well as setting interest rates were subject to policy regulations endorsed by the South African Reserve Bank (Kayawe and Amusa, 2003). The diamond discovery in the early 1970s contributed to the country's massive record of economic growth and financial surpluses (Moffat, 2017). As Harvey (1996) commented, the main problem that arose, therefore, was how to manage the financial surpluses. This gave the government of Botswana the motivation to formulate several financial polices to guarantee adequate management of export proceeds in accordance with economic objectives (Kayawe and Amusa, 2003).

The increased returns from exports and the augmented sense of independence played a major role in influencing the need to propagate Botswana's own monetary policy. The Bank of Botswana was therefore founded in 1975. Its main objectives include: maintaining monetary and price stability, a safe and sound banking and financial system as well as an efficient payment mechanism (Muyambiri and Odhiambo, 2015).

From the beginning, the Bank of Botswana (the Bank hereinafter) imposed a restrictive[1] monetary policy by setting prime lending rate and commercial bank interest rates for each class of deposits. The setting of interest rate ceilings meant much of the 1970s and 1980s real interest rates were negative (Kayawe and Amusa, 2003). Kayawe and Amusa (2003) contend that the central bank had originally intended to boost investment and stimulate economic growth through the policy of low interest rates. However, towards the late 80's, the government expressed concerns that the negative real interest rates would ultimately act as a hindrance to

[1] The substantial increase in diamond exports caused these restrictive measures, which also resulted in higher levels of savings with commercial banks.

savings and could promote borrowing for consumption rather than investment purposes. Like the government, the central bank saw policies that set interest rates and regulated commercial bank charges as having two potentially adverse effects. Such policies tend to move surplus deposits towards unproductive economic activities, and to distort the Banks's monetary management functions. These factors led the Bank to abandon its low interest rate policies in 1989 and to grant commercial banks freedom to determine their own interest rates, fees and charges (Kayawe and Amusa, 2003).

Botswana's liberalisation of its financial sector, like that described by Gemech and Struthers (2003), imitates the scenario described by McKinnon (1973) and Shaw (1973). A detailed analysis of the McKinnon-Shaw hypothesis is discussed in the next section.

3. LITERATURE REVIEW

3.1 Theoretical Framework

McKinnon (1973) began by developing a model of an economy with underdeveloped financial and capital markets, and notable proportions of fragmentation across markets. McKinnon noted that investors in such an economy face constrained opportunities. There are insufficient formal means of investment funding, and few opportunities for extensive financial intermediation. Self-finance was therefore dominant in that economy. Additionally, because investment expenditures are lumpier than consumption expenditures, economic agents must accrue capital and financial assets as well as money balances prior to undertaking relatively costly and indivisible investment projects.

McKinnon (1973) noted that if proceeds on financial assets are purposely kept low in this economy, economic agents will be discouraged from accruing capital, thereby impeding the process of capital formation. It then follows that "*Repressive*" financial policies[2] (especially loan rate and deposit ceilings) adversely affect the accumulation of financial assets, money balances as well as their complements (physical capital), thus limiting economic growth. Hence, under the *McKinnon's complementary hypothesis*, financial and physical assets are complements and not substitutes in developing economies.

The complementarity hypothesis between financial and physical capital in the McKinnon (1973) framework is represented by the demand for real money balances and investment functions.

First, the demand for real money balances:

$$M/P = f(Y, I/Y, (d - \pi^e)) \quad (1)$$

Where M is the money stock, P is the price level, (M/P) signifies the real money stock, Y is the real income, $(d - \pi^e)$ is the own real interest rate on bank deposits (where d is the deposit rate and π^e is the expected rate of inflation) and (I/Y) represents the investment to income ratio. According to Ghosh and Karmakar (2014), the investment to income ratio is included as one of the determinants of real stock of money. McKinnon (1973) contends that such a

[2] According to Yülek (2017), financial repression is the notion that government regulations, laws and other non-market restrictions curb the financial intermediaries of an economy from functioning well. The repressive financial policies include, *inter alia* interest rate ceilings, high bank reserve requirements, restrictions on market entry into the financial sector and government ownership or domination of banks.

construction includes the demand for money that arises directly from the process of capital accumulation.

The partial derivative $\delta(M/P)/\delta(I/Y) > 0$ indicates that a rise in investment increases the monetary savings. On the other hand, $\delta(M/P)/\delta Y > 0$ represents the transactions demand for money, implying that a rise in income raises the motive for holding money. The positive real interest rate is represented by the partial derivative: $\delta(M/P)/\delta(d - \pi^e) > 0$, which measures the real return on bank deposits (savings, notice and time deposits), thereby allowing for a greater demand for money.

The complementarity works in both directions. That is, money supply has a first order impact on determining investment, hence, complementarity can be accomplished by specifying the investment function given by:

$$I/Y = \psi(r, (d - \pi^e)) \tag{2}$$

Where r is the average return on physical capital. The partial derivatives $\delta(I/Y)/\delta r$ and $\delta(I/Y)/\delta\,(d - \pi^e)$ must both be greater than zero.

Therefore, the complementarity's hypothesis is realised in the partial derivates:

$$\delta(M/P)/\delta(I/Y) > 0 \tag{3}$$

and

$$\delta(I/Y)/\delta\,(d - \pi^e) > 0 \tag{4}$$

Equations (3) and (4) propose that in repressed economies, it is not the cost of capital, but the accessibility to finance that limit investment. As noted by Bouzid (2003), a rise in real deposit rates increases level of investment because the financial limitation is relaxed.

Shaw (1973) on the other hand, created a model illustrating a virtuous link between financial intermediation and economic growth; a *debt intermediation view*. In Shaw's model, there is no need for complementarity as investors are not restricted to self-finance. The model assumes an effectual and well-functioning financial system. According to Shaw (1973), higher deposit

rates raise the levels of financial savings and expands on the role of financial institutions in intermediating funds between surplus and deficit units.

An advanced financial system augments the incentive to save, thereby increasing the efficiency of investment and consequently contributing to the acceleration of economic growth. These advantages arise because financial intermediaries can raise real returns to savers by accommodating liquidity preference and lowering information costs. Moreover, real costs to investors are lowered through facilitation of risk-pooling. That is, combining risks facing individual investors into large groups, thus, making it easy to calculate risks for the groups and ensure that large and unpredictable individual financial risks become predictable and are distributed among all members.

Shaw's demand for money function is as follows:

$$M/P = \varphi(Y, (d - \pi^e), V) \quad (5)$$

Where (V) is a vector of the real opportunity costs (real yields on all types of wealth) of holding money (Moore, 2010). Shaw (1973) anticipates a positive effect of real yield on all forms of wealth, including money on the domestic savings ratio. Conversely, financial intermediation is repressed when interest rates are fixed administratively below equilibrium (Ghosh and Karmakar, 2014).

Although there are differences between the theoretical approaches of McKinnon and Shaw, their conclusions are similar. They developed the McKinnon-Shaw Hypothesis (MSH hereafter) which emphasised the impact of financial repression (legal restrictions on interest rates and credit allocations) on the levels of savings and investment in emerging economies. However, researchers have over the years extended the debate to encompass other impacts of financial repression on economic growth, financial crises and poverty (Gemech and Struthers, 2003)

The MSH argues that financial markets in less developed countries are repressed because interest rates are artificially kept below the market equilibrium rate. While the neoclassicals believe that low interest rates promote investment and economic growth, the MSH suggests that high interest rates boost savings and bank credit (Hassan, Samad, and Islam, 1993). According to Francis and Waithe (2013), the standard recommendation therefore is that, the government controls be dismantled so that the true scarcity price of capital can be seen by savers and investors, thereby improving savings mobilisation, promoting efficient investment and accelerating economic growth.

McKinnon and Shaw (1973) also propose that real interest rates influence economic growth through their positive impact on the level of savings and investment. Owusu and Odhiambo (2014) express the MSH in the form of Harrod-Domar format as:

$$g = z(S/Y) = z(I/Y) \quad (6)$$

where *g* represents real output growth, *z* is the productivity of capital and (S/Y) is the ratio of domestic savings to GDP, which is equal to the ratio of domestic investment to GDP (i.e. I/Y) at equilibrium. Consequently, given the productivity of capital, the growth rate should increase, the higher the ratio of savings (investment) to GDP. Conversely, if the ratio of savings to GDP is given, the growth rate can be augmented by improving the efficacy of investments which will then raise the productivity of capital, *z* (Owusu and Odhiambo, 2014).

The conventional approach stated by Shaw (1973) suggests that there will be a rise in savings and the efficiency of investments will improve, following interest rate liberalisation. Owusu and Odhiambo (2014) point out that to do this, the investment should be directed at the sectors of the economy with the highest expected potential economic growth. Equations 1, 2 and 6 are the basis for the empirical estimations in this study.

Equations 7 and 8 (derived from equations 1 and 2, respectively) are used to test the impact of the positive and negative changes of real interest rates on savings and investment, respectively. Equation 9 is derived from equation 6 and is used to examine the impact of financial liberalisation/ repression on economic growth in Botswana.

$$\ln TFS_t = \alpha_0 + \alpha_1 RDR_t^+ + \alpha_2 RDR_t^- + \alpha_3 \ln RGDP_t + \alpha_4 \ln APDB_t + \mu_t \quad (7)$$

$$lnGFCF_t = \beta_0 + \beta_1 RBLR_t^+ + \beta_2 RBLR_t^- + \beta_3 lnTFS_t + \beta_4 RBR_t + \beta_5 lnTBC_t + \varepsilon_t \quad (8)$$

$$lnRGDP_t = \delta_0 + \delta_1 FLI_t^+ + \delta_2 FLI_t^- + \delta_3 lnL_t + \delta_4 lnK_t + \delta_5 lnGFCF_t + \delta_6 lnTBC_t + \delta_7 FDI_t + \epsilon_t \quad (9)$$

The empirical testing of the impact of real interest rates on the level of savings and investment, and ultimately on economic growth, requires data on numerous variables. These include, *inter alia*, demand for real balances measured by savings (proxied by total financial savings (TFS) or time deposit held by banks), real income measured by real gross domestic product per capita (RGDP), own real interest rate on bank deposits measured by real deposit rates (RDR) and investment to income ratio, measured by the real gross fixed capital formation (GFCF) or total bank credit to the private sector (TBC). In addition to the variables above, the following control variables are added: real deposit rates (RDR), real bank lending rates (RBLR), financial

liberalisation index (FLI) proxied by stock market capitalisation/GDP, average population density per bank (APDB) proxied by M2[3]/ total population, capital stock (K), labour force (L), real bank rate (RBR) and direct investment inflows or outflows (FDI).

Regarding the *a priori* expectations, the coefficients α_1, α_2 and α_3 in the savings model are anticipated to be positive and α_4 negative. In the investment model, the expected signs of the coefficients β_1, β_2 and β_4 are negative while β_3 and β_5 are positive. Lastly, the expected signs of the coefficients $\delta_1, \delta_2, \delta_3\ \delta_4, \delta_5, \delta_6$ and δ_7 in the growth model are expected to be positive.

3.2 Empirical Literature Review

Financial liberalisation hypothesises a positive relationship between real interest rates and the level of savings such that the deregulation of interest rates should enhance financial savings, increase credit supply, foster investment and ultimately boost economic growth.

However, various strands of literature have emerged with mixed results and conclusions on the impact of interest rates on the level of savings and investment, as well as the role of financial liberalisation on economic growth. This section evaluates the major studies and their findings.

Through the application of different estimation techniques, a number of studies have found that the deregulation of interest rates generate higher level of savings. Fry (1978) examines the response of domestic savings to changes in the real interest rates for seven Asian developing countries using pooled time series data for the period 1962 - 1972. Real interest rates are found to have a positive impact on the level of savings and economic growth. Giovannini (1983) replicated Fry's (1978) estimation over a different sample period (1964 - 1980) using the same specification and the same set of countries. His study used an instrumental variable regression and failed to reproduce the significantly positive interest rate elasticity of savings. Giovannini (1983) finds the coefficient of real interest rates neither negative or positive, but negligible and insignificant.

Asamoah (2008) examines financial liberalisation and its effect on savings, investment and the growth of GDP in Ghana using monthly data for the period spanning 2000:m1 - 2003:m6. The results from an ordinary least square (OLS) regression analysis indicate that a rise in interest rates in the post-liberalisation years of the financial sector leads to a corresponding increase in savings, which in turn has a positive impact on economic growth.

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[3] M2 is made up of the summation of currency outside depository corporations and transferable deposits (M1), as well as other deposits included in broad money.

Ndanshau and Kilindo (2012) also employs an OLS method and a dynamic error correction model in the time series data to evaluate how financial savings respond to changes in real interests between 1967 and 2010 in Tanzania. Their study finds that real interests have a positive relationship and statistically important short and long run impacts on financial savings.

Using a similar approach (Johannsen maximum likelihood test for cointegration) with different time periods (1961 - 1991 and 1970 - 2001), Pentecost and Ramloga (2000) and Francis and Waithe (2013) examine the economy in Trinidad and Tobago. Both papers reach similar conclusions, finding a positive correlation between real interest rates and long run savings although Francis and Waithe (2013) found no short run effect over the period 1970 to 2001.

Conversely, other studies have reported the impact of interest rate on the level of saving to be inconclusive or negative e.g. Losayza, Schmidt-Hebbel, and Servén (2000); Bandiera, Caprio, Honohan, and Schiantarelli, (2000) and Reinhart and Tokatlidis, (2005). Bandiera, Caprio, et al., (2000) examine the impact of different financial liberalisation measures in eight selected countries for the period spanning 1970 to 1994. Their study finds no evidence that real interest rates are positively linked to the level of savings. Moreover, Losayza et al., (2000) investigated the effect of real interest rates on level of savings. They employ a panel instrumental variable technique on aggregate savings data spanning the years 1966 to 1995 and find a negative relationship between financial liberalisation and private saving rates. That is, increases in real interest rates have an adverse effect on private saving rates. According to Losayza et al. (2000), a one percent increase in real interest rates reduces private savings by 0.25 percent in the short run. They also find that the financial depth indicator, (proxied by M2/GNP) has a statistically significant and small impact on private savings rate. The flow of private domestic credit relative to income has a negative and significant coefficient. Therefore, relaxing credit constraints reduces private savings. Private savings decrease by 0.32 percent in response to a one percent increase in private credit. The authors suggest that though they do not find a direct effect of financial liberalisation on the saving rate, if, financial reforms have a positive impact on growth, then they have a potentially important indirect effect on the saving rate.

In another study, Reinhart and Tokatlidis (2005) use data from 50 countries (14 developed and 36 developing) over the period 1970 to 1998. The authors conclude that financial reforms and development indicators either have no significant statistical impact or significant negative impact on financial savings, especially for emerging markets. They find that the impacts of financial liberalisation on savings were mixed, but largely negative or approximately zero. However, financial liberalisation has positive effects in terms of higher foreign direct

investment and gross capital flows. The authors noted that the benefits of financial liberalisation are not visible in low income countries, as savings decrease following the implementation of financial reforms. It seems that financial liberalisation delivers greater access to international capital markets, though still uneven across regions and, particularly, income groups. This is further substantiated by Bandiera et al. (2000), who suggests that such negative impacts of financial liberalisation on savings can be explained by low income levels and the presence of imperfect financial markets.

The empirical review above suggests that no conclusive consensus has been reached regarding impacts of financial liberalisation on savings. However, some authors suggest that if financial reforms have a positive impact on economic growth, then they have a potentially important indirect effect on the saving rate. Meanwhile, some researchers have been able to find a positive effect of real interest rates on savings following financial liberalisation, while others found the effects to be negative or insignificant.

The McKinnon-Shaw hypothesis also postulates a positive association between real interest rates and investment, through savings. Correa and Rao (2004), state that financial liberalisation is founded under the neoclassical proposition that savings cause investment, with the real interest rate being the channel for equalisation of both. However, little support is found from the experience in India. The authors suggest that the Post Keynesian approach that includes the liquidity preferences of banks might be a fruitful way to examine the dynamics of an economy in transition.

Using an ARDL modelling approach, Shrestha and Chowdhury (2007) and Athukorala (1998) support the McKinnon-Shaw financial liberalisation hypothesis in Nepal and India, respectively. Shrestha and Chowdhury (2007) conclude that deregulating interest rates encourages the efficient allocation of financial resources and promotes savings and investment. On the other hand Athukorala (1998) examining the interrelationship between interest rates, savings and investment, finds that high interest rates in India stimulate investment through self-financed savings rather than through borrowing.

The study by Schiantarelli, Galindo, and Weiss (2002) test whether financial liberalisation improves the efficient allocation of investment funds by employing firm-level panel data from 12 developing countries. Their results suggest that financial deregulation has a positive, substantial and significant impact on the effectual allocation of investment funds. In effect, financial reforms increase the efficiency with which investment funds are allocated.

Using a Johansen estimation technique through a vector error correction model, Ahmed (2007) reviews the financial impacts of the financial reforms in Botswana using yearly data running from 1971 to 2002. More precisely, the author investigates the efficiency of financial deregulation adjustments in terms of investment efficiency, improvements to competition, and market-based mobilisation of resources. There is evidence signifying the fact that liberal entry and exit policies led to healthy competition in the banking industry. Introduction of new and modern banking services, innovation of advanced financial instruments and reduction in transaction costs for consumers have resulted from this increased competition, and the level of financial savings has improved significantly.

In Ahmed's (2007) study, there is a positive correlation between private savings and real deposit rates in Botswana. The financial liberalisation index[4] is positively related to the private savings rate, per capita income and rate of investment, thereby contributing to the surge in private savings. Moreover, the index is assumed to be the fundamental cause of the rising trend in savings levels.

These studies reach a common conclusion that financial liberalisation improves the efficient allocation of investment funds. They agree with the MSH which postulates a positive relationship between real interest rates and investment, through savings.

The McKinnon-Shaw hypothesis predicts that financial liberalisation, which causes institutional interest rates to rise towards competitive free-market equilibrium levels, will stimulate the rate of economic growth in both the short and medium run (Shrestha and Chowdhury, 2007). The deregulation of interest rates increase savings, which in turn raises credit availability for investments stimulating economic growth. An econometric model of growth can be constructed to test for these relationships, and with them the financial liberalisation hypothesis.

Such tests of financial liberalisation are not new. The empirical results by Bashar and Khan (2007) refute the McKinnon-Shaw hypothesis. They indicate that financial liberalisation has a significant but negative impact on economic growth. This implies that financial reforms fail to attract new investment due to adverse investment environments. The study evaluates the effect of liberalisation in the economic growth of Bangladesh by analysing quarterly data from 1972 to 2002 using cointegration and error correction model methods.

[4] Ahmed (2007) constructs the index is constructed using 5 reform indicators: interest rate regulation; reserve requirements; exchange rate and capital account liberalisation; bank ownership and pro-competition and security measures.

However, Obamuyi (2009) and Owusu and Odhiambo (2014), find that financial liberation has a positive effect on economic growth in Nigeria. Both studies investigate the relationship between interest rates liberalisation and sustained economic growth. Using cointegration and the error correction model to capture both short and long run dynamics of variables in the model, the studies establish a long run relationship between sustainable economic growth and financial liberalisation in Nigeria.

Campos and Kinoshita (2010) note the challenge of fully describing the correlation between structural reforms and foreign direct investment inflows because various reforms have different effects. They argue that the complementarities of these reforms have imperative, yet imperfectly understood effects on FDI inflows. However, despite this challenge, Ayouni, Issaoui, and Brahim (2014) suggest that FDI, and with it, economic growth, can be prompted by financial liberalisation. Using panel data from 69 developed and developing countries, between the period 1985 and 2005, their survey finds that FDI has an adverse effect on GDP growth per capita during phases where financial systems are non-liberalised. This suggests that FDI effects on growth are challenged in non-liberalised financial systems. However, FDI has positive effects on growth in advanced financial sectors, indicating that the degree of financial system deregulation determines FDI efficiency.

The studies employ different methodological frameworks, including ordinary least squares (OLS), Johansen cointegration test and the ARDL approach. According to Bhatta and Shrestha (2018), it is imperative to apply the appropriate methodology to obtain unbiased and reliable results. The authors stated that it is best to use OLS or VAR if all variables are stationary. However, if the variable of interest in the model are not stationary, then a Johansen cointegration test is most applicable. Furthermore, if the regressors are purely I(0), purely I(1) or a combination of both, ARDL models introduced by Pesaran, Shin, and Smith (2001) are recommended. Bou and Satorra (2018) noted that panel data may be used to capture the dynamic effects among variables overtime. Importantly, the use of panel data addresses the sources of endogeneity of regressors that prevent estimates from being interpreted as casual effects. These estimation methods measure linear relationships among macroeconomic variables.

However, as Eboreime et al. (2016) point out, a lot of relationships among macroeconomic variables tend to follow nonlinear paths despite the more common linear assumptions. Moreover, the speed at which macroeconomic variables fall is often rarely the same as the speed at with which they rise, further suggesting nonlinearity. With these warmings in mind,

this study uses the Nonlinear Autoregressive Distributed Lag Model (NARDL) introduced by Shin et al. (2013). A nonlinear approach enables one to test the differential impacts of interest rate increases and decreases on savings, investment and growth.

4. METHODOLOGY

This research seeks to test the asymmetric effects of both financial liberalisation and repression in Botswana. To do this, we use three different unrestricted error correction models (UECM) from equations 7, 8 and 9 identified in section 3. The first and second models investigate the asymmetric impacts of real interest rates on savings and investment, while the third model examines the impact of financial liberalisation/repression on economic growth in Botswana, using control variables as well as variables identified in section 3.

4.1 Savings Model

This model seeks to address the research question on examining the impact of positive and negative changes of real deposit rates on the level of savings. The UECM for equation 1 is specified as:

$$\Delta \ln TFS_t = c_1 + \theta_1 \ln TFS_{t-1} + \theta_2^+ RDR_{t-1}^+ + \theta_3^- RDR_{t-1}^- + \theta_4 \ln RGDP_{t-1} + \theta_5 \ln APDB_{t-1} + \sum_{i=1}^{p} \alpha_1 \Delta \ln TFS_{t-i} + \sum_{i=0}^{q} \alpha_2 \Delta RDR_{t-i}^+ + \sum_{i=0}^{q} \alpha_3 \Delta RDR_{t-i}^- + \sum_{i=0}^{q} \alpha_4 \Delta \ln RGDP_{t-i} + \sum_{i=0}^{q} \alpha_5 \Delta \ln APDB_{t-i} + \mu_t \quad (1)$$

Where lnTFS is the log of total financial savings and lnRGDP is the log of real GDP per capita. The real deposit rates (RDR) are proxied by real interest rates on savings as well as notice and time deposits. The real deposit rates are decomposed ($RDR^+ \; and \; RDR^-$) to capture the asymmetric effects of financial liberalisation and repression on total financial savings. The log of average population density per bank (lnAPDB), captures the banks' growth, or financial deepening of the banking sector.

4.2 Investment Model

The second part of the McKinnon-Shaw hypothesis is associated with the positive effect of real interest rate on investment through savings. However, as noted by Eregha (2010), lending interest rates play a negative role on investment decisions to improve and foster the efficiency of investment in an economy. The UECM is specified in equation 2.

$$\Delta \ln GFCF_t = c_2 + \vartheta_1 \ln GFCF_{t-1} + \vartheta_2^+ RBLR_{t-1}^+ + \vartheta_3^- RBLR_{t-1}^- + \vartheta_4 ln TFS_{t-1} + \vartheta_5 RBR_{t-1} + \vartheta_6 \ln TBC_{t-1} + \sum_{i=1}^{p} \gamma_1 \Delta GFCF_{t-i} + \sum_{i=0}^{q} \gamma_2 \Delta ln RBLR_{t-i}^+ + \sum_{i=0}^{q} \gamma_3 \Delta RBLR_{t-i}^- + \sum_{i=1}^{q} \gamma_4 \Delta ln TFS_{t-i} + \sum_{i=1}^{q} \gamma_5 \Delta RBR_{t-i} + \sum_{i=1}^{q} \gamma_6 \Delta \ln TBC_{t-i} + \varepsilon_t \quad (2)$$

Where investment is proxied by the log of gross fixed capital formation (lnGFCF). The independent variables include the log of total financial savings (lnTFS). Furthermore, RBLR

represents the real bank lending rate (proxied by the prime rate). The variable is decomposed into $RBLR^{+}\ and\ RBLR^{-}$ to capture the effects of its positive and negative changes in the level of investment. The real bank rate (RBR) is proxied by the bank rate, while lnTBC represents the log of total bank credit to the private sector.

4.3 Growth Model

The UECM in equation 3 seeks to address the question aimed at examining the impact of financial liberalisation/repression on economic growth in Botswana.

$$\Delta \ln RGDP_t = c_3 + \delta_1 \ln RGDP_{t-1} + \delta_2^{+} FLI_{t-1}^{+} + \delta_3^{-} FLI_{t-1}^{-} + \delta_4 \ln L_t + \delta_5 \ln K_t + \delta_6 \ln GFCF_t + \delta_7 \ln TBC_t + \delta_8 FDI_t + \sum_{i=1}^{p} \varphi_1 \Delta \ln RGDP_{t-i} + \sum_{i=0}^{q} \varphi_2 \Delta FLI_{t-i}^{+} + \sum_{i=0}^{q} \varphi_3 \Delta FLI_{t-i}^{-} + \sum_{i=1}^{q} \varphi_4 \Delta \ln L_{t-i} + \sum_{i=1}^{q} \varphi_5 \Delta \ln K_{t-i} + \sum_{i=1}^{q} \varphi_6 \Delta \ln GFCF_{t-i} + \sum_{i=1}^{q} \varphi_7 \Delta \ln TBC_{t-i} + \sum_{i=1}^{q} \varphi_8 \Delta FDI_{t-i} + \omega_t \quad (3)$$

where $lnRGDP_t$ is the log of real GDP per capita, lnL_t: log of labour, lnK_t: log of capital, $lnGFCF_t$: log of gross fixed capital formation, TBC_t: total bank credit to the private sector, FLI_t: financial liberalisation index, which is decomposed to capture effects of positive and negative variations on economic growth and FDI_t: is the direct investment in Botswana. The improvement on the efficiency of capital requires human effort, which is captured by including capita stock (K) and labour factor (L).

The coefficients c_1, c_2 and c_3 are the drifts, while μ_t, ε_t and ω_t represent the white noise errors. The symbol Δ represents the first difference operator, p and q are used to represent the optimal lag length for the equations. The summation notation in equations 1 through 3 suggest that the NARDL includes variables in the model, up to a certain number of appropriate lags. Furthermore, the summation signs represent the error correction dynamics in the short run. As alluded to by Poon (2010), the coefficients θ_i, ϑ_i and δ_i represent the long run multipliers corresponding to the long run relationship.

The cointegration approach places the emphasis on the long run, particularly the time reaction and the speed of adjustment to long run equilibrium. The Wald test is used to find the asymmetries in the long run $[\{\theta{=}\theta^{+}{=}\theta^{-}\};\ \{\vartheta{=}\vartheta^{+}{=}\vartheta^{-}\};\ \{\delta{=}\delta^{+}{=}\delta^{-}\}]$. $E_t^{+}\ and\ E_t^{-}$ are partial summations of the negative and positive changes in Et[5], presented as follows;

[5] The decomposed variables are created by first, calculating the first difference of each variable, then creating two series of positive and negative values. The cumulative sum of each series is then calculated, after multiplying the positive and negative series by the first difference. The resulting cumulative sums

$E_t^+ = \sum \Delta E_{j+\,t}\, j{=}1 = \sum \max(\Delta E_j, 0),\ t\ j{=}1$

$E_t^- = \sum \Delta E_{j-\,t}\, j{=}1 = \sum \min(\Delta E_j, 0),\ t\ j{=}1$

Where E represents the time series interest rates variables: RDR, RBLR and FLI for the three models. To determine the existence of long run co-integration between in the three specified models, while taking into consideration asymmetries, the study uses the bounds test specified in Shin et al., (2013)[6] based on the error correction model:

$$\Delta y_t = \rho u_{t-1} + \sum_{i=1}^{p-1} \varphi_i \Delta y_{t-i} + \sum_{i=0}^{p} (\pi_i^+ \Delta x_{t-i}^+ + \pi_i^- \Delta x_{t-i}^-) + e_t \qquad (4)$$

This is a joint test of all the lagged levels of the regressor. If $\rho = 0$, equation 4 reduces to the linear regression involving only first differences, thus implying that there is no long run relationship between the levels of y_t, x_t^+ and x_t^-. Furthermore, the study follows Pesaran et al.'s (2001) F-statistic and tests the null hypotheses: $\boldsymbol{\theta} = \theta^+ = \theta^- = 0$; $\boldsymbol{\vartheta} = \vartheta^+ = \vartheta^- = 0$ and $\boldsymbol{\delta} = \delta^+ = \delta^- = 0$ for the saving, investment and growth models, respectively. The rejection of each null hypothesis indicates the presence of a long run relationship between interest rates and savings, investment and economic growth. Finally, if the long run coefficients of the three models: $[-\theta^+/\theta_1]$ and $[-\theta^-/\theta_1]$; $[\vartheta^+/\vartheta_1]$ and $[\vartheta^-/\vartheta_1]$ as well as $[\delta^+/\delta_1]$ and $[\delta^-/\delta_1]$ are different, it implies presence of asymmetry in the long run. We therefore test for the null hypotheses that $[-\theta^+/\theta_1] = [-\theta^-/\theta_1]$; $[\vartheta^+/\vartheta_1] = [\vartheta^-/\vartheta_1]$ and $[\delta^+/\delta_1] = [\delta^-/\delta_1]$. Rejection of these null hypotheses indicate presence of asymmetry in each model.

are the partial sum of positive and negative changes in the real deposit rate, real bank lending rate and financial liberalisation index used in the savings, investment and growth models, respectively.

6 For further derivation of the bounds test specification in equation 4, refer to Shin et al., (2011).

5. DATA DESCRIPTION

Following the model specifications of the saving, investment and economic growth models in the previous segment, this section presents definition of variables used in this study and how they are measured.

The model is evaluated for the period spanning 1995:Q1–2017:Q4 (full sample) and 2004:Q1–2017:Q4 (sub-sample). The choice of the sample period under study is in part driven by the unavailability of data on nominal interest rates and the gross domestic product (which is available in fiscal year[7], not calendar year). Additionally, quarterly data on FDI inflows is only available from 2004 onwards for the latter sample. The data used in this study is sourced from the World Bank database, Bank of Botswana and Statistics Botswana.

The empirical estimation of the three models requires data on the following variables: Real gross domestic product per capita (RGDP), computed as real GDP divided by the total population. It is usually used to indicate the size of an individual's income. The financial liberalisation index (FLI) on the other hand is calculated as stock market capitalisation/GDP. The index is used as an indicator of the development of the stock exchange market. Furthermore, it demonstrates the importance of all financial services and the strength of the financial system in Botswana.

Real deposit rates (RDR) are calculated as the average of the real interest rates on savings as well as notice and time deposits in the savings model, while the real bank rate (RBR) is proxied by the bank rate and is used in the investment model. Additionally, real bank lending rates (RBLR) are proxied by the prime rate. All real rates are calculated from the nominal rates using the formula: $i=\{[(1+r)/(1+\pi)]-1\}*100$, where i = real interest rate, r = nominal interest rate and π = annual inflation. Total financial savings (TFS) is the sum of savings as well as notice and time deposits. On the other hand, total bank credit to the private sector (TBC) is calculated as the sum domestic claims to other financial and nonfinancial corporations, as well as other resident factors. This compilation excludes claims to the state and government as well as public nonfinancial corporation. Average population density per bank (APDB) is proxied by (M2)[8] divided by total population. The variable captures the banks' growth, or the financial deepening of the banking sector. It is worth noting that M2 per capital is only a good proxy for APDB if

[7] The country's fiscal year runs from April to March.

[8] M2 is made up of the summation of currency outside depository corporations and transferable deposits (M1), as well as other deposits included in broad money.

the proportion of the population using banks is relatively stable. However, this has not been the case in Botswana as the proportion of the economic activity that was transacted through bank accounts has fluctuated markedly during the period under study. A caveat is therefore needed in the measure of the variable APDB. Investment is proxied by the real gross fixed capital formation (GFCF). The data is extracted from gross domestic product by type of expenditure (current prices, P million). Capital stock (K) is calculated by multiplying real gross fixed capital formation by the depreciation rate of (0.07)[9] using the formula: $K_t = RGFCF_t(1 - 0.07) + RGFCF_{t-1}$. Labour force (L) on the other hand, is derived using data from International Labour Organization database and World Bank population estimates. The data on labour was retrieved in November 2017. The series was extrapolated from yearly to quarterly figures using Eviews statistical package.

Direct Investment (FDI) is the addition of equity and other capital flows in Botswana. The series is obtained from the Botswana Financial Statistics. This series however, includes negative values. According to Akhtaruzzaman, Hajzler, and Owen (2016), the presence of negative values in a series requires dropping the observations or adding arbitrary constants to ensure all values take on positive values in a series. The inverse hyperbolic sine transformation, $\text{Sinh}^{-1}(y) = \ln[y + (y^2 + 1)^{1/2}]$ is therefore implemented to ensure that all values take on positive values before running the model. As noted by Langenmayr and Reiter (2017), the transformation can be interpreted like the logarithmic transformation, but it has the advantage that it is defined at zero (and negative values). This procedure therefore permits the transformation of zero and negative values unlike the conventional log transformation.

A dummy variable for 2006:Q2 is included in the savings model. This is done to capture the structural break caused by the 12 percent devaluation of the Pula in May 2005 and its effect on generating high inflation levels. A natural logarithm[10] was taken on the following variables: Real GDP per capita; total financial savings; average population density per bank; total bank credit to the private sector; gross fixed capital formation and capital stock and labour force.

[9] According to International Monetary Fund (2004), the depreciation rate was set at 7 percent, which was in line with Botswana Statistics office practice.

[10] Logging helps to interpret coefficients as elasticities and assists in scaling the data.

6. EMPIRICAL RESULTS

This section focuses on properties of the data as well as the empirical outcomes of the various tests applied on the nonlinear ARDL model equations 1, 2 and 3 in section 4.

6.1 Unit Root Test

The nonlinear Autoregressive Distributed Lag (NARDL) cointegration procedure prohibits the use of variables that are integrated of second order I(2) (Ibrahim, 2015 and Tolulope, 2017). The procedure is therefore preceded by unit root testing through employing the Augmented Dickey Fuller test to ensure that the model is appropriate for analysis. The procedure is therefore preceded by unit root testing through employing the Augmented Dickey Fuller test to ensure that the model is appropriate for analysis. The ADF model tests the null hypothesis of $\alpha = 0$ against the alternative of $\alpha < 0$ using the test equation:

$$\Delta y_t = u + \beta t + \alpha y_{t-1} + \sum_{i=1}^{k} c_t \Delta y_{t-1} + \varepsilon_t \quad (1)$$

where Δ denotes the first difference, y is the time series being tested, t is the time trend variable, and k is the number of lags which are added to the model to ensure that the residuals, ε_t are white noise (Glynn and Perera, 2007). Table 1 indicates that all variables are either I(0) or I(1), i.e. stationary at levels or first difference.

Table 1: Unit Root Test

	Levels		First Difference		
Model Type and Variables	Test Statistic	P-value	Test Statistic	P-value	Order of Integration
Savings					
lnRGDP	-5.82034**	0.0000			I(0)
RDR	-2.13471	0.2319	-8.11554*	0.0000	I(1)
lnAPDB	-0.26634	0.9905	-8.16196*	0.0000	I(1)
Investment					
lnGFCF	-3.62070**	0.0333			I(0)
RBLR	-2.26867	0.1843	-7.82180*	0.0000	I(1)
lnTFS	-1.66019	0.7610	-7.17086*	0.0000	I(1)
lnTBC	-1.44322	0.8417	-5.77404*	0.0000	I(1)
RBR	-1.94147	0.3122	-8.30859*	0.0000	I(1)
Economic Growth					
lnK	-3.52590**	0.0427			I(0)
lnL	-2.90016	0.1675	-3.22387***	0.0864	I(1)
lnTBC	-1.31893	0.8769	-5.48530*	0.0001	I(1)
FLI	-2.40835	0.1424	-4.67906*	0.0002	I(1)
FDI	-2.32597	0.1679	-8.40823*	0.0000	I(1)

Note:

1. The asterisks *, ** and *** denote 1, 5 and 10 percent significance levels, respectively.

Source: Author's computations.

6.2 Bounds Testing

Prior to drawing conclusions and making inferences about the estimated coefficients, it is imperative to check if the variables are cointegrated. This is done by employing a joint null hypothesis of non-differenced variables (Shin, Yu, and Greenwood-Nimmo 2013). The critical value of the bound is then compared to the critical values in case three of Pesaran et al., (2001). Case three was chosen because there are constants in each of the three model specifications and the constants are unrestricted. The number of long-run regressors before decomposing variables is represented by *'k'*. Intuition is that, if the Wald tests F-statistics are greater than the upper critical values, there is evidence of cointegration. Conversely, if the F-statistics are lower, there is no cointegration (Pesaran et al., 2007). Tables 2-4 report the bounds F-statistics for the three model specifications in both the full and sub-samples.

Table 2: Bounds testing for Savings model

Model 1	**1995:Q1-2017:Q4**	**2004:Q1-2017:Q4**
lnTFS=*f* (lnRGDP,RDR, lnAPDB, dummy)	**F-statistic**	
	33.26192	29.79101
Case 3: Unrestricted intercept and no trend Pesaran (2001)	k=4, n=88	k=3, n=56
Critical Value	**Lower and Upper bound**	**Lower and Upper bound**
1%	3.74 5.06	4.29 5.61
5%	2.86 4.01	2.23 4.35
10%	2.45 3.52	2.72 3.77

Notes:

1. The 2004:Q1–2017:Q4 sample does not have a dummy because there was no structural break in the model detected by the Cumulative Sum of recursive residuals test compared to the 1995:Q1–2017:Q4, which had a break in 2006:Q2.
2. The results confirm the presence of a long run cointegration relationship in both samples.

Source: Author's computations.

Table 3: Bounds testing for Investment model

Model 2	**1995:Q1-2017:Q4**	**2004:Q1-2017:Q4**
lnGFCF=*f* (RBLR, lnTFS, RDR,lnTBC)	**F-statistic**	
	4.314094	3.403722
Case 3: Unrestricted intercept and no trend Pesaran (2001)	k=4, n=90	k=4, n=56
Critical Value	**Lower and Upper bound**	**Lower and Upper bound**
1%	3.74 5.06	3.74 5.06
5%	2.86 4.01	2.86 4.01
10%	2.45 3.52	2.45 3.52

Note:

1. The results confirm the presence of a long run cointegration relationship in the 1995:Q1–2017:Q4 sample, but not the 2004:Q1–2017:Q4 sample as the F-statistic is lower than all the upper bounds of the critical values.

Source: Author's computations.

Table 4: Bounds testing for Economic Growth model

Model 3	**1995:Q1-2017:Q4**	**2004:Q1-2017:Q4***
lnRGDP=*f* (FLI, lnK, lnL, lnTBC, GFCF, FDI)	**F-statistic**	
	9.781753	24.47683
Case 3: Unrestricted intercept and no trend Pesaran (2001)	k=5, n=90	k=5, n=51
Critical Value	**Lower and Upper bound**	**Lower and Upper bound**
1%	3.41 4.68	3.41 4.68
5%	2.62 3.79	2.62 3.79
10%	2.26 3.35	2.26 3.35

Notes:

1. *The 1995:Q1–2017:Q4 sample excludes the FDI inflows due to unavailability of quarterly data on FDI inflows prior to 2004. However, the 2004:Q1–2017:Q4 sample includes the FDI inflows.
2. The results confirm the presence of a long run cointegration relationship in both samples.

Source: Author's computations.

Tables 2-4 present the results of the bounds test for cointegration amongst the variables. It is confirmed from the results that the F-Statistic is approximately 33.3, 4.3 and 9.8 for all the 1995:Q1- 2017:Q4 models, which is greater that the upper bounds at the 5 percent critical value for each of the models. Furthermore, the F-Statistic is approximately 29.8 and 3.4 for the savings and growth models, which is greater than the upper bounds at the 5 percent critical value of the respective models. These results indicate a rejection of the null hypothesis of no cointegration and ascertain the existence of a long-run relationship among the variables in each

of the models. However, the F-statistic is lower than the upper bound at the 5 percent value in the investment model for the period 2004:Q1–2017:Q4, implying the absence of a long run relationship among the variables.

6.3 Testing for Asymmetry

A Wald test statistic is employed to check for symmetry. The null hypothesis on equality (symmetry) is rejected for all samples of the savings and investment models as well as the sub-sample for the economic growth model.

Table 5: Testing for Asymmetry

Model	1995:Q1–2017:Q4	Findings	2004:Q1–2017:Q4	Findings
Savings	0.0330**	Asymmetry	0.0013**	Asymmetry
Investment	0.0145**	Asymmetry	-	-
Economic growth	-	-[11]	0.0000*	Asymmetry

Note:

1. The asterisks *, ** and *** denote 1, 5 and 10 percent significance levels, respectively.

Source: Author's computations

Given the results in table 5, a traditional ARDL model is not appropriate method to investigate the models with asymmetry, making a NARDL model the best approach for this study. However, the sub-sample for the investment model will not be estimated as the results in table 3 indicate the absence of a long run cointegration relationship. The study, therefore, proceeds to estimate the Nonlinear ARDL model in Equations 1 – 3 in Section 4, for model specifications showing existence of cointegration to obtain both the long-run and short-run coefficients, along with their asymptotic standard errors as shown in Table 6.

[11] The results confirm the presence of symmetry in the full sample of the growth model. This is possibly due to unavailability of a full data set of FDI inflows in quarterly frequency prior to 2004. We therefore exclude the full sample of the growth model from result analysis as we cannot apply a NARDL approach.

6.4 Short run model results

Table 6: Short run results

SAVINGS MODEL		
1995:Q1–2017:Q4		
	Coefficient	**P-value**
Constant	13.7803*	0.0000
DRDR^{+} (-3)	0.1056**	0.0461
DRDR^{-}(-3)	0.1410**	0.0234
DlnRGDP(-1)	-1.2024***	0.0735
DlnRGDP(-3)	-1.3405**	0.0287
DlnAPDB	2.9969**	0.000
DlnAPDB(-3)	-1.3018**	0.0017

INVESTMENT MODEL		
1995:Q1–2017:Q4		
	Coefficient	**P-value**
Constant	11.1874*	0.0000
DRBLR^{+}(-4)	-0.2034***	0.0876
DRBLR^{-}(-4)	-0.1975***	0.1001
DRBR(-4)	0.1946***	0.0917
DLnTFS(-1)	0.4498***	0.0852
DLnTBC(-1)	1.2300***	0.0655
DLnTBC(-4)	1.3377***	0.0636
DlnGFCF(-1)	-1.1747	0.1168
DlnGFCF(-2)	-0.8094	0.1567
DlnGFCF(-3)	-0.6929	0.1217

ECONOMIC GROWTH MODEL		
2004:Q1–2017:Q4		
	Coefficient	**P-value**
Constant	-16.9876*	0.0000
DFLI^{-}	-0.2104*	0.0001
DFLI^{-} (-1)	-0.1062*	0.0032
DlnK	-0.8363***	0.0935
DlnL	1.9157**	0.0141
Dln(-4)	2.3487*	0.0000
DFDI(-1)	0.0584*	0.0000
DFDI(-4)	0.0068**	0.0102
DlnTBC(-1)	0.5521*	0.0000
DlnRGDP(-3)	0.1182*	0.0319

Notes:

1. The asterisks *, ** and *** denote 1, 5 and 10 percent significance levels, respectively.
2. The growth model has a shorter sample because of unavailability of data on FDI inflows in quarterly frequency in the earlier period. Data is only available from 2004 onwards.

Source: Author's computations

As noted by Wooldridge (2009), for quarterly data, 1 to 8 lags is appropriate to attain a more parsimonious model without losing degrees of freedom. Therefore, the maximum lag order considered using the Akaike information criterion in this study is 3 for the savings model and 4 for both the investment and growth models. The short run results in the full sample indicate that a percentage increase in real deposit rates increase savings rate by approximately 11 percent, while a percentage decrease in deposit rates reduce level of savings by 14 percent, ceteris paribus. The negative and significant association between log of RGDP and savings is

similar to the results found by Shrestha and Chowdhury (2007). Their study found that, although there was no significant impact of real income on savings in the long run in Nepal, a change in real income was associated with a negative change in real savings in the short run. The current positive relationship between the log of average density per bank (APDB) and savings implies that the more the people save, the more bank branches open. However, the new branches may not cause the savings but only anticipate them. The 3rd lag of the log of APDB indicates that a percent increase in bank density reduces level of savings by 1.3 percent in the full sample, ceteris paribus. These results parallel Athukorala (1998) finding that rapid expansion of bank branches helped to stimulate financial savings in the Indian economy. Moreover, it improves accessibility to banking facilities of the public and reduces costs of banking transactions (through reduced transport costs). Thus, a negative relationship is assumed between population per bank branch (bank density) and level of financial savings (Athukorala, 1998).

Regarding the sub-sample of the savings model, the results (table 8 in the appendix) indicate that an increase in real deposit rates and the log of RGDP lowered the level of savings in the current and lagged periods, respectively, ceteris paribus. The negative and significant association of real deposit rates and the log of RGDP with the level of savings is not in accordance with theoretical expectations. This is so because McKinnon-Shaw hypothesis suggests that high real interest rates would increase the level of savings (Hassan et al., 1993). Moreover, Owusu and Odhiambo (2014) noted that given the marginal propensity to save in theory, the higher the income, the higher the income is saved. The 3rd lag of the log of APDB indicate that a percent increase in bank density reduces savings levels by 1.7 percent in the sub-sample, ceteris paribus. These results conform to those found by Athukorala (1998). The study concluded that a negative relationship is assumed between population per bank branch (bank density) and level of financial savings in India.

With respect to the investment model in table 6, the results indicate that the fourth lag of real bank lending rate (RBLR) coefficient is negatively related to the investment rate. The results suggest that a percentage increase in real borrowing lending rates reduces investment by 20 percent, while a unit decrease in real borrowing lending rates increases investment by 19.8 percent in the short run. Furthermore, the real bank rate has a positive and significant effect on investment and is significant 10 percent. However, Eregha (2010) found that the changes in interest rates have a negative and significant influence on the investment decisions in an economy. The logarithms of both total financial savings (TFS) and total bank credit to the

private sector (TBC) have a positive impact on investment levels in the short run. Owusu and Odhiambo (2014) found a similar result indicating a positive relationship between changes in total financial savings and investment (proxied by the credit to the private sector). Furthermore, the lags of investment (proxied by GFCF) are all not significant in explaining the current level of investment.

Outcomes from the economic growth model indicate that a deterioration in the financial liberalisation index reduces Botswana's economic growth in the short run. This result is similar to that of Bashar and Khan (2007). They found an alarming result of the negative effect of financial liberalisation on economic growth. On the other hand, a percent increase in capital stock accumulation negatively affects economic growth with a trivial effect of 0.8 percent, ceteris paribus (table 6).

Regarding other variables in the sample, a percentage increase in the 1st and 4th lagged variable of labour inputs and/or hours worked (productivity) increases economic growth in the short run. FDI inflows (calculated using the inverse hyperbolic sine transformation[12]) have a positive and trivial impact on economic growth in the short run. Furthermore, the 1st and 3rd lagged variables of total bank credit to the private sector have a positive effect on economic growth in Botswana. Lastly, a percentage increase in 3rd lagged variable of real GDP per capita was found to increase economic growth by 0.12 percent in the short run, ceteris paribus.

Given the results above, the fundamental assumption is that real deposit rates play a positive and significant role in increasing the level of savings. Just as noted by Peter and Temidayo (2017), higher savings rates, as it is in the short run results, finance higher investment levels. This eventually leads to higher rates of economic growth. Therefore, higher saving rates (as well as higher investment levels and growth) should be anticipated following financial liberalisation. The results clearly support the McKinnon-Shaw hypothesis in Botswana in the short term.

[12] An inverse hyperbolic sine transformation is a suitable transformation because FDI inflows series has some negative values.

6.5 Long run model results

Table 7: Long run results

SAVINGS MODEL		
1995:Q1–2017:Q4		
	Coefficient	**P-value**
Constant	13.7803*	0.0000
RDR^{+}(-1)	-0.0842**	0.0081
RDR^{-}(-1)	-0.1231**	0.0000
lnRGDP(-1)	-0.4969	0.3807
lnAPDB(-1)	-0.9029	0.2522
Dummy	2.2681*	0.0004

INVESTMENT MODEL		
1995:Q1–2017:Q4		
	Coefficient	**P-value**
Constant	11.1874*	0.0000
RBLR^{+}(-1)	0.1834***	0.0568
RBLR^{-}(-1)	0.0858	0.3289
RBR (-1)	-0.1053	0.2405
lnTFS(-1)	-0.2484***	0.0736
lnTBC(-1)	-0.2640	0.2908

ECONOMIC GROWTH MODEL		
2004:Q1–2017:Q4		
	Coefficient	**P-value**
Constant	-16.9876*	0.0000
FLI^{+} (-1)	0.1633*	0.0000
FLI^{-} (-1)	-0.2537*	0.0000
lnK (-1)	-0.0896	0.6210
lnL (-1)	2.5262*	0.0000
lnTBC(-1)	-0.8398*	0.0000
FDI(-1)	-0.0680*	0.0000

Note:

1. The asterisks *, ** and *** denote 1, 5 and 10 percent significance levels, respectively.

Source: Author's computations

The long run results indicate that the real deposit rates (RDR) are negatively related to savings. As noted by Kamewe-Tsafack (2010), the low saving rates are mainly due to low interest rates and high inflation rates. The negative real interest rates therefore motivate people to invest their money in tangible goods instead of investing in the financial sector. Furthermore, as noted by McKinnon (1973) and Shaw (1973), higher interest rates are expected to increase the level of savings. However, the long run results conform the findings of Losayza, Schmidt-Hebbel, and Servén (2000) who found an adverse impact of real interest rates on the savings rate. Moreover, Reinhart and Tokatlidis (2005) found that the impact of financial liberalisation on savings had mixed results, largely negative or roughly zero. This owed to the fact that there was a negative effect of financial liberalisation because of low incomes and the presence of imperfect financial markets.

The negative real deposit rates in Botswana owe mainly to the long history of high inflation. As noted by Mguni (2018), real deposit rates were negative the whole of 2017, continuing a trend dating a decade back. According to the results, a unit increase in RDR reduces savings by 8.4 percent, ceteris paribus. On the other hand, a unit decrease in RDR enhances level of savings by 12.3 percent, ceteris paribus. These results also confirm the findings discussed by Reinhart and Ostry (1995). The study discussed the complexity of assessing the role of real interest rates in savings in the emerging markets, which owes to the fact that financial markets are not fully developed. Moreover, the intricacy arises because the government often sets interest rates at non-market levels, especially in Africa.

These results suggest insignificant and negatively correlated relationship between total financial savings and both real GDP per capita, and average population density per bank (proxied by M2 per capita). A dummy variable for 2006:Q2 was included in the savings model. This was done to capture the structural break detected by the The Cumulative Sum (CUSUM) and Cumulative Sum of Squares (CUSUMQ) of recursive residuals tests, caused by the 12 percent devaluation of the Pula in May 2005 and its effect on generating high inflation levels. Despite the unexpected sign of real deposit rates, the results of the savings model specification do indicate asymmetry in the response of total financial savings to real deposit rates.

The long run results (table 8 in the appendix) indicate that the real deposit rates (RDR) are negatively related to savings. These results resemble those by (Losayza et al., 2000; Carmen Reinhart and Ostry, 1995 and Bandiera et al., 2000). These studies report a negative or inconclusive relationship between interest rates and level of savings. The real GDP per capita coefficient is insignificant, while a percentage increase in average population density per bank reduces the level of savings by 5.4 percent, ceteris paribus.

Regarding the investment model, the real bank lending rate is positively related to investment and statistically significant at 10 percent level (table 7). As alluded to by Owusu and Odhiambo (2014), this relationship may propose that the lending rates of banks have no role in boosting investment (proxied by gross fixed capital formation). On the other hand, real bank rates are found to have the expected negative sign relating to investment and are statistically significant in the long run. However, total financial savings and total bank credit to the private sector carry signs that are at odds with theoretical expectations. Moreover, they have an insignificant relationship with investment.

An improvement in the financial liberalisation index (proxy for development of the stock market, measured as market capitalisation/GDP) boosts economic growth, while a deterioration

has an unexpected opposite relationship with economic growth. This result is similar to the one found by Bashar and Khan (2007). The study finds an alarming result of the negative effect of financial liberalisation on economic growth caused by the lack of physical infrastructure as well as an unfriendly business environment in Bangladesh. The capital stock coefficient is statistically insignificant, while an increase in the lagged variable of labour inputs and/or hours worked (productivity) increases economic growth in the long run.

Despite the significant correlation between TBC and economic growth, the inverse relation between the two macroeconomic variables is not in conformity with the a priori expectations of the model. Direct investment has a negative and small impact on economic growth in the long run. These results could in part be explained by the findings in Makoni (2015). The study finds that the amount of FDI continue to be moderately low, despite the efforts to boost FDI inflows in Botswana because the economy is heavily export oriented and reliant on the mining sector. The author finds FDI to be an unstable source of long-term funding for infrastructural or other permanent future projects in Botswana that could foster economic growth.

The main results indicate that in the short run, there is a positive relationship between real deposit rates and level of savings, while lending rates are negatively related to investment levels. Lastly, financial liberalisation index (proxy for development of stock market, measured as market capitalisation/GDP) is reported to be positively related to economic growth. The short run results are in line with findings reporting that liberalisation of interest rates generates more savings, investment and consequently growth. On the other hand, real deposit rates are negatively related to saving rates in the long run. Additionally, the real bank lending rates are positively related to investment.

These long run results are not in conformity with the financial liberalisation hypothesis, which postulates that liberalisation of interest rates generates more savings, investment and subsequently economic growth. A major contribution of this study pertains to the distinction it makes between positive and negative changes of real interest rates on savings, investment and economic growth. The results differ from the linear models (which assume positive and negative changes of real interest rates are symmetric) as they can clearly differentiate the impact of the increases and decreases of real interest on the level of savings and investment, as well as the effect of an improvement or deterioration of financial liberalisation on economic growth in Botswana simultaneously.

6.6 Diagnostic tests

To confirm that the nonlinear ARDL model is robust, it is important to do a specific series of tests. These include serial correlation, heteroscedasticity and the normality tests. The null hypothesis of no serial correlation, homoscedasticity and normality cannot be rejected for this model. This indicates that the model does not suffer from the problem of serial correlation and heteroscedasticity (variance of errors not constant), respectively. Moreover, the errors are normally distributed (Table 9 in the appendix).

6.7 Stability tests

A stability check is carried out in the model using the Brown, Durbin, and Evans (1975) model of stability verification. The CUSUM and CUSUM of Squares tests are used to test whether the coefficients of the estimated models remain constant over time; a property that signifies the stability of the model. The plots for all three models fall within the 5 percent critical bounds of significance, implying that all models for both samples are stable (figure 1 in the appendix).

7. CONCLUSION

The main objective of the paper is to examine the impact of interest rates on the level of savings and investment, while considering the asymmetries in the behaviour of real interest rates. It also examines the presence of positive and negative changes in the financial liberalisation index (proxied by stock market capitalisation/GDP, used as an indicator of the development of the stock exchange market) and their effect on economic growth in Botswana. The procedure was preceded by testing for unit root, employing the Augmented Dickey Fuller test to ensure variables are either stationary at levels or first difference. Being cognisant of the asymmetries prevalent in time series in section 6.3, the paper uses a nonlinear ARDL approach to examine the asymmetric impact of interest rates on savings and investment, as well as the impact of financial liberalisation on economic growth. The paper evaluates data for the periods spanning 1995:Q1–2017:Q4 for the savings and investment models, as well as the 2004:Q1–2017:Q4 for the economic growth model.

The nonlinear ARDL bounds test of cointegration indicates the presence of a long run relationship among the variables for all models excluding the investment model for the time period 2004:Q1–2017:Q4. The study finds a positive relationship between real deposit rates and saving rates as well as a negative association between real bank lending rates and investment levels in the short run for the full sample. The results of this study are in line with findings that liberalisation of interest rates generates more savings, investment, and consequently growth. The empirical findings in the short run have a significant policy implication; suggesting that the savings and investment can be facilitated by maintaining higher levels of real interest rates. However, policy regulators have the discretion to ensure prudent setting of interest rates consistent with policy objectives that support the financial sector. A further liberalisation of interest rates could encourage higher levels of saving and investment in Botswana in both the short and long term. It is also found that financial liberalisation index is positively related to economic growth.

The long run results indicate that the levels of real deposit rates are negatively related to saving rates. This finding is similar to studies which report that the effect of interest rates on savings and investment is either inconclusive or negative ((Losayza et al., 2000); (Reinhart and Ostry, 1995)). On the other hand, the real bank lending rates are positively related to investment, although not in conformity with the *a priori* expectations of the model. Furthermore, an improvement in the financial liberalisation index boosts economic growth, while a deterioration has an unexpected opposite relationship with economic growth in the long run.

The results of this study differ from those of linear models as they in that they distinguish the different positive and negative changes of real interest rates in level of savings and investment. Moreover, they can tell the impact of positive and negative changes of financial liberalisation on economic growth in the economy, whereas linear models assume positive and negative changes in interest rates as well as in financial liberalisation are symmetric. The short run results are in line with findings reporting that liberalisation of interest rates generate more savings, investment, and consequently growth, while the long run results are not. It is therefore imperative that authorities formulate long run objectives aimed at setting real deposit rates at competitive levels to boost savings, encourage investment and promote economic growth in Botswana.

This study has identified a few areas where further studies could be conducted to the empirical approach used in order to improve the quality of the results. Firstly, further development in the area of study is needed to fill in the existing gap analysis of nonlinear cointegration using all models, simultaneously. Furthermore, future research could improve this study by exploring more variables that could better proxy control variables in all three models, especially, financial liberalisation in the growth model as time was the main constraint in achieving this. Exploring more control variables will help in possibly finding variables with longer time series to increase the sample size of the growth model. In addition to the Direct Investment Inflows used in the study, variables like the ratio of total trade to GDP could be added to represent the trade openness of the economy. These shortcomings, however, do not eliminate the value of this study.

8. APPENDIX

The 2004:Q1-2017:Q4 sample for the savings model in table 8 is included as a robustness test for both the short and long run model output, with the result analysis in sections 6.4 and 6.5, respectively.

Table 8: Short and long run results

Short run results		
	Coefficient	**P-value**
Constant	9.3557*	0.0006
DRDR^{+}	-0.1439**	0.0398
DRDR^{+}(-2)	0.0678***	0.0717
DlnRGDP(-1)	-1.4739***	0.0798
DlnAPDB	6.6435*	0.0001
DlnAPDB(-2)	1.4951***	0.0767
DlnAPDB(-3)	-1.7090*	0.0055

Long run results		
	Coefficient	**P-value**
Constant	9.3557*	0.0006
RDR^{+}(-1)	-0.0504**	0.0463
RDR^{-}(-1)	-0.1056*	0.0001
lnRGDP(-1)	-0.5688	0.2139
lnAPDB(-1)	-5.3724*	0.0037

Note:

1. The asterisks *, ** and *** denote 1, 5 and 10 percent significance levels, respectively.

Source: Author's computations.

Diagnostic tests

We fail to reject the null hypotheses of no serial correlation, homoscedasticity and normality for all the models. The three models passed the diagnostic tests for all the samples used in the study.

Table 9: Diagnostic tests

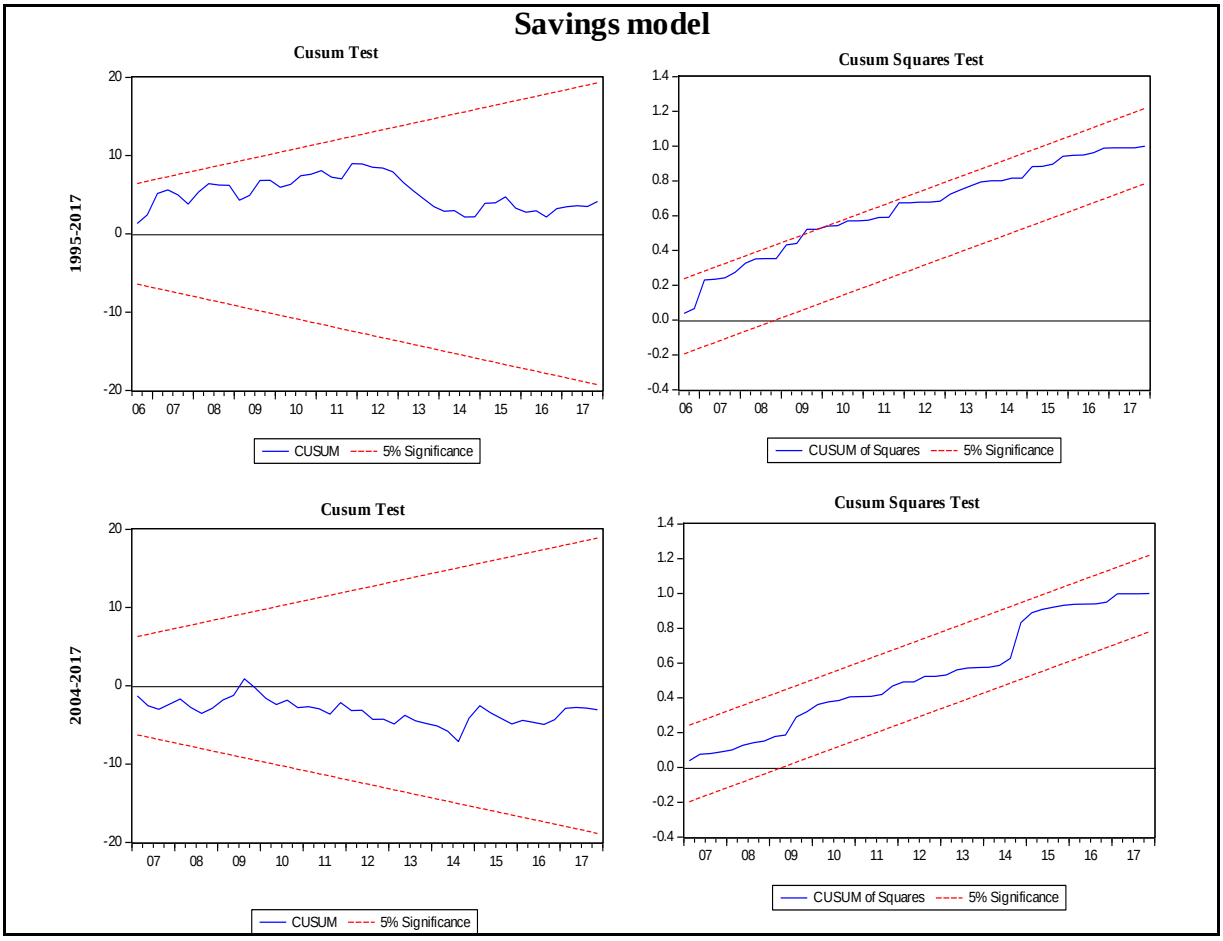
Models	**Samples**	**Homoscedasticity**	**Serial Correlation**	**Normality**
Savings	1995:Q1–2017:Q4 2004:Q1–2017:Q4	0.2308 0.5592	0.5422 0.3562	0.8102 0.1683
Investment	1995:Q1–2017:Q4	0.3204	0.5070	0.4708
Economic Growth	2004:Q1–2017:Q4	0.9199	0.3060	0.4722

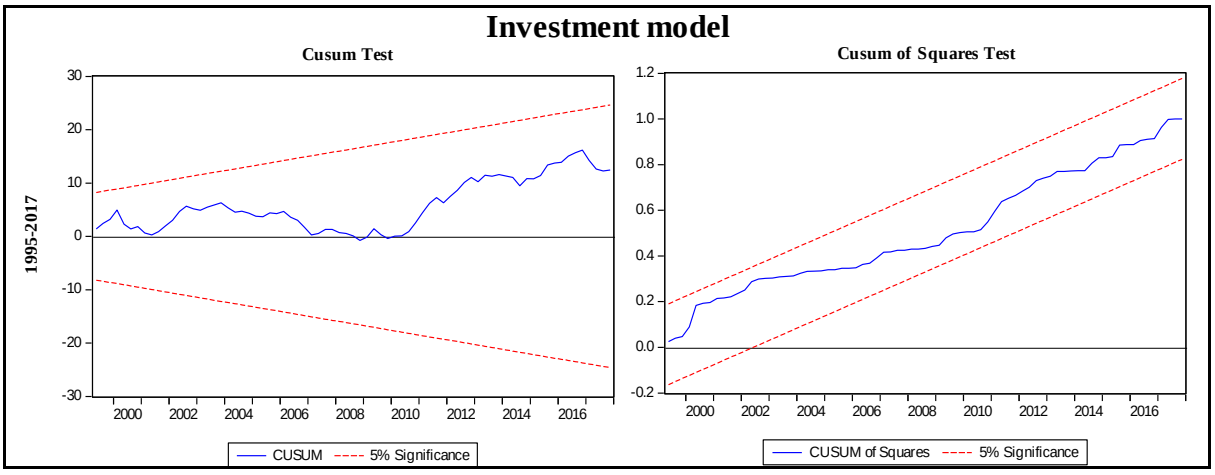
Source: Author's computations.

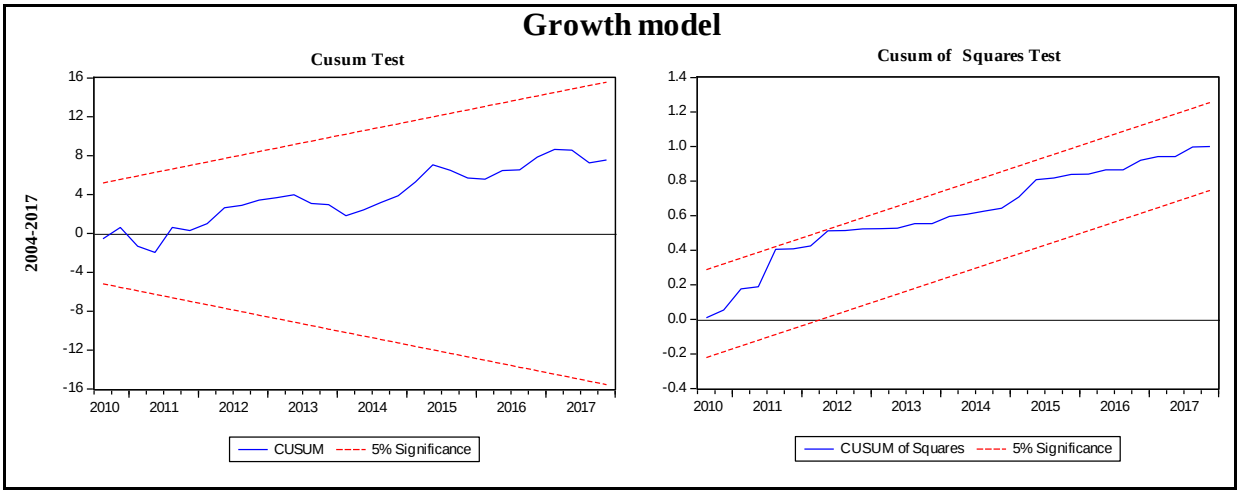
Stability Test Graphs

The Cumulative Sum and Cumulative Sum of Squares of recursive residuals tests are undertaken as further diagnostic tests concerning the stability of the model. As shown in figure 1, results suggest that all models are stable.

Figure 1: Stability Test






Growth model
Cusum Test
2004-2017
16
12
8
4
0
-4
-8
-12
-16
2010
2011
2012
2013
2014
2015
2016
2017
CUSUM
5% Significance
Cusum of Squares Test
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
-0.2
-0.4
2010
2011
2012
2013
2014
2015
2016
2017
CUSUM of Squares
5% Significance

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